Evidence evaluation report —
Diet, exercise and weight management in pregnancy

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1 Process of the review

This review comprises the results of 19 searches conducted to address 11 research questions. Where possible (ie when a number of comparable randomised controlled trials [RCTs] were identified), meta-analyses were undertaken. The following sections outline the research questions, processes for including and excluding studies, selection of outcomes for GRADE assessment, assessment of study quality and grading of the certainty of the body of evidence. Search strategies are included in Appendix A, assessment of risk of bias of risk of bias in RCTs in Appendix B, analyses for those topics where meta-analysis was conducted in Appendix C and lists of excluded studies in Appendix D.

1.1 Research questions

Nutrition advice	
Q1	What dietary advice should be provided to women in pregnancy, including population-specific groups?
Q2	Which foods should be promoted and which avoided during pregnancy?
Q3	What are the harms and benefits of vitamin and mineral supplementation in pregnancy?
Q4	What are the harms and benefits of nutritionally based complementary medicines in pregnancy?
Physical activity advice	
Q5	What are the harms and benefits of physical activity during pregnancy?
Q6	What physical activities are associated with adverse maternal and perinatal outcomes?
Weight assessment	
Q7	When should maternal weight and height be measured and BMI calculated in pregnant women?
Q8	What specific risk assessments are required for pregnant women with high or low BMI at the first antenatal visit?
Interventions	
Q9	What lifestyle interventions are effective in preventing excessive weight gain and other adverse outcomes in pregnant women?
Additional considerations	
Q10	What are the additional considerations for Aboriginal and Torres Strait Islander women?
Q11	What are the additional considerations for migrant and refugee women

Table 1: Mapping of searches to research questions and type of review

Question	Search	Types of studies included	Review type
Question 1	Diet and pregnancy	Systematic reviews, RCTs, observational studies	Narrative review
Question 2	Diet and pregnancy	Systematic reviews, RCTs, observational studies	Narrative review
Question 3	Folic acid	Systematic reviews, RCTs, Australian observational studies	Narrative review
	B vitamins	Systematic reviews, RCTs, Australian observational studies	Narrative review
	Vitamin C	Systematic reviews, RCTs, Australian observational studies	Narrative review
	Vitamin E	Systematic reviews, RCTs, Australian observational studies	Narrative review
	Vitamin A	Systematic reviews, RCTs, Australian observational studies	Narrative review
	Multiple micronutrients	Systematic reviews, RCTs, Australian observational studies	Narrative review
	Iron	Systematic reviews, RCTs, Australian observational studies	Narrative review
	Calcium	Systematic reviews, RCTs, Australian observational studies	Narrative review
	Iodine	Systematic reviews, RCTs, Australian observational studies	Narrative review
	Zinc	Systematic reviews, RCTs, Australian observational studies	Narrative review
	Magnesium	Systematic reviews, RCTs, Australian observational studies	Narrative review
	Selenium	Systematic reviews, RCTs, Australian observational studies	Narrative review
Question 4	Omega-3 fatty acids	Recent Cochrane review	Summary of Cochrane review
	Herbal preparations	Systematic reviews, RCTs, observational studies	Narrative review
	Probiotics	Systematic reviews of RCTs, RCTs	Meta-analysis
Question 5	Physical activity and pregnancy	Systematic reviews, RCTs, observational studies	Narrative review

Question	Search	Types of studies included	Review type
Question 6	Physical activity and pregnancy	Systematic reviews, RCTs, observational studies	Narrative review
Question 7	Gestational weight gain	Determinants of gestational weight gain; women's and health professionals' views on gestational weight gain: Systematic reviews, observational studies Risks associated with low or high gestational weight gain: Systematic reviews, RCTs	Narrative review
	Weight monitoring	Systematic reviews of RCTs, RCTs	Meta-analysis
Question 8	Risk assessments	Systematic reviews of RCTs, RCTs	Narrative review
Question 9	Diet and pregnancy	Systematic reviews of RCTs, RCTs	Meta-analysis
	Physical activity and pregnancy		
Question 10	All searches	All identified studies relevant to Australian context	Narrative review
Question 11			

1.2 Inclusion and exclusion criteria

Table 2: PICO criteria for inclusion of studies in meta-analyses

Probiotics

Population	Intervention	Comparator	Outcomes	Study designs
Pregnant women who are apparently healthy in early pregnancy	Probiotic supplement	Placebo or usual care	Health or clinical outcomes, including longer term outcomes for the mother and child	RCTs Systematic reviews of RCTs

Weight assessment

Population	Intervention	Comparator	Outcomes	Study designs
Pregnant women who are apparently healthy in early pregnancy	Regular weighing as part of antenatal care plus advice on weight gain	Usual care	Health or clinical outcomes, including longer term outcomes for the mother and child	RCTs Systematic reviews of RCTs

Interventions to prevent gestational weight gain

Population	Intervention	Comparator	Outcomes	Study designs
Pregnant women who are apparently healthy in early pregnancy	Intervention related to changes in diet	Usual care	Health or clinical outcomes, including longer term outcomes for the mother and child	RCTs Systematic reviews of RCTs
	Intervention to increase physical activity			
	Combined intervention with dietary and physical activity components			

Exclusion criteria outlined below were applied.

- Not in English
- Duplicate
- Narrative review, opinion piece, letter, editorial
- Wrong setting (ie not antenatal care)
- Wrong intervention
- Wrong study design (question specific; see above)

- Wrong outcomes
- Wrong population
- Wrong comparator
- Systematic literature review with all studies included in another systematic review
- RCT included in a systematic review
- Does not answer research question

The excluded studies are listed in Appendix D.

1.3 Selection of outcomes for GRADE analysis

Table 3: Probiotics — maternal outcomes

Outcome	Importance	Inclusion
Gestational diabetes	9	☑
Gestational hypertension	9	☑
Pre-eclampsia	5	☑
Bacterial vaginosis	5	☑
Group B streptococcus	7	☑
Caesarean section	9	☑

Table 4: Probiotics — infant outcomes

Outcome	Importance	Inclusion
Perinatal death	9	☑
Preterm birth	9	☑
Small for gestational age	9	☑
Large for gestational age	9	☑
Macrosomia	9	☑

Table 5: Weight monitoring — maternal and infant outcomes

Outcome — Maternal	Importance	Inclusion
Excess gestational weight gain	5	☑
Mean gestational weight gain (weekly)	5	☑
Gestational diabetes	9	☑
Hypertensive disorders of pregnancy	5	☑
Depression	7	☑
Anxiety	5	☑
Macrosomia	9	☑

Table 6: Interventions to prevent weight gain — maternal outcomes

Outcome	Importance	Inclusion
Mean gestational weight gain	5	☑
Excess gestational weight gain	5	☑
Gestational diabetes	9	☑
Hypertensive disorders of pregnancy	5	☑
Caesarean section	9	☑
Depression (antenatal and postnatal)	7	☑
Postnatal weight retention	5	☑

Table 7: Interventions to prevent gestational weight gain — infant outcomes

Outcome	Importance	Inclusion
Preterm birth	9	☑
Low birthweight	9	☑
Macrosomia	9	☑
Large for gestational age	9	☑
Small for gestational age	9	☑
Apgar score <7 at 5 minutes	7	☑
Early childhood weight	5	☑

Key: 1 – 3 less important; 4 – 6 important but not critical for making a decision; 7 – 9 critical for making a decision

1.4 Quality assessment

Quality of included studies was assessed using adapted NHMRC criteria for quality assessment of systematic reviews and GRADE criteria for quality assessment of randomised controlled trials and observational studies.

Table 8: Assessment of quality of systematic literature reviews

Considerations in assessing quality of systematic reviews
Questions and methods clearly stated
Search procedure sufficiently rigorous to identify all relevant studies
Review includes all the potential benefits and harms of the intervention
Review only includes randomised controlled trials
Methodological quality of primary studies assessed
Data summarised to give a point estimate of effect and confidence intervals
Differences in individual study results are adequately explained
Examination of which study population characteristics (disease subtypes, age/sex groups) determine the magnitude of effect of the intervention is included
Reviewers' conclusions are supported by data cited
Sources of heterogeneity are explored

Source: Adapted from NHMRC 2000a; 2000b; SIGN 2004[1-3].

Table 9: Assessment of limitations of randomised controlled trials

Study limitation	Explanation
Lack of allocation concealment	Those enrolling patients are aware of the group (or period in a crossover trial) to which the next enrolled patient will be allocated (a major problem in "pseudo" or "quasi" randomised trials with allocation by day of week, birth date, chart number, etc.).
Lack of blinding	Patient, caregivers, those recording outcomes, those adjudicating outcomes, or data analysts are aware of the arm to which participants are allocated.
Incomplete accounting of patients and outcome events	Loss to follow-up and failure to adhere to the intention-to-treat principle in superiority trials; or in noninferiority trials, loss to follow-up, and failure to conduct both analyses considering only those who adhered to treatment, and all patients for whom outcome data are available. The significance of particular rates of loss to follow-up, however, varies widely and is dependent on the relation between loss to follow-up and number of events. The higher the proportion lost to follow-up in relation to intervention and control group event rates, and differences between intervention and control groups, the greater the threat of bias.
Selective outcome reporting	Incomplete or absent reporting of some outcomes and not others on the basis of the results.
Other limitations	Stopping trial early for benefit. Substantial overestimates are likely in trials with fewer than 500 events and large overestimates are likely in trials with fewer than 200 events. Empirical evidence suggests that formal stopping rules do not reduce this bias. Use of unvalidated outcome measures (e.g. patient-reported outcomes) Carryover effects in crossover trial Recruitment bias in cluster-randomised trials

Source: Schünemann et al 2013[4].

1.5 Grading of the certainty of the body of evidence

Assessing the certainty of a body of evidence using GRADE involves consideration of the following five domains: risk of bias, inconsistency, indirectness, imprecision and publication bias.

For an evidence base drawn from RCTs, the grading of the certainty of the body of evidence starts at 'high'. An evidence base drawn from observational studies starts as 'low'. In both cases, the evidence can be downgraded for each of the five domains depending on whether the limitation is considered serious (downgrade one level) or very serious (downgrade two levels). Evidence can also be upgraded when the effect is large (upgrade one level) or very large (upgrade two levels), where confounders would reduce the effect or where there is a dose-response effect.

2 Dietary advice

2.1 Q1: What dietary advice should be provided to women in pregnancy, including population-specific groups?

2.1.1 Background

Australian cross-sectional studies have identified low levels of awareness of dietary guidelines during pregnancy among women and limited dietary counselling by health professionals.

- Results from a web-based questionnaire (n=116),[5] showed that pregnancy nutrition knowledge was associated with education ($p<0.05$) and income ($p<0.05$). Only 2% of pregnant women achieved nutrition knowledge scores over 80%. Few women (30%) received nutrition advice during their pregnancy.
- Another Australian web-based survey (n=857)[6] found that only some women met the recommendations for fruit (56%), dairy (29%) and other core food groups (<10%). None of the women met the recommendations for all five food groups. Women who were born overseas and who were less physically active pre-pregnancy were less likely to adhere to the fruit and dairy recommendations. Women who smoked during pregnancy, were overweight pre-pregnancy and had lower household incomes were also less likely to meet the fruit recommendations; and women living in metropolitan areas were less likely to meet the vegetable recommendations. Sixty-one per cent believed their diet during this pregnancy was healthy.
- In a study using data from the Australian Longitudinal Study on Women's Health (n=1,999),[7] half of pregnant women met 2013 Australian Dietary Guidelines for fruit but low percentages reached guidelines for dairy (22%), meat and alternatives (10%), cereals (2.5%) and vegetables (1.7%).
- A Victorian study comparing the dietary intake of pregnant women to the 2013 Australian Dietary Guidelines (n=1,570)[8] found that only some women met the recommended daily servings for fruit (65.7%), dairy products (55.2%), meat/meat alternatives (31.1%), vegetables (10.3%) and grain foods (1.8%) and that most women (83.8%) regularly consumed up to 2.5 serves of discretionary foods per day. Only one woman met the minimum recommended daily servings for all five food groups. Women were more likely to consume an inadequate diet if they were obese (aOR 2.13, 95% CI 1.53 to 2.95) and less likely to consume an inadequate diet if they had a university degree (aOR 0.63, 95% CI 0.50 to 0.78).
- In another Victorian study that assessed pregnancy nutrition recommendation knowledge and nutrition education practices of antenatal care providers (n=202)[9] women reported receiving limited nutrition advice and clinicians reported that they provided limited nutrition advice due to time constraints, limited nutrition knowledge and a lack of nutrition training.
- In a cross-sectional study in New South Wales (n=326), only some women were aware of the recommended number of serves for fruit and vegetables (46.6%), bread and cereals (34.4%) and protein (28.8%)[10] and demonstrated poor adherence to guidelines.[11] Knowledge of selected recommendations increased the likelihood of consumption of fruit (OR 8; 95%CI 2.3 to 27.7), vegetables (OR 9.1; 95%CI 2.6 to 31.3) and bread and cereals (OR 6.8; 95%CI 3.4 to 13.7).[11]

Identifying women with an 'unhealthy' dietary pattern in early pregnancy affords the opportunity for a dietary intervention which may positively affect both maternal and infant health. An Irish cohort study[12] found that women with a 'health conscious' dietary pattern were older and had lower BMI and higher education than those with an 'unhealthy' dietary pattern. A study in New Zealand also found that a 'health conscious' dietary pattern was associated with increasing age, better self-rated health, lower pre-pregnancy BMI and not smoking.[13]

Women tended to continue the dietary pattern they followed in the first trimester into subsequent trimesters — 'unhealthy' dietary patterns were continued by 72% of women in the second trimester and 56.6% in the third trimester and 'health conscious' dietary patterns were continued by 66.9% of women in the second trimester and 48.6 % in the third trimester.[12]

A review interventions targeting improving nutrition-related outcomes for pregnant Indigenous women residing in Organisation for Economic Co-operation and Development countries,[14] found that programs with statistically significant results for low birthweight employed the following nutrition activities: individual counselling/education; delivery by senior Indigenous woman, peer counsellor or other Indigenous health worker; community-wide interventions; media campaigns; delivery by non-Indigenous health professional; and home visits.

2.1.2 Dietary patterns

A range of studies have compared the outcomes associated with highest versus lowest tertiles or quartiles of specific dietary patterns.

Gestational diabetes

A systematic review (without meta-analysis)[15] suggested that a dietary pattern rich in fruit, vegetables, whole grains, and fish and low in red and processed meat, refined grains and high-fat dairy was beneficial in reducing risk of gestational diabetes.

An RCT[16] found an association between increased risk of gestational diabetes and a dietary pattern high in chocolate, chips, green vegetables, potatoes, processed meat and meat products, root vegetables, sweetened beverages, artificially sweetened beverages and hot potato chips (OR 2.05; 95% CI 1.23, 3.41).

Cohort studies have found associations between increased risk of gestational diabetes and dietary patterns:

- high in protein and low in carbohydrate intake (aOR 1.83; 95%CI 1.21 to 2.79; P trend=0.007; n=2,755)[17]
- high in refined grains, fats, oils and fruit juice (aOR 4.9; 95%CI 1.4 to 17.0; n=166)[18]
- high in nuts, seeds, fat and soybean and low in milk and cheese (aOR 7.5; 95%CI 1.8 to 32.3; n=166)[18]
- high in added sugar and organ meats and low in fruits, vegetables and seafood (aOR 22.3; 95%CI 3.9 to 127.4; n=166)[18]

A dietary pattern low in protein and high in carbohydrates was associated with a lower risk of gestational diabetes (aOR 0.54; 95%CI 0.36 to 0.83; P trend=0.010; n=2,755).[17]

A dietary pattern high in fruits, vegetables, whole grains, low-fat dairy, breakfast bars, and water was negatively associated with maternal insulin (μU/mL: ß -0.12; 95%CI -0.23 to -0.01; n=513) and HOMA-IR (ß -0.13; 95%CI -0.25 to -0.00; n=513) but not glucose (ß 0.86; 95%CI -2.64 to 0.92; n=513).[19]

Case-control studies have found an increased risk of gestational diabetes associated with dietary patterns:

- high in sweets, jams, mayonnaise, soft drinks, salty snacks, solid fat, high-fat dairy products, potatoes, organ meat, eggs, red meat, processed foods, tea and coffee (aOR 1.68, 95%CI 1.04 to 2.27; n=368)[20].
- high in mayonnaise, soft drinks, pizza, sugar (aOR 2.838, 95% CI 1.039 to 7.751; p=0.042; n=204)[21]

A dietary pattern high in leafy green vegetables, fruits, poultry, fish was associated with a lower risk of gestational diabetes (aOR 0.284, 95%CI 0.096 to 0.838; p=0.023; n=204).[21]

Gestational hypertension

A systematic review (without meta-analysis)[22] suggested a beneficial effect of a diet rich in fruit and vegetables on pre-eclampsia, although not all the results were statistically significant.

A large cohort study (n=55,139)[23] found that a dietary pattern characterised by high consumption of fish and vegetables was associated with a lower risk of gestational hypertension (OR 0.86; 95%CI 0.77 to 0.95) and pre-eclampsia (OR 0.79; 95%CI 0.65 to 0.97) while a dietary pattern characterised by high consumption of potatoes (including hot potato chips), mixed meats, margarine and white bread increased risk of gestational hypertension (OR 1.18; 95%CI 1.05 to 1.33) and pre-eclampsia (OR 1.40; 95% CI 1.11 to 1.76).

An Australian cohort study (n=1,907),[24] found that women with the highest Australian Recommended Food Score had the lowest risk of developing gestational hypertension (OR 0.4; 95 % CI 0.2 to 0.7).

Depression

A cross-sectional study (n=1,744)[25] found an association between lower risk of depression and high intake of green and yellow vegetables, other vegetables, mushrooms, pulses, seaweed, potatoes, fish, sea products, miso soup and shellfish (aRR 0.56; 95%CI 0.43 to 0.73, p<0.0001). Another cross-sectional study (n=167)[26] found a significant path between an 'unhealthy' diet at around 16 weeks gestation and depressive symptoms at the same time point (β 0.16, p<0.05, 95%CI 0.02 to 0.30); higher 'unhealthy' dietary pattern scores were related to higher depressive symptoms. A third cross-sectional study (n=253)[27] found that antenatal diet quality as measured by intake of food groups associated with a healthy diet was not associated with postpartum depressive symptoms at 12 months postpartum.

Fetal growth and preterm birth

A narrative systematic review[28] found that diets higher in vegetables, fruits, whole grains, nuts, legumes and seafood and lower in red and processed meats and fried foods were associated with a lower risk of preterm birth and spontaneous preterm birth.

A systematic review of observational studies[29] found that dietary patterns:

- high in vegetables, fruits, wholegrains, low-fat dairy, and lean protein foods-were associated with lower risk of preterm birth (OR 0.79; 95% CI 0.68 to 0.91) and a weak trend towards a lower risk of small-for-gestational-age (OR 0.86; 95%CI 0.73 to 1.01)
- high in refined grains, processed meat and foods high in saturated fat or sugar-were associated with lower birth weight (MD -40 g; 95%CI -61 to -20 g) and a trend towards a higher risk of preterm birth (OR 1.17; 95%CI 0.99 to 1.39).

An RCT (n=1,032)[16] found no clear increases or decreases in risk of large for gestational age, small for gestational age or macrosomia for any dietary pattern.

A cohort study (n=59,949)[30] observed a consistent dose-response association between a dietary pattern high in meat and fats and low in fruits and vegetables and induced preterm birth (aOR 1.66, 95%CI 1.30 to 2.11) but no clear association with spontaneous preterm birth (aOR 1.18, 95%CI 0.99 to 1.39).

A cohort study (n=66,000)[31] found that a "prudent" dietary pattern characterised by high intake of vegetables, fruits, oils, water as beverage, whole grain cereals and fibre-rich bread was associated with significantly reduced risk of preterm birth for the highest versus the lowest third (HR 0.88; 95%CI 0.80 to 0.97). The "traditional" (Norwegian; fish, potatoes) pattern was also associated with reduced risk of preterm birth for the highest versus the lowest third (HR 0.91, 0.83 to 0.99). A further analysis (n=65,904),[32] found that the high prudent pattern was associated with increased risk of small for gestational age (OR 1.25; 95%CI 1.02 to 1.54) and decreased risk of large for gestational age (OR 0.84; 95%CI 0.75 to 0.94), while the high traditional group was associated with decreased risk of small for gestational age (OR 0.92; 95% CI 0.84 to 0.99) and increased risk of large for gestational age (OR 1.12; 95%CI 1.02 to 1.24). In the same study, the "main meal" pattern was associated with a reduced risk of preterm birth (HR 0.90; 95%CI 0.81 to 0.99; p for trend=0.028).[33]

A cohort study (n=1,051)[34] found no association between diet quality and preterm birth (ß 0.91; 0.75 to 1.11) or birth weight (ß -2.00; -22.57 to 18.57).

In an Australian cohort study (n=1,907),[24] women with the highest Australian Recommended Food Score had the lowest odds of having a baby of low birth weight (OR 0.4; 95%CI 0.2 to 0.9).

In a cohort study (n=862)[35] increased diet quality appeared linearly associated with a reduced likelihood of small for gestational age (P-trend=0.03), although each quartile comparison did not reach statistical significance

Childhood outcomes

Results of a systematic review[36] indicated a small positive association between better maternal diet quality during pregnancy and child functioning (p<0.0001).

Cohort studies found associations between:

- higher BMI-for-age z score at birth and high intake of white bread, red and processed meats, fried chicken, French fries, and vitamin C-rich drinks versus high intake of fruits, vegetables, baked chicken, whole-wheat bread, low-fat dairy and water (ß -0.41; 95% CI: -0.79 to -0.03; n=389)[37]
- reduced risk of developing allergen sensitisation at both 18 months (aOR 0.7; 95%CI0.5 to 0.9; n=735) at 36 months (aOR 0.7; 95%CI0.6 to -0.9; n=735) and high intake of seafood and noodles.[38]

A cohort study (n=2,695)[39] found that associations between maternal dietary patterns during pregnancy and body composition of the child at age 6 years are to a large extent explained by sociodemographic and lifestyle factors of mother and child. A cohort study (n=2,592)[40] suggested that there are no consistent independent associations of maternal dietary patterns with offspring cardiometabolic health at 6 years.

2.1.3 Mediterranean diet

The Mediterranean diet is generally characterised by a high intake of fruit, vegetables, nuts, cereals and olive oil, a moderate intake of fish and poultry, and low intakes of dairy products, red and processed meats and sweets.

Systematic reviews have found associations between adherence to the Mediterranean diet in pregnancy and reduced risk of gestational diabetes (OR 0.57; 95%CI 0.41 to 0.79; 10 observational studies; n=124,959)[41] and wheeze in the infant in the first 12 months (OR 0.92; 95%CI 0.88 to 0.95; 3 studies).[42]

An RCT comparing the Mediterranean diet with additional extra virgin olive oil and pistachios with a standard diet with limited fat intake (n=874)[43] found a clear difference in risk of gestational diabetes (aRR 0.75; 95%CI 0.57 to 0.98; p=0.039). The intervention group also had reduced rates of insulin-treated gestational diabetes, preterm

birth, emergency caesarean section, perineal trauma, and small and large for gestational age newborns (all p<0.05).

Post-hoc analysis of the RCT[44] found a linear association between high, moderate, and low adherence to the Mediterranean diet and a lower risk of gestational diabetes, urinary tract infections, preterm birth and small-for-gestational-age (all p < 0.05). Sub-analysis of results for normoglycaemic women[45] found that high versus low adherence was associated with a significantly lower risk of urinary tract infections, emergency caesarean-section, perineal trauma, large-for-gestational-age and small-for-gestational-age (all p<0.05).

Observational studies were consistent in finding an association between adherence to the Mediterranean diet and lower risk of small for gestational age[46] and preterm birth,[47] although one study only found an association between reduced risk of preterm birth among women who were overweight or obese.[48]

Studies into childhood growth found an association between maternal Mediterranean diet score and lower waist circumference, [49,50] skinfold thickness[49] and risk of accelerated growth[51] but were inconsistent about the effect on BMI z-score.[49,50] Studies into child cardiometabolic risk were also inconsistent, with one study finding a potential protective effect[49] and another finding no association with child cardiometabolic risk.[51]

Observational studies did not find an association between adherence to the Mediterranean and childhood wheeze,[52,53] rhinitis,[53] dermatitis[53] or eczema.[52]

2.1.4 Dietary Approaches to Stop Hypertension (DASH) diet

The DASH diet is characterised by high intake of vegetables, fruits and low-fat dairy foods and moderate amounts of whole grains, fish, poultry and nuts.

A systematic review[54] found that, in the absence of gestational weight gain advice, fasting glucose improved in DASH-style diets compared to standard care (MD -0.47; 95%CI -0.73 to -0.21; 3 studies; n=99; moderate certainty). However, a small cohort study (n=513) found no association between DASH score and fasting glucose (ß 0.29; 95%CI -1.46 to 2.04).

Cohort studies found that greater adherence to the DASH diet was:

- not associated with reductions in risk of hypertensive disorders of pregnancy (OR 1.00; 95%CI 0.96 to 1.03), gestational diabetes (OR 1.01; 95%CI 0.96 to 1.06), preterm birth (OR 0.99; 95%CI 0.95 to 1.03), small for gestational age (OR 0.97; 95%CI 0.93 to 1.02) or large for gestational age (OR 0.99; 95%CI 0.96 to 1.02)
- negatively associated with maternal triglycerides (mg/dL) (ß 0.11; 95%CI 0.19 to 0.02), insulin (ß 0.07; 95%CI 0.18 to 0.04), HOMA-IR (ß 0.06; 95%CI 0.18 to 0.06) or cholesterol (ß 2.93; 95%CI 13.95 to 8.08)[19]
- associated with decreased odds of preterm birth (aOR for quartile 4 vs quartile 1: 0.59; 95% CI 0.40 to 0.85).[37]

2.1.5 Vegetarian and vegan diets

A narrative review of vegetarian and vegan diets in pregnancy found inconsistency in results on birthweight, similar duration of pregnancy between vegan-vegetarian and omnivorous diets and a suggestion of risk of vitamin B_{12} and iron deficiency with vegan-vegetarian diets.[55] Another review found lower zinc intakes among vegetarian versus non-vegetarian women.[56] However, neither group met the recommended daily allowance for zinc and there were no differences in serum/plasma zinc or in functional outcomes associated with pregnancy.[56]

A cohort study[57] found that a plant-based dietary pattern was inversely associated with birth weight (ß -67.6 g per 1-unit increase; P<0.001). An interaction with non-white ethnicity and birth weight was observed — among white Europeans, maternal consumption of a plant-based diet was associated with lower birth weight (ß -65.9 g per 1-unit increase; P<0.001), increased risk of small-for-gestational age (OR 1.46; 95% CI 1.08 to 1.54; P=0.005) and reduced risk of large-for-gestational age (OR 0.71; 95% CI 0.53 to 0.95; P=0.02). Among South Asians, maternal consumption of a plant-based diet was associated with a higher birth weight (ß +40.5 g per 1-unit increase; P=0.01), partially explained by cooked vegetable consumption.

2.1.6 Fasting

A systematic review[58] found that fasting during Ramadan did not increase the risk of preterm birth (OR 0.99, 95% CI 0.72 to 1.37; 5 studies) or low birth weight (OR 1.05; 95%CI 0.87 to 1.28; 8 studies).

2.1.7 Evidence summary

Australian cross-sectional studies have identified low levels of awareness of dietary guidelines during pregnancy among women and limited dietary counselling by health professionals.

Studies investigating outcomes associated with dietary patterns were heterogeneous in the patterns that they identified. However, dietary patterns associated with positive outcomes were generally characterised by high intake of fruits, vegetables, legumes, wholegrains, fish, seafood, lean meats, low-fat dairy and water. Dietary patterns associated with poorer outcomes included those high in sweetened foods and beverages, foods high in saturated fats (eg fried foods), red and processed meats and refined grains.

Outcomes positively affected by a healthy dietary pattern and negatively affected by an unhealthy dietary pattern included gestational diabetes, gestational hypertension and antenatal depression. The evidence was inconsistent on the association between dietary pattern in pregnancy and preterm birth, fetal and childhood growth, cardiometabolic health and childhood wheeze.

Systematic reviews into vegan-vegetarian diets found inconsistency in results on birthweight, similar duration of pregnancy between vegan-vegetarian and omnivorous diets and a suggestion of risk of iron, zinc and vitamin B_{12} deficiency with vegan-vegetarian diets.

A systematic review found that fasting during Ramadan did not increase the risk of preterm birth or low birth weight.

2.1.8 Consumer summary

Dietary patterns characterised by high intake of fruits, vegetables, legumes, wholegrains, fish, seafood, lean meats, low-fat dairy and water are associated with positive pregnancy outcomes (including lower risk of gestational diabetes, gestational hypertension, depression, preterm birth and low birth weight). Dietary patterns high in sweetened foods and beverages, foods high in saturated fats (eg fried foods), red and processed meats and refined grains are associated with poorer outcomes (eg gestational diabetes, depression).

Women with vegan-vegetarian diets may be at risk of iron, zinc and vitamin B_{12} deficiency.

Fasting during Ramadan does not appear to increase the risk of preterm birth or low birth weight.

2.1.9 Evidence tables

Table 10: Q1 Dietary patterns in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Borge et al 2017[36]	18 studies 63,861 women	**Aim**: To provide a quantitative summary of the literature exploring the relationship between maternal diet quality during pregnancy and child cognitive and affective outcomes. **Methods**: Relevant studies were identified through a systematic literature search in relevant databases. All studies investigating maternal diet quality during pregnancy in relation to child cognitive or affective functioning in children of elementary school age or younger were assessed for inclusion.	The results indicated a small positive association between better maternal diet quality during pregnancy and child functioning. The overall summary effect size was Hedges' g=0.075 (p<0.0001) adjusted for publication bias (unadjusted g=0.112 (p=0.0001)).	Child diet was not systematically controlled for in the majority of the studies.
Chia et al 2019[29] SLR of observational studies	25 studies 167,507 women	**Aim:** Findings on the relations of maternal dietary patterns during pregnancy and risk of preterm birth and offspring birth size remain inconclusive. We aimed to systematically review and quantify these associations. **Methods**: We searched MEDLINE, Embase, CENTRAL, and CINAHL up to December 2017. Summary effect sizes were calculated with random effects models and studies were summarised narratively if results could not be pooled.	Healthy dietary patterns-characterised by high intakes of vegetables, fruits, wholegrains, low-fat dairy, and lean protein foods-were associated with lower risk of preterm birth (OR for top compared with bottom tertile: 0.79; 95% CI: 0.68 to 0.91; I_2=32%) and a weak trend towards a lower risk of small-for-gestational-age (OR: 0.86; 95%CI: 0.73 to 1.01; I_2=34%). Unhealthy dietary patterns-characterised by high intakes of refined grains, processed meat, and foods high in saturated fat or sugar-were associated with lower birth weight (MD -40 g; 95% CI: -61, -20 g; I_2=0%) and a trend towards a higher risk of preterm birth (OR: 1.17; 95%CI: 0.99 to 1.39; I_2=76%). No consistent associations with birth weight or small- or large-for-gestational-age were observed.	

Study ref	N	Aim/methods	Results	Comments
Raghavan et al 2019[28]	11 gestational age: 1 RCT 7 cohort 21 birthweight: 2 RCTs 19 cohorts	**Aim:** To assess the relationships between dietary patterns before and during pregnancy and 1) gestational age at birth and 2) gestational age- and sex-specific birth weight. **Methods**: Literature was searched from January 1980 to January 2017 in 9 databases including PubMed, Embase, and Cochrane. Two analysts independently screened articles using predetermined inclusion and exclusion criteria. Data were extracted from included articles and risk of bias was assessed. Data were synthesised qualitatively, a conclusion statement was drafted for each question, and evidence supporting each conclusion was graded.	Limited but consistent evidence suggests that certain dietary patterns during pregnancy are associated with a lower risk of preterm birth and spontaneous preterm birth. These protective dietary patterns are higher in vegetables; fruits; whole grains; nuts, legumes, and seeds; and seafood (preterm birth, only), and lower in red and processed meats, and fried foods. No conclusion can be drawn on the association between dietary patterns during pregnancy and birth weight outcomes. Although research is available, the ability to draw a conclusion is restricted by inconsistency in study findings, inadequate adjustment of birth weight for gestational age and sex, and variation in study design, dietary assessment methodology, and adjustment for key confounding factors.	

Study ref	N	Aim/methods	Results	Comments
Schoenaker et al 2014[22]	16 studies	Aim: To synthesise evidence from observational studies of reproductive-aged women on the association between dietary factors and HDP. **Methods**: MEDLINE and EMBASE were searched to identify studies published until the end of May 2014. Studies were included if they were observational studies of reproductive-age women and reported results on dietary factors (energy, nutrients, foods or overall dietary patterns, alone or in combination with dietary supplements) and gestational hypertension and/or pre-eclampsia. Studies were excluded if they reported on supplements not in combination with dietary intake, or examined a biomarker of dietary intake. Random effects meta-analyses were performed on calculated weighted mean differences (WMD) of dietary intake between cases and non-cases, and effect estimates were pooled.	A few studies examining foods and dietary patterns suggested a beneficial effect of a diet rich in fruit and vegetables on pre-eclampsia, although not all the results were statistically significant.	Studies could not be pooled in a meta-analysis because of differences in the foods or patterns examined or different units of exposure.
Schoenaker et al 2016[15]	21 studies	**Aim**: To synthesise evidence from observational studies on the associations between dietary factors and GDM. **Methods**: Medline and Embase were searched for articles published until January 2015. We included observational studies of reproductive-aged women that reported on associations of maternal dietary intake before or during pregnancy, including energy, nutrients, foods, and dietary patterns, with GDM. All relevant results were extracted from each article. The number of comparable studies that adjusted for confounders was insufficient to perform a meta-analysis.	A limited number of prospective cohort studies adjusting for confounders indicated associations with a higher risk of GDM for replacing 1-5% of energy from carbohydrates with fat and for high consumption of cholesterol (>/=300 mg/day), heme iron (>/=1.1 mg/day), red and processed meat (increment of 1 serving/day), and eggs (>/=7 per week). A dietary pattern rich in fruit, vegetables, whole grains, and fish and low in red and processed meat, refined grains, and high-fat dairy was found to be beneficial. The current evidence is based on a limited number of studies that are heterogeneous in design, exposure and outcome measures.	The number of comparable studies that adjusted for confounders was insufficient to perform a meta-analysis.

Table 11: Q1 Dietary patterns in pregnancy — RCT

Study ref	N	Aim/methods	Results	Comments
Flynn et al 2016[16] UPBEAT United Kingdom RCT	1,032 women	**Aim**: To investigate the effect of a behavioural intervention of diet and physical activity advice on dietary patterns in obese pregnant woman participating in the UPBEAT study, and to explore associations of dietary patterns with pregnancy outcomes. **Methods**: Diet was assessed using a food frequency questionnaire (FFQ) at baseline (15(+0)-18(+6) weeks' gestation), post intervention (27(+0)-28(+6) weeks) and in late pregnancy (34(+0)-36(+0) weeks). Dietary patterns were characterised using factor analysis of the baseline FFQ data, and changes compared in the control and intervention arms. Four dietary patterns were identified. 'Fruit and vegetables' — high intakes of bananas, citrus fruit, dried fruit, fresh fruit, green vegetables, pulses, root vegetables, salad vegetables, tropical fruit and yoghurt. 'African/Caribbean' — high loadings on red meat, cassava, white meat, rice including pilau, fried or jollof rice, plantain and fish. 'Processed' — high intakes of chocolate, crisps, green vegetables, potatoes, processed meat and meat products, root vegetables, squash and fizzy drinks, sugar free squash and fizzy drinks and chips. 'Snacks' — high loadings on biscuits, cookies, cakes, pastries, chocolate, full fat cheese and sweets.	In the adjusted model, baseline scores for the African/Caribbean (quartile 4 compared with quartile 1: OR 2.46; 95% CI 1.41 to 4.30) and Processed (quartile 4 compared with quartile 1: OR 2.05; 95% CI 1.23, 3.41) patterns in the entire cohort were associated with increased risk of gestational diabetes. There were no clear increases or decreases in risk for other outcomes (pre-eclampsia, LGA, SGA, macrosomia) for any dietary pattern.	

Table 12: Q1 Dietary patterns in pregnancy — observational studies

Study ref	N	Aim/methods	Results	Comments
Baskin et al 2017[26] Australia Cross-section	167 women	**Aim:** To explore the predictive role of antenatal diet quality for antenatal and postnatal depressive symptoms. **Methods:** Pregnant women completed the Edinburgh Postnatal Depression Scale at time 1 [T1, mean weeks gestation=16.70±0.91], time 2 (T2, mean weeks gestation=32.89±0.89) and time 3 (T3, mean weeks post-partum=13.51±1.97) and a food frequency questionnaire at T1 and T2. Diet quality was determined by extracting dietary patterns via principal components analysis. Two dietary patterns were identified: 'healthy' (including fruit, vegetables, fish and whole grains) and 'unhealthy' (including sweets, refined grains, high-energy drinks and fast foods). Associations between dietary patterns and depressive symptoms were investigated by path analyses.	Examination of beta weights (β) revealed that 'healthy' dietary pattern scores at T1 positively predicted 'healthy' dietary pattern scores at T2 (β =0.30, p<0.01, 95%CI 0.14 to 0.46). Similarly depressive symptoms at T1 positively predicted depressive symptoms at both T2 (β =0.48, p<0.01, 95%CI 0.34 to 0.62) and T3 (β =0.40, p<0.01, 95%CI 0.25 to 0.55). There were no significant paths between a 'healthy' dietary pattern and depressive scores. Examination of beta weights revealed that 'unhealthy' dietary pattern scores at T1 positively predicted 'unhealthy' dietary pattern scores at T2 (β =0.24, p<0.01, 95%CI 0.08 to 0.40). Similarly, depressive symptoms at T1 positively predicted depressive symptoms at both T2 (β =0.49, p<0.01, 95%CI 0.35 to 0.63) and T3 (β =0.37, p<0.01, 95%CI 0.22 to 0.52). There was one significant path between an 'unhealthy' diet at T2 and depressive symptoms at T2 (β =0.16, p<0.05, 95%CI 0.02 to 0.30); higher 'unhealthy' dietary pattern scores were cross-sectionally related to higher depressive symptoms.	

Study ref	N	Aim/methods	Results	Comments
Chia et al 2018[34] Singapore Cohort	1,051 women	**Aim:** To investigate the association of maternal diet quality with the risk of preterm birth, offspring birth size, and adiposity in a multiethnic Asian birth cohort. **Methods**: Dietary intakes were ascertained at 26-28 wk of gestation with the use of 24-h recalls and 3-d food diaries, from which diet quality (score range: 0-100) was measured by the Healthy Eating Index for pregnant women in Singapore (HEI-SGP).	Maternal diet quality during pregnancy was not associated with preterm birth (ß 0.91; 0.75 to 1.11) or birth weight (-2.00; -22.57 to 18.57). Greater adherence to the HEI-SGP (per 10-point increment in HEI-SGP score) was associated with longer birth length [beta (95% CI): 0.14 (0.03, 0.24 cm)], lower body mass index (in kg/m2) at birth [-0.07 (-0.13, -0.01)], lower sum of triceps and subscapular skinfold thickness [-0.15 (-0.26, -0.05 mm)], lower percentage body fat [-0.52% (-0.84%, -0.20%)], lower fat mass [-17.23 (-29.52, -4.94 g)], lower percentage abdominal superficial subcutaneous adipose tissue [-0.16% (-0.30%, -0.01%)], and lower percentage deep subcutaneous adipose tissue [-0.06% (-0.10%, -0.01%)].	
Emond et al 2018[35] United Kingdom Cohort	862 women and infants	**Aim**: To examine the relation between maternal diet quality during pregnancy and infant birth size among women enrolled in a prospective birth cohort. **Methods**: Women 18-45 y old with a singleton pregnancy were recruited at 24-28 wk of gestation from prenatal clinics in New Hampshire. Women completed a validated food frequency questionnaire at enrolment. Diet quality was computed as adherence to the Alternative Healthy Eating Index. Infant birth outcomes (sex, head circumference, weight, and length) were extracted from medical records.	In an adjusted model, increased diet quality appeared linearly associated with a reduced likelihood of SGA (P-trend=0.03), although each quartile comparison did not reach statistical significance. Specifically, ORs for SGA were 0.89 (95%CI 0.37 to 2.15), 0.73 (95%CI 0.28 to 1.89), and 0.35 (95%CI 0.11 to 1.08) for each increasing quartile of diet quality compared to the lowest quartile. Similar trends for SGA were observed among non-smokers (n=756; P-trend=0.07). Also among non-smokers, increased diet quality was associated with lower infant birth weight (P-trend=0.03) and a suggested reduction in macrosomia (P-trend=0.07).	

Study ref	N	Aim/methods	Results	Comments
Englund-Ogge et al 2014[31] Norway Cohort	66,000	**Aim**: To examine whether an association exists between maternal dietary patterns and risk of preterm delivery. **Methods**: Pregnant women (singletons, answered food frequency questionnaire, no missing information about parity or previously preterm delivery, pregnancy duration between 22+0 and 41+6 gestational weeks, no diabetes, first enrolment pregnancy). Hazard ratio for preterm delivery according to level of adherence to three distinct dietary patterns interpreted as "prudent" (for example, vegetables, fruits, oils, water as beverage, whole grain cereals, fibre rich bread), "Western" (salty and sweet snacks, white bread, desserts, processed meat products), and "traditional" (potatoes, fish).	After adjustment for covariates, high scores on the "prudent" pattern were associated with significantly reduced risk of preterm birth for the highest versus the lowest third (HR 0.88; 95%CI 0.80 to 0.97). The prudent pattern was also associated with a significantly lower risk of late and spontaneous preterm birth. No independent association with preterm delivery was found for the "Western" pattern. The "traditional" pattern was associated with reduced risk of preterm birth for the highest versus the lowest third (HR 0.91, 0.83 to 0.99).	
Englund-Ogge et al 2017[33] Norway Cohort	66,000	**Aim:** to examine the associations between meal frequency and glycaemic properties of maternal diet in relation to preterm delivery. **Methods**: Meal frequency and food intake data were obtained from a validated food frequency questionnaire during mid-pregnancy. Three meal frequency patterns were identified: "snack meal", "main meal", and "evening meal". Pattern scores were ranked in quartiles. Glycaemic index and glycaemic load were estimated from table values. Intakes of carbohydrates, added sugar, and fibre were reported in grams per day and divided into quartiles.	After adjustments, the "main meal" pattern was associated with a reduced risk of preterm birth, with hazard ratios (HRs) of 0.89 (95%CI 0.80 to 0.98) and 0.90 (95%CI: 0.81 to 0.99) for the third and fourth quartiles, respectively, and p for trend of 0.028. This was mainly attributed to the group of women with BMI ≥25 kg/m2, with HRs of 0.87 (95%CI: 0.79 to 0.96) and 0.89 (95% CI: 0.80 to 0.98) for the third and fourth quartiles, respectively, and p for trend of 0.010. There was no association between glycaemic index, glycaemic load, carbohydrates, added sugar, fibre, or the remaining meal frequency patterns and preterm birth.	

Study ref	N	Aim/methods	Results	Comments
Englund-Ogge et al 2019[32] Norway Cohort	65,904	**Aim:** To assess whether quality of maternal diet affects birth weight and the risk of small for gestational age (SGA) and/or large for gestational age (LGA) babies. **Methods**: Pregnant women answered a validated food frequency questionnaire at mid-pregnancy. Three maternal dietary patterns were extracted based on characteristics of food items in each pattern. From these we created four non-overlapping groups: "high prudent," "high Western," "high traditional," and "mixed".	Compared to the high Western group, the high prudent group was associated with lower birth weight (beta-ultrasound z-scores -0.041 (95%CI -0.068 to -0.013)) and the high traditional group with higher birth weight (beta-ultrasound 0.067 (95%CI 0.040 to 0.094)) for all three growth standards. The high prudent pattern was associated with increased SGA risk (SGA-ultrasound OR 1.25 (95%CI: 1.02 to 1.54)) and decreased LGA risk (LGA-population OR 0.84 (95%CI: 0.75 to 0.94)), while the high traditional group on the contrary was associated with decreased SGA (SGA-customised OR 0.92 (95% CI: 0.84 to 0.99)) and increased LGA risk (LGA population OR 1.12 (95%CI 1.02 to 1.24)).	
Gresham et al 2016[24] Australia Cohort	1,907 women	**Aim:** To assess whether diet quality before or during pregnancy predicts adverse pregnancy and birth outcomes in a sample of Australian women. **Methods**: The Dietary Questionnaire for Epidemiological Studies was used to calculate diet quality using the Australian Recommended Food Score (ARFS) methodology modified for pregnancy. A national sample of Australian women, aged 20-25 and 31-36 years, who were classified as preconception or pregnant when completing Survey 3 or Survey 5 of the ALSWH, respectively. The women with biologically plausible energy intake estimates were included in regression analyses of associations between preconception and pregnancy ARFS and subsequent pregnancy outcomes.	Women with the highest ARFS had the lowest odds of developing gestational hypertension (OR=0.4; 95 % CI 0.2 to 0.7) or having a baby of low birth weight (OR=0.4; 95 % CI 0.2 to 0.9), which remained significant for gestational hypertension after adjustment for potential confounders.	

Study ref	N	Aim/methods	Results	Comments
Ikem et al 2019[23] Denmark Cohort	55,139	**Aim**: To examine the association between midpregnancy dietary patterns and pregnancy-associated hypertension. **Methods**: Diet was assessed using a validated semi-quantitative 360-item food frequency questionnaire and dietary patterns were derived using factor analysis.	Seven dietary patterns were characterised in the population, of which two were associated with PAH. The Seafood diet characterised by high consumption of fish and vegetables was inversely associated with the odds of developing gestational hypertension (OR 0.86; 95%CI 0.77 to 0.95)] and pre-eclampsia (PE) (OR 0.79; 95%CI 0.65 to 0.97). The Western diet characterised by high consumption of potatoes (including French fries), mixed meat, margarine and white bread increased the odds of developing GH (OR 1.18; 95%CI 1.05 to 1.33) and PE (OR 1.40; 95% CI 1.11 to 1.76). No association was seen with severe PE.	
Leermakers et al 2017[40] Netherlands Cohort	2,592 mother-child pairs	**Aim:** To assess the associations between different dietary patterns during pregnancy and offspring cardiometabolic health among mother-child pairs. **Methods**: Maternal diet was assessed in early pregnancy with a food-frequency questionnaire. We identified three a posteriori-dietary patterns, namely a 'Vegetable, fish and oil', 'Nuts, soy and high-fibre cereals' and 'Margarine, snacks and sugar'-pattern. An a priori-pattern was created based on the 'Dutch Healthy Diet Index'. Cardiometabolic health (pulse wave velocity, blood pressure, insulin, HDL-cholesterol and triglycerides) was measured at the child's age of 6 years.	In the crude models, the 'Vegetable, fish and oil', 'Nuts, soy and high-fibre cereals' and 'Dutch Healthy Diet Index' seemed beneficial, as higher adherence to these patterns was significantly associated with lower blood pressure and lower pulse wave velocity. After adjustment for other socio-demographic and lifestyle factors, most associations disappeared, except for lower pulse wave velocity with the 'Vegetable, fish and oil'-dietary pattern (-0.19 SD (95% CI -0.33 to -0.06), highest quartile of adherence vs. lowest quartile). No associations were found between maternal dietary patterns and offspring blood lipids or insulin levels. CONCLUSIONS: Our results suggest that there are no consistent independent associations of maternal dietary patterns with offspring cardiometabolic health at 6 years.	

Study ref	N	Aim/methods	Results	Comments
Loo et al 2017[38] Singapore GUSTO Cohort	735 children	**Aim**: To examine the role of maternal diet during pregnancy on immune tolerance and the development of allergic diseases in the offspring. **Methods**: We examined the relation between maternal dietary patterns assessed using 24 hr recalls and food diaries at 26-28 weeks of pregnancy and the subsequent development of allergic outcomes in the offspring. Exploratory factor analysis was used to characterise maternal dietary patterns during pregnancy. During repeated visits in the first 36 months of life, questionnaires were administered to ascertain allergic symptoms, namely, eczema, rhinitis and wheezing. At ages 18 and 36 months, we administered skin prick testing to inhalant and food allergens.	Of the three maternal dietary patterns that emerged, the Seafood and Noodle (SfN) pattern was associated with a reduced risk of developing allergen sensitisation at both 18 months (OR 0.7; 95%CI0.5 to 0.9) and 36 months (OR 0.7; 95%CI0.6 to -0.9) after adjustment for family history of allergy, ethnicity, sex and maternal education levels. No associations between Vegetable, Fruit and white Rice and Pasta, Cheese and Processed meat patterns were observed with any of the allergic outcomes in the first 18 and 36 months of life.	
Martin et al 2016[19] United States Cohort	513 women	**Aim:** investigated the association between dietary patterns and cardiometabolic markers (glucose, insulin, insulin resistance (HOMA-IR), triglycerides, and cholesterol) during pregnancy. **Methods**: Diet was assessed using a food frequency questionnaire. Dietary patterns were derived using latent class analysis (LCA) and the Dietary Approaches to Stop Hypertension (DASH) diet. Linear regression was used to examine the dietary patterns-cardiometabolic markers association during pregnancy.	After adjustment for potential confounders including prepregnancy BMI, a diet consistent with Latent Class 3 (fruits, vegetables, whole grains, low-fat dairy, breakfast bars, and water) was negatively associated with maternal insulin (μU/mL: beta -0.12; 95%CI -0.23 to -0.01) and HOMA-IR (beta -0.13; 95%CI -0.25 to -0.00) but not glucose (beta 0.86; 95%CI 2.64 to 0.92), triglycerides (beta 0.01; 95%CI 0.10, 0.08) or cholesterol (beta 5.58; 95%CI 5.63 to 16.79).	

Study ref	N	Aim/methods	Results	Comments
Martin et al 2016[37] United States Cohort	389 mother-child pairs	**Aim:** To investigate the influence of maternal dietary patterns during pregnancy on child growth in the first 3 y of life in 389 mother-child pairs from the Pregnancy, Infection, and Nutrition study. **Methods**: Dietary patterns were derived with the use of latent class analysis (LCA) based on maternal diet, collected with the use of a food-frequency questionnaire at 26-29 wk gestation. Associations between maternal dietary patterns and child body mass index (BMI)-for-age z score and overweight or obesity were assessed with the use of linear regression and log-binomial regression, respectively. We used linear mixed models to estimate childhood growth patterns in relation to maternal dietary patterns.	Three patterns were identified from LCA: 1) fruits, vegetables, refined grains, red and processed meats, pizza, French fries, sweets, salty snacks, and soft drinks (latent class 1); 2) fruits, vegetables, baked chicken, whole-wheat bread, low-fat dairy, and water (latent class 2); and 3) white bread, red and processed meats, fried chicken, French fries, and vitamin C-rich drinks (latent class 3). In crude analyses, the latent class 3 diet was associated with a higher BMI-for-age z score at 1 and 3 y of age and a higher risk of overweight or obesity at 3 y of age than was the latent class 2 diet. These associations were not detectable after adjustment for confounding factors. We observed an inverse association between the latent class 3 diet and BMI-for-age z score at birth after adjustment for confounding factors that was not evident in the crude analysis (latent class 3 compared with latent class 2-beta: -0.41; 95% CI: -0.79 to -0.03).	

Study ref	N	Aim/methods	Results	Comments
Miyake et al 2018[25] Japan Cross-section	1,744 women	**Aim:** To examine the association between dietary patterns and depressive symptoms during pregnancy. The current cross-sectional study examined this issue in Japan. **Methods**: Dietary patterns were derived from a factor analysis of 33 predefined food groups based on a self-administered diet history questionnaire. Depressive symptoms were defined as a Center for Epidemiological Studies Depression Scale score ≥ 16. Adjustment was made for age, gestation, region of residence, number of children, family structure, history of depression, family history of depression, smoking, second-hand smoke exposure, employment, household income, education, and body mass index.	Three dietary patterns were identified: 'healthy', characterised by high intake of green and yellow vegetables, other vegetables, mushrooms, pulses, seaweed, potatoes, fish, sea products, miso soup, sugar, and shellfish; 'Japanese', characterised by high intake of rice and miso soup; and 'Western', characterised by high intake of beef and pork, processed meat, vegetable oil, chicken, eggs, shellfish, and salt-containing seasonings. The healthy and Japanese patterns were independently inversely associated with depressive symptoms during pregnancy: the adjusted prevalence ratios between extreme quartiles were aRR 0.56 (0.43 to 0.73, p<0.0001) and aRR 0.72 (0.55 to 0.94, p=0.008), respectively. No association was observed between the Western pattern and depressive symptoms during pregnancy.	
Nathanson et al [27] Australia Cross-section	253	**Aim**: To examine the association between consumption of food groups characteristic of a quality diet during pregnancy (that is fruit, vegetable and fish intake) and postnatal depressive symptoms at 12 months postpartum. **Methods**: Pregnant women were recruited at 10-18 weeks gestation and completed self-report questionnaires assessing fruit, vegetable and fish intake as well as depressive symptoms at early- to mid- pregnancy. Path analyses were conducted to examine whether fruit, vegetable and fish intake during pregnancy were associated with depressive symptom scores at 12 months postpartum.	There were no associations between fruit, vegetable or fish intake in pregnancy and postnatal depressive symptoms. Antenatal diet quality as measured by intake of food groups associated with a healthy diet was not associated with postpartum depressive symptoms at 12 months postpartum.	

Study ref	N	Aim/methods	Results	Comments
Rasmussen et al 2014[30] Denmark Cohort	59,949 women	**Aim**: To extract and visualise dietary patterns from self-reported dietary data collected in mid-pregnancy (25th week of gestation) and examine their associations with spontaneous and induced preterm birth (gestational age<259 days (<37 weeks)). **Methods**: A total of seven dietary patterns were extracted by principal component analysis, characterised and visualised by color-coded spider plots, and referred to as: Vegetables/Prudent, Alcohol, Western, Nordic, Seafood, Candy and Rice/Pasta/Poultry.	A consistent dose-response association with preterm birth was only observed for Western diet (aOR 1.30; 95%CI 1.13 to 1.49) comparing the highest to the lowest quintile. This association was primarily driven by induced preterm births (aOR 1.66, 95%CI 1.30 to 2.11, comparing the highest to the lowest quintile) while the corresponding odds ratio for spontaneous preterm deliveries was more modest (aOR 1.18, 95%CI 0.99 to 1.39).	
Sedaghat et al 2017[20] Iran Case control	122 cases 266 control	**Aim:** To explore the association between dietary pattern and risk of gestational diabetes. **Method**: Dietary intake was collected using a food frequency questionnaire (FFQ). GDM was diagnosed using a 100-gram, 3-hour oral glucose tolerance test. Dietary pattern was identified by factor analysis. To investigate the relation between each of the independent variables with gestational diabetes, the odds ratio (OR) was calculated.	Western dietary pattern was high in sweets, jams, mayonnaise, soft drinks, salty snacks, solid fat, high-fat dairy products, potatoes, organ meat, eggs, red meat, processed foods, tea, and coffee. The prudent dietary pattern was characterised by higher intake of liquid oils, legumes, nuts and seeds, fruits and dried fruits, fish and poultry whole, and refined grains. Western dietary pattern was associated with increased risk of gestational diabetes mellitus before and after adjustment for confounders (OR 1.97, 95%CI 1.27 to 3.04, aOR 1.68, 95%CI 1.04 to 2.27). However, no significant association was found for a prudent pattern.	

Study ref	N	Aim/methods	Results	Comments
Shin et al 2015[18] United States Cohort	249 women	**Aim:** To identify dietary patterns during pregnancy that are associated with GDM risk in pregnant women. **Methods**: Food items were aggregated into 28 food groups based on Food Patterns Equivalents Database. Three dietary patterns were identified by reduced rank regression with responses including prepregnancy body mass index (BMI), dietary fibre, and ratio of poly- and monounsaturated fatty acids to saturated fatty acid: "high refined grains, fats, oils and fruit juice", "high nuts, seeds, fat and soybean; low milk and cheese", and "high added sugar and organ meats; low fruits, vegetables and seafood". GDM was diagnosed using fasting plasma glucose levels >/=5.1 mmol/L for gestation <24 weeks.	Multivariable AOR (95% CIs) of GDM for comparisons between the highest vs. lowest tertiles were 4.9 (1.4 to 17.0) for "high refined grains, fats, oils and fruit juice" pattern, 7.5 (1.8 to 32.3) for "high nuts, seeds, fat and soybean; low milk and cheese" pattern, and 22.3 (3.9 to 127.4) for "high added sugar and organ meats; low fruits, vegetables and seafood" pattern after controlling for maternal sociodemographic variables, prepregnancy BMI, gestational weight gain, energy intake and log-transformed CRP.	
Van den Broek et al 2015[39] Denmark Cohort	2,695 mother-child pairs	**Aim:** To examine whether maternal dietary patterns during pregnancy are associated with body composition of the child at age 6 years. **Methods**: Maternal diet was assessed in early pregnancy by a 293-item semiquantitative food-frequency questionnaire. Vegetable, fish, and oil; nuts, soy, and high-fibre cereals; and margarine, snacks, and sugar dietary patterns were derived from principal component analysis. We measured weight and height of the child at age 6 y. Total body fat and regional fat mass percentages of the child were assessed with dual-energy X-ray absorptiometry.	In the crude models, statistically significant associations were found for higher adherence to the vegetable, fish, and oil dietary pattern and the nuts, soy, and high-fibre cereals dietary pattern with lower body mass index, lower fat mass index, and lower risk of being overweight, but none of these associations remained significant after adjustment for sociodemographic and lifestyle factors. We found no associations between the margarine, snacks, and sugar dietary pattern and any of the outcomes.	

Study ref	N	Aim/methods	Results	Comments
Zareei et al 2018[21] Iran Case-control	204 women	**Aim:** To examine the dietary pattern in women with GDM. **Methods**: Participants' food intakes were assessed using semi-quantitative food frequency questionnaire, while their activities evaluated by physical activity questionnaire. Anthropometric indices were measured based on standard instructions, and the body mass index was calculated. The dietary patterns were determined using principal component analysis and its relationship with preeclampsia was tested using logistic regression method.	Unhealthy (high intake of mayonnaise, soda, pizza, sugar, etc) and healthy (high intake of leafy green vegetables, fruits, poultry, fish, etc) dietary patterns were identified. In the unhealthy group, after modifying the effect of confounding variables, a significant relationship was observed between dietary pattern and having gestational diabetes (OR 2.838, 95% CI 1.039 to 7.751). In the healthy group, women in the fourth quartile had 149% and 184% higher chance not to experience gestational diabetes before and after modification with confounders, respectively (OR 0.284, 95%CI 0.096 to 0.838), when compared with women in the first quartile.	
Zhou et al 2018[17] China Cohort	2,755 women	**Aim:** To identify maternal dietary patterns and examine their associations with GDM risk, and to evaluate the contributions of macronutrients intake to these associations. **Methods**: Dietary intakes were assessed using a validated semi-quantitative FFQ 2 weeks before the diagnosis of GDM. GDM was diagnosed based on the results of a 75-g, 2-h oral glucose tolerance test at 24-28 weeks gestation. We derived five different dietary patterns from a principal component analysis.	The results showed that high fish-meat-eggs scores, which were positively related to protein intake and inversely related to carbohydrate intake, were associated with a higher risk of GDM (quartile 4 vs quartile 1: aOR 1.83; 95%CI 1.21 to 2.79; P trend=0.007) and higher plasma glucose levels. In contrast, high rice-wheat-fruits scores, which were positively related to carbohydrate intake and inversely related to protein intake, were associated with lower risk of GDM (quartile 3 vs quartile 1: aOR 0.54; 95%CI 0.36 to 0.83; P trend=0.010) and lower plasma glucose levels.	GDM

Table 13: Q1 Mediterranean diet in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Pham et al 2019[41] SLR	12 studies: 10 cohort 1 cross-section 1 case-control 124,959 women	**Aim:** To review and meta-analyse evidence concerning the effect of the intake of several polyphenol-rich foods on gestational diabetes (GDM) risk. **Methods**: A systematic literature search was conducted in PubMed, Web of Science and Embase databases for observational studies on the association between dietary intake of foods/diets rich in polyphenols and GDM risk. Inclusion criteria were original research articles with full texts published in peer-reviewed English language journals, which investigated foods within the top 100 richest dietary sources of polyphenols and reported odds ratio/relative risk with their corresponding 95% confidence intervals. The quality of included studies was assessed using the Newcastle-Ottawa Scale. The intake of polyphenol-rich foods and dietary patterns in relation to GDM were pooled with fixed- and random-effects models. In total, 12 (10 cohort, 1 cross-sectional and 1 case-control) studies were included for the final systematic review, comprising 124,959 participants and including 5,786 women with GDM.	Meta-analyses showed that the risk of GDM was about halved amongst women with the highest score of Mediterranean diet compared to those with the lowest score (OR 0.57; 95%CI 0.41 to 0.79).	GDM

Study ref	N	Aim/methods	Results	Comments
Zhang et al 2019[42]	18 studies	**Aim:** To evaluate the relationship between high adherence to the Mediterranean diet in pregnancy and childhood and the risk of asthma and wheeze in children. **Methods**: We conducted searches of PubMed, EMBASE, and Cochrane Central Register of Controlled Trials from inception to 30 October 2018. Observational studies providing risk estimates and corresponding confidence intervals on the association of high adherence to the Mediterranean diet in pregnancy or childhood and the risk of asthma or wheeze in childhood were included. The methodological quality of all included studies was assessed. Summary odds ratios (OR) were calculated using a random-effects model.	The pooled data suggested high adherence to the Mediterranean diet during pregnancy was associated with a reduced incidence of wheeze in the first 12 months (OR 0.92; 95%CI 0.88 to 0.95; P < 0.001). However, there was no significant association between high adherence of the Mediterranean diet in pregnancy and any of the other meta-analysis end points including diagnosed asthma.	

Table 14: Q1 Mediterranean diet in pregnancy — RCT

Study ref	N	Aim/methods	Results	Comments
Assaf-Balut et al 2017[43] Spain RCT St. Carlos Gestational Diabetes Mellitus Prevention Study	Intervention 434 Control 440	**Aim**: To assess whether a Mediterranean diet can help prevent GDM in unselected pregnant women. **Methods**: We conducted a prospective, randomised controlled trial to evaluate the incidence of GDM with two different dietary models. All consecutive normoglycaemic (<92 mg/dL) pregnant women at 8-12 gestational weeks (GW) were assigned to Intervention Group: MedDiet supplemented with extra virgin olive oil (EVOO) and pistachios; or Control Group: standard diet with limited fat intake. Primary outcome was to assess the effect of the intervention on GDM incidence at 24-28 GW. Gestational weight gain (GWG), pregnancy-induced hypertension, caesarean section (CS), preterm delivery, perineal trauma, small and large for gestational age (SGA and LGA) and admissions to neonatal intensive care unit were also assessed. Analysis was by intention-to-treat.	Intervention vs control: • Gestational diabetes: aRR 0.75 (0.57 to 0.98); p=0.039 • Insulin-treated gestational diabetes aRR 0.43 (0.24 to 0.78); p=0.005 • Preterm birth: aRR 0.29 (0.11 to 0.77); p=0.013 • Small for gestational age: aRR 0.21 (0.08 to 0.54); p=0.001 • Large for gestational age: aRR 0.19 (0.07 to 0.57); p=0.003 • Emergency cesarean section: aRR 0.30 (0.14 to 0.63) p=0.001 • Perineal trauma: aRR 0.21 (0.12 to 0.36); p=0.001	

Study ref	N	Aim/methods	Results	Comments
Assaf-Balut et al 2018[44] Spain Post-hoc analysis of St. Carlos Gestational Diabetes Mellitus Prevention Study	874 women	**Aim:** To evaluate the effect of late first-trimester (>12 gestational weeks) degree of adherence to a MedDiet pattern-based on six food targets-on a composite of materno-foetal outcomes (CMFCs). **Methods**: The CMFCs were defined as having emergency C-section, perineal trauma, pregnancy-induced hypertension and preeclampsia, prematurity, large-for-gestational-age, and/or small-for-gestational-age. Women were stratified into three groups according to late first-trimester compliance with six food targets: >12 servings/week of vegetables, >12 servings/week of fruits, <2 servings/week of juice, >3 servings/week of nuts, >6 days/week consumption of extra virgin olive oil (EVOO), and ≥40 mL/day of EVOO. High adherence was defined as complying with 5(-)6 targets; moderate adherence 2(-)4 targets; low adherence 0(-)1 targets.	High adherence vs low adherence: • Gestational diabetes: OR 0.35 (0.18 to 0.67), p=0.002 • Urinary tract infection: 0.19 (0.07 to 0.52), p=0.001 Moderate adherence vs low adherence: • Preterm birth: 0.30 (0.13 to 0.72), p=0.007 • Small for gestational age: 0.36 (0.17 to 0.77), p=0.009	GDM

Study ref	N	Aim/methods	Results	Comments
Assaf-Balut et al 2019[45] Spain Sub-analysis of St. Carlos Gestational Diabetes Mellitus Prevention Study	697 women Intervention 360 Control 337	**Aim:** To evaluate the effect of a Mediterranean diet (MedDiet), enhanced with extra virgin olive oil (EVOO) and nuts, on a composite of adverse maternofoetal outcomes of women with normoglycaemia during pregnancy. **Methods**: Women were randomised (at 8-12th gestational weeks) to: standard-care control group (337), where fat consumption was limited to 30% of total caloric intake; or intervention group, where a MedDiet, enhanced with EVOO and pistachios (40-42% fats of total caloric intake) was recommended.	High adherence vs low adherence among normoglycaemic women: • Pregnancy-induced hypertension: 13 (3.6) vs 11 (3.3); p=0.484 • Pre-eclampsia: 7 (1.9) vs 4 (1.2); p=0.311 • Urinary tract infection: 17 (4.7) vs 40 (11.9); p=0.001; RR 0.37 (0.20 to 0.66), p=0.001 • Emergency caesarean section: 8 (2.2) vs 25 (7.4); p=0.002; RR 0.28 (0.13 to 0.64) • Perineal trauma: 49 (14.5) vs 13 (3.6; p= 0.001; RR 0.22 (0.12–0.41); p=0.001 • Preterm birth (<37 weeks): 4 (1.1) vs 11 (3.6); p=0.067 • Large for gestational age: 3 (0.8) vs 11 (3.3); p=0.034; RR 0.25 (0.07 to 0.90) • Small for gestational age: 4 (1.1) vs 14 (4.2); p=0.018; RR 0.26 (0.08 to 0.80)	

Table 15: Q1 Mediterranean diet in pregnancy — observational studies

Study ref	N	Aim/methods	Results	Comments
Castro-Rodriguez et al 2016[53] Cohort	1,000 preschool children	**Aim**: To examine whether some foods and Mediterranean diet (MedDiet) consumed by the mother during pregnancy and by the child during the first years of life can be protective for current wheezing, rhinitis and dermatitis at preschool age. **Methods**: Questionnaires of epidemiological factors and food intake by the mother during pregnancy and later by the child were filled in by parents in two surveys at two different time points (1.5 yrs and 4 yrs of life).	Maternal adherence to the Mediterranean diet was not a protective factor for wheeze (p=0.892), dermatitis (p=0.145) or rhinitis (p=0.637) in the child.	
Steenweg-de Graaff et al 2014[59] Netherlands Cohort	3,104 children	**Aim**: To assess the links between maternal nutritional factors during pregnancy and foetal brain development and subsequent offspring behaviour. **Methods**: Within a population-based cohort, we assessed maternal diet using a food frequency questionnaire. Three dietary patterns were derived by means of Principal Component Analysis — The first pattern has been labelled 'Mediterranean', because of its high loadings on vegetables, fish & shellfish, vegetable oil, fruit, and eggs, and relatively high negative loading on processed meat. The second pattern, labelled traditional Dutch, was characterised by high intakes of fresh and processed meat and potatoes, a relatively high intake of margarines and a very low intake of soy and diet products. The third pattern, 'Confectionary', was high in the consumption of cakes, sugar & confectionary products, tea, cereals, fruit and dairy products.	After adjustment, the Mediterranean diet was negatively associated (0.90, 95% CI: 0.83 to 0.97) and the Traditionally Dutch diet (1.11, 95% CI: 1.03 to 1.21) was positively associated with child externalising problems (problem behaviours directed toward the environment such as aggression, cheating, disobeying rules). Both low adherence to the Mediterranean diet and high adherence to the Traditionally Dutch diet during pregnancy are associated with an increased risk of child externalising problems.	

Study ref	N	Aim/methods	Results	Comments
Chatzi et al 2017[49] United States (Viva), Greece (Rhea) Cohort	997 mother-child pairs in United States 569 pairs in Greece	**Aim:** To investigate the association between adherence to Mediterranean diet in pregnancy and offspring cardiometabolic traits in two pregnancy cohorts. **Methods**: We estimated adherence to the Mediterranean diet with an a priori defined score (MDS) of nine foods and nutrients (0 to 9). We measured child weight, height, waist circumference, skin-fold thicknesses, blood pressure, and blood levels of lipids, c-reactive protein and adipokines in mid-childhood (median 7.7 years) in Viva, and in early childhood (median 4.2 years) in Rhea. We calculated cohort-specific effects and pooled effects estimates with random-effects models for cohort and child age.	In Project Viva, the mean (SD, standard deviation) MDS was 2.7 (1.6); in Rhea it was 3.8 (1.7). In the pooled analysis, for each 3-point increment in the MDS, offspring BMI z-score was lower by 0.14 units (95% CI, -0.15 to -0.13), waist circumference by 0.39 cm (95% CI, -0.64 to -0.14), and the sum of skin-fold thicknesses by 0.63 mm (95% CI, -0.98 to -0.28). We also observed lower offspring systolic (-1.03 mmHg; 95% CI, -1.65 to -0.42) and diastolic blood pressure (-0.57 mmHg; 95% CI, -0.98 to -0.16). Greater adherence to Mediterranean diet during pregnancy may protect against excess offspring cardiometabolic risk.	

Study ref	N	Aim/methods	Results	Comments
Fernandez-Barres et al 2019[51] Spain Cohort	2,195 mother-child pairs 697 children at 4 years	**Aim:** To evaluate the associations between maternal adherence to the Mediterranean diet during pregnancy and their offspring's longitudinal body mass index (BMI) trajectories and cardiometabolic risk in early childhood. **Methods**: We included mother-child pairs from the Infancia y Medio Ambiente (INMA) longitudinal cohort study in Spain. We measured dietary intake during pregnancy using a validated food frequency questionnaire and calculated the relative Mediterranean diet score (rMED). We estimated offspring's BMI z score trajectories from birth to age 4 years using latent class growth analyses. We measured blood pressure, waist circumference, and cardiometabolic biomarkers to construct a cardiometabolic risk score at 4 years (n=697 mother-child pairs). We used multivariable adjusted linear and multinomial regression models. RESULTS:	A higher maternal rMED in pregnancy was associated with a lower risk in offspring of larger birth size, followed by accelerated BMI gain (reference trajectory group: children with average birth size and subsequent slower BMI gain) (relative risk of high vs low rMED score, 0.68; 95% CI, 0.47 to 0.99). rMED score during pregnancy was not associated with the cardiometabolic risk score, its components, or related biomarkers. Higher adherence to the Mediterranean diet in pregnancy was associated with lower risk of having offspring with an accelerated growth pattern. This dietary pattern was not associated with the offspring's cardiometabolic risk at 4 years.	Child growth
Fernandez-Barres et al 2016[50] Cohort	1,827 mother-child pairs	**Aim**: To evaluate associations between adherence to the Mediterranean diet (MD) during pregnancy and childhood overweight and abdominal obesity risk at 4 years of age. **Methods**: We analysed mother-child pairs from the Spanish 'Infancia y Medio Ambiente' cohort study. Diet was assessed during pregnancy using a food frequency questionnaire and MD adherence by the relative Mediterranean diet score (rMED). Overweight (including obesity) was defined as an age-specific and sex-specific body mass index ≥85th percentile (World Health Organization referent), and abdominal obesity as a waist circumference (WC) >90th percentile.	There was no association between rMED and body mass index z-score, whereas there was a significant association between higher adherence to MD and lower WC (beta of high vs. low rMED: -0.62 cm; 95% confidence interval: -1.10, -0.14 cm, P for trend=0.009). Pregnancy adherence to the MD was not associated with childhood overweight risk, but it was associated with lower WC, a marker of abdominal obesity.	Child growth

Study ref	N	Aim/methods	Results	Comments
Smith et al 2015[47] United Kingdom Case-cohort	922 LMPT 965 term	**Aim**: To explore the associations between lifestyle factors and late and moderate preterm birth (LMPT: 32(+0)-36(+6) weeks' gestation). **Methods**: Poisson multivariable regression models were fitted to estimate relative risks (RR) of LMPT birth associated with maternal smoking, alcohol and recreational drug use, and diet.	Women who did not have any aspects of a Mediterranean diet were nearly twice as likely to give birth LMPT compared with those whose diet included ≥ Mediterranean characteristics (aRR 1.81; 95%CI 1.04 to 3.14; p=0.036).	preterm
Saunders et al 2014[48] Guadeloupe Cohort	728 women	**Aim:** To evaluate the effect of adherence to a Mediterranean diet (MD) during pregnancy on fetal growth restriction (FGR) and preterm birth (PTB) in a population largely of African descent and present dietary patterns similar to MD. **Methods**: We analysed data for pregnant women who had liveborn singletons without any major congenital malformations. Degree of adherence to MD during pregnancy was evaluated with a semi-quantitative food frequency questionnaire based on nine dietary criteria. Multiple logistic regression models were used to analyse birth outcomes while taking potential confounders into account.	Overall there was no association between MD adherence during pregnancy and the risk of PTB (non-stratified by BMI: aOR 0.9; 95%CI 0.8 to 1.0) or FGR (non-stratified by BMI, term births: aOR 1.0; 95%CI 0.8 to 1.2). However, pre-pregnancy BMI was a strong effect modifier and MD adherence was associated with a decreased risk of PTB in overweight and obese women (aOR 0.7, 95%CI 0.6 to 0.9) (P<0.01) but not women with underweight/normal BMI (aOR 1.1; 95%CI 0.9 to 1.3).	preterm

Study ref	N	Aim/methods	Results	Comments
Martínez-Galiano et al 2018[46] Spain Case-control	518 case-control pairs	**Aim:** To quantify the effect of a Mediterranean dietary pattern, as well as the consumption of olive oil (OO), on the risk of having a small for gestational age infants (SGA). **Methods**: Dietary intake during pregnancy was assessed using a validated food frequency questionnaire. Three indices were used to evaluate the adherence to Mediterranean diet (MD) (Predimed, Trichopoulou and Panagiotakos). Crude odds ratios (cOR) and adjusted odds ratios (aOR) and their 95% confidence intervals (CI) were estimated using conditional logistic regression models.	Results were stratified by severity of SGA: moderate (percentiles 6–10), and severe (percentiles 5). For moderate, four or more points in the Predimed´s index was associated with a 41% reduction of having SGA compared with women with a score 3, aOR 0.59 (95%CI 0.38 to 0.98); for severe, the reduction in risk was not statistically significant. Similar results were found when the other MD indexes were used. An intake of OO above 5 g/day was associated with a lower risk of SGA (aOR 0.53, 95% CI 0.34 to 0.85); statistical significance was observed for moderate SGA (aOR 0.53, 95% CI 0.30 to 0.96), but not for severe SGA (aOR 0.51, 95% CI 0.24 to 1.07), although the magnitude of ORs were quite similar. Adherence to a MD and OO intake is associated with a reduced risk of SGA.	SGA
Alvarez Zallo et al 2018[52] Europe and Latin America International Study of Wheezing in Infants Cross-section	1,087 infants 12-15 months of age	**Aim:** To examine the relationship between different food groups and the adherence to a Mediterranean diet during pregnancy and the risk of wheezing and eczema in children aged 12-15 months. **Methods**: The study of the association of the different food consumption and Mediterranean diet with wheezing, recurrent wheezing and eczema was performed using different models of unconditional logistic regression to obtain adjusted prevalence odds ratios (OR) and 95% confidence intervals (95% CI).	No association was found between a good adherence to the Mediterranean diet during pregnancy and the development of wheezing (p=0.372), recurrent wheezing (p=0.118) or eczema (p=0.315).	Wheeze

Table 16: Q1 Dietary Approaches to Stop Hypertension (DASH) diet in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Ha et al 2017[54] SLR	21 studies 1,865 women	**Aim**: To compare the effects of various common diets, stratified by the addition of gestational weight gain advice, on fasting glucose and insulin, haemoglobin A1c (HbA1c), and homeostatic model assessment for insulin resistance (HOMA-IR) in pregnant women. **Methods**: MEDLINE, EMBASE, Cochrane database, and reference lists of published studies were searched through April 2017. Randomised trials directly comparing two or more diets for ≥2-weeks were eligible. Bayesian network meta-analysis was performed for fasting glucose. Owing to a lack of similar dietary comparisons, a standard pairwise meta-analysis for the other glycaemic outcomes was performed. The quality of the pooled effect estimates was assessed using the GRADE tool.	In the absence of gestational weight gain advice, fasting glucose improved in DASH-style diets compared to standard care (MD -0.47; 95%CI -0.73 to -0.21; 3 studies; n=99; moderate certainty).	Most dietary comparisons were underpowered to detect differences in glycaemic outcomes.

Table 17: Q1 Dietary Approaches to Stop Hypertension (DASH) diet in pregnancy — observational studies

Study ref	N	Aim/methods	Results	Comments
Fulay et al 2018[60] United States Cohort	1,760 women	**Aim**: To examine associations of adherence to the DASH diet with hypertensive disorders of pregnancy (HDP) and other pregnancy outcomes. **Methods**: We derived a DASH score using data from a food frequency questionnaire (FFQ) administered at median 11.1 weeks gestation. We then used multivariable linear regression models that accounted for the woman's age at enrolment, pre-pregnancy body mass index (BMI), education, smoking habits, race/ethnicity, gestational weight gain (GWG) up until the time of the FFQ, and total energy intake to examine associations of the DASH score with HDP, gestational diabetes, preterm delivery (<37 weeks), birth size, and GWG from FFQ to delivery.	Overall, the DASH diet score was not associated with reductions in risk of: • Hypertensive disorders of pregnancy: OR 1.00 (0.96 to 1.03) • Gestational diabetes: OR 1.01 (0.96 to 1.06) • Preterm birth: OR 0.99 (0.95 to 1.03) • Small for gestational age: OR 0.97 (0.93 to 1.02) • Large for gestational age: OR 0.99 (0.96 to 1.02) However, there was a positive association between the DASH diet and subsequent gestational weight gain among women who were obese before pregnancy (0.19 [95%CI 0.05 to 0.34], P≤0.05 kg higher GWG per 1 unit DASH score).	
Martin et al 2016[19] United States Cohort	513 women	**Aim:** investigated the association between dietary patterns and cardiometabolic markers (glucose, insulin, insulin resistance (HOMA-IR), triglycerides, and cholesterol) during pregnancy. **Methods**: Diet was assessed using a food frequency questionnaire. Dietary patterns were derived using latent class analysis (LCA) and the Dietary Approaches to Stop Hypertension (DASH) diet. Linear regression was used to examine the dietary patterns-cardiometabolic markers association during pregnancy.	After adjustment for confounders including prepregnancy BMI, DASH scores within Tertile 3 (higher dietary quality) were negatively associated with maternal triglycerides (mg/dL) (ß 0.11; 95%CI 0.19 to 0.02) but not fasting glucose (ß 0.29; 95%CI 1.46 to 2.04), insulin (ß 0.07; 95%CI 0.18 to 0.04), HOMA-IR (ß 0.06; 95%CI 0.18 to 0.06) or cholesterol (ß 2.93; 95%CI 13.95 to 8.08).	

Study ref	N	Aim/methods	Results	Comments
Martin et al 2015[37] United States Cohort	3,143	**Aim:** To examine the association between maternal dietary patterns during pregnancy and preterm birth. **Methods**: Dietary intake was assessed at 26-29 wk of gestation by using a food-frequency questionnaire, and patterns were derived by using factor analysis and the Dietary Approaches to Stop Hypertension (DASH) diet. Associations between dietary patterns and preterm birth were assessed by logistic regression.	Greater adherence to the DASH diet was associated with decreased odds of preterm birth compared with women in the lowest quartile (aOR for quartile 4 vs quartile 1: 0.59; 95% CI 0.40 to 0.85).	Preterm

Table 18: Q1 Vegetarian or vegan diets in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Piccoli et al 2015[55] SLR	22 studies	**Aim**: To review the literature on vegan–vegetarian diets and pregnancy outcomes. **Methods**: PubMed, Embase, and the Cochrane library were searched from inception to September 2013 for pregnancy and vegan or vegetarian Medical Subject Headings (MeSH) and freetext terms. We excluded case reports and papers analysing vegan– vegetarian diets in poverty and malnutrition. Searching, paper selection, and data extraction were performed in duplicate.	None of the studies reported an increase in severe adverse outcomes or in major malformations, except one report of increased hypospadias in infants of vegetarian mothers. Five studies reported vegetarian mothers had lower birthweight babies, yet two studies reported higher birthweights. The duration of pregnancy was available in six studies and was similar between vegan–vegetarians and omnivores. The nine heterogeneous studies on microelements and vitamins suggest vegan–vegetarian women may be at risk of vitamin B_{12} and iron deficiencies.	The high heterogeneity of the studies led to a narrative review.

Study ref	N	Aim/methods	Results	Comments
Foster et al 2015[56]	6 studies	**Aim**: To explore the relationship between habitual vegetarian diets and dietary zinc intake/status during pregnancy. The association between vegetarian diets and functional pregnancy outcome also is considered. **Methods**: A literature search was conducted of MEDLINE; PubMed; Embase; the Cochrane Library; Web of Science; and Scopus electronic databases up to September 2014.	The zinc intake of vegetarians was found to be lower than that of non-vegetarian women (-1.38±0.35 mg/day; $p<0.001$); and the exclusion of low meat eaters from the analysis revealed a greater difference (-1.53±0.44 mg/day; $p=0.001$). Neither vegetarian nor non-vegetarian groups met the recommended dietary allowance (RDA) for zinc. In a qualitative synthesis; no differences were found between groups in serum/plasma zinc or in functional outcomes associated with pregnancy.	

Table 19: Q1 Vegetarian or vegan diets in pregnancy — observational studies

Study ref	N	Aim/methods	Results	Comments
Zulyniak et al 2017[57] Canada Cohort	3,997 mother-infant pairs	**Aim:** to investigate the influence of maternal diet on birth weight. **Methods**: Dietary information during pregnancy was collected at 24–28 weeks' gestation using a validated semiquantitative Food Frequency Questionnaire (FFQ). We performed principal component analysis (PCA) to identify three dietary patterns: 'plant-based', 'western' and 'health-conscious'.	No associations were identified between the Western and health-conscious diet patterns and birth weight; however, the plant-based dietary pattern was inversely associated with birth weight (beta=-67.6 g per 1-unit increase; P<0.001), and an interaction with non-white ethnicity and birth weight was observed. Ethnically stratified analyses demonstrated that among white Europeans, maternal consumption of a plant-based diet associated with lower birth weight (beta=-65.9 g per 1-unit increase; P<0.001), increased risk of small-for-gestational age (SGA; OR=1.46; 95% CI 1.08 to 1.54;P=0.005) and reduced risk of large-for-gestational age (LGA; OR=0.71; 95% CI 0.53 to 0.95; P=0.02). Among South Asians, maternal consumption of a plant-based diet associated with a higher birth weight (beta=+40.5 g per 1-unit increase; P=0.01), partially explained by cooked vegetable consumption.	

Table 20: Q1 Fasting in pregnancy — systematic review

Study ref	N	Aim/methods	Results	Comments
Glazier et al 2018[58]	22 studies 31,374 women of whom 18,920 were exposed to Ramadan fasting	**Aim**: To determine whether Ramadan fasting by pregnant women affects perinatal outcomes. **Methods**: Systematic review and meta-analysis of observational studies and randomised controlled trials was conducted in EMBASE, MEDLINE, CINAHL, Web of Science, Google Scholar, the Health Management Information Consortium and Applied Social Sciences Index and Abstracts. Studies from any year were eligible. Studies reporting predefined perinatal outcomes in pregnancies exposed to Ramadan fasting were included. Cohort studies with no comparator group or that considered fasting outside pregnancy were excluded, as were studies assuming fasting practice based solely upon family name. Quality of included studies was assessed using the ROBINS-I tool for assessing risk of bias in non-randomised studies. Analyses were performed in STATA.	• Birth weight: SMD 0.03, 95%CI 0.00 to 0.05; 21 studies. • Preterm birth: OR 0.99, 95% CI 0.72 to 1.37; 5 studies. • Low birth weight: OR 1.05; 95%CI 0.87 to 1.28; 8 studies	Further studies are needed to accurately determine whether Ramadan fasting is associated with adverse maternal or neonatal outcome.

Table 21: Q1 Fasting in pregnancy — observational study

Study ref	N	Aim/methods	Results	Comments
Shalit et al 2015[61] Israel Cross-section	744 births	**Aim**: To determine the effect of the Day of Atonement fast (a 25-hour Jewish fast), on preterm birth (<37 weeks). **Methods**: A comprehensive analysis of all births during the Day of Atonement and during the corresponding day a week earlier, between the years 1988 and 2011, was performed. Data on fasting status was deduced from the ethnicity (as only Jewish parturients fast during the Day of Atonement). Multivariable logistic regression model was used to control for confounders.	Jewish parturients (fasting group) were at significantly higher risk for preterm birth during the Day of Atonement (aOR 1.99; 95%CI 1.03 to 3.83; p=0.041). In the corresponding day, a week before the Day of Atonement, Jewish ethnicity was not found to be a risk factor for preterm delivery (aOR 0.92; 95%CI 0.50 to 1.69; p=0.789).	Fasting status was extrapolated from ethnicity.

2.2 Q2: Which foods should be promoted and which avoided during pregnancy?

2.2.1 Background

An Australian cross-sectional survey[62] found that women's knowledge of foods to avoid during pregnancy was poor, with 83% of women incorrectly identifying at least one unsafe food as safe to consume. The average knowledge score for foods to avoid during pregnancy was 7.9±3.4 out of a possible score of 12. Women with a higher number of GP visits and those receiving care in a high-risk clinic were more likely to be adherent to guidelines.

A cross-sectional study in the United States found that food security status was associated with the daily intake of fresh fruits (indirect effect -0.039; 95%CI -0.074 to -0.013) and fresh vegetables (indirect effect -0.048; 95%CI -0.083 to -0.023).[63] As food security worsened, the available variety of fresh fruit and vegetables decreased, which was associated with lower intake.

2.2.2 Fruit and vegetables

Glucose tolerance

A small cohort study (n=180)[64] found that high consumption of vegetables was associated with higher 1-hour glucose challenge test ($p<0.05$).

Pre-eclampsia

Analysis of an RCT (n=987)[65] found highest versus lowest adherence to a vegetable dietary pattern may be associated with a lower risk of preeclampsia (aRR 0.20; 95%CI 0.04 to 0.98; P for trend=0.041), possibly through reducing development of proteinuria (aRR 0.44; 95%CI 0.24 to 0.80).

In a cohort study (n=28,192)[66] women who reported eating organic vegetables 'often' or 'mostly' had a lower risk of pre-eclampsia than those who reported 'never/rarely' or 'sometimes' (aOR 0.79; 95%CI 0.62 to 0.99).

Fetal growth

A case-control study (n=1,036)[67] found a deceased risk of small-for-gestational age with >420 g/day fruit compared to ≤121 g/day (aOR 0.63; 95%CI 0.40 to 0.98). Total legume intake showed an inverse association with the risk of small for gestational age (trend p=0.02). Total consumption of vegetables was not associated with risk of small for gestational age.

Preterm birth

Cohort studies found that:

- higher intake of fruit, vegetables and rice was associated with a lower risk of preterm birth (OR 0.67; 95% CI: 0.50 to 0.91; n=923)[68]
- low consumption of fruit and vegetables was associated with an increased risk of preterm birth compared with those who reported higher consumption levels (RR 1.31; 95%CI 1.03 to 1.66; p=0.027; n=1,877).[47]

Depression and anxiety

In a small cross-sectional study (n=712),[69] low fruit intake was associated with higher prevalence of major depressive disorder (PR 1.43, 95%CI 1.04 to 1.95) and low intake of legumes was associated with generalised anxiety disorder (PR 1.40, 95%CI 1.01 to 1.93). Another cross-sectional study (n=1,745)[70] found a lower prevalence of depressive symptoms during pregnancy associated with higher seaweed consumption (aOR 0.68; 95%CI 0.47 to 0.96) and soy products (aRR 0.63; 95%CI 0.47 to 0.85; p=0.0002).

Sleep

A cohort study (n=2,951)[71] found that total daily fruit and vegetable consumption was not associated with sleep duration among pregnant women, controlling for confounders (ß -0.0395%CI -0.07 to 0.00).

Neural tube defects

A case-control study (n=918)[72] found that risk of neural tubes defects was reduced with ≥7 meals/week of fresh fruit (OR 0.32; 95%CI 0.14 to 0.71) or 3-6 meals/week of nuts (OR 0.49; 95%CI 0.31 to 0.79).

Childhood allergy and asthma

A cross-sectional study (n=1,087)[52] found that high fruit consumption during pregnancy had a protective effect against "wheezing" in 12-month-old infants (OR: 0.44; 95%CI 0.20 to 0.99). A cohort study (n=310)[73] found that prevalence of wheeze at 2 years was lower with high versus low intake of cruciferous vegetables (aRR 0.48; 95%CI 0.26 to 0.89) or folate-rich vegetables (aRR 0.47, 95%CI 0.25 to 0.87).

A cohort study (n=897)[74] found that asthma was inversely associated with higher daily average intake of vegetables (OR 0.96 per serving/day, 95% CI 0.88 to 1.05).

Childhood cancers

A systematic review of case-control studies (2 studies, 413 cases, 490 controls)[75] found a lower risk of childhood leukaemia associated with maternal consumption of fruit (OR: 0.81, 95% CI: 0.67 to 0.99); vegetables (OR: 0.51, 95% CI: 0.28 to 0.94) and legumes (OR: 0.76, 95% CI: 0.62 to 0.94).

A case-control study (n=299)[76] observed a possible association between childhood retinoblastoma and maternal intake of fruit (OR 0.38, 95%CI 0.14 to 1.02).

2.2.3 Meat

Childhood allergy

In a cohort study (n=1,000),[53] low meat consumption (once or twice a week) during pregnancy was protective against wheeze in the child (p=0.039).

Childhood cancers

A case-control study (n=199)[76] found a positive association between maternal intake of cured meats and childhood retinoblastoma (OR 5.07, 95 % CI 1.63 to 15.70)

2.2.4 Fish

Depression

A cohort study (n=12,418)[77] found that, compared with women consuming more than three portions of seafood a week, those consuming no seafood were more likely to have frequent depressive symptoms at 32 weeks of pregnancy (aOR 1.54; 95%CI 1.25 to 1.89).

Preterm birth

A cohort study (n=3,279)[78] found that, compared with lean fish intake of less than 0.2 servings per month, more than one serving per week was associated with a possible higher risk of preterm birth (RR 1.55; 95% CI 1.04 to 2.30) but was not associated with the other pregnancy complications. The study noted that studies of mechanisms and potential contributing factors (including seafood preparation and nutrient contaminant content) are warranted.

Fetal and child growth

Cohort studies have found that:

- although seafood intake was positively associated with increased birth weight, women in the highest quintile of mercury exposure had babies with lower birthweight (MD -34 g; 95%CI -46 g to -22 g) and had an increased risk of giving birth to small-for-gestational-age babies (aOR 1.19; 95%CI 1.08 to 1.30) (n=56,988)[79]
- compared with fish intake of once per week or less, fish intake more than three times a week was associated with increased risk of rapid infant growth (aOR 1.22; 95%CI 1.05 to 1.42) and increased risk of offspring overweight/obesity at 4 years (aOR 1.14; 95%CI 0.99 to 1.32) and 6 years (aOR 1.22; 95%CI 1.01 to 1.47) compared with an intake of once per week or less (n=26,184)[80]
- children of mothers who consumed fish ≥1/week during pregnancy had lower mean BMI z scores than children of mothers who never consumed fish (n=1,025) at the ages 4, 7, 8.5, and 11.5 years. After adjustment for maternal covariates (particularly pre-pregnancy BMI), BMI z scores in children were lower at 7 years (MD -0.14 95% CI -0.25 to -0.03) but not at 4, 8.5 or 11.5 years (n=3,684).[81]

Childhood allergy and asthma

A systematic review[82] found that maternal fish intake during pregnancy was not associated with lower risk of infant eczema (RR 0.88; 95%CI 0.75 to 1.04; 10 studies), wheeze (RR 0.94; 95%CI 0.83 to 1.07; 8 studies), allergic rhinitis (RR 0.95; 95%CI 0.62 to 1.45; 3 studies) or asthma (RR 0.94; 95%CI 0.75 to 1.18; 4 studies).

Cohort studies found:

- no relationship between frequency of maternal intake of fish and infant eczema (p=0.132) (n=650)[83]
- a higher risk of asthma diagnosis at 18 months among infants of women who ate no fish during pregnancy compared to those who ate fish at least 2 times a week (OR 1.30, 95%CI 1.05 to 1.63, p=0.02) (n=28,936)[84]
- an inverse association between asthma and higher maternal daily average intake of oily fish (aOR 0.23 per serving/day, 95% CI 0.04 to 1.41) (n=897 mother-child pairs).[74]

A cross-sectional study (n=1,087) found that maternal consumption of white fish once or twice a week during pregnancy increased the risk of "wheezing" at 12 months (OR: 1.95; 95%CI 1.01 to 3.75).

Childhood neurodevelopment

A qualitative systematic review (8 studies)[85] suggests that intake of fish during pregnancy is associated with positive foetal neurodevelopmental outcomes, noting that it is important that the type of fish consumed is low in mercury.

Cohort studies found that:

- maternal seafood intake during pregnancy was positively associated with the language and communication scales in the infant(n=38,351)[86]
- prenatal methylmercury exposure above the 90th percentile (calculated from reported maternal fish intake) was associated with delayed language and communication skills in a generally low exposed population (n=46,750 mother-child pairs).[87]

Conduct problems in the child

In a cohort study (n=5,727)[88] mothers of early onset persistent conduct problems children consumed less fish during pregnancy (p<0.01).

Childhood cancer

A systematic review of case-control studies (2 studies)[75] found a lower risk of leukaemia among 0-4 year olds associated with maternal consumption of fish (OR 0.27, 95% CI: 0.14 to 0.53).

2.2.5 Dairy products

Depression

A cross-sectional study (n=1,745)[89] found that, compared to 4 g of yoghurt a day, 80 g a day was associated with a lower prevalence of depressive symptoms during pregnancy (aOR 0.69; 95%CI 0.48 to 0.99, P for trend 0.03). No relationships were observed between the intake of all dairy products (aOR 0.93; 95%CI 0.66-1.32; p=0.47), milk (aOR 0.89; 95%CI 0.63 to 1.25; p=039) or cheese (aOR 0.86; 95%CI 0.59-1.24; p=0.58) and depressive symptoms.

Neural tube defects

A case-control study (n=918)[72] found a lower prevalence of neural tube defects associated with consumption of milk ≥7 times a week (OR 0.59; 95%CI 0.38 to 0.90).

Childhood allergy and asthma

Cohort studies have found that:

- higher maternal intake of total dairy products during pregnancy was associated with a reduced risk of infantile eczema (aOR 0.64; 95%CI 0.42 to 0.98), higher intake of cheese was related to a reduced risk of physician-diagnosed infantile asthma (aOR 0.44; 95%CI 0.18 to 0.97) and intake of yogurt during pregnancy was inversely associated with physician-diagnosed infantile atopic eczema (aOR 0.49; 95% CI, 0.20 to 1.16) (n=1,354)[89]
- higher milk intake during the first trimester was associated with reduced risk of asthma (OR 0.83; 95% CI 0.69 to 0.99) and allergic rhinitis (OR 0.85; 95%CI 0.74 to 0.97) in the infant (n=1,227)[90]
- consumption of milk products in the highest quartile during pregnancy was associated with a lower risk of cow's milk allergy in children (OR 0.56, 95%CI 0.37 to 0.86; P<0.01) (n=6,288)[91]
- the incidence of babies' eczema was higher in the group with daily butter intake than in those with an intake 2-3 times a week or less (p=0.044) (n=650).[83]

2.2.6 Carbohydrates

Fetal growth

In an analysis of women who were obese participating in an RCT (n=222),[92] maternal intake of digestible carbohydrates was associated with the baby's relative fat mass in late (P-trend = 0.006) but not early (P-trend = 0.15) pregnancy. A comparison of women in the highest (median: 238 g/d) compared with the lowest (median: 188 g/d) quartile of digestible carbohydrate intake showed a mean adjusted higher value in the baby's relative fat mass of 2.1% (95% CI 0.6 to 3.7), which corresponded in absolute terms to a 103 g (95% CI: 27 to 179 g) higher fat mass. No association was found between the baby's infant fat mass and maternal carbohydrate intake among women with well-controlled glucose.

A cohort study (n=1,196)[93] found that each additional 10 g/day carbohydrate consumption was associated with an increase of 4 g (95%CI 1 to 7; P=0.003) in birth weight.

Childhood allergy

A cohort study (n=1,087) found an association between "wheezing" at 12 months and consumption once or twice a week of cooked potatoes (OR 1.75; 95%CI 1.22 to 2.51) or industrial pastry (OR 1.59; 95%CI 1.13 to 2.24).[52] Consumption of pasta never or occasionally during pregnancy was protective against wheeze in the child (p=0.049).[53]

2.2.7 Protein

Gestational diabetes

A cross-sectional study (n=980)[94] a higher total dietary protein intake was associated with a higher risk of gestational diabetes (OR highest vs lowest quartile of intake 2.15; 95% CI 1.27 to 3.62; p=0.016).

Fetal and childhood growth

Cohort studies have found:

- no evidence of an association between protein intake and birth weight (MD 9; 95%CI -22.0 to 8) (n=1,196)[93]
- that each 1-SD (0.36 g . kg^{-1} . d^{-1}) increment in second-trimester protein intake corresponded to a -0.10 (95%CI -0.18 to -0.03) change in birth length z score, a -0.03 cm/mo (95% CI -0.05 to -0.01 cm/month) change in slope of length growth from birth to <6 months, and a -0.09 cm/year (95% CI: -0.14 to -0.05 cm/year) change in slope of length growth from 6 months to mid childhood (n=1,961)[95]
- higher maternal protein intake was associated with a higher children's fat-free mass index (beta 0.14; 95 % CI 0.03 to 0.25 for highest vs. lowest quartile of protein intake), but not with children's fat mass index or body mass index (n=2,694 mother-child pairs)[96]
- lower new born abdominal internal adipose tissue (-0.18 mL; 95%CI -0.35 to -0.001 mL per 1% protein-to-carbohydrate substitution and -0.25 mL; 95%CI -0.46 to -0.04 mL per 1% protein-to-fat substitution) (n=320 mother-child pairs).[97]

2.2.8 Fats

Gestational diabetes

A cohort study (n=55)[98] found that women with uncomplicated pregnancies had lower daily fat intake (32.1%) than women who developed gestational diabetes (36.2%) (p=0.0251).

Fetal and childhood growth

A cohort study (n=1,196)[93] found that an additional 10 g/day fat intake was associated with a lower birth weight (MD -8 g; 95%CI -16 to -0.3; P=0.04).

2.2.9 Water

A cohort study (n=369)[99] found that higher maternal intakes of dietary water was associated with decreased risk of wheeze in the infant (aOR 0.22; 95%CI 0.07 to 0.68; p=0.009).

2.2.10 Sweetened foods and beverages

Gestational weight gain

An RCT (n=342)[100] found that, compared with women who consumed foods that contributed to intake of added sugars (eg sweets, snacks, cakes and soft drinks) less than once a week, women consuming these foods twice a day had higher gestational weight gain (MD 5.4 kg; 95% CI 2.1 to 8.7). The results for soft drinks alone were more conflicting, as women with high weight gain tended to favour artificially sweetened soft drinks.

Gestational diabetes

A cohort study (n=3,396)[101] found an association between consumption of sugar-sweetened beverages and increased risk of incidence gestational diabetes, for the highest (aOR 2.03; 95%CI 1.25 to 3.31) and intermediate categories (aOR 1.67; 95%CI 1.01 to 2.77) versus the lowest category (p for linear trend: 0.006). Consumption of diet soft drinks was not associated with gestational diabetes incidence (aOR 0.82; 95%CI 0.52 to 1.31) for the highest versus the lowest category (p for linear trend: 0.258).

A cohort study (n=180)[64] found that high consumption of desserts and sweets was associated with higher fasting blood glucose levels (p<0.05).

Depression

A cross-sectional study (n=712)[69] found a high prevalence of major depressive disorder among women with high intake of sweets and sugars (aPR 1.91; 95%CI 1.19 to 3.07).

Child growth

Cohort studies have found that:

- compared with no consumption, daily consumption of artificially sweetened beverages was associated with a 0.20-unit increase in infant BMI z score (adjusted 95% CI, 0.02 to 0.38) and a 2-fold higher risk of infant overweight at 1 year of age (aOR 2.19; 95%CI 1.23 to 3.88) (n=2,686)[102]
- daily consumption of artificially sweetened beverages was positively associated with large-for-gestational age (aRR 1.57; 95%CI 1.05 to 2.35), BMI z score (adjusted beta 0.59; 95% CI 0.23 to 0.96) and overweight/obesity at 7 years (aRR 1.93; 95%CI 1.24 to 3.01) (n=918 mother-infant pairs).[103]

Childhood allergy

A cohort study (n=8,956)[104] found that maternal intake of free sugar was positively associated with atopy (OR for highest versus lowest quintile of sugar intake 1.38, 95% CI 1.06-1.78; per quintile p-trend=0.006) and atopic asthma (OR 2.01, 95% CI 1.23-3.29; per quintile p-trend=0.004).

2.2.11 Fast foods

Gestational diabetes

A cohort study (n=3,048)[105] found that, compared to the lowest category of baseline fast food consumption, fast food consumption was associated with a higher risk of incident gestational diabetes for the intermediate (aOR 1.31; 95%CI 0.81 to 2.13) and high (aOR 1.86; 95% CI 1.13 to 3.06) categories (p for trend: 0.007).

Childhood allergy and asthma

Cohort studies have found that:

- fast food consumption three or more times a week in pregnancy was associated with a higher prevalence of dermatitis in the child (p=0.005) (n=1,000)[53]
- daily fast food consumption during pregnancy was associated with increased risk of asthmatic symptoms in the child (RR 4.46; 95%CI 1.36 to 14.6) (n=1,201 mother-infant pairs).[106]

Childhood cancers

A case-control study (n=299)[76] found a positive association between maternal intake of fried foods and retinoblastoma in the child (OR 4.89, 95 % CI 1.72 to 13.89).

2.2.12 Caffeine

Fetal growth and preterm birth

A cohort study (n=1,898)[107] found no clear differences between women who drank less than one cup of tea a week and those who drank one or more cups of tea per week for preterm birth (aOR 0.99; 95%CI 0.61 to 1.61) or small for gestational age (aOR 1.43; 95%CI 0.83 to 2.46).

A cross-sectional study (n=858)[108] found that maternal total caffeine intake was associated with an increased risk of preterm birth (OR per 100 mg/d caffeine increase 1.28; 95%CI 1.03 to 1.58; P=0.03).

Childhood brain tumours

A case-control study (n=1,019)[109] found an association between childhood brain tumours and any coffee consumption during pregnancy (OR 1.76; 95%CI 1.09 to 2.84) and ≥2 cups per day during pregnancy (OR 2.52; 95% CI 1.26 to 5.04).

Childhood behaviour

A cross-sectional study (1,119 mother-child pairs)[110] found that children of women in the highest quartile of caffeine consumption had a reduced risk of peer problems (aOR 0.51; 95%CI 0.28 to 0.91).

2.2.13 Potential allergens

Cohort studies into maternal intake of potential allergens have found:

- higher maternal wheat intake during the second trimester was associated with reduced atopic dermatitis in the infant (OR 0.64; 95%CI 0.46 to 0.90; n=1,227)[90]

- higher maternal peanut intake (each additional z score) during the first trimester was associated with reduced risk of peanut allergic reaction in the infant (OR 0.53; 95%CI 0.30 to 0.94; n=1,227)[90]
- peanut/tree nut allergy in the offspring was significantly lower among children of non-allergic mothers who consumed more peanuts/tree nuts in their peripregnancy diet (≥5 times vs <1 time per month: OR 0.31; 95% CI 0.13 to 0.75; P(trend)=0.004; n=8,205)[111]
- incidence of babies' eczema was significantly lower in the group with everyday intake of natto (fermented soy beans) compared to women eating it 2-3 times a week or less (p=0.020; n=650).[83]

2.2.14 Evidence summary

The evidence on specific food components that should be promoted or avoided during pregnancy generally aligns with the findings for question 1. No evidence was identified that contradicts the findings of the systematic review undertaken to inform the *Australian Dietary Guidelines*.

Fruit, vegetables and legumes

There is evidence from observational studies that eating vegetables, fruit and legumes during pregnancy is beneficial to both mother and baby. There are possible associations with improvements in glucose tolerance and fetal growth and reductions in risk of neural tube defects, pre-eclampsia, preterm birth, depression and anxiety, allergy or asthma in the child and some childhood cancers.

Meat

There is evidence from observational studies that low meat consumption may be protective against wheeze in the child and that limiting intake of cured meats may reduce the risk of some childhood cancers.

Fish

There is evidence from systematic reviews of observational studies that higher maternal fish intake may be associated with positive neurodevelopmental outcomes and a reduced risk of childhood leukaemia and does not appear to affect the risk of infant eczema, wheeze, allergic rhinitis or asthma. There is evidence from observational studies that high intake of seafood may be associated with reduced risk of antenatal depression and low birth weight but that high fetal exposure to mercury is associated with low birth weight, small-for-gestational age and delayed language and communication skills.

The evidence on an association between maternal fish intake and preterm birth is insufficient for conclusions to be drawn and findings of observational studies on the effect of maternal seafood intake on child growth are inconsistent.

Dairy

There is evidence from observational studies that higher maternal intake of all dairy products is associated with a reduced risk of infantile eczema, higher maternal milk intake is associated with reduced risk of neural tube defects, asthma, allergic rhinitis and cow's milk allergy in children, higher yoghurt intake is associated with lower prevalence of depressive symptoms during pregnancy, and daily butter intake may be associated with increased risk of infant eczema.

Carbohydrates

There is evidence from analysis of RCT participants that, in obese women with impaired glucose tolerance, a moderate carbohydrate intake during pregnancy is associated with a lower fat mass in their baby at birth. There is evidence from cohort studies that high maternal carbohydrate consumption may be associated with increases in birth weight and with infant wheeze.

Protein

There is evidence from observational studies that a higher maternal protein intake may be associated with a higher risk of gestational diabetes, may increase fat-free mass in the infant and reduce new born abdominal adipose tissue and the risk of rapid infant growth.

Fats

There is evidence from observational studies that a higher daily fat intake is associated with increased risk of gestational diabetes and lower birth weight.

Sweetened foods and beverages

There is evidence from an RCT that higher consumption of foods and drinks that contribute to intake of added sugars is associated with gestational weight gain. There is evidence from observational studies of an association

between sugar-sweetened foods and drinks and impaired glucose tolerance and gestational diabetes, major depressive disorder, large for gestational age, increases in infant BMI z score and overweight at 1 year and 7 years of age, and infant atopy and asthma.

Fast foods

There is evidence from cohort studies that fast food consumption is associated with an increased risk of gestational diabetes, infant dermatitis and asthma.

Caffeine

There is evidence from observational studies that the risk of preterm birth and childhood brain tumours increases with caffeine intake.

Potential allergens

There is evidence from observational studies that maternal peanut consumption may reduce the risk of peanut allergy in the infant and higher maternal wheat intake during the second trimester may reduce atopic dermatitis in the infant.

2.2.15 Consumer summary

The evidence suggests that eating plenty of fruit and vegetables during pregnancy is beneficial to women and their infants. There is evidence to suggest that eating fish during pregnancy is beneficial to women and infants but care needs to be taken to limit intake of mercury. There is some evidence that it may be beneficial to limit intake of meat, cured meats and minimise intake of sugar-sweetened foods and beverages, fast food and caffeine during pregnancy. It appears that consuming potential allergens during pregnancy is not harmful to the infant.

2.2.16 Evidence tables

Table 22: Q2 Consumption of fruit and vegetables during pregnancy

Study ref	N	Aim/methods	Results	Comments
Soto et al 2015[64] Puerto Rico Cohort	180	**Aim**: To describe the dietary patterns of pregnant women in northern Puerto Rico and explore associations between diet factors with pregnancy related measurements. **Methods**: Participants completed a food frequency questionnaire (FFQ) around 20-28 weeks of gestation. The following pregnancy related measures were collected from the medical records: haemoglobin, blood glucose, blood pressure and gestational age. Potential associations between diet factors and pregnancy measures were assessed using chi square analysis with SPSS.	High consumption of vegetables was associated with higher 1-hour glucose challenge test ($p < 0.05$).	
Wang et al 2015[72] China Case-control	459 cases 459 controls	**Aim**: To study the associations between maternal consumption of non-staple food in the first trimester and risk of neural tube defects (NTDs) in offspring. **Methods**: Logistic regression models were used to examine the associations between maternal consumption of non-staple food in the first trimester and risk of NTDs in offspring. The effects were evaluated by odds ratio (OR) and 95% confidence intervals (95% CIs) with SAS9.1.3.software.	The ORs for fresh fruit consumption frequency of 1-2, 3-6, ≥7 meals/week were 0.29 (95% CI: 0.12 to 0.72), 0.22 (0.09 to 0.53), and 0.32 (0.14 to 0.71), respectively. The ORs for nut consumption frequency of 1-2, 3-6, ≥7 meals/week were 0.60 (95% CI: 0.38 to 0.94), 0.49 (0.31 to 0.79), and 0.63 (0.36 to 1.08), respectively.	

Study ref	N	Aim/methods	Results	Comments
Martinez-Galian et al 2018[67] Spain Case-control	518 cases 518 controls	**Aim**: To assess whether certain foods were related to the risk of small for gestational age (SGA). **Methods**: A food frequency questionnaire (FFQ) comprising 137 items was completed by all participants. The intake of vegetables, legumes and fruits was categorized in quintiles (Q1-Q5). Crude values and adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were estimated using conditional logistic regression. The variables for adjustment were as follows: preeclampsia, education, smoking, weight gain per week during pregnancy, fish intake and previous preterm/low birthweight newborns.	Total pulse intake showed an inverse association with the risk of SGA (trend p=0.02). Women with an intake of fruits above 420 g/day (Q5), compared with women in Q1 (≤121 g/day) showed a decreased risk of SGA (AOR 0.63, 95%CI 0.40 to 0.98). The total consumption of vegetables was not associated with the risk of SGA.	
Torjusen et al 2014[66] Norway Cohort	28,192 women	**Aim**: To examine associations between organic food consumption during pregnancy and the risk of pre-eclampsia among nulliparous Norwegian women. Methods: Nulliparous pregnant women answered food frequency questionnaire and general health questionnaire in mid-pregnancy and no missing information on height, body weight or gestational weight gain. Relative risk was estimated as ORs by performing binary logistic regression with pre-eclampsia as the outcome and organic food consumption as the exposure.	Women who reported eating organic vegetables 'often' or 'mostly' had a lower risk of pre-eclampsia than those who reported 'never/rarely' or 'sometimes' (aOR=0.79, 95%CI 0.62 to 0.99). The lower risk associated with high organic vegetable consumption was evident also when adjusting for overall dietary quality, assessed as scores on a healthy food pattern derived by principal component analysis.	

Study ref	N	Aim/methods	Results	Comments
Ogawa et al 2018[73] Japan Cohort	310 infants	**Aim**: To assess the effect of maternal intake of vegetables during pregnancy on asthma risk in offspring, which has rarely been studied. **Methods**: We administered a food frequency questionnaire at two periods during the respondents' pregnancy: early and mid to late periods. In addition, a questionnaire including the International Study of Asthma and Allergies in Childhood questionnaire was conducted when the offspring were 2 years old. Multivariate Poisson regression adjusting for maternal baseline demographics was used to elucidate the association between maternal vegetable intake and the incidence of wheeze in the offspring.	The prevalence of wheeze in the child at 2 years was lower among women with the highest first trimester intake compared with the lowest intake of: • Cruciferous vegetables: aRR 0.48; 95%CI 0.26 to 0.89 • Folate-rich vegetables: aRR 0.47, 95%CI 0.25 to 0.87 In trend analysis, a higher maternal intake of cruciferous, folate-rich vegetables, and total vegetables during early pregnancy was less likely to be associated with wheeze in the offspring at 2 years old (p for trend: 0.038, <0.001, and 0.028, respectively). Maternal vegetable intake during mid to late pregnancy was not associated with wheeze in the offspring.	
Miyake et al 2014[70] Japan Cross-section	1,745 women	**Aim**: To investigate the association between seaweed consumption and depressive symptoms during pregnancy in Japan. **Methods**: Dietary consumption during the preceding month was assessed using a self-administered diet history questionnaire. Adjustment was made for age; gestation; region of residence; number of children; family structure; history of depression; family history of depression; smoking; second-hand smoke exposure at home and at work; job type; household income; education; body mass index; and intake of fish and yogurt.	After adjustment for possible dietary and non-dietary confounding factors, higher seaweed consumption was independently associated with a lower prevalence of depressive symptoms during pregnancy: 2nd quartile: aOR 0.72 (0.51 to 1.004) 3rd quartile: aOR 0.71 (0.50 to 1.01) 4th quartile: aOR 0.68 (0.47 to 0.96)	

Study ref	N	Aim/methods	Results	Comments
Viljoen et al 2018[74] Ireland Cohort	897 mother-child pairs	**Aim**: To establish whether vegetable, oily fish and vitamin D intake during pregnancy are associated with childhood asthma risk over a 10-year period. **Methods**: Mother-child pairs with data on nutrient intake during pregnancy and asthma status, respectively, were included in the analysis. Data on socioeconomic and morbidity indicators over 10 years of follow-up on mothers and the index child were collected through self-administered questionnaires.	Asthma was inversely associated with higher daily average intake of vegetables (OR 0.96 per serving/day, 95% CI 0.88 to 1.05).	
Alvarez Zallo et al 2018[52] Europe and Latin America International Study of Wheezing in Infants Cross-section	1,087 infants 12-15 months of age	**Aim:** To examine the relationship between different food groups and the adherence to a Mediterranean diet during pregnancy and the risk of wheezing and eczema in children aged 12-15 months. **Methods**: The study of the association of the different food consumption and Mediterranean diet with wheezing, recurrent wheezing and eczema was performed using different models of unconditional logistic regression to obtain adjusted prevalence odds ratios (OR) and 95% confidence intervals (95% CI).	High fruit consumption during the pregnancy had a protective effect against "wheezing" in 12-month-old infants (OR: 0.44 [0.20 to 0.99]).	
Chia et al 2016[68] Singapore Cohort	923 infants	**Aim**: To characterise maternal dietary patterns in Asian pregnant women and examine their associations with the risk of preterm birth and offspring birth size. **Methods**: At 26–28 wk of gestation, 24-h recalls and 3-d food diaries were collected from women and dietary patterns derived from exploratory factor analysis. Associations were assessed by logistic and linear regressions with adjustment for confounding factors. Results: Three maternal dietary patterns were identified: vegetable, fruit, and white rice (VFR); seafood and noodle (SfN); and pasta, cheese, and processed meat (PCP).	A greater adherence to the VFR pattern (per SD increase in VFR score) was associated with a lower risk of preterm birth (OR 0.67; 95% CI: 0.50 to 0.91), higher ponderal index (b: 0.26 kg/m_3; 95% CI: 0.06, 0.45 kg/m_3), and increased risk of a large-for-gestational-age birth (RR 1.31; 95% CI: 1.06 to 1.62).	

Study ref	N	Aim/methods	Results	Comments
Dessypris et al 2017[75] SLR of case-control studies	2 studies	**Aim**: To quantitatively synthesise published data on the association of maternal/child diet with leukaemia risk. **Methods**: Medline was searched until June 30th, 2016 for eligible articles on the association of childhood leukaemia with consumption of (i) food groups, excluding alcoholic and non-alcoholic beverages, and (ii) specific dietary supplements before/during index pregnancy and childhood.	Statistically significant inverse estimates for leukaemia were found (2 studies, 413 cases, 490 controls) for fruit (OR: 0.81, 95% CI: 0.67 to 0.99); vegetables (OR: 0.51, 95% CI: 0.28 to 0.94) and legumes (OR: 0.76, 95% CI: 0.62 to 0.94).	
Duke et al 2017[71] Cohort United States	2,951 women	**Aim**: To determine the association of fruit and vegetable consumption with overall sleep duration among pregnant women. **Methods**: Data from the 2011 and 2012 Behavioral Risk Factors Surveillance System (BRFSS) were used. All women (n=2951) of childbearing age (18-44 years) who were pregnant and responded to all fruit and vegetable consumption and sleep duration questions were included. Covariates included age, race, education level, exercise, and marital status. Data were analysed using linear and ordinal logistic regression.	Total daily fruit and vegetable consumption was not associated with sleep duration among pregnant women, controlling for confounders [beta=-0.03 (-0.07 to 0.00)]. Orange and green vegetable consumption were both inversely associated with sleep duration [beta=-0.19 (-0.38 to -0.01) and beta=-0.20 (-0.33 to -0.08) respectively]. Ordinal logistic regression found that the odds of meeting or exceeding sleep time recommendations increased slightly with each unit increase in total fruit and vegetable consumption [OR 1.05 (1.003 to 1.092)] and for every unit increase in fruit consumption [OR 1.12 (1.038 to 1.208)].	
Lombardi et al 2015[76] United States Case-control	Cases 163 Controls 136	**Aim**: To examine the relation between maternal diet and unilateral retinoblastoma. **Methods**: A case-control study of 163 unilateral RB cases and 136 controls ascertained information on maternal diet during pregnancy using a standardised food frequency questionnaire. Logistic regression was used to assess the relation between retinoblastoma and food groups and dietary patterns.	We observed a negative association between retinoblastoma and intake of fruit (OR 0.38, 95%CI 0.14 to 1.02). A food pattern of high fruits and vegetables and low fried food and sweets was negatively associated with disease (OR 0.75, 95 % CI 0.61 to 0.92).	

Study ref	N	Aim/methods	Results	Comments
Mi et al 2018[65] China Analysis of RCT	987 women	**Aim**: To examine the associations between dietary patterns during pregnancy and the risk of preeclampsia. **Methods**: We analysed data from a cluster randomized controlled trial among healthy pregnant women in three rural counties in north-western China. Maternal diet during the whole pregnancy was assessed using a 107-item food frequency questionnaire with proportion size administered before delivery. Principal component factor analysis with varimax rotation was used to identify common dietary patterns. Preeclampsia was diagnosed by trained clinicians and recorded in delivery records.	After adjusting for calories, other dietary pattern scores and baseline blood pressure, a higher vegetable pattern score was associated with lower risk of preeclampsia (P for trend=0.041; the highest vs lowest quartile, aRR 0.20; 95%CI 0.04 to 0.98). A similar association was also observed for the risk of proteinuria (P for trend=0.015): the highest vs lowest quartiles of the vegetable pattern score, aRR 0.44 (95%CI 0.24 to 0.80). The other four pattern scores were not associated with preeclampsia.	
Paskulin et al 2017[69] Brazil Cross-section	712 women	**Aim:** To evaluate the association between dietary patterns and mental disorders among pregnant women in southern Brazil. **Methods**: Food intake assessment was performed using the Food Frequency Questionnaire. Dietary patterns were identified by cluster analysis. The Primary Care Evaluation of Mental Disorders (PRIME-MD) was used to evaluate participants' mental health. Poisson regression models with robust variance were fitted to estimate prevalence ratios (PR).	In the adjusted models, there was a high prevalence of major depressive disorder among women with low fruit intake (PR 1.43, 95%CI 1.04 to 1.95). Low intake of legumes was significantly associated with generalised anxiety disorder (PR 1.40, 95%CI 1.01 to 1.93).	
Smith et al 2015[47] United Kingdom Case-cohort	922 LMPT 965 term	**Aim**: To explore the associations between lifestyle factors and late and moderate preterm birth (LMPT: 32(+0)-36(+6) weeks' gestation). **Methods**: Poisson multivariable regression models were fitted to estimate relative risks (RR) of LMPT birth associated with maternal smoking, alcohol and recreational drug use, and diet.	Low consumption of fruit and vegetables was associated with a 31% increased risk of LMPT compared with those who reported higher consumption levels (RR 1.31; 95%CI 1.03 to 1.66; p=0.027).	

Study ref	N	Aim/methods	Results	Comments
Ozawa et al 2014[83] Japan Cohort	650 mother-baby pairs	**Aim**: To investigate the association between the maternal diet during pregnancy and the risk of eczema in infancy in Japan. **Methods**: A birth cohort was set up at 2 hospitals in Chiba city. Dietary habits concerning fish, butter, margarine, yogurt and natto (Japanese traditional fermented soy beans) during pregnancy was obtained from mothers just after delivery. The intake frequencies of these foods were classified into four groups: 1) daily, 2) 2-3 times a week, 3) once a week and 4) once a month or less. Diagnosis of eczema at 6 months of age was made by the presence of an itchy rash that persisted more than two months.	For natto, incidence of babies' eczema was significantly lower in the group with everyday intake than those eating it 2-3 times a week or less (p=0.020).	
Miyake et al 2018[112] Japan Cross-section	1,745 women	**Aim**: To examine the relationship between isoflavones or soybeans and depressive symptoms during pregnancy in Japan. **Methods**: Dietary intake during the preceding month was assessed using a self-administered diet history questionnaire. Depressive symptoms were defined by a score of 16 or over in the Center for Epidemiologic Studies Depression Scale.	Higher intake of total soy products, tofu, tofu products, fermented soybeans, boiled soybeans, miso soup, and isoflavones was independently related to a lower prevalence of depressive symptoms during pregnancy: The adjusted prevalence ratios (95 % confidence intervals, P for trend) between extreme quartiles were 0.63 (0.47-0.85, 0.002), 0.72 (0.54-0.96, 0.007), 0.74 (0.56-0.98, 0.04), 0.57 (0.42-0.76, <0.0001), 0.73 (0.55-0.98, 0.03), 0.65 (0.49-0.87, 0.003), and 0.63 (0.46-0.86, 0.002), respectively.	

Table 23: Q2 Consumption of meat during pregnancy

Study ref	N	Aim/methods	Results	Comments
Castro-Rodriguez et al 2016[53] International Study of Wheezing in Infants Spain Cohort	1,000 preschool children	**Aim**: To examine whether some foods and Mediterranean diet (MedDiet) consumed by the mother during pregnancy and by the child during the first years of life can be protective for current wheezing, rhinitis and dermatitis at preschool age. **Methods**: Questionnaires of epidemiological factors and food intake by the mother during pregnancy and later by the child were filled in by parents in two surveys at two different time points (1.5 yrs and 4 yrs of life).	Intermediate consumption of meat (1 or 2 times/week) during pregnancy was protective against wheeze in the child (p=0.039).	
Lombardi et al 2015[76] United States Case-control	Cases 163 Controls 136	**Aim**: To examine the relation between maternal diet and unilateral retinoblastoma. **Methods**: A case-control study of 163 unilateral RB cases and 136 controls ascertained information on maternal diet during pregnancy using a standardised food frequency questionnaire. Logistic regression was used to assess the relation between retinoblastoma and food groups and dietary patterns.	A positive association was seen with intake of cured meats (OR 5.07, 95 % CI 1.63 to 15.70).	

Table 24: Q2 Consumption of fish during pregnancy

Study ref	N	Aim/methods	Results	Comments
Maslova et al 2013[84] Denmark Cohort	28,936 women	**Aim**: To examine the associations of maternal fish intake during pregnancy with child asthma and allergic rhinitis. **Methods**: Women in the Danish National Birth Cohort (n 28 936) reported their fish intake at 12 and 30 weeks of gestation. Using multivariate logistic regression, we examined the associations of fish intake with child wheeze, asthma and rhinitis assessed at several time points: ever wheeze, recurrent wheeze (>3 episodes), ever asthma and allergic rhinitis, and current asthma, assessed at 18 months (n approximately 22,000) and 7 years (n approximately 17,000) using self-report and registry data on hospitalisations and prescribed medications.	Compared with consistently high fish intake during pregnancy (fish as a sandwich or hot meal ≥2-3 times/week), never eating fish was associated with a higher risk of child asthma diagnosis at 18 months (OR 1.30, 95%CI 1.05 to 1.63, P=0.02), and ever asthma by hospitalisation (OR 1.46, 95% CI 0.99, 2.13, P=0.05) and medication prescription (OR 1.37, 95% CI 1.10, 1.71, P=0.01). A dose-response was present for asthma at 18 months only (P for trend=0.001). We found no associations with wheeze or recurrent wheeze at 18 months or with allergic rhinitis.	
Mesirow et al 2017[88] United Kingdom Cohort	5,727 mother-child pairs	**Aim**: To investigate early life diet as a risk factor for early-onset persistent conduct problems (EOP CP). **Methods**: Mother-child pairs reported intake of fish and processed foods at 32 weeks gestation and, for the child, at 3 years; EOP (n = 666) and Low conduct problem (Low CP, n = 5061) trajectories were measured from 4 to 13 years; hyperactivity and emotional difficulties were assessed in childhood (4-10 years) and early adolescence (12-13 years), in addition to potential confounding factors (family adversity, birth complications, income).	Compared to low conduct problems, mothers of early onset persistent conduct problems children consumed less fish (p<0.01) prenatally.	

Study ref	N	Aim/methods	Results	Comments
Vejrup et al 2014[79] Norway Cohort	56,988 women	**Aim**: To examine the association between calculated maternal dietary exposure to mercury (Hg) in pregnancy and infant birth weight in the Norwegian Mother and Child Cohort Study (MoBa). **Methods**: Exposure was calculated with use of a constructed database of Hg in food items and reported dietary intake during pregnancy. Multivariable regression models were used to explore the association between maternal Hg exposure and infant birth weight, and to model associations with small-for-gestational-age offspring. The study is based on data from MoBa.	Median exposure to Hg was 0.15 mug/kg body weight per week and the contribution from seafood intake was 88 % of total Hg exposure. Women in the highest quintile compared with the lowest quintile of Hg exposure delivered offspring with 34 g lower birth weight (95 % CI -46 g to -22 g) and had an increased risk of giving birth to small-for-gestational-age offspring, adjusted OR = 1.19 (95 % CI 1.08, 1.30). Although seafood intake was positively associated with increased birth weight, stratified analyses showed negative associations between Hg exposure and birth weight within strata of seafood intake.	
Verjup et al 2016[87] Norway Cohort	46,750 mother-child pairs	**Aim**: To examine the association between prenatal exposure to methylmercury (MeHg) and language and communication development at three years, adjusting for intake of fish, n-3 long chain polyunsaturated fatty acids (n-3 LCPUFAs) and co-exposure to dioxins and dioxin like polychlorinated biphenyls (dl-PCBs). **Methods**: MeHg exposure was calculated from reported fish intake during pregnancy by a FFQ in mid-pregnancy. Children's language and communication skills were measured by maternal report on the Dale and Bishop grammar rating and the Ages and Stages communication scale (ASQ). We estimated odds ratios (OR) and 95% confidence intervals (CI) using logistic regressions. Median MeHg exposure was 1.3mug/day, corresponding to 0.14mug/kgbw/week. An exposure level above the 90th percentile (>2.6mug/day, >0.29mug/kgbw/week) was defined as the high MeHg exposure.	Results indicated an association between high MeHg exposure and unintelligible speech with an adjusted OR 2.22 (1.31 to 3.72). High MeHg exposure was also associated with weaker communication skills adjusted OR 1.33 (1.03 to 1.70). Additional adjustment for fish intake strengthened the associations, while adjusting for PCBs and n-3 LCPUFA from diet or from supplements had minor impact. In conclusion, significant associations were found between prenatal MeHg exposure above the 90th percentile and delayed language and communication skills in a generally low exposed population.	

Study ref	N	Aim/methods	Results	Comments
Verjup et al 2018[86] Norway Cohort	38,351 mother-child pairs	**Aim**: To evaluate the association between prenatal mercury exposure, maternal seafood consumption and child language and communication skills at age five. **Methods**: Maternal mercury blood concentration in gestational week 17 was analysed in a sub-sample of 2239 women. Prenatal mercury exposure from maternal diet was calculated from a validated FFQ answered in mid-pregnancy. Mothers reported children's language and communications skills at age five by a questionnaire including questions from the Ages and Stages Questionnaire (ASQ), the Speech and Language Assessment Scale (SLAS) and the Twenty Statements about Language-Related Difficulties (language 20). We performed linear regression analyses adjusting for maternal characteristics, nutritional status and socioeconomic factors.	Median maternal blood mercury concentration was 1.03mug/L, dietary mercury exposure was 0.15mug/kgbw/wk, and seafood intake was 217g/wk. Blood mercury concentrations were not associated with any language and communication scales. Increased dietary mercury exposure was significantly associated with improved SLAS scores when mothers had a seafood intake below 400g/wk in the adjusted analysis. Sibling matched analysis showed a small significant adverse association between those above the 90th percentile dietary mercury exposure and the SLAS scores. Maternal seafood intake during pregnancy was positively associated with the language and communication scales.	
Starling et al 2015[85] SLR	8 studies	**Aim**: To critically evaluate literature on fish intake in pregnant women, with a focus on the association between neurodevelopmental outcomes in the offspring and maternal fish intake during pregnancy. **Methods**: Peer-reviewed journal articles published between January 2000 and March 2014 were included. Eligible studies included those of healthy pregnant women who had experienced full term births and those that had measured fish or seafood intake and assessed neurodevelopmental outcomes in offspring. Medline, Scopus, Web of Science, ScienceDirect and the Cochrane Library were searched using the search terms: pregnant, neurodevelopment, cognition, fish and seafood.	Due to heterogeneity in methodology and measured outcomes, a qualitative comparison of study findings was conducted. This review indicates that the benefits of diets providing moderate amounts of fish during pregnancy outweigh potential detrimental effects in regards to offspring neurodevelopment. It is important that the type of fish consumed is low in mercury.	

Study ref	N	Aim/methods	Results	Comments
Van den Berg et al 2016[81] The Netherlands Cohort	3,684 women	**Aim**: To investigate the association between maternal fish consumption during pregnancy and BMI in children. **Methods**: Maternal fish consumption during pregnancy and the child's body weight and height (up to 11 times) were reported by questionnaire. Generalised estimating equations were used to investigate whether BMI of children differed according to maternal fish consumption during pregnancy.	Children of mothers who consumed fish ≥1/week during pregnancy had statistically significant lower mean BMI z scores than children of mothers who never consumed fish (n=1,025) at the ages 4, 7, 8.5, and 11.5 years. After adjustment for maternal covariates (particularly pre-pregnancy BMI), BMI z scores in children were lower at 7 years (MD -0.14 95% CI -0.25 to -0.03) but not at 4, 8.5 or 11.5 years.	
Viljoen et al 2018[74] Ireland Cohort	897 mother-child pairs	**Aim**: To establish whether vegetable, oily fish and vitamin D intake during pregnancy are associated with childhood asthma risk over a 10-year period. **Methods**: Mother-child pairs with data on nutrient intake during pregnancy and asthma status, respectively, were included in the analysis. Data on socioeconomic and morbidity indicators over 10 years of follow-up on mothers and the index child were collected through self-administered questionnaires.	Asthma was inversely associated with higher daily average intake of oily fish (aOR 0.23 per serving/day, 95% CI 0.04 to 1.41).	
Zhang et al 2017[82] SLR	1 RCT 13 cohort studies	**Aim**: To establish the effect of maternal fish intake on allergic disease in the infant. **Methods**: PubMed, EMBASE, and Cochrane Central Register of Controlled Trials were searched for randomised controlled trials (RCTs) and prospective cohort studies regarding the effect of fish intake during pregnancy or infancy on allergic outcomes in children. The outcomes of interest were atopy, eczema, allergic rhinitis, wheeze, asthma, and food allergy.	Pooled analysis suggested that maternal fish intake during pregnancy was not associated with lower risk of eczema (RR 0.88; 95%CI 0.75 to 1.04; 10 studies), wheeze (RR 0.94; 95%CI 0.83 to 1.07; 8 studies), allergic rhinitis (RR 0.95; 95%CI 0.62 to 1.45; 3 studies) or asthma (RR 0.94; 95%CI 0.75 to 1.18; 4 studies).	

Study ref	N	Aim/methods	Results	Comments
Stratakis et al 2016[80] Cohort Belgium, France, Greece, Ireland, Italy, the Netherlands, Norway, Poland, Portugal, Spain and United States	26,184 women	**Aim**: To examine whether fish intake in pregnancy is associated with offspring growth and the risk of childhood overweight and obesity. **Methods**: Women with singleton births and their children were followed up at 2-year intervals until the age of 6 years. We estimated offspring body mass index percentile trajectories from 3 months after birth to 6 years of age. We defined rapid infant growth as a weight gain z score greater than 0.67 from birth to 2 years and childhood overweight/obesity at 4 and 6 years as body mass index in the 85th percentile or higher for age and sex. We calculated cohort-specific effect estimates and combined them by random-effects meta-analysis.	Women who ate fish >3 times/week during pregnancy gave birth to infants with higher BMI values from infancy through middle childhood compared with women with lower fish intake (≤3 times/week). High fish intake during pregnancy (>3 times/week) was associated with increased risk of rapid infant growth (aOR 1.22; 95%CI 1.05 to 1.42) and increased risk of offspring overweight/obesity at 4 years (aOR 1.14; 95%CI 0.99 to 1.32) and 6 years (aOR 1.22; 95%CI 1.01 to 1.47]) compared with an intake of once per week or less. Interaction analysis showed that the effect of high fish intake during pregnancy on rapid infant growth was greater among girls (aOR 1.31; 95%CI 1.08 to 1.59) than among boys (aOR 1.11; 95%CI 0.92 to 1.34; P=0.02 for interaction).	Findings are in line with the fish intake limit proposed by the US Food and Drug Administration and Environmental Protection Agency
Emmett et al 2015[77] United Kingdom Cohort	12,418	**Aim:** To determine the effect of seafood consumption on depressive symptoms in pregnancy. **Methods:** All publications covering diet during pregnancy that stemmed from the Avon Longitudinal Study of Parents and Children were reviewed. Diet was assessed using a food frequency questionnaire. Socioeconomic background, maternal mental health, and the health and development of the offspring were assessed using a variety of methods, such as direct measurement, self-completion questionnaires, and assays of biological samples.	Compared with women consuming seafood frequently (> 3 portions per week providing > 1.5 g/week n-3 LC-PUFA), those consuming none were more likely to have frequent depressive symptoms at 32 weeks of pregnancy (aOR 1.54; 95%CI 1.25 to 1.89).	

Study ref	N	Aim/methods	Results	Comments
Ozawa et al 2014[83] Cohort Japan	650 mother-baby pairs	**Aim**: To investigate the association between the maternal diet during pregnancy and the risk of eczema in infancy in Japan. **Methods**: A birth cohort was set up at 2 hospitals in Chiba city. Dietary habits concerning fish, butter, margarine, yogurt and natto during pregnancy was obtained from mothers just after birth. The intake frequencies of these foods were classified into four groups: 1) daily, 2) 2-3 times a week, 3) once a week and 4) once a month or less. Diagnosis of eczema at 6 months of age was made by the presence of an itchy rash that persisted more than two months.	No relationship between frequencies of the maternal intake of fish and the onset rate of the babies' eczema was observed (p=0.132).	
Dessypris et al 2017[75] SLR of case-control studies	9 studies	**Aim**: To quantitatively synthesise published data on the association of maternal/child diet with leukaemia risk. **Methods**: Medline was searched until June 30th, 2016 for eligible articles on the association of childhood leukaemia with consumption of (i) food groups, excluding alcoholic and non-alcoholic beverages, and (ii) specific dietary supplements before/during index pregnancy and childhood.	A statistically significant inverse estimate for leukaemia was found for maternal fish intake (OR 0.27, 95% CI: 0.14 to 0.53, among the 0-4 year old; 2 studies).	

Study ref	N	Aim/methods	Results	Comments
Mohanty et al 2016[78] United States Cohort	3,279	**Aim**: To investigate associations of maternal periconceptional shellfish, lean fish and fatty fish intake with risk of pregnancy complications. **Methods**: In this prospective cohort study, we collected information on intake of seafood subtypes using food frequency questionnaire. We categorised seafood intake into frequencies of 1 serving/week. We ascertained gestational hypertension, pre-eclampsia, gestational diabetes and preterm birth diagnoses from medical records. Using generalised linear models with a log link, the Poisson family and robust standard errors, we estimated risk ratios and 95 % confidence intervals across seafood intake categories.	Lean fish intake of >1 servings/week (vs <0.2 servings/month) was associated with a 1.55-fold higher risk of preterm birth (95 % CI 1.04 to 2.30) and was not associated with the other pregnancy complications. Higher intake of seafood (total or other subtypes) was not associated with pregnancy complications (separately or combined).	Studies of mechanisms and potential contributing factors (including seafood preparation and nutrient/ contaminant content) are warranted.
Alvarez Zallo et al 2018[52] Europe and Latin America International Study of Wheezing in Infants Cross-section	1,087 infants 12-15 months of age	**Aim:** To examine the relationship between different food groups and the adherence to a Mediterranean diet during pregnancy and the risk of wheezing and eczema in children aged 12-15 months. **Methods**: The study of the association of the different food consumption and Mediterranean diet with wheezing, recurrent wheezing and eczema was performed using different models of unconditional logistic regression to obtain adjusted prevalence odds ratios (OR) and 95% confidence intervals (95% CI).	The consumption once or twice a week of white fish during pregnancy increased the risk of "wheezing" at 12 months (OR: 1.95 [1.01 to 3.75]).	

Table 25: Q2 Consumption of dairy products during pregnancy

Study ref	N	Aim/methods	Results	Comments
Tuokkola et al 2016[91] Finland Cohort	6,288	**Aim**: To study the associations between maternal diet during pregnancy and lactation and cow's milk allergy (CMA) in offspring. **Methods**: Maternal diet during pregnancy and lactation was assessed by a validated, 181-item semi-quantitative food frequency questionnaire. Register-based information on diagnosed CMA was obtained from the Social Insurance Institution and completed with parental reports. The associations between maternal food consumption and CMA were assessed using logistic regression, comparing the highest and the lowest quarters to the middle half of consumption.	Consumption of milk products in the highest quartile during pregnancy was associated with a lower risk of cow's milk allergy in children (OR 0.56, 95%CI 0.37 to 0.86; P<0.01). When stratified by maternal allergic rhinitis and asthma, there was evidence of an inverse association between high use of milk products and CMA in offspring of non-allergic mothers (OR 0.30, 95%CI 0.13 to 0.69, P<0.001).	
Miyake et al 2015[89] Japan Cross-section	1,354 mother-child pairs	**Aim**: To examine the association between maternal intake of dairy foods, calcium, and vitamin D during pregnancy and childhood allergic disorders in Japanese children aged 23 to 29 months. **Methods**: Maternal intake during pregnancy was assessed with a validated diet history questionnaire administered between April 2007 and March 2008. Wheeze and eczema, defined according to criteria of the International Study of Asthma and Allergies in Childhood, and physician-diagnosed asthma and atopic eczema were assessed via a questionnaire completed by mothers.	Higher maternal intake of total dairy products during pregnancy was significantly associated with a reduced risk of infantile eczema between extreme quartiles (aOR 0.64; 95%CI 0.42 to 0.98). Higher maternal intake of cheese during pregnancy was significantly related to a reduced risk of physician-diagnosed infantile asthma between extreme quartiles (aOR 0.44; 95%CI 0.18 to 0.97). Maternal intake levels of yogurt during pregnancy were significantly inversely associated with physician-diagnosed infantile atopic eczema between extreme quartiles (aOR 0.49; 95% CI, 0.20 to 1.16).	

Study ref	N	Aim/methods	Results	Comments
Wang et al 2015[72] China Case-control	459 cases 459 controls	**Aim**: To study the associations between maternal consumption of non-staple food in the first trimester and risk of neural tube defects (NTDs) in offspring. **Methods**: Logistic regression models were used to examine the associations between maternal consumption of non-staple food in the first trimester and risk of NTDs in offspring. The effects were evaluated by odds ratio (OR) and 95% confidence intervals (95% CIs) with SAS9.1.3.software.	Compared with consumption frequency of <1 meal/week, the ORs for neural tube defects with milk consumption frequency of 1-2, 3-6, ≥7 meals/week were 0.50 (95% CI: 0.28 to 0.88), 0.56 (0.32 to 0.99), and 0.59 (0.38 to 0.90), respectively.	
Bunyavanich et al 2014[90] United States Cohort	1,227 mother-child pairs	**Aim**: To examine the associations between maternal intake of common childhood food allergens during early pregnancy and childhood allergy and asthma. **Methods**: Using food frequency questionnaires administered during the first and second trimesters, we assessed maternal intake of common childhood food allergens during pregnancy. In mid-childhood (mean age 7.9 years), we assessed food allergy, asthma, allergic rhinitis, and atopic dermatitis by questionnaire and serum-specific IgE levels. We examined the associations between maternal diet during pregnancy and childhood allergy and asthma. We also examined the cross-sectional associations between specific food allergies, asthma, and atopic conditions in mid-childhood.	Higher milk intake during the first trimester was associated with reduced asthma (OR 0.83; 95% CI 0.69 to 0.99) and allergic rhinitis (OR 0.85; 95%CI 0.74 to 0.97).	

Study ref	N	Aim/methods	Results	Comments
Miyake et al 2015[89] Japan Cross-section	1,745 women	**Aim:** To examine the relationship between the intake of dairy products and calcium and the prevalence of depressive symptoms during pregnancy. **Methods**: Dietary intake during the preceding month was assessed using a self-administered diet history questionnaire. Scores of 16 or higher on the Center for Epidemiologic Studies Depression Scale denoted depressive symptoms. Adjustment was made for age, gestation, region of residence, number of children, family structure, history of depression, family history of depression, smoking, second-hand smoke exposure at home and at work, job type, household income, education, and body mass index. In our analyses regarding dairy products in general, adjustment was also made for fish intake; in our analysis regarding calcium, adjustment was also made for the intake of saturated fatty acids, eicosapentaenoic acid plus docosahexaenoic acid, and vitamin D.	Higher intake of yogurt was independently related to a lower prevalence of depressive symptoms during pregnancy: the adjusted odds ratio between extreme quartiles (80 vs 4 g/day) was 0.69 (95% CI 0.48 to 0.99, P for trend=0.03). No relationships were observed between the intake of all dairy products (aOR 0.93; 95%CI 0.66–1.32; p=0.47), milk (aOR 0.89; 95%CI 0.63 to 1.25; p=039) or cheese (aOR 0.86; 95%CI 0.59–1.24; p=0.58) and depressive symptoms during pregnancy.	

Table 26: Q2 Consumption of carbohydrates during pregnancy

Study ref	N	Aim/methods	Results	Comments
Alvarez Zallo et al 2018[52] Europe and Latin America International Study of Wheezing in Infants Cohort	1,087 infants 12-15 months of age	**Aim:** To examine the relationship between different food groups and the adherence to a Mediterranean diet during pregnancy and the risk of wheezing and eczema in children aged 12-15 months. **Methods**: The study of the association of the different food consumption and Mediterranean diet with wheezing, recurrent wheezing and eczema was performed using different models of unconditional logistic regression to obtain adjusted prevalence odds ratios and 95% confidence intervals.	The consumption once or twice of cooked potatoes (OR: 1.75 [1.22 to 2.51]) and industrial pastry (OR: 1.59 [1.13 to 2.24]), and the consumption more than three times a week of industrial pastry (OR: 1.47 [1.01 to 2.13]) during pregnancy increased the risk of "wheezing" at 12 months.	
Castro-Rodriguez et al 2016[53] International Study of Wheezing in Infants Spain Cohort	1,000 preschool children	**Aim**: To examine whether some foods and Mediterranean diet (MedDiet) consumed by the mother during pregnancy and by the child during the first years of life can be protective for current wheezing, rhinitis and dermatitis at preschool age. **Methods**: Questionnaires of epidemiological factors and food intake by the mother during pregnancy and later by the child were filled in by parents in two surveys at two different time points (1.5 yrs and 4 yrs of life).	Consumption of pasta never or occasionally (p=0.049) during pregnancy were protective against wheeze in the child.	

Study ref	N	Aim/methods	Results	Comments
Renault et al 2015[92] Analysis of RCT participants Denmark	222	**Aim**: To examine the association between carbohydrate intake in obese pregnant women and their offspring's body composition. **Methods**: Secondary analyses were performed in an observational setting of pregnant women with a pregestational BMI ≥30 participating in a randomized controlled trial. Diet was assessed at gestational weeks 11-14 and 36-37 by using a semiquantitative food-frequency questionnaire. Body composition in the offspring was assessed at birth by dual-energy X-ray absorptiometry. Relative fat mass (%) was the primary outcome. Absolute measures (total fat, abdominal fat, and lean body mass) were secondary outcomes.	Maternal intake of digestible carbohydrates was associated with the offspring's relative fat mass in late (P-trend = 0.006) but not early (P-trend = 0.15) pregnancy. A comparison of mothers in the highest (median: 238 g/d) compared with the lowest (median: 188 g/d) quartile of digestible carbohydrate intake showed a mean adjusted higher value in the offspring's relative fat mass of 2.1% (95% CI 0.6% to 3.7%), which corresponded in absolute terms to a 103 g (95% CI: 27 to 179 g) higher fat mass. Abdominal fat mass was also higher. In a strata of women with well-controlled glucose (2-h glucose values ≤6.6 mmol/L), no association between carbohydrate intake and offspring fat mass was observed, but the associations became significant and increased in strength with higher intolerance (strata with 2-h glucose values between 6.7-7.7 and ≥7.8 mmol/L).	
Sharma et al 2018[93] United Kingdom Cohort	1,196	**Aim:** To investigate the association between maternal dietary macronutrient intakes and their sub-components such as saccharides and fatty acids and birth weight. **Methods**: Women were interviewed in each trimester. Dietary information was collected twice using a 24-h dietary recall about 8-12 weeks and 13-27 weeks of gestation.	Multiple linear regression models adjusted for alcohol and smoking in trimester 1, showed that each additional 10 g/d carbohydrate consumption was associated with an increase of 4 g (95 % CI 1, 7; P=0.003) in birth weight. Maternal diet in trimester 2 suggested that higher intakes of glucose (10 g/d) and lactose (1 g/d) were both associated with higher birth weight of 52 g (95 % CI 4, 100; P=0.03) and 5 g (95 % CI 2, 7; P<0.001) respectively.	

Table 27: Q2 Consumption of protein during pregnancy

Study ref	N	Aim/methods	Results	Comments
Sharma et al 2018[93] United Kingdom Cohort	1,196	**Aim:** To investigate the association between maternal dietary macronutrient intakes and their sub-components such as saccharides and fatty acids and birth weight. **Methods**: Women were interviewed in each trimester. Dietary information was collected twice using a 24-h dietary recall about 8-12 weeks and 13-27 weeks of gestation.	There was no evidence of an association between protein intake and birth weight (MD 9; 95%CI -22.0 to 8).	
Chen et al 2016[97] Singapore Cohort	320 mother-child pairs	**Aim**: To investigate the relation between maternal macronutrient intake and neonatal abdominal adiposity measured by using MRI in a multiethnic Asian mother-offspring cohort. **Methods**: The macronutrient intake of mothers was ascertained by using a 24-h dietary recall at 26-28 wk gestation. Neonatal abdominal adiposity was assessed by using MRI in week 2 of life. Mother-offspring dyads with complete macronutrient intake and adiposity information were included in the analysis. Associations were assessed by both substitution and addition models with the use of multivariable linear regressions.	A higher-protein, lower-carbohydrate or -fat diet during pregnancy was associated with lower abdominal internal adipose tissue (IAT) in the neonates [beta (95% CI): -0.18 mL (-0.35 to -0.001 mL) per 1% protein-to-carbohydrate substitution and -0.25 mL (-0.46 to -0.04 mL) per 1% protein-to-fat substitution].	

Study ref	N	Aim/methods	Results	Comments
Pang et al 2017[94] Singapore Cross-section	980 women	**Aim**: To examine the associations of dietary protein intake from different food sources during pregnancy with the risk of GDM in a multiethnic Asian population. **Methods**: Protein intake was ascertained from 24-h dietary recall and 3-d food diaries at 26-28 wk gestation. GDM was defined as fasting glucose >/=7.0 mmol/L and/or 2-h postload glucose >/=7.8 mmol/L at 26-28 wk gestation. We evaluated the association of dietary protein intake with GDM risk by substituting carbohydrate with protein in an isocaloric model with the use of multivariable logistic regression analysis.	After adjustment for potential confounders, a higher total dietary protein intake was associated with a higher risk of GDM; the OR comparing the highest with the lowest quartile of intake was 2.15 (95% CI 1.27 to 3.62; P-trend = 0.016). Higher intake levels of both animal protein (OR 2.87; 95% CI: 1.58, 5.20; P-trend = 0.001) and vegetable protein (OR 1.78; 95% CI: 0.99, 3.20; P-trend = 0.009) were associated with a higher risk of GDM. Among the animal protein sources, higher intake levels of seafood protein (OR: 2.17; 95% CI: 1.26, 3.72; P-trend = 0.023) and dairy protein (OR: 1.87; 95% CI: 1.11, 3.15; P-trend = 0.017) were significantly associated with a higher GDM risk.	
Tielemans et al 2017[96] The Netherlands Cohort	2,694 mother-child pairs	**Aim**: To examine whether protein intake during pregnancy is associated with offspring body composition at the age of 6 years and whether associations differ for animal protein and vegetable protein. **Methods**: Energy-adjusted protein was measured in pregnancy using a food-frequency questionnaire and analysed in quartiles. At a mean age of 6.1 +/- 0.4 years, we measured children's body mass index, and fat-free mass index and fat mass index using dual-energy X-ray absorptiometry. Outcomes were standardized for age and sex. BMI was used to classify children's overweight status.	After adjustment for sociodemographic and lifestyle factors, a higher maternal protein intake was associated with a higher children's fat-free mass index (beta 0.14; 95 % CI 0.03 to 0.25 for highest vs. lowest quartile of protein intake], but not with children's fat mass index or body mass index. Comparable associations were found for animal protein and vegetable protein. Maternal protein intake was not associated with children's overweight.	

Study ref	N	Aim/methods	Results	Comments
Switowski et al 2016[95] United States Cohort	1,961 mother-child pairs	**Aim**: To examine associations of maternal protein intake during pregnancy with offspring linear growth. **Methods**: We assessed first- and second-trimester diet with the use of food-frequency questionnaires and analysed protein intake as grams per kilogram prepregnancy weight per day. We used research measures of offspring length at birth and in infancy (approximately 6 mo), early childhood (approximately 3 y), and midchildhood (approximately 7 y), as well as clinical growth measures obtained from after birth through midchildhood. We calculated sex-specific birth length z scores for gestational age with the use of international reference data. We used mixed models with repeated length measures to predict individual length gain velocities for birth to <6 mo and 6 mo to 7 y of age, then used these velocities as outcomes in adjusted linear regression models with maternal protein intake as the main predictor.	After adjusting for maternal sociodemographics, gestational weight gain, maternal and paternal height, and child sex, gestational age, and breastfeeding duration, each 1-SD (0.36 g . kg^{-1} . d^{-1}) increment in second-trimester protein intake corresponded to a -0.10 (95% CI -0.18 to -0.03) change in birth length z score, a -0.03 cm/mo (95% CI -0.05 to -0.01 cm/mo) change in slope of length growth from birth to <6mo, and a -0.09 cm/y (95% CI: -0.14 to -0.05 cm/y) change in slope of length growth from 6 mo to midchildhood. Results were similar for first-trimester intake.	

Table 28: Q2 Consumption of fats during pregnancy

Study ref	N	Aim/methods	Results	Comments
Sharma et al 2018[93] United Kingdom Cohort	1,196	**Aim:** To investigate the association between maternal dietary macronutrient intakes and their sub-components such as saccharides and fatty acids and birth weight. **Methods**: Women were interviewed in each trimester. Dietary information was collected twice using a 24-h dietary recall about 8-12 weeks and 13-27 weeks of gestation.	An additional 10 g/d fat intake was associated with a lower birth weight of 8 g (95 % CI 0, 16; P=0.04).	
Mizgier et al 2019[98] Poland Cohort	55 women	**Aim:** To show the relationship between maternal eating habits and the risk of developing gestational diabetes mellitus (GDM). **Methods**: Nutrition was evaluated using a three-day food record and food frequency questionnaire (FFQ) and nutrition of 12 months before pregnancy was assessed only by means of the FFQ. The women were divided into groups: H – with uncomplicated pregnancy (n=42) and GDM – with gestational diabetes mellitus (n=13), based on oral glucose tolerance test (OGTT) results performed between 24 and 28 weeks.	Significant differences were found between groups H and GDM in terms of daily fat intake (32.1 versus 36.2%) and dietary reference values (standards) for total fat, monosaturated fatty acids (MUFA), and polysaturated fatty acids (PUFA). In the GDM group, the coverage of standards for total fat, saturated fatty acids (SFA) and MUFA exceeded the recommended values. Higher intake of energy from total fat and saturated fatty acid in the first half of pregnancy and before pregnancy may contribute to an increased risk of developing GDM.	

Study ref	N	Aim/methods	Results	Comments
Ozawa et al 2014[83] Cohort Japan	650 mother-baby pairs	**Aim**: To investigate the association between the maternal diet during pregnancy and the risk of eczema in infancy in Japan. **Methods**: A birth cohort was set up at 2 hospitals in Chiba city. Dietary habits concerning fish, butter, margarine, yogurt and natto during pregnancy was obtained from mothers just after delivery. The intake frequencies of these foods were classified into four groups: 1) daily, 2) 2-3 times a week, 3) once a week and 4) once a month or less. Diagnosis of eczema at 6 months of age was made by the presence of an itchy rash that persisted more than two months.	No relationship between frequencies of the maternal intake of margarine (p=0.368) during pregnancy and the onset rate of the babies' eczema were observed For butter consumption, the incidence of babies' eczema was significantly higher in the group with daily intake than in those with an intake 2-3 times a week or less (p=0.044).	

Table 29: Q2 Consumption of sweetened foods and beverages during pregnancy

Study ref	N	Aim/methods	Results	Comments
Soto et al 2015[64] Puerto Rico Cohort	180	**Aim**: To describe the dietary patterns of pregnant women in northern Puerto Rico and explore associations between diet factors with pregnancy related measurements. **Methods**: Participants completed a food frequency questionnaire (FFQ) around 20-28 weeks of gestation. The following pregnancy related measures were collected from the medical records: haemoglobin, blood glucose, blood pressure and gestational age. Potential associations between diet factors and pregnancy measures were assessed using chi square analysis with SPSS.	High consumption of desserts and sweets was associated with higher levels of fasting blood glucose levels ($p < 0.05$).	
Zhu et al 2017[103] Denmark Cohort	918 mother-child dyads	**Aim**: To investigate intake of artificially sweetened beverages (ASBs) and sugar-sweetened beverages (SSBs) during pregnancy in relation to offspring growth through age 7 years among high-risk children born to women with gestational diabetes. **Methods**: Maternal dietary intake was assessed by a food frequency questionnaire during pregnancy. Offspring body mass index z-scores (BMIZ) and overweight/obesity status were derived using weight and length/height at birth, 5 and 12 months and 7 years. Linear regression and Poisson regression with robust standard errors were used, adjusting for major risk factors.	Compared to never consumption, daily ASB intake during pregnancy was positively associated with offspring large-for-gestational age (aRR 1.57; 95%CI 1.05 to 2.35 at birth), BMIZ (adjusted beta 0.59; 95% CI 0.23 to 0.96) and overweight/obesity (aRR 1.93; 95%CI 1.24 to 3.01) at 7 years. Per-serving-per-day substitution of ASBs with water during pregnancy was related to a lower overweight/obesity risk at 7 years (aRR 0.83; 95% CI 0.76 to 0.91), whereas SSB substitution with ASBs was not related to a lower risk (aRR 1.14; 95%CI 1.00, 1.31).	

Study ref	N	Aim/methods	Results	Comments
Renault et al 2015[100] RCT Denmark	342	**Aim**: To evaluate improvements and relevance of different dietary factors targeted with respect to gestational weight gain in a 3-arm Randomised Controlled Trial (n=342) among obese pregnant women with BMI30 kg/m2. **Methods**: Randomisation 1:1:1 to either hypocaloric Mediterranean type of diet and physical activity intervention (D+PA); physical activity intervention alone (PA); or control (C). Diet was assessed at baseline (weeks 11–14) and endpoint (weeks 36–37) using a validated food frequency questionnaire.	Foods that contributed to intake of added sugars, including sweets, snacks, cakes, and soft drinks were strongly associated with weight gain, with women consuming sweets 2/day having 5.4 kg (95% CI 2.1-8.7) greater weight gain than those with a low (<1wk) intake. The results for soft drinks were more conflicting, as women with high weight gain tended to favour artificially sweetened soft drinks.	
Paskulin et al 2017[69] Brazil Cross-section	712 women	**Aim:** To evaluate the association between dietary patterns and mental disorders among pregnant women in southern Brazil. **Methods**: Food intake assessment was performed using the Food Frequency Questionnaire. Dietary patterns were identified by cluster analysis. The Primary Care Evaluation of Mental Disorders (PRIME-MD) was used to evaluate participants' mental health. Poisson regression models with robust variance were fitted to estimate prevalence ratios (PR).	In the adjusted models, there was a high prevalence of major depressive disorder among women with high sweets and sugars intake (PR 1.91, 95%CI 1.19 to 3.07).	

Study ref	N	Aim/methods	Results	Comments
Azad et al 2016[102] Canada Cohort	3,033 mother-infant dyads 2,686 infants at 1 year	**Aim**: To determine whether maternal consumption of artificially sweetened beverages during pregnancy is associated with infant body mass index. **Methods**: Healthy pregnant women completed dietary assessments during pregnancy, and their infants' BMI was measured at 1 year of age. Statistical analysis for this study used data collected after the first year of follow-up and maternal consumption of artificially sweetened beverages and sugar-sweetened beverages during pregnancy, determined by a food frequency questionnaire.	Compared with no consumption, daily consumption of artificially sweetened beverages was associated with a 0.20-unit increase in infant BMI z score (adjusted 95% CI, 0.02 to 0.38) and a 2-fold higher risk of infant overweight at 1 year of age (aOR 2.19; 95%CI 1.23 to 3.88). These effects were not explained by maternal BMI, diet quality, total energy intake, or other obesity risk factors. There were no comparable associations for sugar-sweetened beverages.	
Bedard et al 2017[104] United Kingdom Cohort	8,956 children aged 7-9 years	**Aim:** To study the relationship between maternal intake of free sugar (which comprise sugars [monosaccharides and disaccharides] added to foods or drinks by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups and unsweetened fruit juices) during pregnancy and respiratory and atopic outcomes in the offspring in a population-based birth cohort, the Avon Longitudinal Study of Parents and Children. **Methods**: We analysed associations between maternal intake of free sugar in pregnancy (estimated by a food frequency questionnaire), and current doctor-diagnosed asthma, wheezing, hay fever, eczema, atopy, serum total IgE and lung function in children aged 7-9 years.	After controlling for potential confounders, maternal intake of free sugar was positively associated with atopy (OR for highest versus lowest quintile of sugar intake 1.38, 95% CI 1.06-1.78; per quintile p-trend=0.006) and atopic asthma (OR 2.01, 95% CI 1.23-3.29; per quintile p-trend=0.004). These associations were not confounded by intake of sugar in early childhood, which was unrelated to these outcomes.	

Study ref	N	Aim/methods	Results	Comments
Donazar-Ezcurra et al 2018[101] Spain Seguimiento Universidad de Navarra (SUN) Cohort	3,396 women	**Aim:** To investigate the incidence of GDM according to soft drink consumption in the SUN project. **Methods**: A validated 136-item semi-quantitative food frequency questionnaire was used to assess soft drink consumption. Four categories of sugar-sweetened soft drink (SSSD) and diet soft drink (DSD) consumption (servings) were established: rarely or never (<1/month), low (1-3/month), intermediate (>3/month and </=1/week) and high (>/=2/week). Potential confounders were adjusted through non-conditional logistic regression models.	During the follow-up, we identified 172 incident cases of GDM. After adjusting for age, baseline body mass index, family history of diabetes, smoking, total energy intake, physical activity, parity, fast-food consumption, adherence to Mediterranean dietary pattern, alcohol intake, multiple pregnancy, cardiovascular disease/hypertension at baseline, fibre intake, following special diet and snacking, SSSD consumption was significantly associated with an increased risk of incident GDM, for the highest (aOR 2.03; 95%CI 1.25 to 3.31) and intermediate categories (aOR 1.67; 95%CI 1.01 to 2.77) versus the lowest category (p for linear trend: 0.006). Conversely, DSD consumption was not associated with GDM incidence (aOR 0.82; 95%CI 0.52 to 1.31) for the highest versus the lowest category (p for linear trend: 0.258). Additional sensitivity analyses did not change the results.	

Table 30: Q2 Consumption of fast foods during pregnancy

Study ref	N	Aim/methods	Results	Comments
Von Ehrenstein et al 2015[106] United States Cohort	1,201 mother-infant pairs	**Aim**: To investigate whether maternal fast food intake during pregnancy increases offspring's risk for asthmatic symptoms. **Methods**: Detailed information about prenatal fast food intake and other dietary, lifestyle/ environmental factors, and pregnancy was collected shortly after birth; further data were retrieved from birth certificates. Using the International Study of Asthma and Allergies in Childhood core questions, asthma and rhinitis symptoms were assessed, and doctor's diagnoses were recorded in offspring 3.5 years after birth. Poisson regression with robust error variance using a log link function was used to estimate relative risks (RRs). Models were adjusted using covariates or propensity scores.	Maternal prenatal fast food consumption related to increased relative risks of their children for severe, and current asthma symptoms (wheeze last 12 months combined with doctor's diagnosis) in a dose-dependent manner: 'once a month': RR: 0.99 (95% CI: 0.36 to 2.75), 'once a week': 1.26 (0.47 to 3.34); '3-4 days a week': 2.17 (0.77 to 6.12); and 'every day' 4.46 (1.36 to 14.6) compared to 'never', adjusting for potential confounders (p for trend = 0.0025). There was also suggestion of increased risks for rhinitis symptoms.	
Castro-Rodriguez et al 2016[53] International Study of Wheezing in Infants Spain Cohort	1,000 preschool children	**Aim**: To examine whether some foods and Mediterranean diet (MedDiet) consumed by the mother during pregnancy and by the child during the first years of life can be protective for current wheezing, rhinitis and dermatitis at preschool age. **Methods**: Questionnaires of epidemiological factors and food intake by the mother during pregnancy and later by the child were filled in by parents in two surveys at two different time points (1.5 yrs and 4 yrs of life).	High fast food consumption (≥3 times a week) by mothers in pregnancy was associated with a higher prevalence of dermatitis in the child (p=0.005).	

Study ref	N	Aim/methods	Results	Comments
Dominguez et al 2014[105] Spain Seguimiento Universidad de Navarra (SUN) Cohort	3,048 women	**Aim**: To investigate the incidence of gestational diabetes according to the consumption of fast food in a cohort of university graduates. **Methods**: The cohort included data of 3,048 women initially free of diabetes or previous gestational diabetes who reported at least one pregnancy between December 1999 and March 2011. Fast food consumption was assessed through a validated 136-item semi-quantitative food frequency questionnaire. Fast food was defined as the consumption of hamburgers, sausages, and pizza. Three categories of fast food were established: low (0-3 servings/month), intermediate (>3 servings/month and </=2 servings/week) and high (>2 servings/week). Non-conditional logistic regression models were used to adjust for potential confounders.	After adjusting for age, baseline body mass index, total energy intake, smoking, physical activity, family history of diabetes, cardiovascular disease/hypertension at baseline, parity, adherence to Mediterranean dietary pattern, alcohol intake, fibre intake, and sugar-sweetened soft drinks consumption, fast food consumption was significantly associated with a higher risk of incident gestational diabetes, with multivariate adjusted OR 1.31 (0.81 to 2.13) and 1.86 (95% CI: 1.13-3.06) for the intermediate and high categories, respectively, versus the lowest category of baseline fast food consumption (p for linear trend: 0.007).	
Lombardi et al 2015[76] United States Case-control	Cases 163 Controls 136	**Aim**: To examine the relation between maternal diet and unilateral retinoblastoma. **Methods**: A case-control study of 163 unilateral RB cases and 136 controls ascertained information on maternal diet during pregnancy using a standardised food frequency questionnaire. Logistic regression was used to assess the relation between retinoblastoma and food groups and dietary patterns.	A positive association was seen with intake of fried foods (OR 4.89, 95 % CI 1.72 to 13.89).	

Table 31: Q2 Consumption of water during pregnancy

Study ref	N	Aim/methods	Results	Comments
Watson et al 2014[99] New Zealand Cohort	369 women	**Aim:** To investigate the association between water and nutrient intake in pregnant women, and wheeze in their 18-month-old infants. **Methods**: Participants were visited in months 4 and 7 of pregnancy. At each visit anthropometric measurements were taken, diet assessed by 24-hour recall and 3-day food records and questionnaires determining personal details administered. Eighteen months after birth, infants were measured, and questions on infant feeding and wheeze asked.	After adjusting for significant covariates and energy intake, higher maternal intakes of dietary water (aOR 0.22 [0.07,0.68]; p=0.009) was associated with decreased wheeze. Prevalence of infant wheeze decreased 18.5% from the lower to the upper quartile of water intake, and 17.4% from the lower to the upper quartile of manganese intake.	

Table 32: Q2 Consumption of caffeine during pregnancy

Study ref	N	Aim/methods	Results	Comments
Miyake et al 2019[110] Japan Cross-section	1,119 mother-child pairs	**Aim**: To examine the association between maternal caffeine consumption during pregnancy and behavioural problems in Japanese children aged 5 years. **Methods**: Dietary intake was assessed using a diet history questionnaire. Emotional problems, conduct problems, hyperactivity problems, and peer problems were assessed using the Japanese parent-report version of the Strengths and Difficulties Questionnaire. Adjustment was made for maternal age, gestation at baseline, region of residence at baseline, number of children at baseline, maternal and paternal education, household income, maternal depressive symptoms during pregnancy, maternal alcohol intake during pregnancy, maternal smoking during pregnancy, child's birth weight, child's sex, breastfeeding duration, and smoking in the household during the first year of life.	The contributors of caffeine in the diet during pregnancy were Japanese and Chinese tea (74.8%), coffee (13.0%), black tea (4.4%), confectionaries (4.0%), and soft drinks (3.7%). Higher maternal caffeine consumption during pregnancy was independently associated with a reduced risk of peer problems in the children: • Quintile 2: aOR 0.61 (0.35 to 1.06) • Quintile 3: aOR 0.52 (0.29 to 0.91) • Quintile 4: aOR 0.51 (0.28 to 0.91) Maternal caffeine intake during pregnancy was not evidently related to the risk of emotional problems, conduct problems, or hyperactivity problems in the children.	
Okubo et al 2015[108] Japan Cross-section	858 women	**Aim**: To investigate whether maternal consumption of total caffeine and culture-specific major sources of caffeine would be associated with birth outcomes among Japanese pregnant. **Methods**: Maternal diet during pregnancy was assessed using a validated, self-administered diet history questionnaire. Birth outcomes considered were low birth weight (LBW; <2500 g), preterm birth (PTB; <37 weeks of gestation), and small for gestational age (SGA; <10th percentile).	The main caffeine sources were Japanese and Chinese tea (73.5%), coffee (14.3%), black tea (6.6%), and soft drinks (3.5%). After controlling for confounders, maternal total caffeine intake during pregnancy was significantly associated with an increased risk of PTB (OR per 100 mg/d caffeine increase 1.28; 95%CI 1.03 to 1.58; P for trend = 0.03). No evident relationships were observed between total caffeine intake and risk of LBW or SGA.	

Study ref	N	Aim/methods	Results	Comments
Colapinto et al 2015[107] Canada Cohort	1,898 women	**Aim**: To determine whether tea intake in the first trimester was associated with elevated concentrations of various pesticides in maternal blood or urine. Further, we examined the relationship between tea consumption and adverse birth outcomes. **Methods**: All singleton, live births with available biomarkers were included in the analyses. Descriptive statistics were used to characterise the population. The geometric means (GM) of organochlorine (OC) pesticide constituents or metabolites in maternal plasma (lipid adjusted) and organophosphate (OP) pesticide metabolites (adjusted for specific gravity) in maternal urine were calculated for participants who drank regular, green or herbal tea in the first trimester and for those who did not. Differences between groups were examined using chi-square or t-tests. Associations between frequency of drinking tea and adverse birth outcomes were examined using logistic regression (preterm birth and small-for-gestational-age).	<1 vs ≥1 cups tea per week: • Preterm birth: aOR 0.99 (0.61 to 1.61) • Spontaneous preterm birth: aOR 1.08 (0.59 to 1.98) • Small for gestational age: aOR 1.43 (0.83 to 2.46) There were no significant differences in concentrations of OC or OP pesticides or metabolites between tea drinkers and non tea drinkers.	

Study ref	N	Aim/methods	Results	Comments
Greenop et al 2014[109] Australia Case-control	293 cases 726 controls	**Aim**: To investigate whether maternal coffee or tea consumption during pregnancy was associated with the risk of childhood brain tumours (CBTs). **Methods**: Case children were recruited from 10 paediatric oncology centres and control children by nationwide random-digit dialling, frequency matched to cases on the basis of age, sex and state of residence. Coffee and tea intake were assessed using a food frequency questionnaire. Odds ratios (ORs) and confidence intervals (CIs) were calculated using multivariable unconditional logistic regression.	There was little evidence of an association between gestational consumption of any coffee (OR 1.23, 95% CI 0.92 to 1.64) or tea (OR 1.00, 95% CI 0.74 to 1.36) and CBT risk. Among children aged under 5 years, the OR for any coffee consumption during pregnancy was 1.76 (95% CI 1.09 to 2.84) and for ≥2 cups per day during pregnancy was 2.52 (95% CI 1.26, 5.04). There was no association between maternal tea drinking and risk of CBT.	

Table 33: Q2 Potential allergens

Study ref	N	Aim/methods	Results	Comments
Bunyavanich et al 2014[90] United States Cohort	1,227 mother-child pairs	**Aim**: To examine the associations between maternal intake of common childhood food allergens during early pregnancy and childhood allergy and asthma. **Methods**: Using food frequency questionnaires administered during the first and second trimesters, we assessed maternal intake of common childhood food allergens during pregnancy. In mid-childhood (mean age 7.9 years), we assessed food allergy, asthma, allergic rhinitis, and atopic dermatitis by questionnaire and serum-specific IgE levels. We examined the associations between maternal diet during pregnancy and childhood allergy and asthma. We also examined the cross-sectional associations between specific food allergies, asthma, and atopic conditions in mid-childhood.	Higher maternal wheat intake during the second trimester was associated with reduced atopic dermatitis (OR 0.64; 95%CI 0.46 to 0.90).	

Study ref	N	Aim/methods	Results	Comments
Bunyavanich et al 2014[90] United States Cohort	1,227 mother-child pairs	**Aim**: To examine the associations between maternal intake of common childhood food allergens during early pregnancy and childhood allergy and asthma. **Methods**: Using food frequency questionnaires administered during the first and second trimesters, we assessed maternal intake of common childhood food allergens during pregnancy. In mid-childhood (mean age 7.9 years), we assessed food allergy, asthma, allergic rhinitis, and atopic dermatitis by questionnaire and serum-specific IgE levels. We examined the associations between maternal diet during pregnancy and childhood allergy and asthma. We also examined the cross-sectional associations between specific food allergies, asthma, and atopic conditions in mid-childhood.	Higher maternal peanut intake (each additional z score) during the first trimester was associated with 47% reduced odds of peanut allergic reaction (OR 0.53; 95%CI 0.30 to 0.94).	
Frazier et al 2014[111] United States Cohort	8,205 children	**Aim:** To examine the association between peripregnancy consumption of peanuts and tree nuts by mothers and the risk of peanut/tree nut allergy in their offspring. **Methods**: Participants were born between January 1, 1990, and December 31, 1994, and are the offspring of women who previously reported their diet during, or shortly before or after, their pregnancy with this child. In 2006, the offspring reported physician-diagnosed food allergy. Mothers were asked to confirm the diagnosis and to provide available medical records and allergy test results. Cases were reviewed by two board-certified paediatricians, including a board-certified allergist/immunologist.	The incidence of peanut/tree nut allergy in the offspring was significantly lower among children of non-allergic mothers who consumed more peanuts/tree nuts in their peripregnancy diet (≥5 times vs <1 time per month: OR 0.31; 95% CI 0.13 to 0.75; P(trend)=0.004). By contrast, a non-significant positive association was observed between maternal peripregnancy peanut/tree nut consumption and risk of peanut/tree nut allergy in the offspring of peanut/tree nut allergic mothers (P(trend)=0.12).	

2.3 Q3: What are the harms and benefits of vitamin and mineral supplementation in pregnancy?

2.3.1 Vitamins

Folic acid (vitamin B9)

Background

Following the introduction of mandatory folic acid fortification of bread in 2009, estimated mean folic acid intake increased among women of childbearing age (from 102 µg to 247 µg/day), which is below the 400 µg/day recommended to help prevent neural tube defects as expected but still greater than the increase of 100 µg/day predicted when developing the fortification requirement.[113]

Due to differences in folate testing methodologies and the representativeness of the baseline data, it was difficult to accurately quantify changes in folate status in the target population post-mandatory fortification. However, available data sources suggest improvements in mean serum folate levels.[113]

There has been a decrease in neural tube defect rates following the introduction of mandatory folic acid fortification. There was a statistically significant 14.4% decrease in the rate of neural tube defect rates in the total study population (10.2 to 8.7 per 10,000 conceptions that resulted in a birth) and a non-statistically significant 12.5% decrease in the rate of neural tube defects in the population omitting New South Wales residents (12.8 to 11.2 per 10,000 conceptions that resulted in a birth).[113]

Women taking medicines that are folate antagonists (eg carbamazepine, lamotrigine) should be encouraged to take high-dose folate supplements preconception and during the first trimester.[114]

A survey of pregnant women conducted in Sydney found that 30.6% were taking a folic acid supplement.[115] A cross-sectional study that included national and South Australian cohorts found that, while awareness of recommendations on folic acid supplementation was high (90%), adherence was low (27%).[116]

In an Australian cohort study,[117] 19-46% of women did not meet the recommended daily intake for folate. Conversely, 15-19 % of women consumed beyond the recommended upper limit for folate.

The current Guidelines include a recommendation to 'Inform women that dietary supplementation with folic acid, from 12 weeks before conception and throughout the first 12 weeks of pregnancy, reduces the risk of having a baby with a neural tube defect and recommend a dose of 500 micrograms per day' and a practice point 'Specific attention needs to be given to promoting folic acid supplementation to Aboriginal and Torres Strait Islander women of childbearing age and providing information to individual women at the first antenatal visit'.

Current review

This review identified 17 systematic reviews,[75,118-134] and 5 RCTs.[135-139]

Maternal outcomes

Two systematic reviews of RCTs and observational studies, with considerable overlap in studies, analysed the association between multivitamins containing folic acid supplementation and gestational hypertension/pre-eclampsia. One found a reduction in gestational hypertension/pre-eclampsia in RCTs (RR 0.62; 95%CI 0.45 to 0.87; 2 RCTs) but not cohort studies (RR 0.92; 95%CI 0.79 to 1.08; 9 cohort studies).[132] The other found a reduction in pre-eclampsia (RR 0.69; 95%CI 0.58 to 0.83; 12 studies; n=311,991) but not gestational hypertension (RR 1.19; 95%CI 0.92 to 1.54; 4 studies; n=266,938).[134] There was no reduction in pre-eclampsia for folic acid alone (RR 0.97; 95%CI 0.80 to 1.17; 4 studies; n=210,896).[134] A systematic review of observational studies found a reduction in pre-eclampsia associated with folic acid supplementation (OR 0.78; 95%CI 0.63 to 0.98; 8 studies).[126] However, subgroup analysis showed no clear difference between folic acid alone compared to folic acid in or alongside a multivitamin. A multicentre RCT (n=2,271) found no reduction in risk of pre-eclampsia (RR 1.10, 95%CI 0.90 to 1.34; p=0.37).[138]

A small RCT (n=119) found that women who continued folic acid supplementation into the second trimester had higher levels of serum folate (p<0.001), red blood cell folate (p<0.001) and cord blood folate (p=0.001) and lower levels of plasma homocysteine (p=0.006) at 36 weeks than women who did not.[136] In another RCT (n=410), compared to women who took a daily dose of 5 mg, women who took 0.5 mg daily had higher homocysteine levels (p<0.001), higher rates of early abortion (p=0.005) and lower birth weight infants (p=0.031).[137] There was no effect on systolic (p=0.84) or diastolic (p=0.15) blood pressure. Another RCT suggested that a higher dose (4 mg) reduced risk of fetal growth restriction (aRR 0.65; 95%CI 0.46 to 0.93) compared to 0.8 mg per day.[139]

Infant and childhood outcomes

A systematic review of RCTs found no effect on total fetal loss (RR 0.95; 95%CI 0.64 to 1.40; 1 RCT; n=903), early or late miscarriage (RR 0.97; 95%CI 0.65 to 1.44; 1 RCT; n=903) or stillbirth (RR 0.67; 95%CI 0.11 to 4.02; 1 RCT; n=903).[125]

Two systematic reviews of RCTs were consistent in finding no clear effect on preterm birth <37 weeks (RR 0.99; 95%CI 0.82 to 1.18;[121] RR 1.09; 95%CI 0.77 to 1.54; 1 study; n=2,797[133]). They were also consistent in finding no effect on low birthweight (RR 0.79; 95%CI 0.49 to 1.28;[121] RR 0.80; 95%CI 0.63 to 1.02; 3 studies; n=3,089[133]) and perinatal death (RR 0.90; 95%CI 0.60 to 1.34;[121] RR 1.33; 95%CI 0.96 to 1.85; 3 studies; n=3,110[133]). A meta-analysis of RCTs and observational studies also found no clear reduction in low birthweight (OR 0.82; 95%CI 0.63 to 1.06; 3 RCTs, 10 observational studies).[131] However, a systematic review of cohort studies suggested a reduction in risk of preterm birth (RR 0.68; 95%CI 0.52 to 0.90; 2 studies; n=575) and small-for-gestational age (RR 0.84; 95%CI 0.81 to 0.89; 3 studies; n=17,553).[124]

A systematic review of RCTs found that folic acid supplementation was associated with a reduction in risk of neural tube defects (RR 0.31; 95%CI 0.17 to 0.58; 5 RCTs; n=6,708; high certainty) and cleft palate (RR 0.73; 95%CI 0.05 to 0.89; 3 RCTs; n=5,612; low certainty) but there was no effect on other congenital anomalies.[129] A systematic review of observational studies found a reduction in cleft lip with or without cleft palate (OR 0.72; 95%CI 0.61 to 0.85) but not cleft palate only (OR.0.75, 95%CI 0.53 to 1.04).[119]

Systematic reviews of case-control studies found a reduction in congenital heart defects (RR 0.72; 95%CI 0.63 to 0.82;[130] OR 0.60; 95%CI 0.49 to 0.71[123]).

A systematic review of observational studies[122] found no clear difference in risk of asthma (RR 1.04; 95%CI 0.94 to 1.16; low certainty) or wheeze (RR 1.05; 95%CI 0.95 to 1.15; low certainty) with folic acid supplementation during pregnancy in general but a slight increase in risk of wheeze when supplementation occurred in early pregnancy (RR 1.06; 95%CI 1.02 to 1.09; low certainty).

A systematic review of observational studies[118] found a reduction in autism spectrum disorders with folic acid supplementation (RR 0.77; 95%CI 0.64 to 0.93, 16 studies).

Based on evidence from systematic reviews of observational studies, folic acid supplementation during pregnancy appears to reduce the risk of acute myeloid leukaemia (OR 0.52; 95%CI 0.31 to 0.89)[120] and childhood brain and spinal cord tumours (OR 0.77; 95%CI 0.66 to 0.90).[127] The evidence on acute lymphoblastic leukaemia was inconsistent, with one review finding a reduced risk (OR 0.77; 95%CI 0.67 to 0.88)[120] and the other finding no clear difference (RR 0.87; 95%CI 0.57 to 1.34).[75]

Vitamin B_6

Background

Vitamin B_6 plays vital roles in numerous metabolic processes in the human body, such as nervous system development and functioning. It has been associated with some benefits in non-randomised studies, such as higher Apgar scores, higher birthweights, and reduced incidence of pre-eclampsia and preterm birth.[140]

Current review

This review identified two systematic reviews. One review found a clear improvement in nausea score when vitamin B_6 was compared to placebo (MD -3.7; 95%CI -6.9 to -0.5; very low certainty).[141] A Cochrane review[140] found that there is not enough evidence to detect clinical benefits of vitamin B_6 supplementation in pregnancy and/or labour other than one trial suggesting protection against dental decay.

Vitamin B_{12}

Background

Vitamin B_{12} deficiency in pregnancy is associated with adverse maternal and neonatal outcomes.[142] Infants born to vitamin B_{12}-deficient women may be at increased risk of neural tube defects, and maternal vitamin B_{12} insufficiency (<200 pmol/L) can impair infant growth, psychomotor function, and brain development, which may be irreversible.[142] The evidence on an association between maternal B_{12} levels and low birth weight is inconsistent.[143]

Vitamin B_{12} insufficiency during pregnancy is common even in non-vegetarian populations and concentrations of vitamin B_{12} decrease from the first to the third trimester.[143]

The guidelines currently state that:

- vitamin B_{12} deficiency is common in most of the developing world but few studies have examined the prevalence of vitamin B_{12} deficiency in Australia

- there is emerging evidence of vitamin B_{12} deficiency among refugees in Australia due to limited or no sources of animal foods before resettlement
- vitamin B_{12} supplementation may be needed if a woman has a vegetarian or vegan diet.

Current review

This review identified two RCTs of vitamin B_{12} supplementation in pregnancy,[144-146] both of which were conducted in developing countries. These studies found that:

- vitamin B_{12} supplementation (250 mug/day + 60 mg iron + 400 mug folate throughout pregnancy and 3-month postpartum) improved maternal, infant and breast milk B_{12} status and H1N1 vaccine-specific responses in women and may alleviate inflammatory responses in infants[146]
- with vitamin B_{12} supplementation 50 microg/day from 14 weeks gestation to 6 weeks postpartum there was no significant difference in cognitive development among infants at 9 months but higher expressive language scores among infants at 30 months (ß 0.14, P=0.03).[144,145]

Vitamin C

Background

A survey of pregnant women conducted in Sydney found that 8.2% were taking a vitamin C supplement.[115]

The Guidelines currently recommend that women be advised that taking vitamin C supplements is not of benefit in pregnancy and may cause harm.

Current review

This review identified three systematic reviews[125,147,148] and one RCT that reported on the effect of antenatal vitamin C supplementation on airway function in infants of women who smoked during pregnancy.[149]

A Cochrane review into the effect of vitamin supplementation on the risk of miscarriage[125] found no clear difference in total fetal loss (RR 1.28; 95%CI 0.58 to 2.83; 2 RCTs; n=224), early or late miscarriage (RR 1.17; 95%CI 0.52 to 2.65; 2 RCTs; n=224) or stillbirth (RR 3.0; 95%CI 0.12 to 72.77; 1 RCT; n=200).

Another Cochrane review that evaluated the effects of antenatal vitamin C supplementation alone[148] found no clear difference in risk of perinatal death (RR 0.51; 95%CI 0.05 to 5.54; 1 RCT; n=182), intrauterine growth restriction (RR 1.56; 95%CI 0.63 to 3.89; 1 RCT; n=159; high certainty), preterm birth (RR 1.06; 95%CI 0.75 to 1.48; 5 RCTs; n=1,685; high certainty) or pre-eclampsia (RR 0.88; 95%CI 0.48 to 1.61; 3 RCTs; n=1,191). There was a possible reduction in risk of preterm premature rupture of the membranes (PROM) (RR 0.66; 95%CI 0.48 to 0.91; 5 studies; n=1,282) and term PROM (RR 0.55; 95%CI 0.32 to 0.94; 1 study; n=170).

Another systematic review[147] also found no clear difference in risk of pre-eclampsia (RR 0.77; 95%CI 0.38 to 1.57).

The RCT found that antenatal vitamin C supplementation among women who smoked during pregnancy improved infant airway function at 3 months.[149]

Vitamin E

Background

The Guidelines currently recommend that women be advised that taking vitamin E supplements is not of benefit in pregnancy and may cause harm.

Current review

This review identified two systematic reviews that focussed on supplementation of vitamin E alone.[147,150]

One systematic review found no clear difference in risk of pre-eclampsia (RR 0.54; 95%CI 0.06 to 5.11; 1 RCT).[147] The other review was of observational studies and suggested that maternal vitamin E supplementation may reduce the risk of childhood asthma (OR 0.97; 95%CI 0.95 to 1.00) and wheeze in children (OR 0.65; 95%CI 0.56 to 0.75).[150]

Vitamin C and E combined

Background

The Guidelines currently comment that vitamin C and E combined has been associated with perinatal death and preterm rupture of the membranes.

Current review

This review identified five systematic reviews and one RCT that evaluated the relationship between vitamin C and E supplementation and perinatal outcomes by maternal smoking status.

A Cochrane review[125] found no clear difference in risk of total fetal loss (RR 1.14; 95%CI 0.92 to 1.40; 7 RCTs; n=18,949), early or late miscarriage (RR 0.90; 95%CI 0.65 to 1.26; 4 RCTs; n=13,346), stillbirth (RR 1.31; 95%CI 0.97 to 1.76; 7 RCTs; n=21,442), congenital malformations (RR 1.17; 95%CI 0.84 to 1.62; 5 RCTs; n=8,334) or any adverse effects of vitamin supplementation sufficient to stop supplementation (RR 1.16; 95%CI 0.39 to 3.41; 1 RCT; n=739).

Another Cochrane review that assessed the effects of vitamin E alone or in combination with other supplements (most commonly vitamin C)[151] found no clear difference in risk of stillbirth (RR 1.17; 95%CI 0.88 to 1.56, 9 RCTs, n=19,023; moderate certainty), neonatal death (RR 0.81, 95%CI 0.58 to 1.13, 9 RCTs, n=18,617), pre-eclampsia (RR 0.91; 95% CI 0.79 to 1.06; 14 RCTs, n=20,878; moderate certainty), preterm birth (RR 0.98; 95% CI 0.88 to 1.09, 11 RCTs, n=20,565; high certainty), intrauterine growth restriction (RR 0.98, 95%CI 0.91 to 1.06, 11 RCTs, n=20,202; high certainty), preterm prelabour rupture of the membranes (PROM) (RR 1.27; 95% CI 0.93 to 1.75, 5 RCTs, n=1,999; low certainty) or self-reported abdominal pain (RR 1.66; 95% CI 1.16 to 2.37, 1 RCT, n=1,877). The risk of placental abruption appeared to be reduced (RR 0.64; 95% CI 0.44 to 0.93, 7 RCTs, n=14,922; high certainty) and that of term PROM increased (RR 1.77; 95% CI 1.37 to 2.28, 2 RCTs, n=2,504).

The other systematic reviews found no clear difference in risk of pre-eclampsia (RR 0.99; 95%CI 0.90 to 1.08;[147] RR 1.00; 95%CI 0.91 to 1.10)[152] or childhood allergic diseases[153] — recurrent wheeze (OR 0.83; 95%CI 0.26 to 2.59), asthma (OR 0.94; 95%CI 0.42 to 2.11) or eczema (OR 1.10; 95%CI 0.70 to 1.74).

The RCT found a possible reduced risk of placental abruption (RR 0.09; 95%CI 0.00 to 0.87) and preterm birth (RR 0.76; 95%CI 0.58 to 0.99) among women who smoked during pregnancy.

Vitamin A

Background

Vitamin A is a crucial micronutrient for pregnant women and their babies as it is essential for morphological and functional development and ocular integrity and exerts systemic effects on several fetal organs and on the fetal skeleton.[154] While vitamin A deficiency in pregnant women is a public health issue in most developing countries, an excess of vitamin A may exert teratogenic effects in the first 60 days following conception.[154] A survey of pregnant women conducted in Sydney found that 2.3% were taking vitamin A supplements.[115]

The Guidelines currently recommend that women be advised that taking vitamin A supplements is not of benefit in pregnancy and may cause harm.

Current review

The current review identified two systematic reviews[125,155] and one RCT.[156]

In one Cochrane review,[125] there was no clear difference in risk of fetal loss (RR 1.05; 95%CI 0.90 to 1.23; 3 RCTs; n=52,480), early or late miscarriage (RR 0.98; 95%CI 0.92 to 1.04; 1 RCT; n=39,668) or stillbirth (RR 0.95; 95%CI 0.86 to 1.06; 1 RCT; n=39,668).

The other Cochrane review[155] found no clear difference in maternal mortality (RR 0.88; 95%CI 0.65 to 1.20; 4 RCTs; n=154,039; high certainty), perinatal mortality (RR 1.01; 95%CI 0.95 to 1.07; 1 RCT, n=76,178; high certainty) or preterm birth (RR 0.98; 95%CI 0.94 to 1.01; 5 RCTs, n=48,007; high certainty). There was a possible reduced risk of maternal clinical infection (RR 0.45; 95%CI 0.20 to 0.99; 5 RCTs; n=17,313; low certainty) and maternal anaemia (in areas where vitamin A deficiency is common or among women with HIV) (RR 0.64; 95%CI 0.43 to 0.94; 3 RCTs; n=15,649; moderate certainty).

The RCT found no clear effect on cognitive function of children at 8 years of age.[156]

Multiple micronutrients

Background

A survey of pregnant women conducted in Sydney found that 79.1% were taking a multivitamin supplement.[115]

In a cross-sectional study among pregnant women in southern Queensland,[157] 42% of participants used pregnancy multivitamins, with 26.8% using multivitamins in combination with individual micronutrients and 9.8% using specific micronutrient supplements. Nulliparous women were more likely to use supplements than their multiparous peers (aOR 1.938; 95% CI 1.053 to 3.571, p=0.034); smoking (aOR 2.717; 95%CI 1.011 to 7.302; p=0.047) and low socio-economic status (aOR 2.451; 95%CI 1.010–5.949; p=0.048) were associated with no supplement use.

In a retrospective analysis of uncomplicated pregnancies in Queensland,[158] women taking individual zinc, folic acid or iron supplements in combination with a multivitamin in the third trimester were twice as likely to give birth beyond 41 completed weeks (aOR 2.054, 95%CI 1.310 to 7.383, p=0.038) then those who did not take any

supplement and rates of post-dates labour and requirements for induction were lower among women not taking supplements (AOR 0.483, 95% CI 0.278-0.840, p=0.01).

In an Australian cohort study,[159] first trimester multivitamin use was reported by 31.8% of women and, after adjustment, was associated with a 67% reduction in pre-eclampsia risk (95%CI 0.14 to 0.75). Stratification by BMI demonstrated a 55% reduction in pre-eclampsia risk (95%CI 0.30 to 0.86) in overweight and 62% risk reduction (95%CI 0.16 to 0.92) in obese women who supplemented with multivitamins in the first trimester of pregnancy.

In an Australian cohort study,[117] pregnancy-specific multivitamin use was reported by 47% of women in the first trimester, 51% in the second trimester and 46% in the third trimester. General multivitamin use was reported by 31% of women in the first trimester, 27% in the second trimester and 35% in the third trimester.

In an Australian cross-sectional study,[160] 83% of women took a multivitamin during pregnancy, with 90% of women with post-secondary education and 64% of women with only secondary education using these supplements.

A Danish cohort study[161] found that early multivitamin use was associated with an approximately 30% reduction in risk for hyperkinetic disorders diagnosis (aHR: 0.70, 95% CI: 0.52 to 0.96) and 21% reduction in treatment with attention deficit hyperactivity disorder medication (aHR: 0.79, 95% CI: 0.62 to 0.98). A Chinese cohort study[162] found that maternal multimicronutrient supplementation had no effect on intellectual development in children aged 7-10 years.

The current Guidelines note that an observational study has shown a positive association between risk of preterm birth and multivitamins and minerals if taken daily in the third trimester by women who were unlikely to be deficient in these nutrients.[163]

Current review

The current review identified four systematic reviews and four RCTs of relevance to multiple micronutrient supplementation in pregnancy.

A Cochrane review[164] that compared multiple micronutrients with iron and folic acid to iron with or without folic acid found a reduction in risk of very preterm birth (<34 weeks) (RR 0.81, 95% CI 0.71 to 0.93; 4 trials, n=37,701), small for gestational age (RR 0.92, 95% CI 0.88 to 0.97; 17 trials; n=57,348; moderate-certainty evidence) and low birth weight (RR 0.88, 95% CI 0.85 to 0.91; 18 trials, n=68,801; high-certainty evidence). There was a possible reduction in risk of preterm birth (<37 weeks) (RR 0.95, 95%CI 0.90 to 1.01; 18 trials, n=91,425; moderate-certainty evidence), stillbirth (RR 0.95, 95% CI 0.86 to 1.04; 17 trials, n=97,927; high-certainty evidence) and miscarriage (RR 0.99, 95% CI 0.94 to 1.04; 12 trials, n=100,565). There was no clear difference in risk of perinatal mortality (RR 1.00, 95% CI 0.90 to 1.11; 15 trials, n=63,922; high-certainty evidence), neonatal mortality (RR 1.00, 95% CI 0.89 to 1.12; 14 trials, n=80,964; high-certainty evidence), maternal mortality (RR 1.06, 95% CI 0.72 to 1.54; 6 trials, n=106,275), maternal anaemia in the third trimester (RR 1.04, 95% CI 0.94 to 1.15; 9 trials, n=5912), caesarean section (RR 1.13, 95% CI 0.99 to 1.29; 5 trials, n=12,836) or congenital anomalies (R 1.34, 95% CI 0.25 to 7.12; 2 trials, n=1,958).

A systematic review of observational studies[165] that evaluated the association between multivitamin use among women in high-income countries and the risk of adverse outcomes found a reduction in risk of small for gestational age (RR 0.77; 95%CI 0.63 to 0.93; 3 cohort studies; very low certainty), neural tube defects (RR 0.67; 95%CI 0.52 to 0.87; 6 cohort studies; very low certainty), cardiovascular defects (RR 0.83; 95%CI 0.70 to 0.98; 6 cohort studies; low certainty), urinary tract defects (RR 0.60; 95%CI 0.46 to 0.78; 3 cohort studies; very low certainty) and limb deficiencies (RR 0.68; 95%CI 0.52 to 0.89; 3 cohort studies; very low certainty). There was a possible reduction in risk of preterm birth (RR 0.84; 95%CI 0.69 to 1.03; 4 cohort studies; very low certainty), stillbirth (RR 0.78; 95%CI 0.59 to 1.03; 2 studies; low certainty) and cleft lip with or without cleft palate (RR 0.88; 95%CI 0.77 to 1.01; 6 cohort studies; low certainty). There was no clear difference in risk of low birth weight (RR 0.79; 95%CI 0.45 to 1.41; 2 studies; very low certainty) or cleft palate (RR 1.12; 95%CI 0.94 to 1.33; 6 cohort studies; low certainty).

A systematic review of observational studies[166] suggested a reduction in risk of autism spectrum disorder among children of women who took multivitamins during pregnancy (RR 0.57; 95% CI, 0.36 to 0.91; p=0.018; 3 studies).

The RCTs were conducted in developing countries (Bangladesh, China, Iran and Nepal), reported different outcomes and found:

- a possible reduction in risk of gestational hypertension (aOR 0.88; 95%CI 0.76 to 1.02) and late-onset gestational hypertension (aOR 0.85; 95%CI 0.73 to 0.99) among women taking multiple micronutrients compared to those taking iron plus folic acid (n=11,847)[167]

- no clear difference in lung function at 7-9 years of age in children born during a trial of micronutrients versus iron plus folic acid (forced expiratory volume: MD -0.08; 95%CI -0.19 to 0.04; forced vital capacity: MD -0.05; 95%CI -0.17 to 0.06; FEV1/FVC: MD -0.04; 95%CI -0.15 to 0.07)(n=793)[168]
- a lower prevalence of deficiencies of vitamins B_{12}, A and D and zinc (all $p<0.05$) among women taking multivitamins compared to those receiving iron plus folic acid (n=1,526)[169]
- beneficial effects on levels of triglycerides (p=0.04), HDL cholesterol (p=0.02) and glutathione (p=0.003) but not fasting plasma glucose, total cholesterol, LDL cholesterol or total antioxidant capacity among women taking a multivitamin plus calcium, iron and magnesium compared to those receiving the multivitamin alone (n=70).[170]

2.3.2 Minerals

Iron supplementation

Background

Australian studies have investigated rates of iron supplementation, intake and anaemia among Australian women during pregnancy.

- A survey of pregnant women conducted in Sydney found that 30.4% were taking an iron supplement.[115]
- A cross-sectional study in Sydney (n=589)[171] found that overall iron-containing supplement use was 88.0%, of which 70.1% was multivitamin only, 7.2% was iron-only and 22.2% was both. About 65% of women diagnosed with iron deficiency, and 62.3% of women diagnosed with anaemia were taking an iron-only supplement, with or without a multivitamin. The proportion of women consuming low (<30), preventative (30-99) and treatment (≥100) mg/day doses were 36.8%, 45.4%, and 17.8%, respectively. Only 46.7% of women diagnosed with iron deficiency were taking ≥100 mg/day iron from supplements, while 23.3% were taking <30 mg/day.
- In an Australian cohort study[117] 68-82% of women did not meet the recommended daily intake level for iron. Conversely, 11-24% of women consumed beyond the recommended upper limit for iron.
- A study pregnant women from the Gomeroi gaaynggal cohort (in Tamworth, Newcastle and Walgett NSW) found that only 1.72% of women met the estimated average requirement for iron.[172]
- A cohort study in far North Queensland (n=2,076) found that more than half of Aboriginal and Torres Strait Islander women (54.5%; 95%CI 52.4% to 56.7%) had anaemia in pregnancy. For women who gave birth in 2009 and 2010 (n=1,796) with more complete data, those who were iron deficient during pregnancy were more likely to be anaemic (RR 1.40, p=<0.001). Women from localities of relative socioeconomic advantage (29.0%) had a lower risk of anaemia in pregnancy (RR 0.86, p=0.003), as did women (31.9%) who were obese (RR 0.87, p=0.013).

The guidelines currently recommend that iron supplementation should not be routinely offered to women during pregnancy and that supplementation be advised for women with identified anaemia. They also recommend that women with low dietary iron intake be advised that intermittent supplementation is as effective as daily supplementation in preventing iron-deficiency anaemia, with fewer side effects. The Guidelines also include practice points.

- Women at high risk of iron deficiency due to limited access to dietary iron may benefit from practical advice on increasing intake of iron-rich foods.
- Oral iron remains first-line treatment for iron-deficiency anaemia identified in the antenatal period. Intravenous iron should be offered to women who do not respond to oral iron or are unable to comply with therapy. In some remote settings, intramuscular iron may be administered by a health professional who does not have intravenous endorsement or where intravenous iron cannot be accessed.

The second practice point is inconsistent with the National Blood Authority guidelines, which advise against the use of intramuscular iron when alternatives are available.

Current review

This review included four systematic reviews[173-176] and six RCTs.[177-184]

Two systematic reviews — a Cochrane review[174] and a more recent review[173] — reported on maternal anaemia at term, maternal side effects, neonatal death, preterm birth and low birthweight. The reviews were consistent in finding a reduction in risk of maternal anaemia at term (RR 0.30; 95%CI 0.19 to 0.46, 14 RCTs, n=2,199; low certainty[174]; RR 0.38; 95% CI 0.27 to 0.33; 13 RCTs[173]). The reviews were also consistent in finding no clear effect

on maternal side effects (RR 1.29; 95%CI 0.83 to 2.02, 11 RCTs, n=2,423, very low certainty[174]; RR 1.42; 95%CI 0.91 to 2.21; 12 RCTs[173]), neonatal death (RR 0.91; 95%CI 0.71 to 1.18, 4 RCTs, n=16,603, low certainty[174]; RR 0.93; 0.72 to 1.20; 7 RCTs; low certainty[173]), preterm birth (RR 0.93; 95%CI 0.84 to 1.03, 13 RCTs, n=19,286, moderate certainty[173,174]) or low birth weight (RR 0.84; 95%CI 0.69 to 1.03; n=17,613; 11 RCTs; low certainty[174]; RR 0.94, 95% CI 0.79 to 1.13; 7 RCTs; low-certainty[173]).

The Cochrane review[174] also reported a reduction in risk of iron deficiency at term (RR 0.43; 95%CI 0.27 to 0.66, 7 RCTs, n=1,256, low certainty) and no clear effect on maternal infection during pregnancy (RR 1.21; 95%CI 0.33 to 4.46; 1 RCT, n=727; low certainty), maternal death (RR 0.33; 95%CI 0.01 to 8.19, 2 RCTs, n=12,560, very low certainty), birthweight (MD 23.75; 95%CI -3.02 to 50.51, 15 RCTs, n=18,590, moderate certainty) or congenital anomalies (RR 0.88, 95%CI 0.58 to 1.33, 4 RCTs, n=14,636, low certainty).

A systematic review of RCTs[176] found no clear effect on infant neurodevelopment (MD 0.54; 95% CI -0.67 to 1.75; 3 RCTs).

A Cochrane review comparing intermittent and daily iron regimens[175] found a reduction in side effects (RR 0.56; 95%CI 0.37 to 0.84; n=1,777; 1 RCT; very low certainty) but no clear effect on maternal anaemia at term (RR 1.22; 95%CI 0.84 to 1.80; n=676; 4 RCTs; very low certainty), maternal iron-deficiency anaemia at term (RR 0.71; 95%CI 0.08 to 6.63; 1 RCT, very low certainty), neonatal death (RR 0.49; 95%CI 0.04 to 5.42; n=795; 1 RCT; very low certainty), preterm birth (RR 1.03; 95%CI 0.76 to 1.39; n=1,177; 5 RCTs; low certainty), birth weight (MD 5.13 g; 95%CI -29.46 to 39.72; n=1,939; 9 RCTs; low certainty) or low birth weight (RR 0.82; 95%CI 0.55 to 1.22; n=1,898; 8 RCTs; low certainty).

The RCTs reported:

- higher increases in hemoglobin (p<0.001) and serum ferritin (p<0.001) from baseline to birth, reduced risk of maternal iron deficiency (RR, 0.48; 95%CI, 0.32 to 0.70), iron-deficiency anemia (RR, 0.34; 95%CI, 0.19 to 0.62) and anaemia at birth (RR 0.60; 95%CI, 0.51 to 0.71) but no effect on severe anaemia (RR 0.68; 95%CI, 0.41 to 1.14) or birth weight (3,155 vs 3,137 g, p=0.89) (n=1,469)[178]
- higher haemoglobin (p=0.03) and ferritin levels (p=0.04) but no effect on birthweight (p=0.2) among women with high haemoglobin at 20 weeks receiving supplements compared to those who did not (n=64)[177]
- lower risk of nausea (p=0.031), dyspeptic symptoms (p=0.031), vomiting (p=0.039) and constipation (p=0.017) with weekly versus daily supplementation and no clear effect on haemoglobin <11 g/dL (p=0.943), haemoglobin <13 g/dL (p=0.928) or serum ferritin (p=0.927) (n=292)[179]
- no clear difference in glucose-intolerance related outcomes (p=0.12), large-for-gestational age (p=0.95) or macrosomia (p=0.60) between selective and routine supplementation (n=2,694)[181]
- higher haemoglobin and ferritin levels with liposomal iron than with ferrous iron (n=60).[182]

Calcium supplementation

Background

A survey of pregnant women conducted in Sydney found that 12.9% were taking a calcium supplement.[115]

The Guidelines currently comment in the nutrition section that, while calcium supplements are useful in decreasing pre-eclampsia risk if dietary intake is low, they do not appear to be of benefit in preventing preterm birth or low infant birth weight. The section on pre-eclampsia includes the following recommendation 'Advise women at high risk of developing pre-eclampsia that calcium supplementation is beneficial if dietary intake is low' and a practice point 'If a woman has a low dietary calcium intake, advise her to increase her intake of calcium-rich foods.'

Current review

This review included five systematic reviews[185-189], two RCTs[190,191] and a cost-effectiveness study.[192]

There is consistent evidence from systematic reviews that calcium supplementation reduces the risk of gestational hypertension [186,189] and pre-eclampsia [186-189].

High-dose calcium supplementation (≥1 g/day) reduces the risk of gestational hypertension (RR 0.65; 95%CI 0.53 to 0.81; 12 RCTs; n=15,470), with a clearer effect among women with low dietary calcium (RR 0.44; 95%CI 0.28 to 0.70; 7 RCTs; n=10,418) than among women with adequate dietary calcium (RR 0.90; 95%CI 0.81 to 0.99; 4 RCTs; n=5,022) [186]. High dose calcium also reduces the risk of pre-eclampsia (RR 0.45; 95CI 0.31 to 0.65; 13 trials; n=15,730; low certainty).

Low dose calcium (<1 g/day) also reduces the risk of gestational hypertension (RR 0.57; 95%CI 0.39 to 0.82; 3 RCTs; n=558) [186] and pre-eclampsia (RR 0.36; 95%CI 0.23 to 0.57; 4 RCTs; n=980) [187].

A Cochrane review [186] found a reduction in risk of preterm birth <37 weeks with high-dose calcium among all women (RR 0.76; 95%CI 0.60 to 0.97; 11 trials, n=15,275; low certainty). An earlier Cochrane review [185] found no clear difference in risk of preterm birth <34 weeks (RR 1.04; 95%CI 0.80 to 1.36; 4 RCTs, n=5,669; moderate certainty).

Calcium supplementation does not appear to be of benefit in preventing low birth weight (RR 0.93; 95%CI 0.81 to 1.07; 6 RCTs; n=14,162; moderate certainty) [185].

The two RCTs suggested that calcium supplementation may reduce bone resorption.[190,191] A cross-sectional study found that higher calcium supplementation (679 vs 336 mg/day) reduced the prevalence of depressive symptoms during pregnancy (aOR 0.59; 95%CI 0.40 to 0.88, p=0.006).[89]

The cost-effectiveness study found that advising calcium supplementation to all women could reduce the incidence of pre-eclampsia by 25% and is a more efficient approach than advising supplementation to subgroups only.[192]

Iodine supplementation

Background

From September 2009 in New Zealand and from October 2009 in Australia, Standard 2.1.1 of the Code required the use of iodised salt instead of non-iodised salt in bread.[113] The AIHW reports that, while mandatory fortification delivered sufficient amounts of iodine to the general population, intakes for many pregnant and breastfeeding women were insufficient due to their increased requirements.[113]

In a review of Australian cohort studies post-fortification (7 studies),[193] three studies found that the pregnant women in their studies were iodine replete and four found that pregnant women were in the mild-to-moderate iodine deficiency category. Only two studies, documented iodine sufficiency among pregnant women in the absence of iodine supplementation.

An analysis of cross-sectional data from two Australian longitudinal studies pre- and post-fortification of iodine (n=368)[194] found that the median urinary iodine concentration of pregnant Indigenous women in remote locations remains low and targeted interventions are needed to ensure healthy fetal development. In a cross-sectional study in Western Australia (n=425)[195] ethnicity was associated with iodised salt use, with 76% of Asian women used iodised salt compared with 33% of Caucasian women. A Tasmanian study (n=255) found that, despite recommendations for iodine supplementation pregnant Tasmanian women remain at risk of iodine deficiency.[196]

A survey of pregnant women conducted in Sydney found that 6.3% were taking an iodine supplement.[115] A study conducted in Gippsland Victoria, a mildly iodine deficient area, found that only 18.9% of participants followed the National Health and Medical Research Council (NHMRC) recommendation of 150 µg/day iodine supplement, with 42.3% of participants not taking any supplements or taking supplements with no iodine or insufficient iodine.[197] The remaining women (38.7%) were taking supplements with doses of iodine much higher (200-300 µg) than the NHMRC recommended dose or were taking multiple supplements containing iodine. In a South Australian study, 85.9% women met the estimated average requirement (≥160 µg/day) for iodine intake from food and supplements.[198] When iodine from supplements was excluded, 44.5% of women met the estimated average requirement for iodine during pregnancy. In a Western Australian study, 66% of pregnant women were taking iodine supplements.[199]

In a national survey of maternity care providers, while 71% were aware of the National Health and Medical Research Council's recommendation for iodine supplementation, fewer were aware of the recommended dose (38%) or duration (44%) and only 73% recommended iodine supplements in pregnancy.[200]

Based on NHMRC (2010) *NHMRC Public Statement: Iodine Supplementation for Pregnant and Breastfeeding Women*, the Guidelines currently recommend that women who are pregnant be advised to take an iodine supplement of 150 micrograms each day.

Current review

This review included two systematic reviews[201,202] and three RCTs.[203-205]

The Cochrane review[201] reported that, in settings with mild to moderate iodine deficiency, iodine supplementation decreased the likelihood of postpartum hyperthyroidism (average RR 0.32; 95%CI 0.11 to 0.91; three RCTs; n=543 women; low-certainty) and increased the likelihood of digestive intolerance in pregnancy (average RR 15.33; 95%CI 2.07 to 113.70; one RCT; n=76; very low). There were no clear differences between groups for hypothyroidism in pregnancy (average RR 1.90; 95%CI 0.57 to 6.38; one RCT; n=365, low-certainty) or postpartum (average RR 0.44; 95%CI 0.06 to 3.42 three RCTS; n=540; low-certainty), preterm birth (average RR 0.71; 95%CI 0.30 to

1.66; two RCTs; n=376; low-certainty evidence), elevated maternal thyroid peroxidase antibodies in pregnancy (average RR 0.95; 95%CI 0.44 to 2.07; one RCT; n=359; low-certainty) or postpartum (average RR 1.01; 95%CI 0.78 to 1.30; three RCTs; n=397; low-certainty) or hyperthyroidism in pregnancy (average RR 1.90; 95%CI 0.57 to 6.38, one trial; n=365; low-certainty).

The infants of mothers who received iodine supplements had a 34% lower likelihood of perinatal mortality, however this difference was not statistically significant (average RR 0.66; 95%CI 0.42 to 1.03; two RCTs; n=457; low-certainty) and all perinatal deaths occurred in one trial conducted in a severely iodine-deficient setting. There were no clear differences between groups for low birthweight (average RR 0.56; 95%CI 0.26 to 1.23; two RCTs; n=377; low-certainty), neonatal hypothyroidism/elevated thyroid-stimulating hormone (average RR 0.58; 95% CI 0.11 to 3.12, two RCTs; n=260; very low-certainty) or elevated neonatal thyroid peroxidase antibodies (TPO-ab) (average RR 0.61; 95%CI 0.07 to 5.70; one RCT; n=108; very low-certainty).

A subsequent systematic review[202] reported on birthweight and found no clear difference between intervention and control groups (MD -13.75; 95%CI-212.46 to 184.97; four RCTs; n=1,743).

The RCTs reported that iodine supplementation:

- increased maternal urinary iodine levels in areas with iodine deficiency (p<0.05)[205] and mild-moderate deficiency (p<0.0001)[204]
- decreased maternal thyroglobulin levels (p=0.02)[204]
- decreased median neonatal thyroid stimulating hormone levels (p<0.05)[205]
- had no effect on child neurodevelopment at age 5–6 years in mildly iodine-deficient pregnant women.[203]

Zinc supplementation

Background

A survey of pregnant women conducted in Sydney found that 5.6% were taking a zinc supplement.[115]

In an Australian cohort study[117] 17-36% of women did not meet the Recommended Daily Intake for zinc.

The Guidelines currently comment that there is a lack of evidence on the harms and benefits of zinc supplementation that is generalisable to the Australian context.

Current review

This review included three systematic reviews of RCTs[206-208] and three RCTs.[209-211]

The systematic reviews found that maternal zinc supplementation:

- resulted in a small reduction in preterm birth (RR 0.86; 95%CI 0.76 to 0.97; 16 RCTS; n=7,637; moderate certainty) but not low birthweight (RR 0.93; 95%CI 0.78 to 1.12; 14 RCTs; n=5,643; moderate certainty) and there were no clear differences between groups for any of the other primary maternal or neonatal outcomes, except for induction of labour in a single trial[206]
- did not clearly decrease the risk of low birth weight (RR 0.76, 95%CI: 0.52 to 1.11)[207]
- had no clear effect on maternal serum zinc concentration (MD 0.86 umol/L, 95%CI 0.67 to 1.05; 2 studies).[208]

Two RCTs reported on preterm birth. One found a reduced risk among women with low zinc levels (RR 0.52; 95%CI 0.29 to 0.92; n=397)[209] and the other found no clear difference among women without identified low levels of zinc (RR 0.93; 95%CI 0.46 to 1.90).[210] There were no clear differences in any other outcomes reported in the RCTs.

The third RCT found that zinc supplementation increased haemoglobin concentration at birth (MD -0.26 g/dL; 95% CI: -0.50 to -0.02; p=0.03) but did not alter serum ferritin (p=0.14) or plasma zinc (p=0.15).[211]

Magnesium supplementation

Background

The Guidelines currently comment that there is insufficient evidence to show whether dietary magnesium supplementation during pregnancy is beneficial.

Current review

This review identified one Cochrane review[212] and four RCTs that reported on relevant outcomes.[213-216]

In the Cochrane review, there was no clear difference between magnesium and control groups in perinatal mortality (RR 1.10; 95%CI 0.72 to 1.67; 5 RCTs, n=5,903), small-for-gestational age (RR 0.76; 95%CI 0.54 to 1.07; 3 RCTs,

n=1,291), preterm birth (RR 0.89; 95%CI 0.69 to 1.14, 7 RCTs, n=5,981), pre-eclampsia (RR 0.87; 95%CI 0.58 to 1.32; 3 RCTs, n=1,042) or pregnancy-induced hypertension (RR 0.39; 95%CI 0.11 to 1.41; 3 RCTs; n=4,284). Magnesium supplementation was associated with significantly fewer babies with an Apgar score less than seven at 5 minutes (RR 0.34; 95%CI 0.15 to 0.80; 4 RCTs; n=1,083) and women receiving magnesium were significantly less likely to require hospitalisation during pregnancy (RR 0.65, 95%CI 0.48 to 0.86; 3 RCTs, n=1,158).

The Cochrane authors concluded that there is not enough high-certainty evidence to show that magnesium supplementation during pregnancy is beneficial.

Two RCTs by the same group found that magnesium supplementation reduced the number of women experiencing increases in diastolic blood pressure in late pregnancy among women with magnesium deficiency in early pregnancy (p=0.012)[214] but not among women with no risk factors for developing hypertension (RR 1.09; 95%CI 0.73 to 2.08).[213] Another RCT found that magnesium supplementation appeared to reduce the risk of preterm uterine contractions (RR 0.33; 95%CI 0.24 to 0.47) and threatened preterm labour (RR 0.50; 95%CI 0.33 to 0.76) but noted that further larger studies are required to confirm these preliminary results.[215] Magnesium supplementation for women with leg cramps reduced their frequency (p=0.007) and intensity (p=0.048).

Selenium supplementation

Background

The Guidelines currently note that a systematic review found that selenium levels were lower among women with pre-eclampsia than among controls.

Current review

This review included two RCTs reported in seven studies.[217-223] One RCT reported a reduced risk of premature rupture of the membranes (RR 0.38; 95%CI 0.01 0.18 to 0.79; n=125).[218] The incidence of pre-eclampsia[217] and of biomarkers for pre-eclampsia risk[221] were lower in the supplementation groups but did not reach statistical significance. Both studies noted that larger studies are required to draw conclusions on the efficacy of selenium supplementation in reducing risk of pre-eclampsia. There were no clear differences in any other outcome in either study.

2.3.3 Evidence statements

Vitamins

Folic acid

There is high certainty evidence that folic acid supplementation in pregnancy is associated with a reduction in risk of neural tube defects and lower certainty evidence that it may also reduce the risk of orofacial clefts and congenital heart defects.

There is evidence from systematic reviews of observational studies that folic acid supplementation during pregnancy may reduce the risk of acute myeloid leukaemia, brain and spinal cord tumours in the child and autism spectrum disorders.

The evidence suggests that folic acid supplementation does not affect the risk of early or late miscarriage, stillbirth, fetal loss, preterm birth, low birth weight, perinatal death, or asthma or wheeze in the infant.

The evidence is inconsistent on the effect of folic acid supplementation on gestational hypertension, pre-eclampsia and acute lymphoblastic leukaemia in the infant.

Vitamin B_6

There is insufficient evidence to detect clinical benefits of vitamin B_6 in pregnancy, although it appears to be of benefit in reducing nausea.

Vitamin B_{12}

The evidence on vitamin B_{12} supplementation in pregnancy is of insufficient quality to draw conclusions.

Vitamin C

The evidence does not support routine vitamin C supplementation for the prevention of fetal or neonatal death, poor fetal growth, preterm birth or pre-eclampsia. Further research is required to clarify the possible role of vitamin C in the prevention of placental abruption and prelabour rupture of membranes.

Vitamin E

The evidence on vitamin E supplementation is of insufficient quality to draw conclusions.

Vitamins C and E combined

Supplementation with vitamins C and E during pregnancy appears to reduce the risk of placental abruption and increase the risk of term PROM. It does not appear to affect other perinatal outcomes. Combined vitamins C and E may reduce the risk of preterm birth and placental abruption in pregnant women who smoke.

Vitamin A

The evidence does not support vitamin A supplementation for the prevention of fetal loss, maternal mortality, perinatal mortality or preterm birth. The evidence on the role of vitamin A supplementation in reducing risk of maternal clinical infection and anaemia may not be generalisable to the Australian context.

Multiple micronuntrients

There is high certainty evidence from studies conducted in low- to middle-income countries that multivitamin use during pregnancy reduces the risk of low birth weight and may reduce the risk of stillbirth but does not affect the risk of perinatal or neonatal mortality. There is moderate certainty evidence of a reduction in risk of small for gestational age and a possible reduction in risk of preterm birth (<37 weeks). There is evidence of unspecified certainty that multivitamin use is associated with a reduction in risk of very preterm birth (<34 weeks), a possible reduction in risk of miscarriage and has no effect on maternal mortality, maternal anaemia, caesarean section or congenital anomalies. These findings may not be generalisable to the Australian context.

There is very low to low certainty evidence that prenatal multivitamin supplementation among women in high income countries is associated with a reduced risk of small for gestational age and some congenital anomalies and a possible reduced risk of preterm birth.

Minerals

Iron

There is moderate certainty evidence that iron supplementation in pregnancy has no clear effect on the risk of preterm birth. There is low certainty evidence that iron supplementation in pregnancy reduces the risk of maternal anaemia and iron deficiency at term and has no clear effect on maternal infection, neonatal death, congenital anomalies or low birth weight. There is very low certainty evidence that iron supplementation in pregnancy has no clear effect on the risk of maternal death or maternal side effects. There is evidence from a systematic review of RCTs that iron supplementation has no clear effect on infant neurodevelopment.

There is low certainty evidence that intermittent versus daily iron supplementation in pregnancy has no clear effect on preterm birth, birth weight or low birthweight. There is very low certainty evidence that maternal side effects are reduced with intermittent versus daily iron supplementation and that there is no clear effect on maternal anaemia at term, maternal iron-deficiency at term or neonatal death.

Calcium

There is consistent evidence from systematic reviews that calcium supplementation reduces the risk of pre-eclampsia. Calcium supplements do not appear to be of benefit in preventing low birth weight and their role in preventing preterm birth is unclear. There is evidence that routine calcium supplementation is more cost-effective than selective supplementation.

Iodine

There is low certainty evidence that, in settings with mild to moderate iodine deficiency, iodine supplementation may reduce the risk of postpartum hyperthyroidism and very low certainty evidence of an increased likelihood of gastrointestinal intolerance during pregnancy. There is low certainty evidence that iodine supplementation does not appear to increase or decrease the likelihood of other outcomes or side effects for mothers or infants. Based on background information and the lack of harms associated with iodine supplementation in pregnancy, no changes to the existing recommendation are required.

Zinc

There is moderate certainty evidence that zinc supplementation may play a role in reducing the risk of preterm birth but has no clear effect on low birthweight. Supplementation does not appear to increase or reduce the risk of other outcomes. There is insufficient evidence to support a recommendation on zinc supplementation.

Magnesium

There is insufficient evidence to draw conclusions on magnesium supplementation in pregnancy.

Selenium

There is insufficient evidence to draw conclusions on selenium supplementation in pregnancy.

2.3.4 Evidence tables

Table 34: Q3 Harms and benefits of vitamin B_9 (folic acid) supplementation in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Wang et al 2015[122]	16 cohort 7 case-control 3 cross-sectional studies	**Aim**: To investigate whether indirect or direct exposure to folate and impaired folate metabolism, reflected as methylene-tetrahydrofolate reductase (*MTHFR*) C677T polymorphism, would contribute to the development of asthma and other allergic diseases. **Methods:** Electronic databases were searched to identify all studies assessing the association between folate status and asthma or other allergic diseases. Two reviewers independently assessed the eligibility of studies and extracted data. The relative risk (RR) or odds ratio (OR) with 95% confidence intervals (CI) was calculated and pooled.	Supplementation during pregnancy vs no supplementation: • Asthma: RR 1.04; 95%CI 0.94 to 1.16; low certainty • Wheeze: RR 1.05; 95%CI 0.95 to 1.15; low certainty Supplementation in early pregnancy vs no supplementation: • Asthma: RR 0.98; 95%CI 0.78 to 1.23; low certainty • Wheeze: RR 1.06; 95%CI 1.02 to 1.09; low certainty • Atopic dermatitis: RR 1.15; 95%CI 0.91 to 1.45; very low certainty	

Study ref	N	Aim/methods	Results	Comments
Wang et al 2017[118]	16 observational studies	**Aim:** To reassess the relationship between folic acid and the risk of autism spectrum disorders. **Methods**: The electronic databases PubMed, Web of Knowledge, and Wanfang Data were carefully searched to find eligible studies as recent as March 2017. A random effects model was used to combine the relative risk (RR) with 95% confidence intervals (CI). Sensitivity analysis and publication bias were conducted.	Folic acid supplementation vs no supplementation: *Autism spectrum disorders* • All populations: RR 0.77; 95%CI 0.64 to 0.93, 16 studies • Asian populations: RR 0.67; 95%CI 0.46 to 0.97; 8 studies • European populations: RR 0.84; 95%CI 0.68 to 0.99; 3 studies • American populations: RR 0.41; 95%CI 0.17 to 0.99; 5 studies	
Metayer et al 2014[120]	7 case-control studies	**Aim**: To examine the association between maternal vitamin supplementation and acute myeloid leukaemia (AML). **Methods**: We obtained original data on prenatal use of folic acid and vitamins from 12 case-control studies participating in the Childhood Leukaemia International Consortium (enrolment period: 1980-2012), including 6,963 cases of ALL, 585 cases of AML, and 11,635 controls. Logistic regression was used to estimate pooled odds ratios (ORs) and 95% confidence intervals (CIs), adjusted for child's age, sex, ethnicity, parental education, and study centre.	Folic acid during pregnancy vs no folic acid: • Acute lymphoblastic leukaemia: OR 0.77; 95%CI 0.67 to 0.88 • Acute myeloid leukaemia: OR 0.52; 95%CI 0.31 to 0.89	
Dessypris et al 2017[75]	3 case-control studies	**Aim**: To quantitatively synthesise published data on the association of maternal/child diet with leukaemia risk. **Methods**: Medline was searched until June 30th, 2016 for eligible articles on the association of childhood leukaemia with consumption of (i) food groups, excluding alcoholic and non-alcoholic beverages, and (ii) specific dietary supplements before/during index pregnancy and childhood.	Dietary supplement of folic acid versus no supplement: • Childhood acute lymphoblastic leukaemia: RR 0.87 (0.57 to 1.34); 3 studies	

Study ref	N	Aim/methods	Results	Comments
Chiavarini et al 2018[127]	10 studies: 1 cohort study 9 case-control studies	**Aim**: To investigate the effect of maternal diet and prenatal multivitamin supplementation on paediatric cancer risk, in particular childhood brain and spinal cord tumours (CBSCT). **Methods**: We conducted a systematic review and meta-analysis on maternal folate intake before and during pregnancy and the risk of CBSCT. We systematically reviewed publications obtained by searching the Institute for Scientific Information Web of Knowledge and PubMed literature databases. We extracted the risk estimate of the highest and the lowest reported categories of intake from each study and conducted a meta-analysis using a random-effects model.	Folate supplementation vs no folate supplementation: • CBSCT: OR 0.77 (0.66 to 0.90), p=0.001	

Study ref	N	Aim/methods	Results	Comments
De Regil et al 2015[129]	5 RCTs 2,033 women with a history of NTDs 5,358 women with no history	**Aim:** To examine whether periconceptional folate supplementation reduces the risk of neural tube and other congenital anomalies (including cleft palate) without causing adverse outcomes in mothers or babies. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (31 August 2015). Additionally, we searched the World Health Organization (WHO) International Clinical Trials Registry Platform (ICTRP) (31 August 2015) and contacted relevant organisations to identify ongoing and unpublished studies. We included all randomised or quasi-randomised trials evaluating the effect of periconceptional folate supplementation alone, or in combination with other vitamins and minerals, in women independent of age and parity.	Supplementation with folate (alone or in combination with other vitamins and minerals) versus no intervention, placebo or other micronutrients without folate: • Neural tube defects: RR 0.31 (0.17 to 0.58); 5 RCTs; n=6,708; high certainty • Cleft lip: RR 0.79 (0.14 to 4.36); 3 studies; n=5,612; low certainty • Cleft palate: RR 0.73 (0.05 to 0.89); 3 studies; n=5,612; low certainty • Congenital cardiovascular defects: RR 0.57 (0.24 to 1.33); 3 studies; n=5,612; low certainty • Other congenital anomalies: RR 0.94 (0.53 to 1.66); 3 studies; n=5,612 • Miscarriage: RR 1.10 (0.94 to 1.28); 5 studies; n=7,391; moderate certainty • Any other birth defects: RR 0.94; 95%CI 0.53 to 1.66; 3 studies; n=5,612; low certainty	

Study ref	N	Aim/methods	Results	Comments
Feng et al 2015[130]	18 studies: 1 RCT 1 cohort study 16 case-control studies	**Aim**: To conduct a meta-analysis of the association between maternal folic acid supplementation and congenital heart defects in offspring. **Methods**: We searched the MEDLINE and EMBASE databases for articles catalogued between their inceptions and October 10, 2014 and identified relevant published studies that assessed the association between maternal folate supplementation and the risk of CHDs. Study-specific relative risk estimates were pooled using random-effects or fixed-effects models. Out of the 1,606 articles found in our initial literature searches, a total of 1 randomised controlled trial, 1 cohort study, and 16 case-control studies were included in our final meta-analysis.	Maternal folate supplementation versus no supplementation: • Congenital heart defects: RR 0.72 (0.63 to 0.82)	
Xu et al 2016[123]	20 case-control studies	**Aim**: To examine the relationship between maternal folic acid (FA) supplementation and birth prevalence of congenital heart defects (CHDs). **Methods**: Eligible articles were retrieved by searching databases, including PubMed, Cochrane library, EMBASE, CNKI, and WanFang up to September 2015. A meta-analysis was performed to evaluate the effects of FA on CHDs. Odds ratios (ORs) and 95% confidence interval (CIs) were merged using STATA 12.0. Meta-regression analysis was used to explore the possible sources of heterogeneity. Subgroup analysis according to the selected sources was also performed. Publication bias was assessed by Egger's test.	Supplementation vs no supplementation: *Congenital heart defect* • All populations: OR 0.60; 95%CI 0.49 to 0.71 • American populations: OR 0.92; 95%CI 0.83 to 1.02 • Chinese populations: OR 0.44; 95%CI 0.33 to 0.56 • European populations: OR 0.83; 95%CI 0.75 to 0.91	

Study ref	N	Aim/methods	Results	Comments
Balogun et al 2016[125]	1 RCT n=903	**Aim**: to determine the effectiveness and safety of any vitamin supplementation on the risk of spontaneous miscarriage. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group Trials Register (6 November 2015) and reference lists of retrieved studies. All randomised and quasi-randomised trials comparing supplementation during pregnancy with one or more vitamins with either placebo, other vitamins, no vitamins or other interventions. We have included supplementation that started prior to conception, periconceptionally or in early pregnancy (less than 20 weeks' gestation).	Folic acid without multivitamin vs no folic acid/multivitamin: • Total fetal loss: RR 0.95 (0.64 to 1.40); 1 study; n=903 • Early or late miscarriage: RR 0.97 (0.65 to 1.44); 1 study; n=903 • Stillbirth: RR 0.67 (0.11 to 4.02); 1 study; n=903	
Hua et al 2016[132]	13 studies: 2 RCTs 10 cohort studies 1 case-control study	**Aim:** To evaluate the effect of folic acid supplementation during pregnancy on the risk of gestational hypertension/preeclampsia. **Methods**: A systematic review and meta-analysis were conducted. Medline, Embase, Scopus, and the Web of Science were searched from inception to December 2014.	Folic acid in any format including in multivitamins vs no supplementation: • Gestational hypertension/preeclampsia: RR 0.62 (0.45 to 0.87); 2 RCTs • Gestational hypertension/pre-eclampsia: RR 0.92 (0.79 to 1.08); 9 cohort studies • Pre-eclampsia: RR 0.88 (0.76 to 1.02); 8 cohort studies	Considerable overlap in studies with Lui et al 2018

Study ref	N	Aim/methods	Results	Comments
Liu et al 2018[134]	14 studies 1 RCT 13 cohort studies	**Aim:** To systematically assess the relationship between folic acid supplementation in pregnancy and risk of preeclampsia and gestational hypertension. **Methods:** The relevant studies were included by retrieving the Embase, PubMed and Cochrane library databases. Data extraction was conducted by two investigators independently. The risk ratio (RR) and 95% confidence interval (CI) were used as effect indexes to evaluate the relationship between folic acid supplementation and risk of gestational hypertension or preeclampsia. A subgroup analysis was performed according to the supplementation patterns of folic acid. The homogeneity of the effect size was tested across the studies, and publication biases were examined.	Multivitamins containing folic acid versus no supplementation: • Gestational hypertension: RR 1.19 (0.92 to 1.54); 4 studies; n=266,938 • Pre-eclampsia: RR 0.69 (0.58 to 0.83); 12 studies; n=311,991 Folic acid alone versus no supplementation: • Pre-eclampsia: RR 0.97 (0.80 to 1.17); 4 studies; n=210,896	Considerable overlap in studies with Hua et al 2016[132]
Hodgetts et al 2015[131]	1 cohort study Meta-analysis of: 3 RCTs 9 cohort studies 1 case-control study	**Aim**: To assess the effect of timing of folic acid (FA) supplementation during pregnancy on the risk of the neonate being small for gestational age (SGA). **Methods**: A population database study and a systematic review with meta-analysis including the results of this population study. A UK regional database was used for the population study and an electronic literature search (from inception until August 2013) for the systematic review. Singleton live births with no known congenital anomalies were included; 111,736 in population study and 188,796 in systematic review.	Folic acid supplementation 400-500 µg daily post-conception versus no supplementation: • Birthweight <5th percentile: OR 0.82 (0.63 to 1.06)	

Study ref	N	Aim/methods	Results	Comments
Jahanbin et al 2018[119]	6 cohort studies 31 case-control studies	**Aim**: To assess whether folate supplementation during pregnancy can reduce the risk of nonsyndromic cleft lip with or without cleft palate (CL/P) and cleft palate only (CPO) in infants. **Methods**: Eligible articles were identified by searching databases, including PubMed, Medline, Scopus, ISI (Web of Knowledge) to September 2017. A meta-analysis was performed to evaluate the effects of maternal supplementation on oral clefts. Odds ratios (ORs) and 95% confidence intervals (CIs) were pooled using Stata software. Publication bias was assessed by the Begg and Egger test.	Folic acid alone supplementation vs no supplementation: • Orofacial cleft: OR 0.73, 95%CI 0.62 to 0.85 • CL/P: OR 0.72; 95%CI 0.61 to 0.85 • CPO: OR 0.75, 95%CI 0.53 to 1.04.	
Bulloch et al 2018[126]	8 observational studies	**Aim**: To investigate the effect of maternal folic acid supplementation during pregnancy on risk of preeclampsia and gestational hypertension. **Methods**: Multiple scientific databases and grey literature were searched for relevant studies. Studies were reviewed according to pre-specified inclusion and exclusion criteria. Study characteristics were summarised and study quality was assessed. A meta-analysis of observational studies was conducted to examine the effect of maternal folic acid supplementation on preeclampsia risk.	Folic acid supplementation vs no folic acid supplementation: • Pre-eclampsia: OR 0.78 (0.63 to 0.98) Subgroup analysis showed no significant difference between folic acid supplementation taken by itself, in comparison to folic acid taken in or alongside a multivitamin.	

Study ref	N	Aim/methods	Results	Comments
Saccone et al 2016[121]	5 RCTs	**Aim**: To evaluate the efficacy of folic acid supplementation during pregnancy to prevent preterm birth (PTB). **Methods**: The research protocol was designed a priori, defining methods for searching the literature in electronic databases, including and examining articles, and extracting and analysing data. We included all randomized trials (RCTs) of asymptomatic singleton gestations without prior PTB who were randomized to prophylactic treatment with either FA supplementation or control (placebo or no treatment). The primary outcome was the incidence of PTB <37 weeks.	Folic acid vs placebo or no treatment: • Preterm birth <37 weeks: RR 0.99; 95%CI 0.82 to 1.18 • Preterm birth <34 weeks: RR 0.77; 95%CI 0.55 to 1.09 • Preterm premature rupture of membranes: RR 0.81; 95%CI 0.44 to 1.50 • Birth weight: MD 85.58g, 95%CI -55.17 to 226.34 • Low birth weight: RR 0.79; 95%CI 0.49 to 1.28 • Perinatal death: RR 0.90; 95%CI 0.60 to 1.34	
Zhang et al 2017[124]	12 cohort studies	**Aim**: To investigate the effect of folic acid (FA) supplementation on the risks of preterm delivery (PTD) and small for gestational age births (SGA). **Methods**: Cohort studies including healthy women who want to get pregnancy or being pregnant were identified from MEDLINE, EMBASE, the Cochrane Library, CINAHL, and CBM from inception to January 2015.	Moderate to low dose of folic acid post conception vs no supplementation: • Preterm birth: RR 0.68; 95%CI 0.52 to 0.90; 2 studies; n=575 • Small for gestational age: RR 0.84; 95%CI 0.81 to 0.89; 3 studies; n=17,553	

Study ref	N	Aim/methods	Results	Comments
Lassi et al 2013[133]	3 RCTs	**Aim**: To assess the effectiveness of oral folic acid supplementation alone or with other micronutrients versus no folic acid (placebo or same micronutrients but no folic acid) during pregnancy on haematological and biochemical parameters during pregnancy and on pregnancy outcomes. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (31December 2012) and we contacted major organisations working in micronutrient supplementation, including UNICEF Nutrition Section, World Health Organization (WHO) Maternal and Reproductive Health, WHO Nutrition Division, and National Center on Birth defects and Developmental Disabilities, US Centers for Disease Control and Prevention (CDC). We included all randomised, cluster-randomised and cross-over controlled trials evaluating supplementation of folic acid alone or with other micronutrients versus no folic acid (placebo or same micronutrients but no folic acid) in pregnancy.	Folic acid alone or with other micronutrients versus no folic acid: • Preterm birth (<37 weeks): RR 1.09 (0.77 to 1.54); 1 study; n=2,797 • Stillbirth/neonatal death: RR 1.33 (0.96 to 1.85); 3 studies; n=3,110 • Low birthweight (<2,500 g): RR 0.80 (0.63 to 1.02); 3 studies; n=3,089	

Table 35: Q3 Harms and benefits of vitamin B_9 (folic acid) supplementation in pregnancy — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Catena et al 2016[135] NUHEAL Germany, Spain, Hungary	Intervention 27 Placebo 32	**Aim**: To analyse the long-term effects of FO, 5-methyltetrahydrofolate (5-MTHF), or FO+5-MTHF prenatal supplementation on attention networks. **Population:** Children born to mothers from the NUHEAL (Nutraceuticals for a Healthy Life) project who were recalled for a new examination 8.5 y later. **Intervention**: Women were randomly assigned to receive fish oil and/or 5-MTHF or placebo prenatal supplementation.	Children born to mothers supplemented with 5-MTHF alone solved the response conflict more quickly than did the placebo and the FO+5-MTHF groups (all P<0.05).	
McNulty et al 2013[136] Northern Ireland	Intervention 59 Control 60	**Aim**: To investigate maternal folate and homocysteine responses and related effects in the newborn that resulted from continued folic acid (FA) supplementation after the first trimester of pregnancy. **Population**: Pregnant women, aged 18-35 y, who were attending an antenatal clinic with singleton uncomplicated pregnancies and reported taking FA supplements in the first trimester. **Intervention**: women were randomly assigned at the start of trimester 2 to receive 400 mug FA/d or placebo.	Response from gestational weeks 14 to 36 intervention vs control: • Serum folate: 0.9±24.7 vs -26.1±19.0; p<0.001 • Red blood cell folate: 549+661 vs -250±690; p<0.001 • Plasma homocysteine: 0.1±1.1 vs 1.0±1.9; p=0.006 • Cord blood folate: 1993±862 vs 1418±557; p=0.001	
Sayyah-Melli et al 2016[137] Iran	Low dose 200 High dose 210	**Aim**: To assess the effect of low doses and high doses of folic acid on homocysteine levels, blood pressure, urea, creatinine and neonatal outcome. **Population**: Nulliparous pregnant women. **Intervention**: Group received 0.5 mg of folic acid daily and group 2 received 5 mg of folic acid per daily.	Low dose vs high dose: • Homocysteine concentrations: 13.17±3.89 µmol/l vs 10.31±3.54, µmol/l; p<0.001 • Systolic blood pressure: p=0.84 • Diastolic blood pressure: p=0.15 • Birthweight: 3,366.12±421.39 vs 3,456.39±410.30; p=0.031 • Early abortion (not defined): 10/200 (5%) vs 1/210 (0.5%); p=0.005	

Study ref	N	Aim/population/intervention	Results	Comments
Wen at al 2018[138] Argentina, Australia, Canada, Jamaica, United Kingdom	Intervention 1,114 Control 1,157	**Aim:** To determine the efficacy of high dose folic acid supplementation for prevention of pre-eclampsia in women with at least one risk factor. **Population**: Pregnant women with pre-existing hypertension, prepregnancy diabetes (type 1 or 2), twin pregnancy, pre-eclampsia in a previous pregnancy, or body mass index ≥35. **Intervention**: Eligible women were randomised to receive either daily high dose folic acid (four 1.0 mg oral tablets) or placebo from eight weeks of gestation to the end of week 16 of gestation until delivery.	Intervention vs control: • Pre-eclampsia: 169/1144 (14.8%) vs 156/1157 (13.5%); RR 1.10, 95%CI 0.90 to 1.34; P=0.37.	
Yusuf et al 2019[139] United States	Low dose 171 High dose 174	**Aim**: To determine the efficacy of higher-dose folic acid in preventing a reduction in fetal body size among infants of women who smoked tobacco cigarettes during pregnancy. **Population**: Pregnant women with status as currently active smokers per self report and cotinine biomarker; an age between 18 and 44 years; gestation <21 weeks at study entry. **Intervention**: Eligible participants were randomly assigned in a 1:1 ratio to receive either 4mg of folic acid per day (the higher-dose group) or 0.8mg of folic acid per day (the standard-dose group).	High dose vs low dose: • Birth weight: MD 140.39; 95% CI 1.63 to 279.15 g • Small for gestational age: aRR 0.69; 95%CI 0.46 to 1.03 • Fetal growth restriction: aRR 0.65; 95%CI 0.46 to 0.93 No elevated risk of adverse effects associated with higher dose folic acid were identified	

Table 36: Q3 Harms and benefits of vitamin B_6 supplementation in pregnancy — systematic review

Study ref	N	Aim/methods	Results	Comments
Sridharan et al 2018[141] SLR	2 studies	**Aim: To** carry out a network meta-analysis comparing the interventions used for treating nausea and vomiting in pregnancy. **Methods:** We searched PubMed, Cochrane CENTRAL, and Google Scholar for randomised clinical trials carried out in pregnant women with nausea or vomiting. Those carried out in women with hyperemesis gravidarum were excluded. Direct estimates were derived by pooling the data from head-to-head clinical trials while indirect estimates through a common comparator.	Vitamin B6 vs placebo: • Difference in nausea score: MD -3.7; 95%CI -6.9 to -0.5; very low certainty	

Study ref	N	Aim/methods	Results	Comments
Salam et al 2015[140]	4 studies 1,646 women	**Aim:** To evaluate the clinical effects of vitamin B6 supplementation during pregnancy and/or labour. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group Trials Register (31 March 2015) and reference lists of retrieved studies. We included randomised controlled trials comparing vitamin B6 administration in pregnancy and/or labour with: placebos, no supplementations, or supplements not containing vitamin B6. Two review authors independently assessed trials for inclusion and risk of bias, extracted data and checked them for accuracy. For this update, we assessed methodological quality of the included trials using risk of bias and the GRADE approach.	Vitamin B6 as oral capsules or lozenges vs placebo or no supplementation: • dental decay in pregnant women: capsules: RR 0.84; 95%CI 0.71 to 0.98; 1 trial, n=371, low certainty; lozenges: RR 0.68; 95%CI 0.56 to 0.83; 1 trial, n=342, low certainty. • mean birthweights: (MD -0.23 kg; 95%CI -0.42 to -0.04; n=33; 1 trial) There was no statistically significant difference in: • risk of eclampsia (capsules: n=1,242; 3 trials; lozenges: n=944; 1 trial) • pre-eclampsia (capsules n=1,197; 2 trials, low certainty; lozenges: n=944; 1 trial, low-certainty) • low Apgar scores at one minute (oral pyridoxine: n=45; one trial). No differences were found in Apgar scores at five minutes, or breastmilk production between controls and women receiving oral (n=24; 1 trial) or intramuscular (n=24; 1 trial) loading doses of pyridoxine at labour.	

Table 37: Q3 Harms and benefits of vitamin B_{12} supplementation in pregnancy — RCTs

Study ref	N	Aim/methods	Results	Comments
Siddiqua et al 2016[146] Bangladesh	68	**Aim**: To evaluate effects of pre- and postnatal B12 supplementation on biomarkers of B_{12} status and vaccine-specific responses in mothers and infants. **Population**: Women aged 18-35 years, haemoglobin <110 g/L, 11-14 weeks pregnant **Intervention**: 250 mug/day B12 or a placebo throughout pregnancy and 3-month postpartum along with 60 mg iron + 400 mug folate. Women were immunized with pandemic influenza A (H1N1) vaccine at 26- to 28-week gestation. Blood from mothers (baseline, 72-h post-delivery, 3-month postpartum), newborns and infants (3-month) was analysed for haemoglobin, B12, methylmalonic acid (MMA), total homocysteine (tHcy), ferritin and serum transferrin receptor, C-reactive protein (CRP) and alpha-1-acid glycoprotein (AGP).	B_{12} supplementation vs placebo: • increased B_{12} in plasma, colostrum and breast milk ($p<0.05$) • lowered MMA in neonates, mothers and infants at 3 months ($p<0.05$) • increased H1N1-specific IgA responses in plasma and colostrum in mothers and reduced proportion of infants with elevated AGP and CRP.	

Study ref	N	Aim/methods	Results	Comments
Srinivasan et al 2017[144,145] India	Intervention 131 Control 125	**Aim**: To report the effects of maternal B_{12} supplementation on cognitive development in infants. **Population**: Pregnant women less than 14 weeks gestation. **Intervention**: Oral vitamin B_{12} supplementation (50 microg/day) beginning at <14 weeks of gestation through to 6-week post-partum.	Maternal B_{12} supplementation (n=78) vs placebo in infants at 9 months (n=100): • no significant differences in any subscales of BSID-III Elevated maternal homocysteine levels vs no elevated homocysteine: • second trimester: expressive language (ß -3.13, P<0.001) • third trimester: expressive language (ß -2.29, P<0.001) and fine motor (ß -1.41, P=0.005) Maternal B_{12} supplementation (n=114) vs placebo (n=104) in infants at 30 months: • significantly higher scores on expressive language (ß 0.14, P=0.03). Elevated maternal homocysteine vs no elevated homocysteine: • Second trimester: expressive language (ß - 0.18, P=0.03) and gross motor (ß -0.23, P=0.008) • Third trimester: expressive language (ß - 0.19, P=0.02) and gross motor (ß -0.30, P=0.001)	

Table 38: Q3 Harms and benefits of vitamin C supplementation in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Balogun et al 2016[125]	40 studies 276,820	**Aim**: to determine the effectiveness and safety of any vitamin supplementation on the risk of spontaneous miscarriage. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group Trials Register (6 November 2015) and reference lists of retrieved studies. All randomised and quasi-randomised trials comparing supplementation during pregnancy with one or more vitamins with either placebo, other vitamins, no vitamins or other interventions. We have included supplementation that started prior to conception, periconceptionally or in early pregnancy (less than 20 weeks' gestation).	Vitamin C vs placebo: • Total fetal loss: RR 1.28 (0.58 to 2.83); 2 studies; n=224 • Early or late miscarriage; RR 1.17 (0.52 to 2.65); 2 studies; n=224 • Stillbirth: RR 3.0 (0.12 to 72.77); 1 study; n=200	
Fu et al 2018[147]	1 study	**Aim**: To define the efficacy of vitamins supplementation on the risk of preeclampsia. **Methods**: Potential articles were systematically searched on the databases of Pubmed, Embase and Web of Science up to May 2016. Relative risk (RR) and 95% confidence intervals (95%CIs) were used to analyse the relationship of vitamins supplementation with risk of preeclampsia.	Vitamin C vs placebo: • Pre-eclampsia: RR 0.77 (0.38 to 1.57)	

Study ref	N	Aim/methods	Results	Comments
Rumbold et al 2015[148]	29 studies 24,300	**Aim**: To evaluate the effects of vitamin C supplementation, alone or in combination with other separate supplements, on pregnancy outcomes, adverse events, side effects and use of health resources. **Methods:** We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (31 March 2015) and reference lists of retrieved studies. All randomised or quasi-randomised controlled trials evaluating vitamin C supplementation in pregnant women. Interventions using a multivitamin supplement containing vitamin C or where the primary supplement was iron were excluded.	Vitamin C (1,000 mg) supplementation alone: • Stillbirth: RR 1.06 (0.58 to 1.94); 2 studies; n=1,015 • Neonatal death: RR 0.70 (0.30 to 1.63); 2 studies; n=958 • Perinatal death: RR 0.51 (0.05 to 5.54); 1 study; n=182 • Intrauterine growth restriction: RR 1.56 (0.63 to 3.89); 1 study; n=159 • Preterm birth: RR 1.06 (0.75 to 1.48); 5 studies; n=1,685 • Preterm PROM: average RR 0.66 (0.48 to 0.91); 5 studies; n=1,282 • Term PROM: RR 0.55 (0.32 to 0.94); 1 study; n=170 • Clinical pre-eclampsia: RR 0.88 (0.48 to 1.61); 3 studies; n=1,191	

Table 39: Q3 Harms and benefits of vitamin C supplementation in pregnancy — RCT

Study ref	N	Aim/population/intervention	Results	Comments
McEvoy et al 2019[149] United States	Intervention 113 Control 109	**Aim**: To determine if infants of pregnant smokers randomized to daily supplemental vitamin C would have improved forced expiratory flows (FEFs) at 3 months of age compared with those randomized to placebo, and to investigate the association of the alpha5 nicotinic acetylcholine receptor. **Population**: women >15 years old with a singleton gestation between 13 weeks and 0 days and 22 weeks and 6 days based on clinical information and confirmed by ultrasound, current cigarette smoker (>1 cigarette in last week). **Intervention**: Vitamin C (500 mg/d).	Vitamin C (500 mg/d) versus placebo: • FEF_{75} at 3 months: 200.7 vs 188.7 ml/s; adjusted 95%CI -3.33 to 35.64; P=0.10 • FEF_{50} at 3 months: 436.7 vs 408.5 ml/s; adjusted 95%CI 6.10 to 61.30; P=0.02 • FEF_{25-75}: 387.4 vs 365.8 ml/s; adjusted 95%CI 0.92 to 55.34; P=0.04	Included in Vahdaninia et al 2017[153]

Table 40: Q3 Harms and benefits of vitamin E supplementation — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Fu et al 2018[147]	1 study	**Aim**: To define the efficacy of vitamins supplementation on the risk of preeclampsia. **Methods**: Potential articles were systematically searched on the databases of Pubmed, Embase and Web of Science up to May 2016. Relative risk (RR) and 95% confidence intervals (95%CIs) were used to analyse the relationship of vitamins supplementation with risk of preeclampsia.	Intervention vs control: • Pre-eclampsia: RR 0.54 (0.06 to 5.11); 1 RCT	
Wu et al 2018[150]	19 studies	**Aim**: To critically examine the current evidence on the association of vitamin E with childhood asthma and wheezing. **Methods**: We searched electronic databases for observational studies in English-language journals published from 2000 to 2016.	Intervention vs control: • Asthmatic diseases in childhood: OR 0.74 (0.61 to 0.89) • Childhood asthma: RR 0.97 (0.95 to 1.00) • Wheeze in children: RR 0.65 (0.56 to 0.75)	

Table 41: Q3 Harms and benefits of vitamin C and vitamin E supplementation in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Balogun et al 2016[125]	40 studies 276,820	**Aim**: to determine the effectiveness and safety of any vitamin supplementation, on the risk of spontaneous miscarriage. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group Trials Register (6 November 2015) and reference lists of retrieved studies. All randomised and quasi-randomised trials comparing supplementation during pregnancy with one or more vitamins with either placebo, other vitamins, no vitamins or other interventions. We have included supplementation that started prior to conception, periconceptionally or in early pregnancy (less than 20 weeks' gestation).	Vitamin C plus vitamin E vs placebo: • Total fetal loss: RR 1.14 (0.92 to 1.40); 7 studies; n=18,949 • Early or late miscarriage: RR 0.90 (0.65 to 1.26); 4 studies; n=13,346 • Stillbirth: RR 1.31 (0.97 to 1.76); 7 studies; n=21,442 • Congenital malformations: RR 1.17 (0.84 to 1.62); 5 studies; n=8,334 • Any adverse effects of vitamin supplementation sufficient to stop supplementation: RR 1.16 (0.39 to 3.41); 1 study; n=739	
Fu et al 2018[147]	12 studies	**Aim**: To define the efficacy of vitamins supplementation on the risk of preeclampsia. **Methods**: Potential articles were systematically searched on the databases of Pubmed, Embase and Web of Science up to May 2016. Relative risk (RR) and 95% confidence intervals (95%CIs) were used to analyse the relationship of vitamins supplementation with risk of preeclampsia.	Intervention vs control: • Pre-eclampsia: RR 0.99 (0.90 to 1.08)	

Study ref	N	Aim/methods	Results	Comments
Rumbold et al 2015[151]	17 studies 22,129 women	**Aim:** To assess the effects of vitamin E supplementation, alone or in combination with other separate supplements, on pregnancy outcomes, adverse events, side effects and use of health services. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (31 March 2015) and reference lists of retrieved studies. All randomised or quasi-randomised controlled trials evaluating vitamin E supplementation in pregnant women. We excluded interventions using a multivitamin supplement that contained vitamin E.	Vitamin E alone or in combination with other supplements (most commonly vitamin C) compared with placebo: • Stillbirth: RR 1.17, 95%CI 0.88 to 1.56, 9 studies, n=19,023; moderate certainty • Neonatal death: RR 0.81, 95% CI 0.58 to 1.13, 9 trials, n=18,617 • Pre-eclampsia: average RR 0.91, 95% CI 0.79 to 1.06; 14 trials, n=20,878; moderate certainty • Preterm birth: average RR 0.98, 95% CI 0.88 to 1.09, 11 trials, n=20,565; high certainty • Intrauterine growth restriction: RR 0.98, 95%CI 0.91 to 1.06, 11 trials, n=20,202; high certainty • Placental abruption: RR 0.64, 95% CI 0.44 to 0.93, 7 trials, n=14,922; high certainty • Self-reported abdominal pain: RR 1.66, 95% CI 1.16 to 2.37, 1 trial, n=1877 • Term prelabour rupture of membranes (PROM): average RR 1.77, 95% CI 1.37 to 2.28, 2 trials, n=2,504 • Preterm PROM: average RR 1.27, 95% CI 0.93 to 1.75, 5 trials, n=1,999; low certainty	

Study ref	N	Aim/methods	Results	Comments
Tenorio et al 2018[152]	11 studies	**Aim**: To determine whether oral antioxidant therapies, of various types and doses, are able to prevent or treat women with preeclampsia. **Methods**: The following databases were searched: MEDLINE, CENTRAL, LILACS, and Web of Science. Inclusion criteria were: a) randomized clinical trials; b) oral antioxidant supplementation; c) study in pregnant women; d) control group, treated or not with placebo. Meta-analyses were conducted on prevention and treatment studies, separately.	Intervention (500 to 1,000 mg vitamin C plus 400 IU vitamin E) vs placebo: • Pre-eclampsia: RR: 1.00 (0.91 to 1.10) P=0.98	
Vahdaninia et al 2017[153]	1 study	**Aim:** To synthesise the evidence from RCTs assessing the efficacy of vitamin interventions during pregnancy on developing allergic diseases in offspring. **Methods:** We searched CENTRAL, MEDLINE, SCOPUS, WHO's Int. Clin. Trials Reg., E-theses and Web of Science. Study quality was evaluated using the Cochrane's risk of bias tool. Included RCTs had a minimum of 1-month follow-up post gestation.	Intervention (1,000 mg vitamin C plus 400 IU vitamin E from 16-22 weeks until birth) vs control: • Recurrent wheeze: OR 0.83, 95%CI 0.26 to 2.59, p=0.66 • Asthma: OR 0.94, 95%CI 0.42 to 2.11, p=0.85 • Eczema: OR 1.10, 95%CI 0.70 to 1.74, p=0.58	

Table 42: Q3 Harms and benefits of vitamin C and vitamin E supplementation in pregnancy — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Abramovici et al 2015[224] United States	Smokers: Intervention 788 Control 763 Non-smokers Intervention 4,205 Control 4,213	**Aim**: To evaluate the relationship between prenatal vitamin C and E (C/E) supplementation and perinatal outcomes by maternal self-reported smoking status focusing on outcomes known to be impacted by maternal smoking. **Population**: low-risk nulliparous women with singleton pregnancies at 9-16 weeks gestation. **Intervention**: 1000 mg of vitamin C (ascorbic acid) and 400 IU of vitamin E (RRR-a-tocopherol acetate) or matching placebo	Intervention vs control — Smokers vs non-smokers • Pre-eclampsia: RR 1.15 (0.81 to 1.65) vs RR 1.06 (0.90 to 1.24) • Pregnancy-associated hypertension: RR 1.14 (0.99 to 1.32) vs RR 1.09 (1.01 to 1.17) • Placental abruption: RR 0.09 (0.00 to 0.87) vs RR 0.92 (0.52 to 1.62) p=0.01 • Preterm birth (<37 wks): RR 0.76 (0.58 to 0.99) vs RR 1.03 (0.90 to 1.17) p=0.46 • Small-for-gestational age (<10th %): RR 1.26 (0.98 to 1.63) vs RR 1.02 (0.90 to 1.16)	Results for pre-eclampsia included in Fu et al 2018[147]

Table 43: Q3 Harms and benefits of vitamin A supplementation in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Balogun et al 2016[125]	40 studies 276,820	**Aim**: to determine the effectiveness and safety of any vitamin supplementation, on the risk of spontaneous miscarriage. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group Trials Register (6 November 2015) and reference lists of retrieved studies. All randomised and quasi-randomised trials comparing supplementation during pregnancy with one or more vitamins with either placebo, other vitamins, no vitamins or other interventions. We have included supplementation that started prior to conception, periconceptionally or in early pregnancy (less than 20 weeks' gestation).	Vitamin A compared with placebo: • Total fetal loss: RR 1.05, 95%CI 0.90 to 1.23, 3 trials, n=52,480 women • Early or late miscarriage: RR 0.98, 95% CI 0.92 to 1.04, 1 trial, n=39,668 • Stillbirth: RR 0.95, 95% CI 0.86 to 1.06, 1 trial, n=39,668	

Study ref	N	Aim/methods	Results	Comments
McCauley et al 2015[155]	19 trials Over 310,000 women	**Aim**: To review the effects of supplementation of vitamin A, or one of its derivatives, during pregnancy, alone or in combination with other vitamins and micronutrients, on maternal and newborn clinical outcomes. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (30 March 2015) and reference lists of retrieved studies. All randomised or quasi-randomised trials, including cluster-randomised trials, evaluating the effect of vitamin A supplementation in pregnant women.	Vitamin A alone versus placebo or no treatment: • Maternal mortality: RR 0.88 (0.65 to 1.20); 4 trials; n=154,039; high certainty • Perinatal mortality: RR 1.01 (0.95 to 1.07); 1 study, n=76,178; high certainty • Preterm birth: RR 0.98 (0.94 to 1.01); 5 studies, n=48,007; high certainty • Maternal clinical infection: RR 0.45 (0.20 to 0.99); 5 trials; n=17,313; low certainty • Maternal anaemia (RR 0.64 (0.43 to 0.94); 3 studies, n=15,649; moderate certainty	

Table 44: Q3 Harms and benefits of vitamin A supplementation in pregnancy — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Ali et al 2017[156] Bangladesh	1,577 children	Aim: To examine independent and combined effects of antenatal and newborn supplementation with vitamin A on the cognitive function of children at 8 y of age. **Population**: Pregnant women; follow-up of children at 8 years. **Intervention**: weekly oral doses of vitamin A (23,300 IU or 7000 mg retinol equivalents)	Antenatal vitamin A supplementation vs placebo: • Proportion failed number stroop test: 1.37 (0.99 to 1.89) • Scholastic achievement standard score difference: — Reading: -1.2 (-5.0 to 2.7) — Spelling: -1.1 (-4.2 to 2.0) — Maths: -0.4 (-.28 to 2.1)	

Table 45: Q3 Harms and benefits of multiple micronutrient supplementation in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments

Study ref	N	Aim/methods	Results	Comments
Keats et al 2019[164]	20 RCTs	**Aim**: To evaluate the benefits of oral multiple-micronutrient (MMN) supplementation during pregnancy on maternal, fetal and infant health outcomes. **Methods**: All prospective randomised controlled trials evaluating MMN supplementation with iron and folic acid during pregnancy and its effects on pregnancy outcomes were eligible, irrespective of language or the publication status of the trials. We included cluster-randomised trials, but excluded quasi-randomised trials. Trial reports that were published as abstracts were eligible.	MMN with iron and folic acid versus iron, with or without folic acid: • preterm birth (<37 weeks): RR 0.95, 95%CI 0.90 to 1.01; 18 trials, n=91,425; moderate-certainty • very preterm birth (<34 weeks): RR 0.81, 95% CI 0.71 to 0.93; 4 trials, n=37,701 • small-for-gestational age: RR 0.92, 95% CI 0.88 to 0.97; 17 trials; n=57,348; moderate-certainty • low birthweight: RR 0.88, 95% CI 0.85 to 0.91; 18 trials, n=68,801; high-certainty • perinatal mortality: RR 1.00, 95% CI 0.90 to 1.11; 15 trials, n=63,922; high-certainty • stillbirth: RR 0.95, 95% CI 0.86 to 1.04; 17 trials, n=97,927; high-certainty • neonatal mortality: RR 1.00, 95% CI 0.89 to 1.12; 14 trials, n=80,964; high-certainty • maternal anaemia in the third trimester: RR 1.04, 95% CI 0.94 to 1.15; 9 trials, n=5912 • maternal mortality: RR 1.06, 95% CI 0.72 to 1.54; 6 trials, n=106,275 • miscarriage: RR 0.99, 95% CI 0.94 to 1.04; 12 trials, n=100,565 • caesarean section: RR 1.13, 95% CI 0.99 to 1.29; 5 trials, n=12,836 • congenital anomalies: RR 1.34, 95% CI 0.25 to 7.12; 2 trials, n=1,958	

Study ref	N	Aim/methods	Results	Comments
Wolf et al 2017[165]	4 RCTs 31 observational studies 98,926 women	**Aim**: To evaluate the association between multivitamin use among women in high-income countries and the risk of adverse birth outcomes (preterm birth [primary outcome], low birthweight, small for gestational age, stillbirth, neonatal death, perinatal mortality, and congenital anomalies without further specification). **Methods**: We searched electronic databases (MEDLINE, Embase, Cochrane, Scopus, and CINAHL) from inception to June 17, 2016, using synonyms of pregnancy, study/trial type, and multivitamins. Eligible studies were all studies in high-income countries investigating the association between multivitamin use (3 or more vitamins or minerals in tablets or capsules) and adverse birth outcomes. We evaluated randomized, controlled trials using the Cochrane Collaboration tool. Observational studies were evaluated using the Newcastle-Ottawa Scale. Meta-analyses were applied on raw data for outcomes with data for at least 2 studies and were conducted using RevMan (version 5.3). Outcomes were pooled using the random-effect model. The quality of evidence was assessed using the Grades of Research, Assessment, Development and Evaluation approach.	Multivitamin versus no vitamin use: • preterm birth: RR 0.84; 95%CI 0.69 to 1.03; 4 cohort studies; very low certainty • low birth weight: RR 0.79; 95%CI 0.45 to 1.41; 2 studies; very low certainty • small for gestational age: RR 0.77; 95%CI 0.63 to 0.93; 3 cohort studies; very low certainty • stillbirth: RR 0.78; 95%CI 0.59 to 1.03; 2 studies; low certainty • neural tube defects: RR 0.67; 95%CI 0.52 to 0.87; 6 cohort studies; very low certainty • cleft lip with or without cleft palate: RR 0.88; 95%CI 0.77 to 1.01; 6 cohort studies; low certainty • cleft palate: RR 1.12; 95%CI 0.94 to 1.33; 6 cohort studies; low certainty • cardiovascular defects: RR 0.83; 95%CI 0.70 to 0.98; 6 cohort studies; low certainty • urinary tract defects: RR 0.60; 95%CI 0.46 to 0.78; 3 cohort studies; very low certainty • limb deficiencies: RR 0.68; 95%CI 0.52 to 0.89; 3 cohort studies; very low certainty	Timing of supplementation varied in included studies (preconception, peri-conception and post-conception pooled)

Study ref	N	Aim/methods	Results	Comments
Guo et al 2019[166]	3 cohort 1 case-cohort 1 case-control	**Aim**: To perform a systematic review and meta-analysis of published studies to evaluate the actual association between maternal multivitamin supplementation during the prenatal period and the risk of autism spectrum disorder (ASD) in children. **Methods**: PubMed, EMBASE, PsychINFO, Web of Science, and Cochrane Library were searched up to August 26, 2018. The random-effects model was used to calculate the pooled results. The adjusted risk ratios (RRs) were used as the common measure of association among studies. Sensitivity and subgroup analyses were also conducted.	Multivitamin use during pregnancy vs no multivitamin: ASD: RR 0.57; 95% CI, 0.36 to 0.91; p=0.018; 3 studies	

Table 46: Q3 Harms and benefits of multiple micronutrient supplementation in pregnancy — RCTs

Study ref	N	Aim/methods	Results	Comments
Chen et al 2019[167] China	MMN 5,914 Folic acid 5,933	**Aim**: To examine whether 30 mg iron plus folic acid or multiple micronutrients during pregnancy reduces the risk of pregnancy-induced hypertension. **Methods**: We conducted a secondary data analysis by the dataset from a double-blind randomised controlled trial in China from 2006 to 2009 that was conducted to investigate the effects of multiple micronutrient supplements on adverse pregnancy outcomes when provided to pregnant women with no/mild anaemia. We used logistic regression to estimate the adjusted odds ratio and 95% confidence interval and test for effect modification.	Multiple micronutrient vs folic acid: • Pregnancy-induced hypertension: aOR 0.88; 95%CI 0.76 to 1.02 • Late-onset gestational hypertension: aOR 0.85; 95%CI 0.73 to 0.99	

Study ref	N	Aim/methods	Results	Comments
Devakumar et al 2015[168] Nepal	MMN 400 IFA 393	**Aim**: To investigate the effect of antenatal multiple micronutrients on subsequent lung function by measuring spirometry at 7-9 years of age in children born during a trial of micronutrients versus iron plus folic acid. **Methods**: Children were seen at mean 8.5±0.4 years. Technically successful spirometry results were obtained in 793 (94.3%) children, 50% of whom had been randomised to micronutrient supplementation. Background characteristics, including anthropometry, were similar in the two allocation groups.	MMN vs iron plus folic acid: • Forced expiratory volume: MD -0.08; 95%CI -0.19 to 0.04 • Forced vital capacity: MD -0.05; 95%CI -0.17 to 0.06 • FEV1/FVC: MD -0.04; 95%CI -0.15 to 0.07	
Schulze et al 2019[169] Bangladesh	MM 749 IFA 777	**Aim**: To assess the efficacy of a daily multiple micronutrient (MM) (15 nutrients) compared with iron plus folic acid (IFA) supplement, each providing approximately 1 RDA of nutrients and given beginning at pregnancy ascertainment, on late pregnancy micronutrient status of women in rural Bangladesh. **Methods**: Within a double-masked trial (JiVitA-3) among 44,500 pregnant women, micronutrient status indicators were assessed in women, allocated by cluster to receive daily MM or IFA at 10 wk (baseline: before supplementation) and 32 wk (during supplementation) gestation. Efficacy of MM supplementation on micronutrient status indicators at 32 wk was assessed, controlling for baseline status and other covariates (e.g., inflammation and season), in regression models.	At 32 wk gestation, vitamin B-12, A, and D and zinc status indicators were 3.7-13.7% higher, and ferritin, gamma-tocopherol, and thyroglobulin indicators were 8.7-16.6% lower, for the MM group compared with the IFA group, with a 15-38% lower prevalence of deficiencies of vitamins B-12, A, and D and zinc (all $P < 0.05$). However, indicators typically suggested worsening status during pregnancy, even with supplementation, and baseline status or other covariates were more strongly associated with late pregnancy indicators than was MM supplementation.	

Study ref	N	Aim/methods	Results	Comments
Taghizadeh et al 2015[170] Iran	Multivitamin 35 Multivitamin -mineral 35	**Aim**: To determine the favourable effects of multivitamin versus multivitamin-mineral (same multivitamin plus calcium, iron and magnesium) supplements on metabolic profiles and biomarkers of oxidative stress among Iranian pregnant women. Methods: This double-blind randomized-controlled clinical trial was conducted among 70 pregnant women, primigravida, aged 18-35 years old between 16 and 37 weeks gestation. Subjects were randomly assigned to receive either the multivitamin or multivitamin-mineral supplements for 20 weeks. Fasting blood samples were taken at baseline and after a 20-week intervention to measure lipid profiles and biomarkers of oxidative stress.	Multivitamin-mineral versus multivitamin supplementation; changes in: • Fasting plasma glucose (mg/dL): -2.6±2 vs 2.5±3; p=0.15 • Total cholesterol: 11.1±8.9 vs 27.5±7.9; p=0.17 • Triglycerides (mg/dL): 6.1±13.2 vs +45.9±14.3 mg/dl, p = 0.04 • LDL cholesterol (mg/dL): 9.8±8.7 vs 25.7±6.2; p=0.13 • HDL-cholesterol (mg/dL): +0.1 vs -7.4 mg/dl, p = 0.02 • Total antioxidant capacity (mmol/L): 196.84±53.15 vs 149.23±33.8; p=0.45 • Glutathione (micromol/L): +151.09±73.26 vs -116.21±46.81, p = 0.003	

Table 47: Q3 Harms and benefits of iron supplementation in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Abraha et al 2019[173]	9 systematic reviews; 31 RCTs	**Aim**: To summarise and update the evidence concerning oral iron-based interventions compared to placebo or no iron-based interventions to prevent critical outcomes in pregnancy or treat critical outcomes in the postpartum phase. **Methods**: Published systematic reviews (Feb 2018) and primary studies (from 2015 to March 2018) retrieved from MEDLINE, EMBASE, and the Cochrane Library were examined. The AMSTAR (Assessing the Methodological Quality of Systematic Reviews) tool was used to assess the quality of reviews. GRADE was used to rate the quality of the evidence for critical outcomes.	Iron-based therapies vs placebo/no treatment: • Maternal anaemia at term: RR 0.38; 95% CI 0.27 to 0.33; 13 RCTs • Side effects: RR 1.42; 95%CI 0.91 to 2.21; 12 RCTs • Preterm birth: RR 0.93; 95%CI 0.84 to 1.03; 13 RCTs; low-certainty • Neonatal death: RR 0.93; 0.72 to 1.20; 7 RCTs; low certainty • Low birthweight: RR 0.94, 95% CI 0.79 to 1.13; 7 RCTs; low-certainty	

Study ref	N	Aim/methods	Results	Comments
Pena-Rosas et al 2015[174]	44 RCTs	**Aim**: To assess the effects of daily oral iron supplements for pregnant women, either alone or in conjunction with folic acid, or with other vitamins and minerals as a public health intervention in antenatal care. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group's Trials Register. We also searched the WHO International Clinical Trials Registry Platform and contacted relevant organisations for the identification of ongoing and unpublished studies. Selection criteria included randomised or quasi-randomised trials evaluating the effects of oral preventive supplementation with daily iron, iron + folic acid or iron + other vitamins and minerals during pregnancy. We assessed the methodological quality of trials using standard Cochrane criteria. Two review authors independently assessed trial eligibility, extracted data and conducted checks for accuracy. We used the GRADE approach to assess the quality of the evidence for primary outcomes.	Any supplements containing iron vs same supplement without iron or no treatment/placebo: • Maternal anaemia at term: RR 0.30; 95%CI 0.19 to 0.46, 14 RCTs, n=2,199; low certainty • Iron deficiency at term: RR 0.43; 95%CI 0.27 to 0.66, 7 RCTs, n=1,256, low certainty • Maternal severe anaemia in the second or third trimester: RR 0.22; 95% CI 0.01 to 3.20, 9 RCTs, n=2,125 women, very low certainty • Maternal infection during pregnancy: RR 1.21; 95%CI 0.33 to 4.46; 1 RCT, n=727; low certainty • Maternal death: RR 0.33; 95%CI 0.01 to 8.19, 2 RCTs, n=12,560, very low certainty • Maternal side effects: RR 1.29; 95%CI 0.83 to 2.02, 11 RCTs, n=2,423, very low certainty • Low birth weight: RR 0.84; 95%CI 0.69 to 1.03; n=17,613; 11 RCTs; low certainty • Preterm birth: RR 0.93; 95%CI 0.84 to 1.03, 13 RCTs, n=19,286, moderate certainty • Birthweight: MD 23.75; 95%CI -3.02 to 50.51, 15 RCTs, n=18,590, moderate certainty • Neonatal death: RR 0.91; 95%CI 0.71 to 1.18, 4 RCTs, n=16,603, low certainty • Congenital anomalies: RR 0.88, 95%CI 0.58 to 1.33, 4 RCTs, n=14,636, low certainty	

Study ref	N	Aim/methods	Results	Comments
Pena-Rosas et al 2015[175]	21 RCTs	**Aim**: To assess the benefits and harms of intermittent supplementation with iron alone or in combination with folic acid or other vitamins and minerals to pregnant women on neonatal and pregnancy outcomes. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (31 July 2015), the WHO International Clinical Trials Registry Platform (ICTRP) (31 July 2015) and contacted relevant organisations for the identification of ongoing and unpublished studies (31 July 2015). Randomised or quasi-randomised trials were included. We assessed the methodological quality of trials using standard Cochrane criteria. Two review authors independently assessed trial eligibility, extracted data and conducted checks for accuracy.	Intermittent vs daily versus iron regimen (with or without other vitamins and minerals): • Low birthweight: RR 0.82; 95%CI 0.55 to 1.22; n=1,898; 8 RCT; low certainty • Infant birthweight: MD 5.13 g; 95%CI -29.46 to 39.72; n=1,939; 9 RCTs; low certainty • Premature birth: RR 1.03; 95%CI 0.76 to 1.39; n=1,177; 5 RCTs; low certainty • Neonatal death: RR 0.49; 95%CI 0.04 to 5.42; n=795; 1 RCT; very low certainty • Maternal anaemia at term: RR 1.22; 95%CI 0.84 to 1.80; n=676; 4 RCTs; very low certainty • Maternal iron deficiency anaemia at term: RR 0.71; 95%CI 0.08 to 6.63; 1 RCT, very low certainty • Side effects: RR 0.56; 95%CI 0.37 to 0.84; n=1,777; 1 RCT; very low certainty	
Jayasinghe et al 2018[176]	3 RCTs	**Aim**: To assess whether routine maternal antenatal iron supplementation confers later neurodevelopmental benefit to offspring. **Methods**: Electronic databases were searched using MESH terms or key words and identified papers were reviewed by two independent reviewers. The study quality was assessed using the Cochrane risk of bias assessment tool. The review was registered in the PROSPERO CRD data base.	Iron supplementation vs no supplementation: • Neurodevelopment of offspring: MD 0.54; 95% CI -0.67 to 1.75)	

Table 48: Q3 Harms and benefits of iron supplementation in pregnancy — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Alizadeh et al 2016[177] Iran	Intervention 32 Control 32	**Aim**: To examine the effect of iron supplementation on iron status markers in pregnant women with high haemoglobin. **Population**: Pregnant women with Hb>13.2 g/dL and ferritin>15 mug/l in the 16th-20th week of pregnancy. **Intervention**: One ferrous sulfate tablet containing 50 mg of elemental iron daily from week 20.	Intervention vs control: • Haemoglobin level (g/dL): 12.05±0.9 vs 11.94±0.65; p=0.03 • Ferritin level (µg/L): 28.5±9.3 vs 27.22±12.96; p=0.04 • Birth weight: 3391/56±422 vs 3314/06±341; p=0.2.	
Etheredge et al 2015[178] Tanzania	Intervention 731 Control 738	**Aim**: To evaluate the safety and efficacy of iron supplementation during pregnancy in a malaria-endemic region. **Population**: Iron-replete, non-anaemic women who were uninfected with human immunodeficiency virus, primigravidae or secundigravidae, and at or before 27 weeks of gestation. **Intervention**: 60 mg of iron or placebo daily, returning every 4 weeks for standard prenatal care, including malaria screening, prophylaxis with the combination of sulfadoxine and pyrimethamine and treatment as needed.	Intervention vs control: • Placental malaria: RR 1.03; 95%CI, 0.65 to 1.65; p=0.89 • Birthweight: 3,155 vs 3,137 g, P=0.89 • Mean increase in haemoglobin from baseline to birth: 0.1 vs -0.7 g/dL, P<0.001 • Mean increase in serum ferritin from baseline to birth: 41.3 vs 11.3 microg/L, P<0.001 • Anaemia at birth: RR 0.60; 95% CI, 0.51 to 0.71; p<0.001 • Severe anemia: RR 0.68; 95% CI 0.41 to 1.14; p=0.14 • Iron deficiency at birth: RR 0.48; 95% CI, 0.32 to 0.70; p=0.001 • Iron deficiency anaemia at birth: RR 0.34; 95% CI, 0.19 to 0.62; p<0.001.	

Study ref	N	Aim/population/intervention	Results	Comments
Goonewardene et al 2018[179] Sri Lanka	Weekly 149 Daily 143	**Aim:** To determine whether weekly antenatal oral iron and folate supplementation is an effective alternative to a daily regimen in non-anaemic pregnant women to prevent anaemia and iron deficiency during the third trimester. **Population**: Non-anaemic pregnant women at 14-22 weeks gestation who had been treated with mebendazole 100 mg twice daily for three days **Intervention**: 120 mg elemental iron, 3 mg folic acid and 100 mg vitamin C weekly or 60 mg elemental iron, 1 mg folic acid and 100 mg vitamin C daily.	Daily vs weekly intervention: • Haemoglobin <11 g/dL: RR 1.01; 95%CI 0.76 to 1.34; p=0.943 • Serum ferritin <30 µg/L: RR 0.991; 95%CI 0.83 to 1.18; p=0.927 • Haemoglobin <13 g/dL: RR 1.04; 95%CI 0.37 to 2.97; p=0.928 • Nausea: 56/143 (39%) vs 25/149 (17%); p<0.001 • Dyspeptic symptoms: 40/143 (28%) vs 28/149 (19%); p=0.031 • Vomiting: 27/143 (19%) vs 17/149 (9%); p=0.039 • Constipation: 20/143 (14%) vs 10/149 (7%); p=0.017	
Jafarbegloo et al 2015[180] Iran	Intervention 88 Control 88	**Aim**: To assess gastrointestinal (GI) complications of ferrous sulfate in pregnant women. **Population**: Pregnant women with Hb ≥13.2 gr/dL at 13-18 weeks of gestation. **Intervention**: 50-mg ferrous sulfate tablet daily from the 20(th) week to the end of pregnancy.	None of the GI complications were significantly different between the ferrous sulfate and placebo groups at 24-28 and 32-36 weeks. Haemoglobin drop lower than 10.5 gr/dL at 24-28 weeks or lower than 11 g/dL at 32-36 weeks was not observed in any women.	There are some discrepancies in the reported outcomes so these have not been included here

Study ref	N	Aim/population/intervention	Results	Comments
Kinnunen et al 2016[181] Finland	Selective 1,358 Routine 1,336	**Aim**: To re-analyse data from a randomised controlled trial of iron supplementation to see whether it supports the associated risk of gestational diabetes found in observational studies. **Population**: Pregnant women **Intervention**: Elemental iron 50 mg twice a day only if diagnosed as anaemic, continuing until their haemoglobin increased to 110 g L(-1)) (selective group) or elemental iron 100 mg day(-1) throughout the pregnancy regardless of haemoglobin level (routine group).	Selective vs routine: • Glucose intolerance-related outcomes: 13.0 vs 11.0%, p=0.12 • Large-for-gestational-age: 8.3 vs 8.2%, p=0.95 • Macrosomia (>4,000 g): 21.3 vs 22.1%; p=0.60	
Parisi et al 2017[182] Italy	Ferrous iron 20 Liposomal iron 14 mg 20 Liposomal iron 28 mg Control 20	**Aim**: To compare different regimens of iron supplementation on maternal haematological status and pregnancy outcome. **Population**: Non-anaemic women with a normal singleton pregnancy recruited at 11-13 weeks. **Intervention**: ferrous iron 30 mg/daily; liposomal iron 14 mg/daily or liposomal iron 28 mg/daily up to 6 weeks post-partum.	Both LI28 and LI14 groups showed significantly higher haemoglobin and ferritin concentrations compared with controls. Birth weight showed a trend to increase with supplementation, resulting in higher birth weight in the LI28 group compared with controls (3499±464.1 g and 3092±469.5 g, respectively, $p < 0.01$).	

Table 49: Q3 Harms and benefits of calcium supplementation in pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Buppasiri et al 2015[185]	23 studies 17,842 women	**Aim**: To determine the effect of calcium supplementation on maternal, fetal and neonatal outcomes (other than for preventing or treating hypertension) as well as any possible side effects. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (30th September 2014). We considered all published, unpublished and ongoing randomised controlled trials (RCTs) comparing maternal, fetal and neonatal outcomes in pregnant women who received calcium supplementation versus placebo or no treatment.	Calcium supplementation vs placebo: • Preterm birth (<37 weeks; all doses): RR 0.86 (0.70 to 1.05); 13 studies, n=16,139; moderate certainty • Preterm birth (<37 weeks; all doses; sensitivity analysis): RR 0.80 (0.65 to 0.99; 11 trials; n=15,379 • Preterm birth (<37 weeks high dose): RR 0.81; 95%CI 0.66 to 0.99; 12 RCTs; n=15,479 • Preterm birth (<34 weeks): RR 1.04 (0.80 to 1.36); 4 trials, n=5,669; moderate certainty • Low birthweight: RR 0.93 (0.81 to 1.07); 6 trials, n=14,162; moderate certainty • Birthweight: MD 56.40 (13.55 to 99.25); 21 trials, n=9,202 There were no clear differences in rates of adverse effects.	Preterm birth with low dose calcium not included as the single trial used calcium plus vitamin D

Study ref	N	Aim/methods	Results	Comments
Hofmeyr et al 2018[186]	13 studies 15,730 women	**Aim**: To assess the effects of calcium supplementation during pregnancy on hypertensive disorders of pregnancy and related maternal and child outcomes. **Methods**: We searched Cochrane Pregnancy and Childbirth's Trials Register, ClinicalTrials.gov, the WHO International Clinical Trials Registry Platform and reference lists of retrieved studies. We included randomised controlled trials (RCTs), including cluster-randomised trials, comparing high-dose calcium supplementation (at least 1 g daily of calcium) during pregnancy with placebo.	Routine high-dose calcium (>1 g daily) vs placebo: • Gestational hypertension (all): RR 0.65 (0.53 to 0.81); 12 trials, n=15,470 • Gestational hypertension (adequate Ca): RR 0.90 (0.81 to 0.99); 4 trials; n=5,022 • Gestational hypertension (low Ca): RR 0.44 (0.28 to 0.70); 7 trials; n=10,418 • Pre-eclampsia: RR 0.45 (0.31 to 0.65); 13 trials, n=15,730; low-certainty evidence • Pre-eclampsia (adequate Ca): RR 0.62 (0.32 to 1.20); 4 trials; n=5,022 • Pre-eclampsia (low Ca): RR 0.36 (0.20 to 0.65); 8 trials; n=10,678 • Preterm birth (<37 weeks; all): RR 0.76 (0.60 to 0.97); 11 trials, n=15,275; low certainty evidence Low-dose calcium (<1 g/day) vs placebo: • Gestational hypertension: RR 0.57 (0.39 to 0.82); 3 trials; n=558 • Preterm birth: RR 0.40 (0.21 to 0.75); 1 trial; n=1,422	
Hofmeyr et al 2014[187]	4 studies 980 women	**Aim**: To review the impact of lower dose calcium (<1g/day) supplementation on pre-eclampsia risk. **Methods**: We searched PubMed and the Cochrane Pregnancy and Childbirth Group trials register.	Low-dose calcium (<1 g/d) alone vs placebo: • Pre-eclampsia: RR 0.36 (0.23 to 0.57); 4 trials, n=980 women	

Study ref	N	Aim/methods	Results	Comments
Khaing et al 2017[188]	16 studies 25,936 women	**Aim**: To determine the effects of vitamin D with or without calcium in preventing pre-eclampsia. **Methods**: Literature was systematically searched in Medline, Scopus and Cochrane databases from inception to July 2017. Only randomised controlled trials (RCTs) in English were selected if they had any pair of interventions (calcium, vitamin D, both, or placebo).	Calcium vs placebo: • Pre-eclampsia: RR 0.54 (0.41 to 0.70), 16 RCTs, n=25,936 vs. 13,060	
Sun et al 2019[189]	27 studies 28,492 women	**Aim**: To investigate whether calcium supplement with or without other drugs could reduce the risk of preeclampsia and gestational hypertension. **Methods**: PubMed, Cochrane library, and EMBASE database were searched. 27 studies, with 28 492 pregnant women were included. The results showed calcium supplement was associated with lower incidence of Sub-analyses revealed high-dose (1.2-2 g/day), moderate-dose (0.6-1.2 g/day), and low-dose (<0.6 g/day) of calcium supplement could reduce the risk of preeclampsia. For gestational hypertension, only high dose and moderate dose groups were associated with reducing the risk of gestational hypertension. However, we could draw a conclusion which does group was the most protective, as we were unable to directly compare the effects of different doses.	Calcium vs placebo: • Preeclampsia: RR 0.51 (0.40 to 0.64) • Gestational hypertension: RR 0.70 (0.60 to 0.82)	

Table 50: Q3 Harms and benefits of calcium supplementation in pregnancy — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Cullers et al 2019[190] United States	15 intervention 15 control	**Aim**: To determine the effect of maternal calcium supplementation on peripheral cortical and trabecular bone loss during pregnancy and bone gain postpartum. **Population**: Women at 16 weeks gestation. **Intervention**: 1,000 mg Ca/d for the remainder of the pregnancy.	Intervention vs control: • Osteocalcin (ng/mL) 4 months postpartum: 14.2±2.5 vs 17.3±3.9 • Osteocalcin (ng/mL) 12 months postpartum: 11.3±3.6 vs 13.9±3.4	
Ettinger et al 2014[191] Mexico	Intervention 334 Control 336	**Aim:** To evaluate the effect of dietary calcium supplementation on bone turnover during pregnancy and the early postpartum period **Population**: Women in the first trimester of pregnancy. **Intervention**: 1,200 mg Ca/d	Intervention vs control: • Bone resorption: reduction of 15.8% relative to placebo ($p<0.001$)	

Table 51: Q3 Harms and benefits of calcium supplementation in pregnancy — cost-effectiveness study

Study ref	N	Aim/methods	Results	Comments
Meertens et al 2018[192]	100,000	**Aim**: To predict the impact of advising pregnant women to use calcium supplements (1,000 mg/day) on the number of cases of pre-eclampsia prevented and related health care costs. **Methods**: By use of a decision-analytic model, we assessed the expected impact of advising calcium supplementation to either (1) all pregnant women, (2) women at high risk of developing pre-eclampsia, or (3) women with a low dietary calcium intake compared with current care. Calculations were performed for a hypothetical cohort of 100,000 pregnant women living in a high-income country.	The incidence of pre-eclampsia could be reduced by 25%, 8%, or 13% when advising calcium supplementation to all pregnant women, women at high risk of pre-eclampsia, or women with a low dietary calcium intake, respectively. Expected net financial benefits of the three scenarios were of euro4,621,465, euro2,059,165, or euro2,822,115 per 100,000 pregnant women, respectively. Advising pregnant women to use calcium supplements can be expected to cause substantial reductions in the incidence of pre-eclampsia as well as related health care costs. It appears most efficient to advise calcium supplementation to all pregnant women, not subgroups only.	

Table 52: Q3 Harms and benefits of iodine supplementation in pregnancy — systematic reviews

Study ref	N	Aim/population/interventions	Results	Comments
Harding et al 2017[201]	11 studies >2,700 women	**Aim**: To assess the benefits and harms of supplementation with iodine, alone or in combination with other vitamins and minerals, for women in the preconceptional, pregnancy or postpartum period on their and their children's outcomes **Population**: women during the preconception, pregnancy and postpartum period **Settings**: Settings with mild to moderate iodine deficiency (Denmark, Germany, Morocco, New Zealand, Thailand, Zaire) **Intervention**: any supplement containing iodine versus same supplement without iodine or no intervention/placebo	Intervention vs control: • Hypothyroidism in pregnancy or postpartum (pregnancy: average RR 1.90; 95%CI 0.57 to 6.38, one trial, 365 women, low-certainty evidence, and • Hypothyroidism postpartum: average RR 0.44 (0.06 to 3.42) (3 studies; n= 540 women; low-certainty) • Preterm birth: average RR 0.71 (CI 0.30 to 1.66) (2 studies; n=376; low-certainty) • Elevated thyroid peroxidase antibodies (TPOab) in pregnancy: average RR 0.95 (0.44 to 2.07) (1 study; n=359; low-certainty) • Elevated TPOab postpartum: average RR 1.01 (0.78 to 1.30) (3 studies; n=397 ; low-certainty) • Hyperthyroidism in pregnancy: average RR 1.90 (0.57 to 6.38) (1 study; n=365; low-certainty) • Postpartum hyperthyroidism: average RR 0.32 (0.11 to 0.91) (3 studies, n=543; low-certainty) • Digestive intolerance in pregnancy: average RR 15.33 (2.07 to 113.70) (1 study; n=76; very low-certainty)	

Study ref	N	Aim/population/interventions	Results	Comments
Farebrother et al 2018[202] Australia, China, France, India, Thailand	4 studies 783 women	**Aim**: to assess the effects of iodine fortification or supplementation on prenatal and postnatal growth outcomes in noncretinous children **Population**: Pregnant women with mild to moderate iodine deficiency **Intervention**: 150–200 μg/day (for 30 days in one study and from enrolment until birth or 3 months postpartum in the others)	Intervention vs control: • Birthweight: MD –13.75 (–212.46 to 184.97) (4 studies; n=1,743)	Overlap of two studies with Harding et al 2017[201]

Table 53: Q3 Harms and benefits of iodine supplementation in pregnancy — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Censi et al 2019[204] Italy	52 intervention 38 control	**Aim**: To assess the efficacy of iodine supplementation during pregnancy in areas with mild-to-moderate iodine deficiency. **Population**: Pregnant women before 12 weeks gestation. **Intervention**: Women in the intervention group were given an iodine supplement (225 ug/day, potassium iodide tablets) from enrolment to 8 weeks after birth.	Intervention vs control at T3: • UI/Creat (ug/g): 171.16 vs 84.19 (p<0.0001) • Thyroglobulin (ng/mL): 6.07 vs 9.8 (p=0.02)	

Study ref	N	Aim/population/intervention	Results	Comments
Chawanpaiboon et al 2019[205] Thailand	Intervention 112 Control 111	**Aim**: To establish the correlation of maternal urine iodine and neonatal thyroid stimulating hormone (TSH) in iodine supplemented and non-iodine supplemented pregnant women in an area of iodine deficiency. **Population**: Pregnant women who were older than 18 years and who had a singleton fetus at a gestational age of less than 18 weeks. **Intervention**: Participants in the intervention group were given iodine-containing ferrous tablets and the control group were given ferrous tablets (no dosages reported).	Intervention vs control: • Urinary iodine levels: 84.14±61.85 vs 58.41±41.36 microgram/L (p<0.05) • Median neonatal TSH levels: 3.7±1.87 vs 4.4±1.99 mIU/ml (p<0.05).	
Gowachirapant et al 2017[203] India, Thailand	Intervention 159 Control 156	**Aim**: To assess the effect of maternal iodine supplementation on neurodevelopment of their offspring in areas where schoolchildren were iodine sufficient **Population**: Mildly iodine-deficient pregnant women **Intervention**: 200 µg iodine orally once a day	Intervention vs control: • WPPSI-III, verbal IQ: MD –0.7 (–2.9 to 1.5) p=0.77 • WPPSI-III, performance IQ: MD –1.6 (–4.5 to 1.3) p=0.44 • WPPSI-III, processing speed: MD –1.6 (–4.2 to 1.0) p=0.15 • WPPSI-III, full scale IQ –1.2 (–3.5 to 1.1) p=0.44 • BRIEF-P, global executive: –0.9 (–6.8 to 5.0) p=0.74 WPPSI-III: Wechsler Preschool and Primary Scale of Intelligence Third Edition	

Table 54: Q3 Harms and benefits of zinc supplementation in pregnancy — systematic reviews

Study ref	N	Aim/population/intervention	Results	Comments
Ota et al 2015[206] Bangladesh, Chile, China, Denmark, Egypt, Ghana, Indonesia, Iran, Nepal, Pakistan, Peru, South Africa, UK, USA	21 studies >17,000 women	**Aim**: To assess the effects of zinc supplementation in pregnancy on maternal, fetal, neonatal and infant outcomes. **Population**: Healthy pregnant women with no systemic illness. Women may have had normal zinc levels or they may have been, or likely to have been, zinc deficient. **Interventions**: Most trials (15/21) compared zinc with placebo. Two trials compared zinc with non-zinc supplement (iron plus folate). In some trials, all women were also given iron, folate or vitamins or combinations of these.	Intervention vs control: • Preterm birth: RR 0.86 (0.76 to 0.97) (16 studies; n=7,637; moderate certainty) • Perinatal death: RR 1.12 (0.86 to 1.46) (8 studies; n=5,100; low certainty) • Birthweight: MD 0.90 (-22.23 to 24.02) (17 studies; n=6,757; low certainty) • Small for gestational age: RR 1.02 (0.94 to 1.11) (8 studies; n=4,252; moderate certainty) • Low birthweight: RR 0.93 (0.78 to 1.12) (14 studies; n=5,643; moderate certainty)	
Liu et al 2018[207] Australia, Bangladesh, Chile, China, Denmark, Egypt, Ghana, India, Indonesia, Iran, Nepal, Pakistan, Peru, Tanzania, United Kingdom, United States	24 studies 13,167 women	**Aim:** to systematically review and meta-analyse RCTs evaluating effects of preventive zinc supplementation for 3 months or longer during pregnancy **Population**: Pregnant women **Intervention**: 10–50 mg/day for a mean duration of 22.9 weeks	Intervention vs control: • Birthweight: WMD 0.08 kg (–0.05 to 0.22) • Low birthweight: RR 0.76 (0.52 to 1.11)	Considerable overlap with Ota et al 2015;[206] includes some studies that were excluded from the Cochrane review.

Study ref	N	Aim/population/intervention	Results	Comments
Oh et al 2020[208]	2 studies	**Aim**: To compile evidence from both efficacy and effectiveness trials, evaluating different supplementation interventions on maternal, birth, child health, and developmental outcomes. **Methods**: We evaluated randomised controlled trials and quasi-experimental studies published since 1995 in peer-reviewed and grey literature.	Zinc versus placebo: • maternal serum/ plasma zinc concentration: MD 0.86 umol/L, 95%CI 0.67 to 1.05; 2 studies	

Table 55: Q3 Harms and benefits of zinc supplementation in pregnancy — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Noor et al 2019[211]	Intervention 641 Control 639	**Aim:** To determine the effects of prenatal zinc, vitamin A, and iron supplementation on maternal hematologic and micronutrient status at delivery in Tanzania. **Methods**: We analysed 2 large randomized controlled trials, using generalized estimating equations, and examined the effect of daily zinc (25 mg) and vitamin A (2500 IU) supplementation starting in the first trimester of pregnancy compared with placebo (n = 2500), and separately evaluated the safety and efficacy of daily iron (60 mg) supplementation among iron-replete pregnant women (n = 1500). Blood samples from baseline and delivery were tested for Hb, serum ferritin, soluble transferrin receptor, plasma zinc, and zinc protoporphyrin.	Zinc supplementation versus no zinc: • Haemoglobin concentration at birth: MD -0.26 g/dL; 95% CI: -0.50 to -0.02; p=0.03 • Serum ferritin at birth: -11.31 µg/L; 95%CI -26.19 to 3.56; p=0.14 • Plasma zinc: -6.64 µg/dL; 95%CI -15.71 to 2.43; p=0.15	

Study ref	N	Aim/population/intervention	Results	Comments
Nossier et al 2015[209] Egypt	Intervention 198 Control 100 3-armed study; control group halved	**Aim**: To evaluate the effect of two regimens of zinc supplementation on pregnancy **Population**: Healthy pregnant women at 16 weeks gestation with Zn level at the time of enrolment below the estimated median for gestational age. **Intervention**: 30 mg/day.	Intervention vs control: • Stillbirth: 1/198 (0.5%) vs 2/100 (2.5%) — RR 0.25 (0.02 to 2.75] • Preterm birth: 2/198 (1.0%) vs 11/100 (10.6%) — RR 0.10 (0.02 to 0.40) • Birthweight: 2922.22±324.05 g vs 2929.12±330.28 g — MD -6.90 (-85.82 to 72.02)	Included in Lui et al 2018[207]
Zahiri Sorouri et al 2016[210] Iran	Intervention 270 Control 270	**Aim:** to evaluate the impact of prenatal zinc supplementation on pregnancy outcomes. **Population:** healthy women at 16 weeks of gestation **Intervention**: 400 μg folic acid and 30 mg ferrous sulphate, with or without 15-mg zinc sulphate from the 16th week of gestation until birth.	Intervention vs control: • Pre-eclampsia: 23/270 (8.5%) vs 19/270 (7.0%) — RR 1.21 (0.68 to 2.17) • Preterm birth (<37 wks): 14/270 (8.5%) vs 15/270 (5.6%) — RR 0.93 (0.46 to 1.90) • Low birthweight: 17/263 (6.5%) vs 19/265 (7.2%) — RR 0.90 (0.48 to 1.70) • Macrosomia (≥4,000 g): 11/263 (4.2%) vs 8/265 (3.0%) — RR 1.39 (0.57 to 3.39) • Apgar score <7 at 5 mins: 16/263 (6.1%) vs 17/265 (6.4%) — RR 0.95 (0.49 to 1.84)	

Table 56: Q3 Harms and benefits of magnesium supplementation in pregnancy — systematic reviews

Study ref	N	Aim/population/interventions	Results	Comments
Makrides et al 2014[212] Angola, Austria, China, Hungary, Italy, Switzerland, South Africa, United States	10 studies 9,090 women	**Aim**: To assess the effects of magnesium supplementation during pregnancy on maternal, neonatal/infant and paediatric outcomes **Population**: Primiparous and multiparous women **Interventions**: the compositions of the magnesium supplements, gestational ages at commencement, and doses administered varied, including: magnesium oxide, 1000 mg daily from four months post-conception (one trial); magnesium citrate, 365 mg daily from 18 weeks until hospitalisation after 38 weeks (one trial), and 340 mg daily from nine to 27 weeks' gestation (one trial); magnesium gluconate, 2 to 3 g from 28 weeks' gestation until birth (one trial), and 4 g daily from 23 weeks' gestation (one trial); magnesium aspartate, 15 mmol daily (three trials, commencing from either six to 21 weeks' gestation until birth, 16 weeks' gestation until birth, or < 12 weeks until birth), or 365 mg daily from 13 to 24 weeks until birth (one trial); and magnesium stearate, 128 mg elemental magnesium from 10 to 35 weeks until birth (one trial).	Intervention vs control: • Perinatal mortality: RR 1.10 (0.72 to 1.67) (5 studies; n=5,903) • Small for gestational age: RR 0.76 (0.54 to 1.07) (3 studies; n=1,291) • Pre-eclampsia RR 0.87 (0.58 to 1.32) (3 studies; n=1,042) • Miscarriage <20 wks: RR 0.85 (0.49 to 1.49) (6 studies; n=3,704) • Preterm birth (<37 wks): RR 0.89 (0.69 to 1.14) (7 studies; n=5,981) • Low birthweight (<2,500 g): RR 0.95 (0.83 to 1.09) (5 studies; n=5,577) • Apgar score <7 at 5 min: RR 0.34 (0.15 to 0.80) (4 studies; n=1.083) • Significant congenital abnormality: RR 2.05 (0.77 to 5.45) (1 study; n=4,082) • Maternal gastrointestinal side effects: RR 0.88 (0.69 to 1.12) (4 studies; n=1,388) • Systolic blood pressure near birth: MD 1.0 (0.03 to 1.97) (3 studies; n=1,432) • Diastolic blood pressure near birth: MD 0.23 (-0.67 to 1.13) (3 studies; n=1,432) • Pregnancy-induced hypertension: RR 0.39 (0.11 to 1.41) (3 studies; n=4,284) • Need for maternal hospitalisation: RR 0.65 (0.48 to 0.86) (3 studies; n=1,158)	Of the 10 trials included in the review, only two were judged to be of high certainty overall. When an analysis was restricted to these two trials none of the review's primary outcomes (perinatal mortality, small-for-gestational age, pre-eclampsia) were significantly different between the magnesium supplemented and control groups.

Table 57: Q3 Harms and benefits of magnesium supplementation in pregnancy — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Bullarbo et al 2013[214] Sweden	Intervention 28 Control 29	**Aim**: To assess if hypertension during the last part of pregnancy could be prevented by magnesium supplementation. **Population**: Pregnant nulliparous women with high urinary excretion of Mg and calcium in early pregnancy, indirectly indicating Mg deficiency **Intervention**: 300 mg oral magnesium as citrate from pregnancy week 25.	Intervention vs control: • Diastolic blood pressure at 37 weeks: 72/1.4 mean/SEM vs 77/1.4, p=0.031 — MD -0.66 (-1.20 to -0.13) • Increase in DBP ≥15 mmHg: significantly higher in the placebo group than in the magnesium group p=0.012 (actual data not reported).	
Bullarbo et al 2018[213] Sweden	Intervention 53 Control 58	**Aim**: To investigate the effect of magnesium (Mg) supplementation in healthy pregnant women for prevention of blood pressure increase. **Population**: Women who were nulliparous with no regular medication, normotension, singleton pregnancy, and maternal age >18 years and <40 years **Intervention**: 400 mg magnesium	Intervention vs control: • Increase in diastolic blood pressure ≥15 mmHg: 25/53 (47.2%) vs 25/58 (43.1%) — RR 1.09 (0.73 to 1.65) • Increase in systolic blood pressure ≥30 mmHg: 3/53 (5.7%) vs 6/58 (10.3%) — RR 0.55 (0.14 to 2.08) • Gestational hypertension: 11/53 (20.8%) vs 10/58 (17.2%) — RR 1.20 (0.56 to 2.60)	
Parente et al 2014[215] Italy	Intervention 250 Control 50	**Aim**: To evaluate the efficacy of a supplementation of magnesium and alpha-lipoic acid in preventing premature uterine contractions. **Population:** nulliparous (n=100) and multiparous (n=200) with history of spontaneous birth or caesarean section, among which 50 women reported previous miscarriages or preterm birth (before 35 weeks of gestation). **Intervention:** Magnesium 225 mg, alpha lipoic acid 100 mg and vitamin B6 1.3 mg	Intervention vs control: • Frequent and persistent episodes of preterm uterine contractions associated with pain: 50/250 (20%) vs 30/50 (60%) — RR 0.33 (0.24 to 0.47) • Maternal need for hospital admission for threatened preterm labor: 50/250 (20%) vs 20/50 (40%) — RR 0.50 (0.33 to 0.76)	

Study ref	N	Aim/population/intervention	Results	Comments
Supakatisant et al 2015[216] Thailand	Intervention 41 Placebo 39	**Aim:** To evaluate the therapeutic efficacy of oral magnesium in pregnant women with leg cramps. **Population**: Healthy pregnant women at 14-34 weeks of gestation who had leg cramps at least twice per week. **Intervention**: 300 mg magnesium bisglycinate chelate daily.	Intervention vs control: • Reduction of cramp frequency: 86.0% vs. 60.5%, P=0.007 • 50% reduction of cramp intensity: 69.8% vs. 48.8%, P=0.048.	

Table 58: Q3 Harms and benefits of selenium supplementation in pregnancy — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Tara et al 2010[217-220] Iran	Intervention 61 Control 64	**Aim**: To examine the effects of selenium supplementation in the prevention of preeclampsia in high-risk pregnant women. **Population**: primigravid pregnant women **Intervention**: 100 µg of selenium yeast daily from the first trimester of their pregnancy until delivery for a period of approximately 6 months.	Intervention vs control: • Pre-eclampsia: 0/61 vs 3/64 — RR 0.15 (0.01 to 2.84) • Premature rupture of the membranes: 8/61 vs 22/64 — RR 0.38 (0.18 to 0.79) • Birthweight: 3085.3±622.2 vs 3069.0±551.1 — MD 16.30 (-190.12 to 222.72) • EPDS score: 8.8+5.1 (n=44) vs 10.7+4.4 (n=41) — MD -1.90 (-3.92, 0.12)	The authors note that larger trials are required to draw conclusions on the efficacy of selenium supplementation in pregnancy for preventing preeclampsia.

Study ref	N	Aim/population/intervention	Results	Comments
Rayman et al 2014[221-223] United Kingdom	Intervention 105 Control 109	**Aim**: To evaluate the role of selenium supplementation in reducing risk of pre-eclampsia. **Population**: Women with a first pregnancy at 12–14 weeks. **Intervention**: 60 µg daily of selenium as selenium-enriched yeast	Intervention vs control: • sFlt-1: RR 0·95 (0·80 to 1·12) • PlGF: RR 0·97 (0·78 to 1·21) • sFlt-1:PlGF: RR 0·97 (0·70 to 1·36) • subclinical hypothyroidism: 16/106 vs 13/109 — RR 1.37 (0.68 to 2.76) • Insulin resistance: no adverse effect on the concentration of adiponectin, a biomarker of insulin resistance, in pregnant women of modest selenium status.	The authors note that the finding that selenium supplementation has the potential to reduce the risk of pre-eclampsia needs to be validated in an adequately powered trial.

2.4 Q4: What are the harms and benefits of nutritionally based complementary medicines in pregnancy?

2.4.1 Omega-3 fatty acids

Background

Higher intakes of foods containing omega-3 long-chain polyunsaturated fatty acids (LCPUFA), such as fish, during pregnancy have been associated with longer gestations and improved perinatal outcomes.

The guidelines do not currently include information on omega-3 fatty acids.

Current review

As a recent Cochrane review on omega-3 fatty acids for improving birth outcomes for women at or beyond term has recently been published, it was agreed that the findings from the review be used to inform this review rather than new searches being conducted.

The updated review included 70 RCTs (involving 19,927 women at low, mixed or high risk of poor pregnancy outcomes) which compared omega-3 LCPUFA interventions (supplements and food) compared with placebo or no omega-3. Overall study-level risk of bias was mixed, with selection and performance bias mostly at low risk, but there was high risk of attrition bias in some trials. Most trials were conducted in upper-middle or high-income countries; and nearly half the trials included women at increased/high risk for factors which might increase the risk of adverse maternal and birth outcomes.

The review found lower rates of preterm birth <37 weeks (13.4% versus 11.9%; RR 0.89, 95%CI 0.81 to 0.97; 26 RCTs, n=10,304; high-certainty) and early preterm birth <34 weeks (4.6% vs 2.7%; RR 0.58, 95%CI 0.44 to 0.77; 9 RCTs, n=5,204; high-certainty) among women who received omega-3 LCPUFA compared with no omega-3. Prolonged pregnancy >42 weeks was probably increased from 1.6% to 2.6% in women who received omega-3 LCPUFA compared with no omega-3 (RR 1.61 95%CI 1.11 to 2.33; n=5,141; 6 RCTs; moderate-certainty evidence).

For infant outcomes, there was:

- a possibly reduced risk of perinatal death (RR 0.75, 95%CI 0.54 to 1.03; 10 RCTs, n=7,416; moderate-certainty)
- possibly fewer neonatal care admissions (RR 0.92, 95%CI 0.83 to 1.03; 9 RCTs, n=6,920; moderate-certainty)
- a reduced risk of low birthweight (15.6% vs 14%; RR 0.90, 95%CI 0.82 to 0.99; 15 trials, n=8,449; high-certainty)
- a possible small increase in large-for-gestational age babies (RR 1.15, 95%CI 0.97 to 1.36; 6 RCTs, n=3,722; moderate-certainty)
- little or no difference in small-for-gestational age or intrauterine growth restriction (RR 1.01, 95%CI 0.90 to 1.13; 8 RCTs, n=6907; moderate-certainty).

For the maternal outcomes, there is insufficient evidence to determine the effects of omega-3 on:

- induction post-term (average RR 0.82, 95%CI 0.22 to 2.98; 3 RCTs, n=2,900; low-certainty)
- maternal serious adverse events (RR 1.04, 95%CI 0.40 to 2.72; 2 RCTs, n=2,690; low-certainty)
- maternal admission to intensive care (RR 0.56, 95%CI 0.12 to 2.63; 2 RCTs, n=2,458; low-certainty)
- postnatal depression (average RR 0.99, 95%CI 0.56 to 1.77; 2 RCTs, n=2,431; low-certainty).

Mean gestational length was greater in women who received omega-3 LCPUFA (MD 1.67 days, 95%CI 0.95 to 2.39; 41 RCTs, n=12,517; moderate certainty), and pre-eclampsia may possibly be reduced with omega-3 LCPUFA (RR 0.84, 95%CI 0.69 to 1.01; 20 RCTs, n=8,306; low certainty).

For the child/adult outcomes, very few differences between antenatal omega-3 LCPUFA supplementation and no omega-3 were observed in cognition, IQ, vision, other neurodevelopment and growth outcomes, language and behaviour (mostly low-certainty to very low-certainty evidence). The effect of omega-3 LCPUFA on body mass index at 19 years (MD 0, 95%CI -0.83 to 0.83; 1 RCT, n=243; very low-certainty evidence) was uncertain. No data were reported for development of diabetes in the children of study participants.

Summary of findings

Omega- 3 LCPUFA compared with no omega- 3 during pregnancy: birth/ infant outcomes

Patient or population: Pregnant women and their babies

Setting: Angola, Australia, Belgium, Canada, Chile, Croatia, Chile, Denmark, Egypt, Germany, India, Iran, Italy, Mexico, Netherlands, Norway, Russia, Sweden, Turkey, UK, USA

Intervention: Omega-3

Comparison: No omega-3

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with no omega-3	Risk with omega-3			
Preterm birth <37 weeks	134 per 1,000	**119 per 1,000** (109 to 130)	**RR 0.89** (0.81 to 0.97)	10,304 (26 RCTs)	⊕⊕⊕⊕ HIGH [1]
Early preterm birth <34 weeks	46 per 1,000	**27 per 1,000** (20 to 35)	**RR 0.58** (0.44 to 0.77)	5,204 (9 RCTs)	⊕⊕⊕⊕ HIGH [2]
Perinatal death	20 per 1,000	**15 per 1,000** (15 to 21)	**RR 0.75** (0.54 to 1.03)	7,416 (10 RCTs)	⊕⊕⊕◯ MODERATE [3]
Small for gestational age	129 per 1,000	**130 per 1,000** (116 to 146)	**RR 1.01** (0.90 to 1.13)	6,907 (8 RCTs)	⊕⊕⊕◯ MODERATE [3]
Low birth weight	156 per 1,000	**140 per 1,000** (128 to 154)	**RR 0.90** (0.82 to 0.99)	8,449 (15 RCTs)	⊕⊕⊕⊕ HIGH
Large for gestational age	117 per 1,000	**134 per 1,000** (113 to 159)	**RR 1.15** (0.97 to 1.36)	3,722 (6 RCTs)	⊕⊕⊕◯ MODERATE [4]
Serious adverse events for neonate /infant	63 per 1,000	**45 per 1,000** (37 to 62)	**RR 0.72** (0.53 to 0.99)	2,690 (2 RCTs)	⊕⊕◯◯ LOW [5]

* The basis for the assumed risk (e.g. the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95%CI).
CI: confidence interval; **RCT**: randomised controlled trial; **RR**: risk ratio;

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

1 Design limitations: larger studies of high quality, but some smaller studies with unclear risk of selective reporting and some smaller studies with unclear or high attrition bias at the time of birth (not downgraded for study limitations)
2 Design limitations: larger studies of higher quality, but several studies with unclear or high attrition bias at the time of birth, or baseline imbalances (not downgraded for study limitations)
3 Imprecision (-1): downgraded one level due to crossing line of no effect and/ or wide confidence intervals
4 Imprecision (-1): downgraded one level due to wide confidence intervals
5 Design limitations (-2): downgraded two levels; one study with unclear allocation concealment and attrition bias; specific adverse events not detailed in this study

2.4.2 Probiotics

Background

The guidelines do not currently include information on probiotics.

Current review

This review identified three systematic reviews[225-227], from which study data and risk of bias assessment were extracted for 15 RCTs, and 10 RCTs[228-237] published subsequently to the reviews.

The inclusion criteria differed between the systematic reviews but results were consistent in finding no clear difference in risk of preterm birth,[225-227] caesarean section[225,227] or macrosomia.[225,227] The two reviews that conducted a meta-analysis of risk of gestational diabetes were inconsistent (RR 0.52; 95%CI 0.34 to 0.80; 3 RCTs[227] versus RR 1.25; 95%CI 0.61 to 2.56; 388; 3 RCTs[225]). One review found no clear difference in infant mortality.[226] Another found no clear difference in risk of gestational hypertension, small for gestational age or large for gestational age.[225]

This meta-analysis includes RCTs that compared probiotics during pregnancy with placebo or no intervention. The study populations were heterogeneous and included healthy pregnant women,[229,231,233,234,238-240] women with gestational diabetes,[241-245] women who were overweight or obese,[228,232,236] women colonised with Group B streptococcus,[230,235] and women with a fetus at risk of allergies.[237,246-251]

The type(s) of probiotic given in the studies also varied, as did the timing and duration of the intervention, with duration varying from 4 to 31 weeks.

The studies were carried out in Australia (n=3),[228,235,247] Brazil (n=1),[239] Canada (n=1),[234] Finland (n=4),[233,240,248,251] Germany (n=1),[229] Iran (n=4),[242-245] Ireland (n=2),[236,241] Italy (n=1),[238] Korea (n=1),[249] the Netherlands (n=1),[250] New Zealand (n=2),[232,237] Norway (n=1),[252] Sweden (n=1),[246] Taiwan (n=1),[230] and the United Kingdom (n=1).[231] Study sample sizes were small with all but one study having a sample size of less than 500 — ≤100 (n=7),[230,235,238,242-245] 101-200 (n=6),[234,236,241,248-250] 201-300 (n=8),[229,231-233,240,246,247,251] 401-500 (n=3),[228,237,252] and one study had a sample size of 644.[239]

There was evidence from three RCTs of a possible reduction in Group B streptococcus colonisation (RR 0.76; 95%CI 0.61 to 0.97; n=244; very low certainty; analysis 1.5; page 456). There was evidence of a possible reduction in risk of gestational diabetes (RR 0.87; 95%CI 0.71 to 1.08; 8 RCTs; n=1,722; very low certainty; analysis 1.1; page 455) and caesarean section (RR 0.92; 95%CI 0.81 to 1.05; 15 RCTs; n=2,650; low certainty; analysis 1.6; page 456).

There was no clear difference in risk of:

- gestational hypertension (RR 1.24; 95%CI 0.74 to 2.06; 4 RCTs; n=955; very low certainty; analysis 1.2; page 455)
- pre-eclampsia (RR 1.88; 95%CI 0.96 to 3.71; 2 RCTs; n=598; low certainty; analysis 1.3; page 455)
- bacterial vaginosis (RR 1.73; 95%CI 0.89 to 3.38; 2 RCTs; n=509; low certainty; analysis 1.4; page 456)
- perinatal death (RR 1.17; 95%CI 0.62 to 2.24; 6 RCTs; n=1,670; low certainty; analysis 1.7; page 457)
- preterm birth <37 weeks (RR 1.10; 95%CI 0.81 to 1.50; 16 RCTs; n=3,671; low certainty; analysis 1.8; page 457)
- small for gestational age (RR 1.04; 95%CI 0.55 to 1.94; 3 RCTs; n=318; very low certainty; analysis 1.9; page 457)
- large for gestational age (RR 0.95; 95%CI 0.47 to 1.93; 3 RCTs; n=316; low certainty; analysis 1.10; page 458)
- macrosomia (>4,000 g) (RR 1.06; 0.85 to 1.33; 7 RCTs; n=1,407; low certainty; analysis 1.11; page 458).

While many of the studies reported on allergy in the infant, this outcome is not reported here as the infant received probiotics directly or indirectly in breastmilk.

Summary of findings

Probiotics compared to placebo during pregnancy — maternal outcomes

Patient or population: Pregnant women

Setting: Australia, Brazil, Canada, Finland, Germany, Iran, Ireland, Italy, Korea, the Netherlands, New Zealand, Norway, Sweden, Taiwan, the United Kingdom

Intervention: Probiotics administered to pregnant women

Comparison: Placebo or no intervention

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with placebo	**Risk with Probiotics administered to pregnant women**			
Gestational diabetes	174 per 1,000	**152 per 1,000** (124 to 188)	**RR 0.87** (0.71 to 1.08)	1,722 (8 RCTs)	⨁◯◯◯ VERY LOW [a,b,c]
Gestational hypertension	52 per 1,000	**64 per 1,000** (38 to 107)	**RR 1.24** (0.74 to 2.06)	955 (4 RCTs)	⨁◯◯◯ VERY LOW [b,c]
Pre-eclampsia	41 per 1,000	**76 per 1,000** (39 to 150)	**RR 1.88** (0.96 to 3.71)	598 (2 RCTs)	⨁⨁◯◯ LOW [b,c]
Bacterial vaginosis	48 per 1,000	**83 per 1,000** (43 to 162)	**RR 1.73** (0.89 to 3.38)	509 (2 RCTs)	⨁⨁◯◯ LOW [b,c]
Group B streptococcus	529 per 1,000	**402 per 1,000** (323 to 514)	**RR 0.76** (0.61 to 0.97)	244 (3 RCTs)	⨁◯◯◯ VERY LOW [b,d]
Caesarean section	269 per 1,000	**248 per 1,000** (218 to 283)	**RR 0.92** (0.81 to 1.05)	2650 (15 RCTs)	⨁⨁◯◯ LOW [b,c]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

a. Moderate heterogeneity in results

b. Heterogeneity in populations and type, timing and duration of intervention

c. Confidence interval crosses line of no effect

d. Unclear risk of performance and detection bias in one study and high risk of selection and performance bias in another study

Probiotics compared to placebo during pregnancy — infant outcomes

Patient or population: Pregnant women

Setting: Australia, Brazil, Canada, Finland, Germany, Iran, Ireland, Italy, Korea, the Netherlands, New Zealand, Norway, Sweden, Taiwan, the United Kingdom

Intervention: Probiotics administered to pregnant women

Comparison: Placebo

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with placebo	**Risk with Probiotics administered to pregnant women**			
Perinatal death	18 per 1,000	**21 per 1,000** (11 to 40)	**RR 1.17** (0.62 to 2.24)	1,670 (6 RCTs)	⨁⨁◯◯ LOW [b,c]
Preterm birth < 37 weeks' gestation	39 per 1,000	**43 per 1,000** (31 to 58)	**RR 1.10** (0.81 to 1.50)	3,671 (16 RCTs)	⨁⨁◯◯ LOW [b,c]
Small for gestational age	108 per 1,000	**113 per 1,000** (60 to 210)	**RR 1.04** (0.55 to 1.94)	318 (3 RCTs)	⨁◯◯◯ VERY LOW [a,b,c]
Large for gestational age	91 per 1,000	**86 per 1,000** (43 to 175)	**RR 0.95** (0.47 to 1.93)	316 (3 RCTs)	⨁⨁◯◯ LOW [b,c]
Macrosomia	169 per 1,000	**179 per 1,000** (143 to 224)	**RR 1.06** (0.85 to 1.33)	1,407 (7 RCTs)	⨁⨁◯◯ LOW [b,c]

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

a. Moderate heterogeneity in results

b. Heterogeneity in populations and type, timing and duration of intervention

c. Confidence interval crosses line of no effect

2.4.3 Herbal preparations

Background

A survey of pregnant women conducted in Sydney found that 4.4% were taking raspberry leaf, 1.5% spirulina, 1.5% evening primrose and 0.5% 'other', which comprised nettle leaf, St John's wort, fenugreek and ginseng.[115]

An Australian cohort study (n=1,835) found that 34.4% of the sample were using herbal preparations during pregnancy, of which 77.9% were self-prescribing these products.[253] Women were more likely to use herbal medicine if they had anxiety (OR 1.30; 95%CI, 1.02 to 1.64; p=0.031), sleeping problems (OR 1.55; 95%CI 1.15 to 2.11; p=0.005) or fatigue (OR 1.32; 95%CI 1.04 to 1.68; p=0.025), but less likely to use herbal medicine if they had nausea (OR 0.71; 95%CI 0.56 to 0.91; p=0.007). Women were more likely to self-prescribe herbal medicine if they suffered from varicose veins (OR 2.46; 95%CI 1.04 to 5.84; p=0.041) and less likely to self-prescribe herbal medicine if they suffered from pre-eclampsia (OR 0.23; 95%CI 0.81 to 0.63; p=0.005). Women who self-prescribed herbal medicine during pregnancy were also more likely to live in a rural environment (OR 2.22; 95%CI 1.32 to 3.73; p=0.003). Women who used herbal preparations viewed them as a preventative measure, were looking for something holistic and were concerned about evidence of clinical efficacy when considering the use of these products during pregnancy.[254]

A systematic review of found that women use complementary and alternative medicine (including herbal preparations) in their pregnancy as a means of supporting their sense of self-determination, to pursue a natural and safe childbirth, and because they experience a close affiliation with the philosophical underpinnings of complementary and alternative medicine as an alternative to the biomedical model.[255]

A multinational, cross-sectional study (n=9,483),[256] found that 29.3% of women reported the use of herbal preparations in pregnancy, of which 47.4% used herbal preparations classified as safe for use in pregnancy, 31.6% used herbal preparations classified as requiring caution in pregnancy and 20.0% used herbal preparations classified as contraindicated in pregnancy.

Current review

An Australian cohort study (n=2,445)[257] found no clear difference between women who used herbal preparations during pregnancy and those who did not in risk of preterm birth (OR 0.71; 95%CI 0.20 to 2.56), caesarean section after onset of labour (OR 0.55; 95%CI 0.10 to 3.10), induction of labour (OR 0.98; 95%CI 0.62 to 1.55) or low birthweight (OR 1.78; 95%CI 0.30 to 10.51) but a possible reduction in likelihood of caesarean section before onset of labour (OR 0.26; 95%CI 0.07 to 0.98).

Evidence on specific herbs identified through the review is as follows.

- *Ginger*: A systematic review found a reduction in nausea score with ginger compared with placebo (MD -4.2; 95%CI -6.5 to -1.9; moderate certainty) and a low risk of adverse effects in a mixed treatment comparison (OR 0.4; 95%CI 0.1 to 0.9).[141]
- *Garlic*: A systematic review found a probable reduction in gestational hypertension (RR 0.50; 95%CI 0.25 to 1.00), no clear difference in risk of pre-eclampsia (RR 0.78, 95% CI 0.31 to 1.93) or caesarean section (RR 1.35, 95% CI 0.93 to 1.95) and an increase in likelihood of women experiencing odour (RR 8.50, 95% CI 2.07 to 34.88).[258] A subsequent RCT found no clear difference in risk of gestational diabetes (p=0.31), mild pre-eclampsia (p=0.29), severe pre-eclampsia (p=0.31) or caesarean section (p=0.57).[259]
- *Chamomile*: A systematic review found a reduction in nausea score with chamomile versus placebo (MD -4.2; 95%CI -6.7 to -1.7; 1 RCT; very low certainty).[141]
- *Echinacea*: A systematic review found no evidence on the efficacy and safety of echinacea in pregnancy,[260] while a cohort study (n=68,522) found no clear difference in risk of congenital anomalies (aOR 1.1; 95%CI 0.6 to 2.1), preterm birth (aOR 1.0; 95%CI 0.6 to 1.7), small for gestational age (aOR 1.0; 95%CI 0.7 to 1.6) or low birth weight (aOR 1.1; 95%CI 0.5 to 2.1).[261]
- *Elderberry*: A systematic review found no evidence on the efficacy and safety of elderberry in pregnancy.[260]
- *Lettuce seed*: In an RCT, lettuce seed improved sleep in women with insomnia during pregnancy (p=0.03).[262]

2.4.4 Evidence statements

Omega-3 fatty acids

There is high certainty evidence that rates of preterm birth <37 weeks and early preterm birth <34 weeks are lower in women receiving omega-3 LCPUFA compared with no omega-3. There is moderate-certainty evidence that prolonged pregnancy >42 weeks is probably increased with omega-3 fatty acid supplementation. There is high certainty evidence of a reduced risk of low birth weight and moderate certainty evidence for a possible reduced risk of perinatal death, neonatal care admission and a possible small increase in risk of large-for-gestational age babies with omega-3 LCPUFA.

Probiotics

There is low certainty evidence that supplementation with probiotics may be associated with a possible reduction in caesarean section and very low certainty evidence of a reduction in Group B streptococcus colonisation and a possible reduction in risk of gestational diabetes. There is very low or low certainty evidence that probiotic supplementation has no effect on gestational hypertension, pre-eclampsia, bacterial vaginosis, perinatal death, preterm birth, small for gestational age, large for gestational age or macrosomia.

Herbal preparations

The evidence on the efficacy and safety of herbal preparations during pregnancy is limited.

There is moderate certainty evidence that ginger reduces nausea, with a low risk of adverse effects. There is very low certainty evidence that chamomile is also effective in reducing nausea.

There is evidence from a systematic review that garlic may reduce gestational hypertension but does not have an effect on pre-eclampsia or caesarean section, with a high likelihood of experiencing odour.

There is insufficient evidence on the efficacy and safety of echinacea and elderberry during pregnancy.

2.4.5 Evidence tables

Table 59: Q4 Use of herbal preparations during pregnancy

Study ref	N	Aim/methods	Results	Comments
Aalami-Harandi et al 2015[259] Iran RCT	Intervention 22 Control 22	**Aim**: To determine the favourable effects of garlic on metabolic status and pregnancy outcomes among pregnant women at risk for pre-eclampsia. **Methods**: Participants were randomly assigned at 27 weeks gestation to receive either one garlic tablet (equal to 400 mg garlic and 1 mg allicin) (n=22) or placebo (n=22) once daily for 9 weeks. Fasting blood samples were taken at baseline and after 9 weeks' intervention to measure metabolic profiles and biomarkers of oxidative stress. Results were narratively synthesised; planned meta-analysis was not possible due to heterogeneity and incomplete reporting. A simple economic evaluation considered the implied values of treatments.	Garlic vs control: • Caesarean section: 11/25 (44.0%) vs 13/25 (52.0%); p=0.57 • Gestational diabetes: 0/25 vs 1/25 (4.0%); p=0.31 • Severe pre-eclampsia: 0/25 vs 1/25 (4.0%); p=0.31 • Mild pre-eclampsia: 1/25 (4.0%) vs 3/25 (12.0%); p=0.29 No adverse effects were reported.	

Study ref	N	Aim/methods	Results	Comments
Heitman et al 2016[261] Norway Cohort	68,522	**Aim**: To study the consequences of the use of echinacea on malformations and common adverse pregnancy outcomes. **Methods**: This study is based on the Norwegian Mother and Child Cohort Study (MoBa). Information was retrieved from three self-administered questionnaires completed by the women in pregnancy weeks 17 and 30 and 6 months after birth. Information on pregnancy outcomes was retrieved from the Medical Birth Registry of Norway. Generalized estimating equations analyses were performed to assess the association between exposure to echinacea and pregnancy outcomes. Pearson's chi-square test was used to assess factors related to use of echinacea in pregnancy.	Women who used echinacea versus those who did not: • Congenital anomalies: aOR 1.1; 95%CI 0.6 to 2.1 • Preterm birth: aOR 1.0; 95%CI 0.6 to 1.7 • Small for gestational age: aOR 1.0; 95%CI 0.7 to 1.6 • Low birth weight: aOR 1.1; 95%CI 0.5 to 2.1	

Study ref	N	Aim/methods	Results	Comments
Holst et al 2014[260] SLR	Echinacea: 20 RCTs Elderberry: 3 RCTs	**Aim:** To evaluate the safety of echinacea and elderberry in pregnancy. **Methods**: The electronic databases PubMed, ISI Web of Science, AMED, EMBASE, Natural Medicines Comprehensive Database, and Cochrane Library were searched from inception to November 2013. Relevant references from the acquired articles were included. No clinical trials concerning safety of either herb in pregnancy were identified. One prospective human study and two small animal studies of safety of echinacea in pregnancy were identified. No animal- or human studies of safety of elderberry in pregnancy were identified. Twenty clinical trials concerning efficacy of various echinacea preparations in various groups of the population were identified between 1995 and 2013. Three clinical trials concerning efficacy of two different elderberry preparations were identified between 1995 and 2013.	Due to lack of evidence of efficacy and safety, health care personnel should not advise pregnant women to use echinacea or elderberry against upper respiratory tract infection.	No clinical trials concerning the safety of either herb in pregnancy were identified

Study ref	N	Aim/methods	Results	Comments
Meher et al 2006[258] SLR	1 study	**Aim:** To assess the effects of garlic on prevention of pre-eclampsia and its complications. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group Trials Register (February 2006), the Cochrane Central Register of Controlled Trials (The Cochrane Library 2005, Issue 2), and EMBASE (1974 to April 2005). Studies were included if they were randomised trials evaluating the effects of garlic on prevention of pre-eclampsia and its complications. Two review authors independently selected trials for inclusion and extracted data. Data were entered on Review Manager software for analysis, and double checked for accuracy.	Garlic versus placebo: • Gestational hypertension: RR 0.50; 95%CI 0.25 to 1.00 • Pre-eclampsia: RR 0.78, 95% CI 0.31 to 1.93 • Odour: RR 8.50, 95% CI 2.07 to 34.88 • Caesarean section: RR 1.35, 95% CI 0.93 to 1.95 There were no perinatal deaths in the study.	
Pour et al 2018[262] RCT Iran	Intervention 50 Control 50	**Aim:** To evaluate the effects of lettuce seed on pregnant women for the treatment of insomnia. **Methods**: In a prospective randomised clinical trial, 100 pregnant women with insomnia aged 20-45 years were assigned to receive capsules containing 1000 mg of lettuce seed or a placebo daily for two weeks. The main outcome was the quality of sleep, which was measured using the Pittsburgh Sleep Quality Index (PSQI).	Linear regression analysis showed that, after controlling for the other variables, the average sleep score of the experimental group was significantly lower than for the placebo group (p=0.03).	

Study ref	N	Aim/methods	Results	Comments
Sridharan et al 2018[141] SLR	Ginger: 10 studies Chamomile: 1 study	**Aim: To** carry out a network meta-analysis comparing the interventions used for treating nausea and vomiting in pregnancy. **Methods:** We searched PubMed, Cochrane CENTRAL, and Google Scholar for randomised clinical trials carried out in pregnant women with nausea or vomiting. Those carried out in women with hyperemesis gravidarum were excluded. Direct estimates were derived by pooling the data from head-to-head clinical trials while indirect estimates through a common comparator.	Difference in nausea score: • Ginger vs placebo: MD -4.2; 95%CI -6.5 to -1.9; moderate certainty • Chamomile vs placebo: MD -4.2; 95%CI -6.7 to -1.7; very low certainty Adverse effects (mixed treatment comparison): • Ginger OR 0.4; 95%CI 0.1 to 0.9	
Steel et al 2014[257] Australia Cohort	2,445	**Aim:** To report findings outlining the incidence of adverse birth outcomes among women using herbal preparations during pregnancy. **Methods**: A survey-based cohort sub-study from the nationally-representative Australian Longitudinal Study on Women's Health (ALSWH) was undertaken in 2010.	Women who used herbal preparations versus those who did not: • Premature birth: OR 0.71; 95%CI 0.20 to 2.56 • Caesarean section before onset of labour: OR 0.26; 95%CI 0.07 to 0.98 • Caesarean section after onset of labour: OR 0.55; 95%CI 0.10 to 3.10 • Induction of labour: OR 0.98; 95%CI 0.62 to 1.55 • Low birthweight: OR 1.78; 95%CI 0.30 to 10.51	

Table 60: Q4 Supplementation of probiotics during pregnancy — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Han et al 2019[227] SLR	10 RCTs 1,139 women	**Aim**: To assess the effects of probiotic supplementation on the maternal metabolism and the risk of development of gestational diabetes mellitus (GDM) in the pregnant women by a meta-analysis of relevant randomised controlled trials (RCTs). **Methods**: The medical literature was searched from PubMed, Web of Science and the Cochrane Library since inception to October 2017. Two investigators independently performed the data extraction and quality assessment. The mean differences (MD) or standardized mean differences (SMD) or relative risk (RR) with 95% confidence intervals (CIs) were calculated with the random-effects model. Results:	Probiotics versus placebo: • Gestational diabetes: RR 0.52; 95%CI 0.34 to 0.80; 3 studies • Caesarean section: RR 1.00; 95%CI 0.81 to 1.24; 5 studies • Preterm birth: RR 1.94; 95%CI 0.98 to 3.84; 4 studies • Macrosomia: RR 1.31; 95%CI 0.87 to 1.96; 3 studies	

Study ref	N	Aim/methods	Results	Comments
Grev et al 2018[226]	11 RCTs	**Aim**: To compare the efficacy of maternal probiotic administration versus placebo or no intervention in mothers during pregnancy for the prevention of preterm birth and the prevention of morbidity and mortality of infants born preterm. Methods: We used the standard search strategy of Cochrane Neonatal to search the Cochrane Central Register of Controlled Trials (CENTRAL 2017, Issue 2), MEDLINE via PubMed (1966 to 21 March 2017), Embase (1980 to 21 March 2017), and CINAHL (1982 to 21 March 2017). We also searched clinical trials databases, conference proceedings, and the reference lists of retrieved articles for randomized controlled trials and quasi-randomized trials. We included randomized controlled trials in the review if they administered oral probiotics to pregnant mothers at risk for preterm birth.	Probiotics versus placebo or nor intervention: • Preterm birth < 37 weeks: RR 0.92, 95%CI0.32 to 2.67; 4 RCTs, 518 mothers and 506 infants • Preterm birth < 34 weeks: RD 0.00, 95% CI -0.02 to 0.02; 2 RCTs, 287 mothers and infants • Infant mortality: RD 0.00, 95% CI -0.02 to 0.02; 2 RCTs, 309 mothers and 298 infants	

Study ref	N	Aim/methods	Results	Comments
Jarde et al 2018[225] SLR	27 RCTs	**Aim**: To perform a systematic review and meta-analysis of the risk of preterm birth and other adverse pregnancy outcomes in pregnant women taking probiotics. **Methods**: We searched six electronic databases (MEDLINE, EMBASE, CINAHL, Cochrane Central Register of Controlled Trials, Web of Science's Core collection and BIOSIS Preview) up to September 2016 and contacted authors for additional data. We included randomised controlled trials in which women with a singleton pregnancy received a probiotic. Two independent reviewers extracted data using a piloted form and assessed the risk of bias using the Cochrane risk of bias tool. We used random-effects meta-analyses to pool the results.	Probiotics versus control: • Gestational diabetes; RR 1.25; 95%CI 0.61 to 2.56; 388; 3 RCTs • Gestational hypertension: RR 1.99; 95%CI 0.49 to 7.99; n=144; 1 RCT • Caesarean section: RR 0.83; 95%CI 0.67 to 1.04; n=1,482; 9 RCTs • Preterm birth <34 weeks: RR 1.03, 95% CI 0.29 to 3.64, n=1,017; 5 RCTs • Preterm birth <37 weeks: RR 1.08, 95% CI 0.71 to 1.63, n=2,484; 11 RCTs • Small for gestational age: RR 1.03; 95%CIi 0.35 to 3.06; n=353; 3 RCTs • Large for gestational age: RR 0.96; 95%CI 0.47 to 1.94; n=344; 3 RCTs • Macrosomia (>4,000g): RR 1.08; 95%CI 072 to 1.63; n=414; 3 RCTs	Control groups in some included studies received an intervention; these have not been included in this meta-analysis. In order to consider a study as overall having low risk of bias, it had to have none of the domains considered as high risk of bias and at least four (not counting 'Other biases') considered as low risk of bias, with at least one of them being 'random sequence generation' or 'allocation concealment'.

Table 61: Q4 Supplementation of probiotics during pregnancy — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Callaway et al 2019[228] RCT Australia	Intervention 207 Control 204	**Aim**: To determine whether probiotics (Lactobacillus rhamnosus and Bifidobacterium animalis subspecies lactis) administered from the second trimester in overweight and obese women prevent GDM as assessed by an oral glucose tolerance test (OGTT) at 28 weeks' gestation. **Population**: Singleton pregnancy at <20 weeks' gestation, BMI >25 kg/m_2, >18 years of age. **Intervention**: A mixture of *Lactobacillus rhamnosus* (LGG) and *Bifidobacterium animalis* subspecies *lactis* (BB-12) at a dose of >1 x 10_9 colony-forming units each per day	Probiotics versus placebo: • Gestational diabetes: 38/207 vs 25/204 • Pre-eclampsia: 19/206 vs 10/203 • Gestational hypertension: 10/206 vs 11/203 • Caesarean section: 73/206 vs 80/204 • Excessive weight gain: 55/169 vs 81/176 • Preterm birth: 17/193 vs 12/180 • Stillbirth: 0/207 vs 1/204 • Macrosomia (>4,000 g): 31/206 vs 35/203 • Low birth weight: 7/206 vs 6/203	
Gille et al 2016[229] RCT Germany	Intervention 154 Control 151	**Aim**: To evaluate whether an oral probiotic food supplement supports the maintenance or restoration of a normal vaginal microbiota during pregnancy. **Population**: Women aged >18 years <12 weeks gestation **Intervention**: Oral *Lactobacillus rhamnosus* GR-1and *L reuteri* RC-14 (10(9) colony-forming units) or placebo were administered for 8 weeks to women with <12 completed weeks of pregnancy.	Probiotics versus placebo: • Preterm birth: 6/154 vs 8/151 • Miscarriage (<22 weeks): 12/154 vs 5/151 • Bacterial vaginosis: 3/135 vs 2/136	

Study ref	N	Aim/population/intervention	Results	Comments
Ho et al 2016[230] RCT Taiwan	Intervention 49 Control 50	**Aim**: To examine the effect of Lactobacillus rhamnosus GR-1 and Lactobacillus reuteri RC-14 taken orally before bedtime on Group B Streptococcus (GBS)-positive pregnant women with respect to becoming GBS negative. **Population**: Pregnant women at 35-37 weeks of gestation who were diagnosed by GBS culture as being GBS positive for both vaginal and rectal GBS colonisation. **Intervention**: Two probiotic capsules (containing L. rhamnosus GR-1 and L. reuteri RC-14) before bedtime until birth.	Probiotics versus placebo: • Absence of GBS colonisation at birth: 21/49 vs 9/50	
Husain et al 2020[231] RCT United Kingdom	Intervention 123 Control 115	**Aim**: To determine the effects on the vaginal microbiota of an oral probiotic preparation administered from early pregnancy. **Population**: Women aged 16 years or older recruited at 9-14 weeks' gestation. **Intervention**: Participants were randomly allocated to receive oral capsules of probiotic containing Lactobacillus rhamnosus GR-1 and Lactobacillus reuteri RC-14 each at 2.5 x 10(9) colony-forming units (CFUs) or placebo once daily from recruitment until the end of pregnancy.	Probiotics versus placebo: • Bacterial vaginosis at 18-20 weeks: 19/123 vs 10/115	

Study ref	N	Aim/population/intervention	Results	Comments
Lindsay et al 2014[236] Ireland	Intervention 63 Control 75	**Aim:** To investigate the effect of a probiotic capsule on maternal fasting glucose in obese pregnant women. **Population**: Pregnant women with an early pregnancy body mass index (BMI; in kg/m(2)) from 30.0 to 39.9. **Intervention**: Women were randomly assigned to receive either a daily probiotic (*Lactobacillus salivarius* UCC118 [10_9 cfu]) or a placebo capsule from 24 to 28 wk of gestation in addition to routine antenatal care.	Probiotics vs control: • Gestational diabetes: 3/62 vs 3/74 • Gestational hypertension: 5/62 vs 3/74 • Caesarean section: 20/62 vs 25/74 • Preterm birth >37 weeks: 3/63 vs 2/75 • Macrosomia: 15/62 vs 16/74 • Small for gestational age: 5/63 vs 11/75 • Large for gestational age: 6/62 vs 7/74	
Okesene-Gafa et al 2019[232] RCT New Zealand	Intervention 115 Placebo 115	**Aim**: To determine whether a culturally tailored dietary intervention and or daily probiotic capsules in pregnant women with obesity reduces the co-primary outcomes of (1) excessive gestational weight gain (mean >0.27 kg/week) and (2) birthweight. **Population**: Women without diabetes at pregnancy booking, BMI ≥30 kg/m(2) and a singleton pregnancy at 12(+0) to 17(+6) weeks' gestation. **Intervention**: Daily capsules containing either (Lactobacillus rhamnosus GG and Bifidobacterium lactis BB12, minimum 6.5 x 10(9) colony forming units), or placebo, until birth.	Probiotics versus placebo: • Excessive gestational weight gain: 89/108 and 80/109, RR 1.14, 95%CI 0.99 to 1.31 • Gestational diabetes: 28/105 vs 25/91; RR 0.94; 95%CI 0.59 to 1.49 • Gestational hypertension: 11/108 vs 7/113; RR 1.61; 95%CI 0.64 to 4.09 • Caesarean section: 40/112 vs 35/114; RR 1.23; 95%CI 0.70 to 2.15 • Stillbirth: 2/112 vs 2/114; RR 1.02; 95%CI 0.14 to 7.36	

Study ref	N	Aim/population/intervention	Results	Comments
Olsen et al 2018[235] RCT Australia	Intervention 19 Control 13	**Aim:** To perform a pilot project to determine if this research design was appropriate to explore potential causal relationships between oral probiotic use and vaginal Group B Streptococcal (GBS) colonisation rates in pregnant women. **Population**: GBS-positive women at 36 weeks pregnancy. **Intervention**: Daily oral dose of *Lactobacillus rhamnosus* GR-1 (GR- 1) and *Lactobacillus fermentum/reuteri* RC-14 (RC-14) in a dose of 10^8 viable strains for three weeks or until birth.	Intervention versus control: • GBS colonisation at birth: 15/19 vs 10/13 • Presence of vaginal commensals at birth: 5/19 vs 0/13	
Pellonpera et al 2019[233] RCT Finland	Intervention 109 Control 110	**Aim**: To assess whether the risk of gestational diabetes mellitus (GDM) may be lowered and glucose metabolism improved by daily administration of fish oil and/or probiotic supplements in overweight and obese pregnant women. **Population**: Women (mean 13.9±2.1 gestational weeks [gw]) **Intervention**: Lactobacillus rhamnosus HN001 and Bifidobacterium animalis ssp. lactis 420, 10(10) colony-forming units each were provided for daily consumption from randomisation beyond birth.	Probiotics versus placebo: • Gestational diabetes: 25/88 vs 31/84 • Miscarriage < 22 weeks: 1/109 vs 2/110 • Stillbirth: 0/96 vs 1/93 • Gestational hypertension: 4/96 vs 4/93 • Pre-eclampsia: 4/96 vs 2/93 • Caesarean section: 10/96 vs 8/92 • Preterm birth: 4/96 vs 3/92 • Macrosomia: 13/96 vs 13/92	

Study ref	N	Aim/population/intervention	Results	Comments
Sharpe et al 2019[234] RCT Canada	Intervention 57 Control 56	**Aim**: To assess the effect of probiotic supplementation on GBS vaginal/rectal colonisation at 35-37 weeks' gestation. **Population**: Pregnant women >18 years of age and <45 years of age and with a gestational age of <25 weeks. **Intervention**: Two capsules of probiotics (Lactobacillus rhamnosus GR-1 and Lactobacillus reuteri RC-14) orally daily for 12 weeks at 23-25 weeks' gestation.	Probiotics versus placebo: • GBS colonisation at 35-37 weeks: 9/57 vs 12/56	
Wickens et al 2017[237] New Zealand	Intervention 212 Control 211	**Aim**: To assess whether supplementation with the probiotic Lactobacillus rhamnosus HN001 (HN001) can reduce the prevalence of gestational diabetes mellitus (GDM). **Population**: Pregnant women with a personal or partner history of atopic disease. **Intervention**: Women were randomised at 14-16 weeks' gestation to receive HN001 (6x109 colony-forming units) or placebo daily.	Intervention vs control: • Gestational diabetes: 15/184 vs 26/189 • Caesarean section: 57/206 vs 51/201 • Preterm birth <37 weeks: 16/205 vs 8/201 • Macrosomia >4,000g: 46/205 vs 32/202	

Table 62: Q4 Summary of RCTs included in the probiotics meta-analysis

Reference	Population	Probiotic	Timing	Duration
Abrahamsson et al 2007[246] Sweden	Women with a fetus at risk of allergies; n=232	*Lactobacillus reuteri*	From 36 weeks until birth	4 weeks
Badehnoosh et al 2018[243] Iran	Women with GDM; n=60	*Lactobacillus acidophilus, Lactobacillus casei, Bifidobacterium bifidum* ($2x10^9$ cfu/g each)	From week 24-28	6 weeks
Boyle et al 2011[247] Australia	Women with a fetus at risk of allergies; n=250	*Lactobacillus rhamnosis* GG	36 weeks until birth	4 weeks
Callaway et al 2019[228] Australia	Women with BMI ≥25; n=411	*Lactobacillus rhamnosus* (LGG), *Bifidobacterium animalis* subspecies *lactis* (BB-12) (>$1x10^9$ cfu/day)	From week 20 until birth	20 weeks
Dolatkhah et al 2015[244] Iran	Women with GDM; n=64	*Lactobacillus acidophilus* LA-5, *Bifidobacterium animalis* BB-12, *Streptococcus thermophiles* STY-31 and *Lactobacillus delbrueckii bulgaricus* LBY-27) (>$4x10^9$ cfu)	From week 24-28+6 until birth	8 weeks
Dotterud et al 2010[252] Norway	Healthy pregnant women; n=415	*Lactobacillus rhamnosus* GG, *Lactobacillus acidophilus* LA5, *Bifidobacterium animalis* subsp *lactis* BB-12	36 weeks until birth	4 weeks
Gille et al 2016[229] Germany	Healthy pregnant women; n=205	*Lactobacillus rhamnosus* GR-1and *Lactobacillus reuteri* RC-14 (10^9 cfu)	From week 12	8 weeks
Ho et al 2016[230] Taiwan	Women colonised with Group B streptococcus; n=99	*Lactobacillus rhamnosus* GR1, *Lactobacillus reuteri* RC14	From week 37 until birth	3 weeks
Husain et al 2019[231] United Kingdom	Healthy pregnant women; n=238	*Lactobacillus rhamnosus* GR-1, *Lactobacillus reuteri* RC-14 ($2.5x10^9$ cfu each)	From week 9-14 until birth	26-31 weeks

Reference	Population	Probiotic	Timing	Duration
Jafarnejad et al 2016[245] Iran	Women with GDM; n=82	*Lactobacillus acidophilus, Lactobacillus plantarum, Lactobacillus paracasei, Lactobacillus delbrueckii bulgaricus, Bifidobacterium breve, Bifidobacterium longum, Bifidobacterium infantis, Streptococcus thermophilus*	From mean gestational age 26.4 weeks until birth	8 weeks
Kalliomaki et al 2001[248] Finland	Women carrying a fetus at risk of atopic disease; n=159	*Lactobacillus rhamnosus* GG	From week 36-38 until birth	2-4 weeks
Karamali et al 2016[242] Iran	Women with GDM; n=60	*Lactobacillus acidophilus, Lactobacillus casei, Bifidobacterium bifidum* ($2x10^9$ cfu)	From 24-28 weeks until birth	6 weeks
Kim et al 2010[249] Korea	Women with a fetus at risk of allergies; n=112	*Lactobacillus acidophilus* AD031, *Bifidobacterium bifidum* BGN4, *Bifidobacterium animalis* subsp *lactis* AD011	From 32 weeks until birth	8 weeks
Krauss-Silva et al 2011[239] Brazil	Healthy pregnant women; n=644	*Lactobacillus rhamnosus* GR1 *Lactobacillus reuteri* RC14	From week 12 until week 24-26	6-12 weeks
Laitinen et al 2009[240] Finland	Healthy pregnant women; n=256	*Lactobacillus rhamnosus* GG (10^{10}cfu) and *Bifidobacterium lactis* BB12 (10^{10}cfu)	From mean gestational week 13.9 until birth	26 weeks
Lindsay et al 2014[236] Ireland	Pregnant women with BMI ≥30; n=165	*Lactobacillus salivarius* UCC118 (10^9 cfu)	From week 24-28 until birth	12-16 weeks
Lindsay et al 2015[241] Ireland	Women with GDM; n=149	*Lactobacillus salivarius* UCC118 (10^9 cfu)	From mean week 31.5 until birth	8.5 weeks
Mastromarino et al 2015[238] Italy	Healthy pregnant women; n=67	*Lactobacillus acidophilus, Lactobacillus plantarum, Lactobacillus paracasei, Lactobacillus delbrueckii bulgaricus, Bifidobacterium breve, Bifidobacterium longum, Bifidobacterium infantis, Streptococcus thermophilus*	From week 36 until birth	4 weeks

Reference	Population	Probiotic	Timing	Duration
Niers et al 2009[250] Netherlands	Women carrying a fetus at risk of allergy; n=156	*Bifidobacterium animalis* subsp *lactis* W52, *Bifidobacterium bifidum* W23, *Lactobacillis lactis* W58	From 34 weeks until birth	6 weeks
Okesene-Gafa et al 2019[232] New Zealand	Women with BMI ≥30; n=230	*Lactobacillus rhamnosus* GG, *Bifidobacterium lactis* BB12 (minimum 6.5 x 10^9 cfu)	From week 12-17_6 until birth	22-28 weeks
Olsen et al 2018[235] Australia	Women with GBS colonisation at 37 weeks	*Lactobacillus rhamnosus* GR-1 (GR- 1) and *Lactobacillus fermentum/reuteri* RC-14 (RC-14)	From week 37 to birth	3 weeks
Pellonpera et al 2019[233] Finland	Healthy pregnant women; n=219	*Lactobacillus rhamnosus* HN001, *Bifidobacterium animalis ssp. lactis* 420 (10^{10} cfu)	From week 13.9±2.1 until birth	26 weeks
Rautava et al 2012[251] Finland	Women with a fetus at risk of allergies; n=241	Group 1: *Lactobacillus rhamnosus* LPR, *Bifidobacterium longum* BL999 Group 2: *Lactobacillus paracasei* ST11, *Bifidobacterium longum* BL999	From week 32 until birth	8 weeks
Sharpe et al 2019[234] Canada	Healthy pregnant women; n=113	*Lactobacillus rhamnosus* GR-1, *Lactobacillus reuteri* RC-14	From week 23-25	12 weeks
Wickens et al 2017[237] New Zealand	Women with a fetus at risk of allergies; n=408	*Lactobacillus rhamnosus* HN001	From week 14-16 until birth	24-26 weeks

3 Physical activity advice

3.1 Q5: What are the harms and benefits of physical activity during pregnancy?

3.1.1 Background

The Guidelines currently recommend that women be advised that low- to moderate-intensity physical activity during pregnancy is associated with a range of health benefits and is not associated with adverse outcomes.

However, an Australian cross-sectional study found that fewer women participated in exercise during pregnancy (61%) compared to before pregnancy (87%) and that they exercised at a significantly lower frequency ($p<0.05$), intensity ($p<0.05$) and for a shorter time/duration ($p<0.05$).[263]

In a survey of regionally-based Australian women (n=142),[264] around half of women (53%) reported receiving advice on exercise as part of antenatal care. However, the advice given was frequently inconsistent with evidence-based guidelines concerning frequency, intensity, duration and benefits and harms.

Systematic reviews have found that:

- barriers to physical activity were predominantly intrapersonal such as fatigue, lack of time and pregnancy discomforts, while enablers included maternal and fetal health benefits (intrapersonal), social support (interpersonal) and pregnancy-specific programs[265]
- barriers to participating in exercise were categorised as intrapersonal (pregnancy-related symptoms and limitations, time constraints, perceptions of already being active, lack of motivation and mother-child safety concerns), interpersonal (lack of advice and information and lack of social support) and environmental, organisational and policy barriers (adverse weather, lack of resources).[266]

An Irish cross-sectional study[267] found that having the social opportunity to engage in exercise and being supported by partners were enablers. Identified barriers to participating in exercise were knowledge about safe activities during pregnancy, the physical capability and physical opportunity to carry out exercise, experiencing pain, a lack of time, having other children and working.

3.1.2 Effect on physical fitness and risk of injury

A systematic review (26 RCTs) found low to high certainty evidence that exercise was associated with improved predicted/measured $VO_{2\ max}$ (5 RCTs, n=430; MD 2.77 mL/kg/min; 95%CI 0.32 to 5.21), reduced resting heart rate (9 RCTs, n=637; MD -1.71 bpm; 95%CI -3.24 to -0.19), resting systolic blood pressure (16 RCTs, n=1,672; MD −2.11 mmHg, 95% CI −3.71 to −0.51) and diastolic blood pressure (15 RCTs, n=1,624; MD −1.77 mmHg, 95%CI −2.90 to −0.64).

Six RCTs[268-273] assessed physical fitness and were consistent in finding an improvement.

A small cohort study (n=1,469) found that rates of exercise-related injuries were low (4.1 per 1,000 exercise hours), that most exercise-related injuries occurred during walking (57.1%) and the most common types of injuries were bruises or scrapes (55%).[274]

3.1.3 Effect on quality of life

RCTs assessing quality of life among women who had participated in an exercise program were inconsistent in their findings. Two RCTs found higher summary scores for physical and mental health summaries of the SF36.[275,276] One found no influence on women's psychological wellbeing and self-perceived general health,[277] one found that exercise contributed to improvements in some variables related to maternal well-being and quality of life[278] and another that exercise during pregnancy improves health-related quality of life.[279]

3.1.4 Effect on common conditions in pregnancy

Incontinence

A Cochrane review[280] found that pelvic floor muscle training among continent women during pregnancy reduced the risk of incontinence in late pregnancy (RR 0.38; 95%CI 0.20 to 0.72; 6 studies; n=624; low certainty) and at 3-6 months postpartum (RR 0.71; 95%CI 0.54 to 0.95; 5 studies; n=673; moderate certainty). Among women with or without incontinence, there was a reduction in risk of urinary incontinence in late pregnancy (RR 0.74; 95%CI 0.61 to 0.90; 9 studies; n=3,164; low certainty), 3-6 months postpartum (RR 0.73; 95%CI 0.55 to 0.97; 5 studies; n=1,921; very low certainty) but not at 6-12 months postpartum (RR 0.85; 95%CI 0.63 to 1.14; 2 studies; n=244; low certainty). There was no clear difference in faecal incontinence in late pregnancy among women with or without faecal incontinence at baseline (RR 0.61; 95%CI 0.30 to 1.25; 2 studies; n=867; moderate certainty).

Another systematic review[281] found low to moderate certainty evidence that prenatal pelvic floor muscle training with or without aerobic exercise decreased the odds of urinary incontinence in pregnancy (15 RCTs, n=2,764 women; OR 0.50, 95%CI 0.37 to 0.68). On further analysis, exercise was beneficial at preventing the development of urinary incontinence in women with continence but not in treating incontinence. There was 'low' certainty evidence that prenatal exercise had a moderate effect in the reduction of urinary incontinence symptom severity (5 RCTs, SMD -0.54, 95%CI -0.88 to -0.20).

Pelvic girdle and low back pain

A systematic review that grouped low back, pelvic girdle and lumbopelvic pain as a single outcome[282] found that exercise during pregnancy was associated with a possible reduction in the likelihood of pain during pregnancy (OR 0.78; 95%CI 0.60 to 1.02; 13 studies; very low to moderate certainty) but the difference in the postpartum period was unclear (OR 0.89; 95%CI 0.51 to 1.56; 4 studies; very low to moderate certainty). There appeared to be a reduction in severity of pain during pregnancy (SMD 1.03; 95%CI -1.58 to -0.48; 10 studies; very low to moderate certainty).

A systematic review that reported outcomes separately[283] found a possible reduction in low back pain (RR 0.91, 95%CI 0.83 to 0.99; 7 studies; n=1,175) and lumbopelvic pain (RR 0.96, 95%CI 0.90 to 1.02; 8 studies; n=1,737) associated with exercise but no clear difference in risk of pelvic girdle pain (RR 0.99, 95%CI 0.81 to 1.21; 4 studies, n=565).

An RCT (n=42)[284] found that exercise during pregnancy had a beneficial effect on the severity of lumbopelvic pain.

A cohort study (n=3,482)[285] found that women who exercised one or two times a week had a lower risk of low back pain (aOR 0.80, 95% CI 0.66 to 0.97) but not pelvic girdle pain (aOR 0.88; 95%CI 0.72 to 1.07), while women who exercised three or more times a week had a lower risk of pelvic girdle pain (aOR: 0.76, 95%CI 0.61 to 0.96) but not low back pain (aOR 0.82; 95%CI 0.68 to 1.02).

Anaemia

A small RCT (n=142)[286] found higher third trimester iron levels among women who participated in an exercise program in pregnancy (p=0.007). There were no clear differences in second trimester iron levels or in haemoglobin concentration in either trimester.

Sleep quality

A systematic review (7 RCTs)[287] found that, compared with women who did not exercise, regularly exercising women had significantly enhanced sleep quality (OR 6.21, 95%CI 2.02 to 19.11; p=0.001; SMD -0.93 (95%CI -1.19 to -0.67; p<0.001). However, exercising women showed no significant improvement in insomnia (SMD -2.85, 95% CI -7.67 to 1.98; p=0.250) relative to women who did not exercise.

Two RCTs investigated the association between exercise in pregnancy and sleep quality. One suggested that sleep quality was improved with moderate-intensity aquatic exercise (n=134) [288] and the other (n=132) [289] found a significant attenuation of the worsening of several sleep characteristics, such as restless sleep, snoring, diurnal tiredness, and excessive daytime sleepiness. A cohort study (n=138) [290] suggested a weak association between physical activity and sleep in pregnant women.

3.1.5 Effect on labour

Duration of labour

One systematic review[291] and eleven RCTs[292-302] reported on duration of labour among women who had participated in a physical activity intervention during pregnancy and those who had not. The systematic review found no clear difference in length of the first (MD 2.00; 95%CI -1.15 to 5.15; 1 study; n=18) or second stage (MD -5.72; 95%CI -15.22 to 3.78; 1 study; n=18) stage of labour [291]. While some RCTs found that women who had participated in exercise had a shorter first stage of labour,[294,295,300-302] second stage of labour[298,301] and a shorter total duration of labour,[294,301] most found no clear difference in duration of any stage of labour.

Pain during labour

Five RCTs[292,298-300,303] reported on pain relief during labour among women who had participated in a physical activity intervention during pregnancy and those who had not. One study reported fewer requests for analgesia (RR 0.42; 95%CI 0.23 to 0.77) [292] but there was no clear difference in the other studies.

Perineal tears

Five RCTs[273,297,298,304,305] reported on perineal tears among women who had participated in a physical activity intervention during pregnancy and those who had not. One study found higher rates of intact perineum among

the intervention group (aOR 8.57; 95% CI 1.85 to 39.68)[305] but there was no clear difference in rates of perineal tears in any other study.

3.1.6 Effect on the infant and child

Congenital anomaly

A systematic review[306] found that exercise did not increase the odds of congenital anomalies (OR 1.23, 95%CI 0.77 to 1.95; 14 studies; n=78,735; very low certainty).

Birth weight

Two cohort studies reported on the association between regular exercise during pregnancy and fetal growth. A large Norwegian study (n=36,896)[307] found that exercising more than 3 times a week reduced the risk of macrosomia among nulliparous women (aOR 0.77; 95%CI 0.61 to 0.96). A smaller study in the United States (n=2,245)[308] found that compared to women who exercised both before and during pregnancy, women who exercised before but not during pregnancy had an increased risk of low birth weight (1,500 to 2,499 g) (OR 1.28; 95%CI 1.05 to 1.56) and very low birth weight (<1,500 g) (OR 2.05; 95%CI 1.69 to 2.48) and women who did not exercise before or during pregnancy had an increased risk of very low birth weight (OR 1.75; 95%CI 1.50 to 2.04).

Childhood weight

A small cohort study (n=802)[309] found no association between maternal leisure time physical activity and childhood adiposity.

Child neurodevelopment

A systematic review of one RCT and five cohort studies[310] reported that the cohort studies found a positive association between physical activity during pregnancy and offspring neurodevelopment, while the RCT did not.

3.1.7 Summary

There is a possible increase in physical fitness associated with exercise in pregnancy and rates of injury appear to be low. The evidence on the effect on quality of life suggests an improvement with physical activity.

Pelvic floor muscle exercises appear to reduce the risk of urinary incontinence but do not appear to affect the risk of faecal incontinence.

There is evidence from systematic reviews, an RCT and a cohort study of a possible reduction in risk of low back and lumbopelvic pain and a reduction in severity of pain during pregnancy. The evidence on the effect of exercise on pelvic girdle pain and pain in the postpartum period is unclear.

Moderate to vigorous exercise during pregnancy appears to improve sleep quality but is not effective in treating insomnia in pregnancy.

There is no clear difference in the duration of labour, pain during labour or perineal tears between women who exercise during pregnancy and those who don't, although some RCTs have reported a shorter duration of labour and fewer requests for analgesia among women who exercised during pregnancy.

There is no clear association between leisure-time exercise during pregnancy and congenital anomaly and it appears to be protective against macrosomia and low birth weight. It does not appear to affect childhood weight but cohort studies suggest a positive association between physical activity during pregnancy and offspring neurodevelopment.

3.1.8 Evidence tables

Physical fitness and quality of life

Table 63: Q5 Physical activity in pregnancy and physical fitness — systematic review

Study ref	N	Aim/methods	Results	Comments
Kramer et al 2006[291]	9 studies	**Aim**: To assess the effects of advising healthy pregnant women to engage in regular aerobic exercise (at least two to three times per week), or to increase or reduce the intensity, duration, or frequency of such exercise, on physical fitness, the course of labour and delivery, and the outcome of pregnancy. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (31 August 2009), MEDLINE (1966 to August 2009), EMBASE (1980 to August 2009), Conference Papers Index (earliest to August 2009), contacted researchers in the field and searched reference lists of retrieved articles.	Of the nine trials reporting on the effect of aerobic exercise during pregnancy on physical fitness, six reported significant improvement in physical fitness in the exercise group, although inconsistencies in summary statistics and measures used to assess fitness prevented quantitative pooling of results.	
Cai et al 2020[311]	26 RCTs	**Aim:** To examine the influence of prenatal exercise on maternal cardiorespiratory health and fitness during pregnancy. **Methods:** Online databases were searched up to February 25, 2019. Studies of randomised controlled trials (RCTs) were eligible, which contained information on the relevant population (pregnant women), intervention (subjective or objective measures of frequency, intensity, duration, volume, or type of exercise), comparator (no exercise intervention), and outcomes (maternal cardiorespiratory fitness [CRF], including VO_{2max}, submaximal VO_2, VO_2 at anaerobic threshold, and cardiorespiratory health, including resting heart rate, resting systolic and diastolic blood pressure during pregnancy).	Low to high certainty evidence revealed that exercise was associated with improved predicted/measured $VO_{2\ max}$ (5 RCTs, n=430; MD 2.77 mL/kg/min; 95%CI 0.32 to 5.21), reduced resting heart rate (9 RCTs, n=637; MD -1.71 bpm; 95%CI -3.24 to -0.19), resting systolic blood pressure (16 RCTs, n=1,672; MD −2.11 mmHg, 95% CI −3.71 to −0.51) and diastolic blood pressure (15 RCTs, n=1,624; MD −1.77 mmHg, 95%CI −2.90 to −0.64).	

Table 64: Q5 Physical activity in pregnancy and physical fitness — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Halvorsen et al 2013[268] Norway	Intervention 34 Control 28	**Aim**: To evaluate the effectiveness of aerobic dance on cardiorespiratory fitness in pregnant women. **Population**: Primiparous women with a mean age of 30.6±3.7 years **Intervention** Two aerobic dance classes per week and 30 minutes of daily self-imposed physical activity for 12 weeks.	Intervention vs control: • VO_2 (mL/kg/minute at 1.5 mmol above resting blood lactate levels) post-intervention: 24.5±3.8 vs 24.5±2.5	
Bisson et al 2015[269] Canada	Intervention 23 Control 22	**Aim**: To evaluate whether a 12-week supervised exercise program promotes an active lifestyle throughout pregnancy in pregnant women with obesity. **Population**: Pregnant women with BMI ≥30 kg/m2) and a singleton pregnancy. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Stationary cycling, treadmill, muscle strengthening; 60 min 3 times a week from week 15 to 27 • *Intensity*: Moderate; 70% HR or perceived exertion score of 3-5/10	Intervention (n=22) vs control (n=22): • Change in VO_2 AT (oxygen uptake at the anaerobic threshold): 1.6±13.3 vs -6.5±9.9; MD 8.1; (%%CI 0.7 to 9.5; p<0.05	

Study ref	N	Aim/population/intervention	Results	Comments
de Oliveria Melo et al 2012[270] Brazil	Intervention 13 weeks 62 Intervention 20 weeks 63 Control 62 3-armed; control group halved	**Aim**: To estimate the effect of supervised physical exercise on maternal physical fitness, fetoplacental blood flow, and fetal growth. **Population**: healthy pregnant women who were sedentary at admission to the study, gestational age 13 weeks with an uncomplicated singleton pregnancy. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic; 15 min walking, 3 times weekly, increasing according to woman's ability from 13 weeks (Group A) or 20 weeks (Group B) until birth • *Intensity*: Moderate; 60-80% maximum HR; Borg scale 12-16	Intervention (initiated at 13 weeks; n=62) vs control (n=31): • VO_2 max (maximal oxygen consumption) at 28 weeks: 27.3±4.3 vs 25.5±3.8 Intervention (initiated at 20 weeks; n=63) vs control (n=31) • VO_2 max (maximal oxygen consumption) at 28 weeks: 28.0±3 vs 25.5±3.8	
Guelfi et al 2016[271] Australia NCT01283854	Intervention 84 Control 85	**Aim**: To investigate the effect of a supervised home-based exercise program on the recurrence and severity of gestational diabetes mellitus (GDM) together with other aspects of maternal health and obstetric and neonatal outcomes. **Population**: Women with a history of gestational diabetes. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic; Stationary cycling 20-60 min, 3 times a week for 14 weeks from 13±1 weeks • *Intensity*: Moderate; 75–85% maximum HR; Borg scale 14–16.	Intervention vs control: • Oxygen consumption [L/min] at 75% maximum heart rate: 1.65±0.38 vs 1.52±0.24; p<0.01	

Study ref	N	Aim/population/intervention	Results	Comments
Hopkins et al 2010;[272] New Zealand	Intervention 47 Control 37	**Aim**: to determine the effects of aerobic exercise training in the second half of pregnancy on maternal insulin sensitivity and neonatal outcomes. **Population**: Healthy nulliparous women (age, 30±4 yr; BMI 25.5±4 kg/m2). **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic; Stationary cycling; 40 min, up to 5 times a week • *Intensity*: Moderate; 65% of predicted capacity.	Intervention vs control: • Peak VO_2: 20.0±3.5 vs 18.7±3.3; p<0.01	
Seneviratne et al 2016[273] New Zealand	Intervention 37 Control 37	**Aim:** To assess whether antenatal exercise in overweight/obese women would improve maternal and perinatal outcomes. **Population:** Pregnant women with body mass index ≥25 kg/m2. **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic; Stationary cycling; 25-45 min, 3-5 times a week depending on stage of pregnancy, from week 25 to 35. • *Intensity*: Moderate (40–59% VO_2 reserve).	Intervention vs control: • Change in fitness test time (seconds): 31.6±88.4 vs -12.6±69.1; p=0.19 • Change in test work load: 4.6±15.3 vs -3.6±12.2; p=0.019	

Table 65: Q5 Physical activity in pregnancy and quality of life — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Rodriguez-Blanque et al 2020[275] SWEP NCT02761967	Intervention 65 Control 64	**Aim**: To analyse the quality of life in pregnancy for women who complete a programme of moderate physical activity in water. **Population**: **H**ealthy pregnant women with uncomplicated singleton pregnancies. **Intervention**: • *Supervised*: Yes • *Intervention*: Aerobic and muscle strengthening exercises in water for 60 minutes 3 times/week from weeks 20 to 37. • *Intensity*: Moderate; Borg scale 12-14	Intervention vs control at 35 weeks: • SF36v2 physical component summary: 49.79±4.59 vs45.39±4.21; p group=0.001 • SF36v2 mental health component summary: 42.57±5.16 vs 39.2±4.16; p group =0.016.	
Prabha et al 2019[276]	Intervention 84 Control 86	**Aim:** To evaluate the effect of structured antenatal exercise program and education on health-related quality of life. **Population**: Healthy women aged 21-36 years, gestational age >20 weeks. **Intervention**: Deep breathing exercises, pelvic floor exercise, neck exercises, arm and leg exercises, trunk exercises, pelvic tilting exercises, relaxation technique, Stretching exercise for low back, calf, adductors, wall exercises, Floor exercises for stretching hamstrings, low back, adductors (8-10 repetitions with the duration of 15-20 minutes; 3-5 times a week).	Intervention vs control at 32 weeks: • SF36 physical component summary: 52.25±5.75 vs 49.97±6.92 • SF36v2 mental health component summary: 46.07±7.05 vs 43.02±5.61	

Study ref	N	Aim/population/intervention	Results	Comments
Gustafsson et al 2016[277] Norway	855	**Aim**: To investigate whether a customised exercise programme influences pregnant women's psychological wellbeing and general health perception reflecting health-related quality of life (HRQoL) in late pregnancy. **Population**: Healthy Caucasian pregnant women. **Intervention**: The intervention group was offered a 12-week exercise programme between 20 and 36 weeks of pregnancy. One weekly group session was led by physiotherapists, in addition women were encouraged to follow a home exercise programme at least twice a week. The exercise programme followed standard recommendations and included both aerobic and strength training.	Intervention vs control: • PGWBI index at 32-36 weeks: 79.5 (78.5 to 80.6) vs 78.5 (77.5 to 79.6) Higher score indicates a better outcome.	
Montoya arizabaleta et al 2010[279] Colombia	Intervention 24 Control 26	**Aim**: To determine whether supervised aerobic exercise during pregnancy improves health-related quality of life. **Population**: Nulliparous women aged 16-30 years between 16 and 20 weeks of gestation. **Intervention**: The experimental group completed a 3-month supervised exercise program, commencing at 16 to 20 weeks of gestation. Each session included walking (10 min), aerobic exercise (30 min), stretching (10 min), and relaxation (10 min).	Difference between groups in improvement in health-related quality of life: • Physical component: 6 points (2 to 11) • Physical function: 7 points (0 to 14) • Bodily pain: 7 points (1 to 13) • General health: 5 points (1 to 10)	

Study ref	N	Aim/population/intervention	Results	Comments
Haakstad et al 2016[278] Norway	Intervention 52 Control 53	**Aim**: to examine the effects of supervised group exercise on maternal psychological outcomes and commonly reported pregnancy complaints. **Population**: Sedentary, nulliparous pregnant women, mean age 30.7±4.0 years, pre-pregnancy BMI 23.8±4.3 at mean gestation week 17.7±4.2. **Intervention**: the intervention included a 60 minutes general fitness class, with 40 minutes of endurance training/aerobic and 20 minutes of strength training and stretching/relaxation, performed at least twice per week for a minimum of 12 weeks.	Intervention vs control: • Quality of life: 4.43±0.6 vs 4.28±0.7; p=0.3	

Injury

Table 66: Q5 Physical activity in pregnancy and injury — cohort study

Study ref	N	Aim/methods	Results	Comments
Vladutiu et al 2010[274] United States	1,469 Cohort	**Aim:** To conduct population-based research on the circumstances surrounding injuries from physical activity during pregnancy. **Methods**: Physical activity and subsequent injuries among a cohort of 1469 pregnant women in North Carolina were examined prospectively from the third phase of the Pregnancy, Infection, and Nutrition Study between 2001 and 2005. Chi-square analyses were used to compare distributions of maternal characteristics among women who sustained injuries from physical activity and women who reported no injuries during pregnancy. Injury incidence rates were calculated.	Number of injuries: • Physical activity-related injuries: 3.2 per 1,000 physical activity hours • Exercise-related injuries: 4.1 per 1,000 exercise hours The most common types of injuries were bruises or scrapes (55%). Exercise-related injuries occurred during walking (57.1%) or other exercise (42.9%)	

Table 67: Q5 Physical activity in pregnancy and incontinence — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Woodley et al 2017[280]	38 studies	**Aim:** To determine the effectiveness of pelvic floor muscle training (PFMT) in the prevention or treatment of urinary and faecal incontinence in pregnant or postnatal women. **Methods**: We searched the Cochrane Incontinence Specialised Register (16 February 2017) and reference lists of retrieved studies.	Intervention vs control in continent women: • urinary incontinence in late pregnancy: RR 0.38 (0.20 to 0.72); 6 trials, 624 women; low-certainty evidence • urinary incontinence in the mid-postnatal period (more than three to six months' postpartum): RR 0.71 (0.54 to 0.95); 5 trials, 673 women; moderate-certainty evidence Intervention vs control among women with or without incontinence • Urinary incontinence in late pregnancy: RR 0.74 (0.61 to 0.90); 9 trials, n=3,164; low-certainty • Urinary incontinence in the mid-postnatal period: RR 0.73 (0.55 to 0.97); 5 trials, n=1,921; very low-certainty • Urinary incontinence late postpartum (6-12 months): RR 0.85 (0.63 to 1.14); 2 trials, n=244; low-certainty Intervention vs control among women with or without faecal incontinence: • faecal incontinence in late pregnancy (RR 0.61 (0.30 to 1.25); 2 trials, n=867; moderate-certainty	

Study ref	N	Aim/methods	Results	Comments
Davenport et al 2018[281]	24 studies 15,982 women	**Aim**: To examine the relationships between prenatal physical activity and prenatal and postnatal urinary incontinence (UI). **Methods**: Systematic review with random effects meta-analysis and meta-regression. Online databases were searched up to 6 January 2017. Studies of all designs were included (except case studies) if they were published in English, Spanish or French and contained information on the Population (pregnant women without contraindication to exercise), Intervention (subjective or objective measures of frequency, intensity, duration, volume or type of exercise, alone ["exercise-only"] or in combination with other intervention components [e.g., dietary; "exercise + co-intervention"]), Comparator (no exercise or different frequency, intensity, duration, volume and type of exercise) and Outcome (prenatal or postnatal UI).	'Low' to 'moderate' certainty evidence revealed prenatal pelvic floor muscle training (PFMT) with or without aerobic exercise decreased the odds of UI in pregnancy (15 RCTs, n=2,764 women; OR 0.50, 95%CI 0.37 to 0.68). When we analysed the data by whether women were continent or incontinent prior to the intervention, exercise was beneficial at preventing the development of UI in women with continence, but not effective in treating UI in women with incontinence. There was 'low' certainty evidence that prenatal exercise had a moderate effect in the reduction of UI symptom severity (5 RCTs, SMD -0.54, 95%CI -0.88 to -0.20).	

Table 68: Q5 Physical activity in pregnancy and pelvic girdle/low back pain — systematic reviews

Study ref	N	Aim/methods	Results	Comments
Davenport et al 2019a[282]	32 studies 52,297	**Aim**: To investigate the relationship between prenatal exercise, and low back (LBP), pelvic girdle (PGP) and lumbopelvic (LBPP) pain. **Methods**: Online databases were searched up to 6 January 2017. Studies of all designs were eligible (except case studies and reviews) if they were published in English, Spanish or French, and contained information on the population (pregnant women without contraindication to exercise), intervention (subjective or objective measures of frequency, intensity, duration, volume or type of exercise, alone ["exercise-only"] or in combination with other intervention components [eg, dietary; "exercise + co-intervention"]), comparator (no exercise or different frequency, intensity, duration, volume and type of exercise) and outcome (prevalence and symptom severity of LBP, PGP and LBPP).	'Very low' to 'moderate' certainty evidence from RCTS showed prenatal exercise alone did not reduce the odds of experiencing LBP, PGP and LBPP either in pregnancy (OR 0.78; 95%CI 0.60 to 1.02; 13 studies) or the postpartum period (OR 0.89; 95%CI 0.51 to 1.56; 4 studies). However, 'very low' to 'moderate' certainty evidence identified lower pain severity during pregnancy in women who exercised during pregnancy (SMD -1.03; 95%CI -1.58 to -0.48) compared with those who did not exercise.	
Shiri et al 2018[283]	11 studies 2,347	**Aim**: to assess the effect of exercise on low back pain, pelvic girdle pain and associated sick leave. **Methods**: Literature searches were conducted in PubMed, EMBASE, Cochrane Library, Google Scholar, ResearchGate and ClinicalTrials.gov databases from their inception through May 2017. RCTs were eligible for inclusion in the review if they compared an exercise intervention with usual daily activities and at least some of the participants were free from low back pain and/or pelvic girdle pain at baseline. Methodological quality of included studies was evaluated using the Cochrane Collaboration's tool. A random-effects meta-analysis was performed, and heterogeneity and publication bias were assessed.	• Low back pain in pregnancy: RR 0.91, 95%CI 0.83 to 0.99; 7 studies; n=1,175 • Pelvic girdle pain: RR 0.99, 95%CI 0.81 to 1.21; 4 studies, n=565 • Lumbopelvic pain: RR 0.96, 95%CI 0.90 to 1.02; 8 studies; n=1,737 • New episodes of sick leave due to lumbopelvic pain: RR 0.79, 95%CI 0.64 to 0.99; 3 studies; n=1,168	

Table 69: Q5 Physical activity in pregnancy and pelvic girdle/low back pain — RCT

Study ref	N	Aim/methods/intervention	Results	Comments
Sklempe Kokic et al 2017[284] Croatia	Intervention 20 Control 22	**Aim**: To investigate the effect of a supervised, structured exercise programme on the occurrence and severity of pregnancy-related lumbopelvic pain. **Population**: Healthy pregnant women and women with mild gestational diabetes controlled by lifestyle measures. **Intervention**: Aerobic and resistance exercises performed bi-weekly from the date of inclusion into the study until the end of pregnancy, together with at least 30 min of brisk daily walks.	There were significant differences between the 2 groups on the numeric rating scale, PGQ and RMDQ scores in the 36th week of pregnancy ($p = 0.017$; $p = 0.005$; $p < 0.001$, respectively) in favour of the intervention group.	

Table 70: Q5 Physical activity in pregnancy and pelvic girdle/low back pain — observational studies

Study ref	N	Aim/methods	Results	Comments
Gjestland et al 2013[285] Norway	3,482 women	**Aim**: To investigate the association between exercise in mid-pregnancy and subsequent low-back pain, pelvic girdle pain and depression at 32 weeks of pregnancy. **Methods**: The study included pregnant women participating in the Akershus Birth Cohort study (response rate 80.5%). Data were collected by a questionnaire in pregnancy weeks 17-21, pregnancy week 32 and electronic birth journal. The results were analysed by logistic regression and are presented as crude (cOR) and adjusted OR (aOR) with 95% CI.	Women who exercised ≥3 times a week vs women who exercised <1 time a week: • Pelvic girdle pain: aOR: 0.76, 95%CI 0.61 to 0.96 • Low back pain: aOR 0.82; 95%CI 0.68 to 1.02 Women exercising 1-2 times a week vs women who exercised <1 time a week: • Pelvic girdle pain: aOR 0.88; 95%CI 0.72 to 1.07 • Low-back pain: aOR 0.80, 95% CI 0.66 to 0.97	

Table 71: Q5 Physical activity in pregnancy and anaemia — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Barakat et al 2009[286] Spain	Intervention 72 Control 70	**Aim**: to examine the effect of light intensity resistance exercise training performed during the second and third trimester of pregnancy. **Population**: Healthy sedentary pregnant women; mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Resistance; Toning and joint mobilisation; 35-40 min 3 times a week from weeks 12-13 to 38-39. • *Intensity*: Light; ≤80% of age-predicted maximum HR	Mean haemoglobin concentration (g/dL) intervention vs control: • 2nd trimester: 11.9±7.3 vs 11.7±7.0; p=0.132 • 3rd trimester: 12.2±8.2 vs 11.9±7.7; p=0.070 Mean iron level (μg/dL) intervention vs control: • 2nd trimester: 76.5±31.1 vs 68.5±25.7; p=0.097 • 3rd trimester: 83.4±27.7 vs 71.9±21.8; p=0.007	

Table 72: Q5 Physical activity in pregnancy and sleep — systematic review

Study ref	N	Aim/methods	Results	Comments
Yang et al 2020[287]	7 RCTs	**Aim**: To assess the effects of a specific exercise program on the sleep quality in pregnant women. **Methods**: Searches were executed in seven databases since their inceptions until February 28, 2019, for randomized controlled trials evaluating the effects of an exercise program on the sleep quality and insomnia in pregnant women. A random-effects model was applied for meta-analysis, and odds ratio, mean differences (MDs), and 95% confidence intervals (CIs) are shown as parts of outcomes.	Compared with their not-exercising counterparts, analyses showed that regularly exercising women had significantly enhanced sleep quality (OR 6.21, 95% CI 2.02 to 19.11; p=0.001; SMD -0.93 (95%CI -1.19 to -0.67; p<0.001). However, exercising women showed no significant insomnia improvement (SMD -2.85, 95% CI -7.67 to 1.98; p =0.250), relative to their not-exercising counterparts.	

Table 73: Q5 Physical activity in pregnancy and sleep — RCT

Study ref	N	Aim/population/intervention	Results	Comments
Kocsis et al 2017[289] Romania	Intervention 79 Control 53	**Aim**: to investigate the effect of a regular, specific, medium-term physical training program on sleep characteristics in healthy pregnant women. **Population**: healthy pregnant women, with gestational age between 18 weeks and 22 weeks. **Intervention**: • *Supervised*: Yes • *Type and duration*: Muscle strengthening, relaxation; 2 hours twice a week for 10 weeks. • *Intensity*: Not described.	Interventions vs control: • the same general pattern of decrease in sleep quality, which is related to the progression of pregnancy • a significant attenuation of the worsening of several sleep characteristics, such as restless sleep, snoring, diurnal tiredness, and excessive daytime sleepiness. Nocturnal and diurnal sleep quantity increased significantly in both groups.	Non-randomised; data only presented as figures

Table 74: Q5 Physical activity in pregnancy and sleep — observational studies

Study ref	N	Aim/methods	Results	Comments
Loprinzi et al 2012[290] United States	138 Cohort	**Aim**: to examine the association between objectively-measured physical activity and sleep among a nationally representative sample of U.S. pregnant women. **Methods**: Data from the National Health and Examination Survey 2005-2006 was used for the present study. Pregnant women who had worn an accelerometer on the right hip for at least 4 days for a minimum of 10 h per day were identified. Questions on sleep were asked during a household interview.	For every 1-min increase in moderate-to-vigorous physical activity, pregnant women were 17% less likely to have difficulty finishing a meal because of being tired or sleepy (OR 1.17; 95%CI 0.98 to 1.38; p=0.06).	

Labour

Table 75: Q5 Physical activity in pregnancy and duration of labour — systematic review

Study ref	N	Aim/methods	Results	Comments
Kramer et al 2006[291]	1 study n=18	**Aim**: To assess the effects of advising healthy pregnant women to engage in regular aerobic exercise (at least two to three times per week), or to increase or reduce the intensity, duration, or frequency of such exercise, on physical fitness, the course of labour and delivery, and the outcome of pregnancy. **Methods**: We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (31 August 2009), MEDLINE (1966 to August 2009), EMBASE (1980 to August 2009), Conference Papers Index (earliest to August 2009), contacted researchers in the field and searched reference lists of retrieved articles.	Intervention vs control increase in exercise in sedentary women: • First stage of labour: MD 2.00 (-1.15 to 5.15) • Second stage of labour: MD -5.72 (-15.22 to 3.78)	

Table 76: Q5 Physical activity in pregnancy and duration of labour — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Baciuk et al 2008;[292] Cavalcante et al 2009[312] Brazil	Intervention 34 Control: 37	**Aim**: To evaluate the association between water aerobics, maternal cardiovascular capacity during pregnancy, labour and neonatal outcomes. **Population**: Women of < 20 weeks of pregnancy with a singleton pregnancy and no gestational risk factors. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic; Aquatic; 50 min 3 times a week from <20 wks to birth • *Intensity*: Moderate 70% predicted HR	Intervention vs control: • Length of labour: 457.9±249.6 vs 428.9±203.2 p=0.69	

Study ref	N	Aim/population/intervention	Results	Comments
Barakat et al 2008;[293] Barakat et al 2009a;[313] Barakat et al 2009b;[303] Spain NCT00813657	Intervention 72 Control 70	**Aim**: to examine the effect of light intensity resistance exercise training performed during the second and third trimester of pregnancy. **Population**: Healthy sedentary pregnant women; mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Resistance; Toning and joint mobilisation; 35-40 min 3 times a week from weeks 12-13 to 38-39. • *Intensity*: Light; ≤80% of age-predicted maximum HR	Intervention vs control: • Dilation time (min): 426±20 vs 378±13 p>0.1 • Expulsion time (min): 32.5±24.7 vs 36.0±31.5 p>0.1 • Childbirth time (min): 8.1±2.3 vs 7.7±1.7 p>0.1	
Barakat et al 2018[294] Spain NCT02109588	Intervention 176 Control 149	**Aim**: To examine the influence of an exercise program throughout pregnancy on the duration of labour. **Population**: Healthy pregnant women. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Aquatic; 50-55-min 3 times a week, from weeks 9-11 to 38-39 • *Intensity*: Moderate, HR<70%; Borg 12-14	Intervention vs control: • First stage of labour: 409.15+185.74 vs 462.83±208.37 p=0.01 • Second stage of labour: 33.23±22.53 vs 36.21±25.93 p=0.68 • Cumulative first and second stage of labour: 442.37±188.72 vs 499.04±215.84 p=0.01 • Third stage of labour: 8.37±2.16 vs 8.14±1.86 p=0.66 • Total duration of labour: 450.74±188.64 vs 507.19±216.06 p=0.01	

Study ref	N	Aim/population/intervention	Results	Comments
Perales et al 2016a[295] Spain	Intervention 83 Control 83	**Aim**: To examine the influence of moderate physical exercise throughout pregnancy on the duration of labour stages. **Population**: Pregnant women (31.6±3.8 years) with uncomplicated and singleton pregnancies. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 55-60 min, 3 times a week from week 9-11 to 39-40. • *Intensity*: Light to moderate; 55-60% maximal HR.	Intervention vs control: • Stage 1 (min): 399.1±322.1 vs 537.4±409.3 p=0.01 • Stage 2 (min): 40.6±42.8 vs 37.4±44.7 p=0.87 • Stage 3 (min) 8±7.7 vs 8.8±7 p=0.46	
Perales et al 2016b[296] Spain NCT01723098	Intervention 83 Control 59	**Aim:** To examine the effects of pregnancy exercise on echocardiographic indicators of haemodynamics, cardiac remodelling, left ventricular function, and cardiovascular disease risk factors. **Population**: Pregnant women with no obstetric complications, no serious medical condition preventing them from exercising safely,<16 wk gestation and not exercising regularly for more than 30 min on 3 d·wk^{-1}. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 55-60 min, 3 times a week from week 9-11 to 39-40. • *Intensity*: Light to moderate; 55-60% maximal HR.	Intervention vs control: • Dilation time (min): 360±309 vs 516±332; p>0.1 • Expulsion time (min): 98±73 vs 111±77; p>0.1 • Childbirth time (min): 6±4 vs 7±5; p>0.1 • Total duration of labour (min): 495±234 vs 656±360; p>0.1	

Study ref	N	Aim/population/intervention	Results	Comments
Perales et al 2020[302]	Intervention 688 Control 660	**Aim**: To study the influence of pregnancy exercise on maternal/offspring cardiometabolic health until delivery and at follow-up by pooling data from two randomised controlled trials that were performed following the same methodology (one unpublished). **Population**: Sedentary women with a singleton uncomplicated pregnancy. BMI ≤25 kg/m2; BMI ≥25 kg/m2. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 50-55 min, 3 times a week. • *Intensity*: Moderate; <60% of age-predicted maximum HR; Borg scale 10 to 12.	Intervention vs control: • Duration of 1st stage of labour: 382±256 vs 430±501; p=0.039 • Duration of 2nd stage of labour: 45±50 vs 49±53; p=0.199 • Duration of 3rd stage of labour: 8±7 vs 9±11; p=0.060	
Salvesen et al 2004[297] Norway	Intervention 111 Control 113	**Aim**: To examine a possible effect on labour of training the muscles of the pelvic floor during pregnancy. **Population**: Healthy nulliparous women. **Intervention**: A structured training programme with exercises for the pelvic floor muscles between the 20th and 36th week of pregnancy.	Intervention vs control • First stage of labour: 260±349.4 vs 259±238.6; p=0.44 • Second stage of labour: 40±37.6 vs 45±38.0; p=0.06	

Study ref	N	Aim/population/intervention	Results	Comments
Salvesen et al 2014[298] Norway	Intervention 427 Control 426	**Aim**: To study effects of regular physical exercise in pregnancy on duration of the active phase of labour and the proportions of women with prolonged active second stage. **Population**: Women >18 years with a singleton pregnancy. **Intervention**: • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 55-70 min, 3 times a week from week 20 to 36 plus 45 min home exercise program at least twice a week. • *Intensity*: Moderate; Borg scale 13-14.	Nulliparous women intervention (n=245) vs control (n=239) • Duration of labour (min): 373±266 vs 377±373; p=0.90 • Duration of active second stage: 44±27 vs 38±24; p=0.03 • Prolonged active second stage: 41/208 (20%) vs 34/201 (17%) Parous women intervention (n=182) vs control (n=187) • Duration of labour (min): 182±158 vs 161±170; p=0.25 • Duration of active second stage: 16±14 vs 16±14; p=0.75 • Prolonged active second stage: 2/160 (1%) vs 4/157 (3%)	
Taniguchi & Sato 2016[299] Japan	Intervention 54 Control 53	**Aim**: To examine the effects of home-based walking on sedentary women's pregnancy outcomes and mood. **Population**: Pregnant women with a healthy singleton pregnancy aged 20–30 years; sedentary in daily life by self-report; no physical, mental or social problems by self-report; no psychiatric drug use; in at least the 30th week of pregnancy. Mixed BMIs. **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic; Walking; 30 min, 3 times a week from 30 weeks until birth. • *Intensity*: Not described.	Intervention vs control: • Duration of first stage of labour: 529.9±526.3 598.1±520.4; p=0.52 • Duration of second stage of labour (min): 41.4±99.5 30.3±19.0; p=0.44 • Duration of labour (min): 556.3±532.2 vs 627.8±525.3; p=0.51	

Study ref	N	Aim/population/intervention	Results	Comments
Rodriguez-Blanque et al 2018[301] SWEP NCT02761967	Intervention 60 Control 60	**Aim**: To determine the duration of labour in pregnant women who completed a program of moderate physical exercise in water and subsequently presented eutocic birth. **Population**: **H**ealthy pregnant women with uncomplicated singleton pregnancies. **Intervention**: • *Supervised*: Yes • *Intervention*: Aerobic and muscle strengthening exercises in water for 60 minutes 3 times/week from weeks 20 to 37. • *Intensity*: Moderate; Borg scale 12-14	Intervention vs control: • Duration of 1st stage of labour: 260.00 (137.50 to 390.000) vs 405 (295.00 to 498.75); p<0.001 • Duration of 2nd stage of labour: 90.00 (30.00 to 187.50) vs 152 (70.00 to 210.00); p=0.007 • Duration of 3rd stage of labour: 5.00 (5.00 to 10.00) vs 8.00 (5.00 to 10.00); p=0.383 • Average total duration of labour: 389.33±216.18 min vs 561.30±199.94 min; p<0.001	

Study ref	N	Aim/population/intervention	Results	Comments
Sanda et al 2018[300] Fit for Delivery Norway	Intervention 303 Control 303	**Aim**: To present secondary analyses from the Norwegian Fit for Delivery randomized controlled trial, aiming at studying the effect of a lifestyle intervention including group exercise classes, as well as the possible influence of physical activity level in late pregnancy, on labour outcomes. **Population**: Pregnant women who were nulliparous, with a singleton pregnancy at ≤20 weeks of gestation, had a pre-pregnancy body mass index (BMI) of ≥19 kg/m2. **Intervention**: Dietary counselling was performed by telephone, with an initial consultation and then a follow-up 4–6 weeks later, each of approximately 20 minutes. Counsellors were either experienced clinical dieticians or graduate students in public health. Nutritional advice was based on recommendations from the Norwegian Directorate for Health with specific attention given to intake of fruits and vegetables, drinking water instead of drinks containing energy, regular meal patterns, and limiting consumption of snack foods and foods/drinks containing added sugar. The physical activity component consisted of access to twice-weekly exercise classes at a local gym, all following the same pattern: 10 minutes of warm-up, 40 minutes of strength training and cardiovascular exercise at moderate intensity (using aerobics, calisthenics, and weight training), and 10 minutes of stretching. The intensity of the exercise was self-monitored using Borg's scale with a target of 12-14. Classes were led by physical therapists or students in sports science.	Intervention vs control: • duration of active labour: 322.7±166.8 vs 278.3±164.4; p=0.027 • duration of 1st stage of labour: 293.4±201.8 min vs 257.1±181.4 min, p=0.030 • duration of 2nd stage of labour: 69.5±43.4 vs 66.0±41.9; p=0.49	

Table 77: Q5 Physical activity in pregnancy and pain during labour — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Baciuk et al 2008;[292] Cavalcante et al 2009[312] Brazil	Intervention 34 Control: 37	**Aim**: To evaluate the association between water aerobics, maternal cardiovascular capacity during pregnancy, labour and neonatal outcomes. **Population**: Women of < 20 weeks of pregnancy with a singleton pregnancy and no gestational risk factors. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic; Aquatic; 50 min 3 times a week from <20 wks to birth • *Intensity*: Moderate 70% predicted HR	Intervention vs control: • Request for analgesia: 9/34 (27%) vs 24/37 (65%) RR 0.42 95%CI 0.23 to 0.77	
Barakat et al 2008;[293] Barakat et al 2009a;[313] Barakat et al 2009b;[303] Spain NCT00813657	Intervention 72 Control 70	**Aim**: to examine the effect of light intensity resistance exercise training performed during the second and third trimester of pregnancy. **Population**: Healthy sedentary pregnant women; mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Resistance; Toning and joint mobilisation; 35-40 min 3 times a week from weeks 12-13 to 38-39. • *Intensity*: Light; ≤80% of age-predicted maximum HR	Intervention vs control: • Epidural anaesthesia: 50/72 (69.4%) vs 48/70 (68.6%); p>0.1	

Study ref	N	Aim/population/intervention	Results	Comments
Salvesen et al 2014[298] Norway	Intervention 427 Control 426	**Aim**: To study effects of regular physical exercise in pregnancy on duration of the active phase of labour and the proportions of women with prolonged active second stage. **Population**: Women >18 years with a singleton pregnancy. **Intervention**: • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 55-70 min, 3 times a week from week 20 to 36 plus 45 min home exercise program at least twice a week. • *Intensity*: Moderate; Borg scale 13-14.	Epidural analgesia intervention vs control • Nulliparous women: 87/239 (36%) vs 88/233 (38%); p=0.76 • Parous women: 34/177 (19%) vs 23/183 (13%); p=0.08	

Study ref	N	Aim/population/intervention	Results	Comments
Sanda et al 2018[300] Fit for Delivery Norway	Intervention 303 Control 303	**Aim**: To present secondary analyses from the Norwegian Fit for Delivery randomized controlled trial, aiming at studying the effect of a lifestyle intervention including group exercise classes, as well as the possible influence of physical activity level in late pregnancy, on labour outcomes. **Population**: Pregnant women who were nulliparous, with a singleton pregnancy at ≤20 weeks of gestation, had a pre-pregnancy body mass index (BMI) of ≥19 kg/m2. **Intervention**: Dietary counselling was performed by telephone, with an initial consultation and then a follow-up 4–6 weeks later, each of approximately 20 minutes. Counsellors were either experienced clinical dieticians or graduate students in public health. Nutritional advice was based on recommendations from the Norwegian Directorate for Health with specific attention given to intake of fruits and vegetables, drinking water instead of drinks containing energy, regular meal patterns, and limiting consumption of snack foods and foods/drinks containing added sugar. The physical activity component consisted of access to twice-weekly exercise classes at a local gym, all following the same pattern: 10 minutes of warm-up, 40 minutes of strength training and cardiovascular exercise at moderate intensity (using aerobics, calisthenics, and weight training), and 10 minutes of stretching. The intensity of the exercise was self-monitored using Borg's scale with a target of 12-14. Classes were led by physical therapists or students in sports science.	Intervention vs control: • Epidural analgesia: 56/280 vs 76/287; p=0.068 • Fentanyl analgesia: 169/276 vs 168/282; p=0.69	

Study ref	N	Aim/population/intervention	Results	Comments
Taniguchi & Sato 2016[299] Japan	Intervention 54 Control 53	**Aim**: To examine the effects of home-based walking on sedentary women's pregnancy outcomes and mood. **Population**: Pregnant women with a healthy singleton pregnancy aged 20–30 years; sedentary in daily life by self-report; no physical, mental or social problems by self-report; no psychiatric drug use; in at least the 30th week of pregnancy. Mixed BMIs. **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic; Walking; 30 min, 3 times a week from 30 weeks until birth. • *Intensity*: Not described.	Intervention vs control: • Birth pain (VAS: 0–10 cm): 8.8±1.4 vs 8.5±1.7; p=0.37	

Table 78: Q5 Physical activity in pregnancy and perineal tears — RCTs

Study ref	N	Aim/population/intervention	Results	Comments
Rodriguez-Blanque et al 2019[305] SWEP NCT02761967	Intervention 65 Control 64	**Aim**: To determine the effect of an aquatic physical exercise program performed during pregnancy on rate of intact perineum after childbirth. **Population**: **H**ealthy pregnant women with uncomplicated singleton pregnancies. **Intervention**: • *Supervised*: Yes • *Intervention*: Aerobic and muscle strengthening exercises in water for 60 minutes 3 times/week from weeks 20 to 37. • *Intensity*: Moderate; Borg scale 12-14	Intervention vs control: • intact perineum: aOR 8.57; 95% CI 1.85 to 39.68 Maternal weight gain did not influence the odds of intact perineum (OR 1.072, 95%CI 0.896 to 1.283). Women who previously gave birth and followed the SWEP method had an OR of 10.197 (95% CI 2.190, 47.476 for an intact perineum. The administration of anaesthesia and previous pregnancy also were associated with intact perineum (OR 6.68, 95%CI 1.21 to 36.84 and OR 5.42, 95%CI 1.64 to 17.89), respectively.	

Study ref	N	Aim/population/intervention	Results	Comments
Salvesen et al 2004[297] Norway	Intervention 111 Control 113	**Aim**: To examine a possible effect on labour of training the muscles of the pelvic floor during pregnancy. DESIGN: Randomised controlled trial. **Population**: Healthy nulliparous women. **Intervention**: A structured training programme with exercises for the pelvic floor muscles between the 20th and 36th week of pregnancy.	Grade 3 and 4 perineal tears intervention vs control: • 7/111 (6%) vs 9/113 (8%); p=0.64	
Salvesen et al 2014[298] Norway	Intervention 427 Control 426	**Aim**: To study effects of regular physical exercise in pregnancy on duration of the active phase of labour and the proportions of women with prolonged active second stage. **Population**: Women >18 years with a singleton pregnancy. **Intervention**: • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 55-70 min, 3 times a week from week 20 to 36 plus 45 min home exercise program at least twice a week. • *Intensity*: Moderate; Borg scale 13-14.	Grade 3 and 4 perineal tears intervention vs control: • Nulliparous women: 12/206 (6%) vs 12/207 (6%) p=0.99 • Parous women: 2/164 (1%) vs 4/164 (2%) p=0.41	

Study ref	N	Aim/population/intervention	Results	Comments
Seneviratne et al 2016[273] New Zealand	Intervention 37 Control 37	**Aim:** To assess whether antenatal exercise in overweight/obese women would improve maternal and perinatal outcomes. **Population:** Pregnant women with body mass index ≥25 kg/m$_2$. **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic; Stationary cycling; 25-45 min, 3-5 times a week depending on stage of pregnancy, from week 25 to 35. • *Intensity*: Moderate (40–59% VO_2 reserve).	Perineal tears intervention vs control: • 6/37 (22%) vs 10/37 (35%); p=0.061	
Garnaes et al 2016;[304] Garnaes et al 2017;[314] Garnæs et al 2018[315] Norway	Intervention 38 Control 36	**Aim**: to assess whether regular supervised exercise training in pregnancy could reduce gestational weight gain in women with prepregnancy overweight/obesity. **Population**: Pregnant women with a prepregnancy body mass index (BMI) ≥28 kg/m$_2$. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Treadmill walking/jogging and muscle strengthening; 60 min, 3 times weekly plus 50 min home exercise program 2 times a week. • *Intensity*: Moderate; 80% maximal capacity, Borg scale 12-15.	Grade 3 and 4 perineal tears intervention vs control: • 4/38 (18%) vs 2/36 (10%); p=0.66	

Effect on the infant and child

Table 79: Q5 Physical activity in pregnancy and congenital anomaly — observational studies

Study ref	N	Aim/methods	Results	Comments
Davenport et al 2019b[306]	14 studies 78,735	**Aim**: To investigate the relationships between exercise and incidence of congenital anomalies. **Methods**: Online databases were searched from inception up to 6 January 2017. Studies of all designs were eligible (except case studies and reviews) if they were published in English, Spanish or French, and contained information on population (pregnant women without contraindication to exercise), intervention (subjective or objective measures of frequency, intensity, duration, volume or type of exercise, alone ["exercise-only"] or in combination with other intervention components [e.g., dietary; "exercise + co-intervention"]), comparator (no exercise or different frequency, intensity, duration, volume or type of exercise) and outcome (maternal temperature and fetal anomalies).	Prenatal exercise did not increase the odds of congenital anomalies (OR 1.23, 95% CI 0.77 to 1.95, I_2=0%; very low certainty).	

Table 80: Q5 Physical activity in pregnancy and macrosomia — observational studies

Study ref	N	Aim/methods	Results	Comments
Owe et al 2009[307] Norway	36,896 Cohort	**Aim**: To estimate the association between regular exercise during pregnancy and excessive infant birth weight. **Methods**: Information on regular exercise was based on answers to two questionnaires to collect data from the Norwegian Mother and Child Cohort Study at 17 and 30 weeks.	Adjusted odds ratio of macrosomia at week 17: *Nulliparous* • 1-3 times/month: aOR 0.93 (0.74 to 1.18) • 1-2 times/week: aOR 0.91 (0.73 to 1.14) • ≥3 times/week: aOR 0.72 (0.56 to 0.93) *Multiparous* • 1-3 times/month: aOR 1.05 (0.91 to 1.22) • 1-2 times/week: aOR 0.95 (0.83 to 1.10) • ≥3 times/week: aOR 0.90 (0.76 to 1.07) Adjusted odds ratio of macrosomia at week 30: *Nulliparous* • 1-3 times/month: aOR 1.04 (0.86 to 1.27) • 1-2 times/week: aOR 0.90 (0.75 to 1.09) • ≥3 times/week: aOR 0.77 (0.61 to 0.96) *Multiparous* • 1-3 times/month: aOR 1.02 (0.90 to 1.15) • 1-2 times/week: aOR 1.00 (0.89 to 1.13) • ≥3 times/week: aOR 1.09 (0.90 to 1.32)	

Table 81: Q5 Physical activity in pregnancy and low birth weight — observational studies

Study ref	N	Aim/methods	Results	Comments
Lieferman et al 2003[308] United States	2,245 Cohort	**Aim**: to determine the effect of regular leisure physical activity (RLPA) on two different adverse birth outcomes: timeliness of birth (<37 weeks, preterm; 37–42 weeks, term; and >42 weeks, postterm) and low birth weight (<1500 g, very low; 1500–2499 g, low).	Preterm birth and level of exercise during pregnancy compared to Group 1: • Group 2: OR 0.91 (0.71 to 1.17) • Group 3: OR 1.08 (0.76 to 1.55)	

Study ref	N	Aim/methods	Results	Comments
		Methods: The sample was obtained from the 1988 National Maternal and Infant Health Survey (NMIHS) data. The NMIHS was developed to examine adverse birth outcomes by assessing various maternal characteristics such as demographic, behavioural, and health care factors not found in vital statistics data. Women were grouped as exercising before and during pregnancy (Group 1), exercising before but not during pregnancy (Group 2), exercising during pregnancy but not before (Group 3), and not exercising before or during pregnancy (Group 4).	• Group 4: OR 1.11 (0.93 to 1.31) Post-term birth and level of exercise during pregnancy compared to Group 1: • Group 2: OR 0.88 (0.64 to 1.19) • Group 3: OR 0.88 (0.60 to 1.30) • Group 4: OR 0.89 (0.75 to 1.05) Low birth weight (1,500-2,499 g) and level of exercise during pregnancy compared to Group 1: • Group 2: OR 1.28 (1.05 to 1.56) • Group 3: OR 0.85 (0.62 to 1.17) • Group 4: OR 1.15 (0.99 to 1.34) Very low birth weight (<1,500 g) and level of exercise during pregnancy compared to Group 1: • Group 2: OR 2.05 (1.69 to 2.48) • Group 3: OR 1.13 (0.85 to 1.49) • Group 4: OR 1.75 (1.50 to 2.04)	

Table 82: Q5 Physical activity in pregnancy and childhood weight

Study ref	N	Aim/methods	Results	Comments
Kong et al 2016[309] United States	802 mother-child dyads	**Aim**: to examine associations of maternal LTPA with offspring overall and central adiposity in mid-childhood. **Methods**: We analysed data from mother-child dyads from Project Viva, a prospective pre-birth cohort study. Women reported average weekly LTPA before and during mid-pregnancy. At age 7-10 years, we measured fat, truncal fat and lean mass with dual-energy X-ray absorptiometry. Using multivariable linear regression, we examined associations of maternal LTPA with offspring adiposity, adjusting for child age and sex, maternal race/ethnicity, education, age, pre-pregnancy body mass index, marital status and smoking status.	Associations between mid pregnancy leisure time physical activity of >8 hours/week • Fat mass index: 0.07 (−0.22, 0.36) • Truncal fat mass index: 0.03 (−0.10, 0.17) • Lean mass index: 0.03 (−0.18, 0.25)	

Table 83: Q5 Physical activity in pregnancy and neurodevelopment of the child

Study ref	N	Aim/methods	Results	Comments
Nino Cruz et al 2018[310]	6 studies 1 RCT; 5 cohort SLR	**Aim**: To review the literature on the association between physical activity (PA) during pregnancy and offspring neurodevelopment. **Methods**: LILACS, MEDLINE and Web of Science were searched for studies published since 1977. Original studies conducted in humans, without language, country, or study type restriction, were eligible. Information on the study methodology like study design, sample size, PA exposure and neurodevelopment assessment, covariates, and the effect measure were extracted from the selected articles.	The instruments used to measure PA during pregnancy and neurodevelopment varied between the studies. PA was self-reported at different gestational ages and neurodevelopment was assessed prospectively in offspring aged 1-8 years old. Only the randomised clinical trial found no effect of PA over offspring neurodevelopment. Cohort studies found a positive association between physical activity during pregnancy and offspring neurodevelopment.	

3.2 Q6: What physical activities are associated with adverse maternal and perinatal outcomes?

3.2.1 Existing guidelines on exercise in pregnancy

There are several activities that pose increased risks in pregnancy such as scuba diving and exertion in the supine position. Activities that increase the risk of falls, such as skiing, or those that may result in excessive joint stress, such as jogging and tennis, should include cautionary advice for most pregnant women, but evaluated on an individual basis with consideration for individual abilities.

3.2.2 Any exercise

Systematic reviews have found:

- no increase in risk of miscarriage (OR 0.69; 95%CI 0.40 to 1.22; 10 studies) or perinatal mortality (OR 0.79; 95%CI 0.26 to 2.38; 6 studies) between women who exercised in pregnancy compared to those who did not (46 studies, n=266,778)[316]
- no adverse impact on fetal heart rate or uteroplacental blood flow metrics (9 studies; 4,651 women).[317]

3.2.3 Vigorous exercise

A systematic review (5 RCTs, 10 cohort studies; n=32,703)[318] found no clear difference in birthweight (p=0.79), small for gestational age (p=0.13), low birthweight (p=0.35) or maternal weight gain (p=0.5) between women who engaged in vigorous physical activity and those who did not. Women who engaged in vigorous physical activity had a small increase in gestational age at birth (p<0.001) and a small but significantly reduced risk of prematurity (p=0.03).

A secondary cohort analysis of an RCT (n=1,890)[319] found no clear difference in low birthweight (p=0.946), high birthweight (p=0.278), large for gestational age (p=0.533) or small for gestational age (p=0.160).

Three cohort studies[320-322] examined the association between vigorous leisure time physical activity and adverse outcomes (miscarriage and preterm and post-term birth).

One study (n=92,671)[320] with potential bias from retrospective data collection suggested an increase in risk of miscarriage <18 weeks with high impact exercise (jogging, ball games and racket sports) or workout/fitness training (75-269 minutes/week). However, the authors noted that it is too early to draw any public health inferences on this basis.

In regard to preterm and post-term birth:

- in one study (n=1,699),[321] there was no clear difference in risk of preterm birth with exercise in the first (OR 0.80; 95%CI 0.48 to 1.35) or second trimester (OR 0.52; 95%CI 0.24 to 1.11) and no clear difference in risk of post-term birth with exercise in the first (OR 0.93; 95%CI 0.45 to 1.89) or second (OR 1.15; 95%CI 0.47 to 2.79) trimester
- another study (n=1,647)[322] found no clear difference in risk of preterm birth based on duration of vigorous activity up to >435 min/week (OR 1.2; 95%CI 0.5 to 3.1).

3.2.4 Supine exercise

A systematic review[323] found very low to low certainty evidence from three RCTs that exercise interventions that included supine exercise were not associated with low birth weight (narrative synthesis). Very low to low certainty evidence from four observational studies showed no adverse events in the mother but a potential association between an acute bout of supine exercise and abnormal fetal heart rate (narrative synthesis). The authors noted that there was insufficient evidence to ascertain whether maternal exercise in the supine position is safe or should be avoided during pregnancy.

3.2.5 Swimming and aqua aerobics

A cohort study (n=92,671)[320] found no association between swimming and risk of miscarriage <22 weeks (19-22 weeks HR 0.9; 95%CI 0.4 to 1.9).

A cohort study (n=109)[324] found that moderate intensity aqua aerobics in water temperatures of 28.8 to 33.4°C did not significantly increase maternal body temperature (mean body temperature increase 0.16±0.35°C).

A case-control study (n=8,655)[325] found no significant positive associations between any or frequent pool use and birth defect and a possible decrease in risk of spina bifida (aOR 0.68; 95%CI 0.47 to 0.99).

3.2.6 Bicycling/horseback riding

A cohort study (n=92,671)[320] found an association between bicycling or horseback riding and risk of miscarriage at 11-14 weeks (HR 1.7; 95%CI 1.4 to 2.0) but not at other times before 22 weeks.

3.2.7 Occupational activities

Fetal loss

A systematic review of cohort and cross-sectional studies[326] found no clear increase or decrease in the risk of miscarriage with lifting >100 kg per day (RR 1.32; 95%CI 0.93 to 1.87) but a possible increase in risk associated with standing >6 hours per day (RR 1.16; 95%CI 1.01 to 1.32).

A large cohort study (n=71,500)[327] found an increased risk of early miscarriage (≤12 weeks) with occupational lifting of 101-200 kg per day (aHR 1.38; 95%CI 1.10 to 1.74) and a doubling of risk with lifting of >1,000 kg/day (aHR 2.02; 95%CI 1.23 to 3.33). The risk of late miscarriage (13-21 weeks) was increased with lifting of 201-500 kg per day (aHR 1.42; 95%CI 1.15 to 1.76). There was no clear difference in risk of stillbirth (≥22 weeks) with lifting of 201-500 kg per day (aHR 0.72; 95%CI 0.45 to 1.16). However, further analysis of the same cohort (n=68,086)[328] found no clear difference in risk of early or late miscarriage with lifting loads of 101-975 kg a day but an increased risk of stillbirth with lifting of 201-975 kg per day (aHR 2.87; 95%CI 1.37 to 6.01) among women with a prior fetal death. There was no clear difference in fetal loss at any time or with any lifting load for women without a prior fetal death.

A case-control study (n=1,762) found that women who experienced spontaneous abortion were more likely than controls to have participated in high intensity occupational activity (59.8 vs 30.7%) and occupational lifting (53.9 vs 36.5%).[329]

Risk of preterm premature rupture of the membranes

A cohort study (n=2,929)[330] found an increased risk of preterm premature rupture of the membranes with strenuous occupational physical exertion (OR 1.72; 95%CI 1.16 to 2.56).

Risk of preterm birth

A systematic review of cohort studies[331] found possible associations between preterm birth and lifting and carrying >5 kg at any time (OR 1.24; 95%CI 1.00 to 1.54) or in the third trimester (OR 1.30; 95%CI 1.01 to 1.67), physical effort or exhaustion (OR 1.30; 95%CI 1.05 to 1.61) and standing and walking >3 hours per day (OR 1.25; 95%CI 0.99 to 1.57).

Cohort studies found an increased risk of preterm birth among:

- primigravid women lifting 101-200 kg/day (aHR 1.34; 95%CI 1.14 to 1.58) or 201-975 kg/day (aHR 1.43; 95%CI 1.13 to 1.80) but no clear increase in risk among multigravida women lifting 101-200 kg/day (aHR 1.17; 95%CI 1.00 to 1.36) or 201-975 kg/day (aHR 1.09; 95%CI 0.89 to 1.33) (n=65,530)[328]
- women engaging in moderate or heavy occupational activity (n=380)[332]
- women whose work at 34 weeks entailed trunk bending for >1 h/day (OR 2.92; 95%CI 1.27 to 6.70) (n=1,327).[333]

However, other cohort studies have found no clear association between preterm birth among women:

- who lifted repeatedly (RR 1.3; 95%CI 0.6 to 2.9) or stood at least 30 hours per week (RR 1.3; 95%CI 0.8 to 2.3) (n=1,908)[334]
- frequently lifted >25 kg (OR 0.55; 95%CI 0.13 to 2.28) or often had long periods of standing (OR 0.95; 95%CI 0.65 to 1.40) (n=4,680).[335]

Case-control studies found an increased risk of preterm birth among women:

- lifting and carrying loads of ≥25 kg (aOR 2.42; 95%CI 1.15 to 5.09) (n=938)[336]
- standing longer than 3 hours a day (OR 4.1; 95%CI 1,29 to 13.10) or engaging in physical exertion (OR 2.91; 95%CI 1.29 to 6.58) (n=223 pairs)[337]

Low birth weight

Cohort studies have found clear difference in birth weights among women:

- standing ≥3 hours a day versus those standing <3 hours a day (MD -27.80; 95%CI -86.34 to 30.74), women involved in occupational lifting versus those who were not (MD-8.70; 95%CI -69.13 to 51.73) and those engaging in medium or heavy physical exertion versus those engaging in light physical exertion (MD -1.20; 95%CI -55.93 to 53.53) (n=1,222)[338]

- frequently lifted >25 kg (OR 1.86; 95%CI 0.44 to 7.77) or often had long periods of standing (OR 1.02; 95%CI 0.60 to 1.73) (n=4,680).[335]

A small cohort study (n=380)[332] found an increased risk of low birth weight among women engaging in moderate or heavy occupational activity.

Small-for-gestational age

Cohort studies have found no clear association between small-for-gestational age and:

- person lifting of 501-1,000 kg/day (aOR 1.34; 95%CI 0.98 to 1.83) or lifting >1,000 kg/day that did not involve lifting persons (aOR 1.51; 95%CI 0.83 to 2.76) (n=66,963)[339]
- lifting repeatedly (RR 1.0; 95%CI 0.6 to 1.5) or standing at least 30 hours per week (RR 1.2; 95%CI 0.6 to 2.2) (n=1,908).[334]
- frequently lifting >25 kg (OR 1.85; 95%CI 0.70 to 4.88) or often had long periods of standing (OR 0.95; 95%CI 0.63 to 1.45) (n=4,680).[335]

A case-control study (n=5,677)[340] found no association between small-for-gestational age and standing ≥7 hours a day (OR 1.2; 95%CI 0.9 to 1.6) or lifting ≥7 kg (OR 1.2; 95%CI 0.9 to 1.5).

Risk of pelvic pain

A cohort study (n=50,143)[341] found an increased risk of pelvic pain among women lifting 101-200 kg/day (aOR 1.21; 95%CI 1.09 to 1.34), 201-500 kg/day (aOR 1.45; 95%CI 1.31 to 1.60), 501-1,000 kg/day (aOR 1.45; 95%CI 1.23 to 1.72) or >1,000 kg/day (aOR 1.31; 95%CI 1.02 to 1.69).

A case-control study (n=2,758)[342] found no clear difference in incidence of pelvic pain among women predominantly standing or walking at work (OR 1.04; 95%CI 0.80 to 1.35) but a probable increase among women engaging in physically strenuous work (OR 1.47; 95%CI 1.17 to 1.84).

Another case-control study (n=2,758)[342] found an increased risk of pelvic pain associated with physically strenuous work (OR 1.47; 95%CI 1.17 to 1.84).

Risk of congenital anomalies

A case-control study (n=3,255)[343] found associations between cleft lip and palate and longest versus shortest time standing (OR 1.33; 95%CI 1.04 to 1.69) and keeping or regaining balance (OR 1.32; 95%CI 1.03 to 1.68) but not bending or twisting or climbing. There was no association between any of these activities and cleft palate alone.

3.2.8 Evidence summary

No evidence was identified to support an association between adverse effects in the mother and exercise, vigorous exercise or swimming during pregnancy. There is very low to low certainty evidence to suggest a potential association between an acute bout of supine exercise and abnormal fetal heart rate. Bicycling and horseback riding may be associated with miscarriage at 11-14 weeks. A systematic review noted that there was insufficient evidence to ascertain whether maternal exercise in the supine position is safe or should be avoided during pregnancy.

The evidence on risks associated with occupational physical activity during pregnancy is unclear. Heavy lifting (eg >200 kg/day) may be associated with an increased risk of pelvic pain, stillbirth among women with a previous fetal loss and preterm birth among primigravid women but is not associated with small-for-gestational age or low birth weight. There is a possible association between occupational standing and increased risk of miscarriage (>6 hours a day) or preterm birth (>3 hours a day) but no clear difference in small-for-gestational age, birth weight or pelvic pain. There is insufficient evidence to draw conclusions on strenuous occupational physical exertion in pregnancy but it may be associated with preterm premature rupture of the membranes and pelvic pain.

3.2.9 Evidence tables

Table 84: Q6 Potential adverse effects associated with any exercise — systematic review

Study ref	N	Aim/methods	Results	Comments
Davenport et al 2019C[316]	46 studies 266,778	**Aim**: To perform a systematic review of the relationship between prenatal exercise and fetal or newborn death. **Methods**: Online databases were searched up to 6 January 2017. Studies of all designs were included (except case studies) if they were published in English, Spanish or French and contained information on the population (pregnant women without contraindication to exercise), intervention (subjective or objective measures of frequency, intensity, duration, volume or type of exercise alone and outcome (miscarriage or perinatal mortality).	Risk in women who exercised in pregnancy compared to those who did not: • Miscarriage: OR 0.69 (0.40 to 1.22); 10 studies • Perinatal mortality: OR 0.79 (0.26 to 2.38); 6 studies	
Davenport et al 2018[344]	58 studies 8,699 women	**Aim**: To perform a systematic review and meta-analysis to explore the relationship between prenatal exercise and glycaemic control. **Methods**: Online databases were searched up to 6 January 2017. Studies of all designs were included (except case studies and reviews) if they were published in English, Spanish or French, and contained information on the population (pregnant women without contraindication to exercise), intervention (subjective or objective measures of frequency, intensity, duration, volume or type of acute or chronic exercise, alone ('exercise-only') or in combination with other intervention components (eg, dietary; 'exercise+cointervention') at any stage of pregnancy), comparator (no exercise or different frequency, intensity, duration, volume and type of exercise) and outcome (glycaemic control).	There was very low certainty evidence showing that an acute bout of exercise was associated with a decrease in maternal blood glucose from before to during exercise (6 studies, n=123; MD -0.94 mmol/L, 95%CI -1.18 to -0.70) and following exercise (n=333; MD -0.57 mmol/L, 95% CI -0.72 to -0.41). Subgroup analysis showed that there were larger decreases in blood glucose following acute exercise in women with diabetes (n=26; MD -1.42, 95% CI -1.69 to -1.16, I(2)=8%) compared with those without diabetes (n=285; MD -0.46, 95% CI -0.60 to -0.32, I(2)=62%). Finally, chronic exercise-only interventions reduced fasting blood glucose compared with no exercise postintervention in women with diabetes (2 studies, n=70; MD -2.76, 95% CI -3.18 to -2.34; 'low' certainty of evidence), but not in those without diabetes (9 studies, n=2,174; MD -0.05, 95% CI -0.16 to 0.05).	

Study ref	N	Aim/methods	Results	Comments
Skow et al 2018[317]	91 studies 4,641 women	**Aim**: To perform a systematic review and meta-analysis examining the influence of acute and chronic prenatal exercise on fetal heart rate (FHR) and umbilical and uterine blood flow metrics. Methods: Online databases were searched up to 6 January 2017. Studies of all designs were included (except case studies) if published in English, Spanish or French, and contained information on the population (pregnant women without contraindication to exercise), intervention (subjective or objective measures of frequency, intensity, duration, volume or type of exercise, alone or in combination with other intervention components), comparator (no exercise or different frequency, intensity, duration, volume and type of exercise) and outcomes (FHR, beats per minute (bpm); uterine and umbilical blood flow metrics .	Overall, FHR increased during (MD 6.35bpm; 95%CI 2.30 to 10.41, p=0.002) and following acute exercise (MD 4.05; 95%CI 2.98 to 5.12, p<0.00001). The incidence of fetal bradycardia was low at rest and unchanged with acute exercise. There were no significant changes in umbilical or uterine S/D, PI, RI, blood flow or blood velocity during or following acute exercise sessions. Chronic exercise decreased resting FHR and the umbilical artery S/D, PI and RI at rest.	

Table 85: Q6 Adverse effects associated with vigorous exercise during pregnancy — systematic review

Study ref	N	Aim/methods	Results	Comments
Beetham et al 2019[318]	10 cohort studies; 32,080 women 5 RCTS; 623 women	**Aim**: To investigate the effects of vigorous intensity exercise performed throughout pregnancy, on infant and maternal outcomes. **Methods**: Electronic searching of the PubMed, Medline, EMBASE, Cochrane Library, Web of Science and CINAHL databases was used to conduct the search up to November 2018. Study designs included in the systematic review were randomised control trials, quasi-experimental studies, cohort studies and case-control studies. The studies were required to include an intervention or report of pregnant women performing vigorous exercise during gestation, with a comparator group of either lower intensity exercise or standard care.	No significant difference existed in birthweight for infants of mothers who engaged in vigorous physical activity and those who lacked this exposure (MD 8.06 g, n=8006, p=0.79). Moreover, no significant increase existed in risk of small for gestational age (RR 0.15, n=4,504, p=0.13), risk of low birth weight (<2500 g) (RR 0.44, n=2,454; p=0.35) or maternal weight gain (MD -0.46 kg, n=1,834; p=0.5). Women who engaged in vigorous physical activity had a small but significant increase in length of gestational age before delivery (MD 0.21 weeks, n=4,281; p<0.001) and a small but significantly reduced risk of prematurity (RR -0.20, n = 3025; p=0.03).	

Table 86: Q6 Adverse effects associated with vigorous exercise during pregnancy — RCT

Study ref	N	Aim/methods	Results	Comments
Hoffman et al 2019[319] Germany GeliS NCT01958307	1,890	**Aim**: To investigate the associations between prenatal physical activity and adverse obstetric and neonatal outcomes in a secondary cohort analysis of the cluster-randomized GeliS ("healthy living in pregnancy") trial. **Population**: Women with a pre-pregnancy BMI between 18.5 and 40.0 kg/m(2) recruited from gynaecological and midwifery practices prior to the end of the 12(th) week of gestation. **Intervention**: Four lifestyle counselling sessions covering a balanced healthy diet, regular physical activity and self-monitoring of weight gain were performed by trained healthcare providers alongside routine pre- and postnatal practice visits.	Association between vigorous physical activity at week 29: • Low birthweight OR 0.97; 95%CI 0.36 to 2.57; p=0.946 • High birthweight: OR 1.38; 95%CI 0.77 to 2.49; p=0.278 • Large for gestational age: OR 1.24; 95%CI 0.64 to 2.40; p=0.533 • Small for gestational age: OR 1.48; 95%CI 0.86 to 2.55; p=0.160	

Table 87: Q6 Adverse effects associated with vigorous exercise during pregnancy — observational studies

Study ref	N	Aim/methods	Results	Comments
Madsen et al 2007[320] Denmark	92,671 Cohort	**Aim**: To examine the association between leisure time physical exercise during pregnancy and the risk of miscarriage. **Methods**: Data on exercise during pregnancy and potential confounders were obtained through computer-assisted telephone interviews either during pregnancy or after an early miscarriage. Outcome of pregnancy was identified by register linkage. Using Cox regression analysis, we estimated the hazard ratio (HR) of miscarriage according to weekly amount of exercise and the type of exercise. The HR was estimated for <11, 11–14, 15–18, and 19–22 weeks of gestation, respectively.	Risk of miscarriage with high impact exercise (jogging, ball games and racket sports) (75 to 269 minutes/week) compared to no exercise: • <11 weeks: HR 3.6 (2.5 to 5.2) • 11-14 weeks: HR 4.2 (3.4 to 5.2) • 15-18 weeks: HR 2.1 (1.2 to 3.5) • 19-22 weeks: HR 1.2 (0.5 to 3.0) Risk of miscarriage with workout/fitness training (75 to 269 minutes/week) compared to no exercise: • <11 weeks: HR 2.1 (1.3 to 3.4) • 11-14 weeks: HR 1.9 (1.4 to 2.6) • 15-18 weeks: HR 2.0 (1.2 to 3.6) • 19-22 weeks: HR 2.3 (1.0 to 5.2)	Potential bias arising from retrospective data collection may explain part of the association

Study ref	N	Aim/methods	Results	Comments
Evenson et al 2002[321] United States	1,699 Cohort	**Aim**: To examine association between vigorous leisure activity and birth outcomes. **Methods**: Women with a singleton pregnancy were recruited at 24–29 weeks' gestation. The type and duration of any regular vigorous leisure activity was assessed in telephone interviews covering the 3-month period before pregnancy and during the first and second trimesters of pregnancy.	First trimester: • Preterm birth: OR 0.80 (0.48 to 1.35) • Post-term birth: OR 0.93 (0.45 to 1.89) Second trimester: • Preterm birth: OR 0.52 (0.24 to 1.11) • Post-term birth: OR 1.15 (0.47 to 2.79)	
Jukic et al 2012[322] United States	1,647 Cohort	**Aim**: To examine the associations between vigorous physical activity during pregnancy and length of gestation and birthweight. **Methods**: Women were recruited before 10 weeks gestation. At 13–16 weeks gestation, participants reported the type, frequency, and duration of their typical weekly vigorous physical activities. Birthweight (from vital records) was studied among term births. We analysed gestational age among 1,647 births using discrete-time survival analysis.	Vigorous activity in the first trimester and odds ratio for preterm birth: • 1–30 min/week: OR 1.0 (0.4 to 2.3) • 31-60 min/week: OR 0.2 (0.05 to 1.0) • 61–435 min/week: OR 0.6 (0.3 to 1.2) • >435 min/week: OR 1.2 (0.5 to 3.1)	

Table 88: Q6 Adverse effects associated with supine exercise during pregnancy — systematic review

Study ref	N	Aim/population/intervention	Results	Comments
Mottola et al 2019[323]	7 studies n=1,759	**Aim**: To explore theoretical concerns regarding the supine position at rest due to the gravid uterus obstructing aorta and vena caval flow may impinge uterine blood flow (UBF) to the fetus and maternal venous return. Eligible population (pregnant without contraindication to exercise), intervention (frequency, intensity, duration, volume or type of supine exercise), comparator (no exercise or exercise in left lateral rest position, upright posture or other supine exercise), outcomes (potentially adverse effects on maternal blood pressure, cardiac output, heart rate, oxygen saturation, fetal movements, UBF, fetal heart rate (FHR) patterns; adverse events such as bradycardia, low birth weight, intrauterine growth restriction, perinatal mortality and other adverse events as documented by study authors), and study design (except case studies and reviews) published in English, Spanish, French or Portuguese.	'Very low' to 'low' certainty evidence from three RCTs indicated no association between supervised exercise interventions that included supine exercise and low birth weight compared with no exercise. There was 'very low' to 'low' certainty evidence from four observational studies that showed no adverse events in the mother; however, there were abnormal FHR patterns (as defined by study authors) in 20 of 65 (31%) fetuses during an acute bout of supine exercise. UBF decreased (13%) when women moved from left lateral rest to acute dynamic supine exercise.	

Table 89: Q6 Adverse effects associated with swimming during pregnancy — observational studies

Study ref	N	Aim/population/intervention	Results	Comments
Agopian et al 2013[325] United States	Cases 191-1929 Controls 6,826 Case control	**Aim**: To evaluate the relationship between maternal swimming pool use during early pregnancy and risk for select birth defects in offspring associated with water-borne pathogens and exposure to water-disinfection by products. **Methods**: Data were evaluated for non-syndromic cases with 1 of 16 types of birth defects (n=191-1829) and controls (n=6826) from the National Birth Defects Prevention Study delivered during 2000-2006. Logistic regression analyses were conducted separately for each birth defect type. Separate analyses were conducted to assess any pool use (yes vs no) and frequent use (5 or more occasions in 1 month) during the month before pregnancy through the third month of pregnancy.	Adjusted odds ratio of birth defects associated with frequent pool use: • Spina bifida: aOR 0.68 (0.47 to 0.99) There were no significant positive association between any or frequent pool use and any of the types of birth defect.	
Brearley et al 2015[324] Australia	109 Cohort	**Aim**: To examine the body temperature response of healthy pregnant women exercising at moderate intensity in an aqua-aerobics class where the water temperature is in the range of 28.8 to 33.4°C, as typically found in community swimming pools. **Methods:** Tympanic temperature was measured at rest pre-immersion (T1), after 35 minutes of moderate-intensity aqua-aerobic exercise (T2), after a further 10 minutes of light exercise while still in the water (T3) and finally on departure from the facility (T4).	Mean body temperature increase 0.16±0.35°C	

Study ref	N	Aim/population/intervention	Results	Comments
Madsen et al 2007[320] Denmark	92,671	**Aim**: To examine the association between leisure time physical exercise during pregnancy and the risk of miscarriage. **Methods**: Data on exercise during pregnancy and potential confounders were obtained through computer-assisted telephone interviews either during pregnancy or after an early miscarriage. Outcome of pregnancy was identified by register linkage. Using Cox regression analysis, we estimated the hazard ratio (HR) of miscarriage according to weekly amount of exercise and the type of exercise. The HR was estimated for <11, 11–14, 15–18, and 19–22 weeks of gestation, respectively.	Risk of miscarriage with swimming (75-269 minutes/week) compared to no exercise: • <11 weeks: HR 0.8 (0.5 to 1.3) • 11-14 weeks: HR 0.8 (0.6 to 1.1) • 15-18 weeks: HR 0.7 (0.4 to 1.2) • 19-22 weeks: HR 0.9 (0.4 to 1.9)	

Table 90: Q6 Adverse effects associated with bicycling/horseback riding during pregnancy — observational studies

Study ref	N	Aim/population/intervention	Results	Comments
Madsen et al 2007[320] Denmark	92,671	**Aim**: To examine the association between leisure time physical exercise during pregnancy and the risk of miscarriage. **Methods**: Data on exercise during pregnancy and potential confounders were obtained through computer-assisted telephone interviews either during pregnancy or after an early miscarriage. Outcome of pregnancy was identified by register linkage. Using Cox regression analysis, we estimated the hazard ratio (HR) of miscarriage according to weekly amount of exercise and the type of exercise. The HR was estimated for <11, 11–14, 15–18, and 19–22 weeks of gestation, respectively.	Risk of miscarriage with bicycling/horseback riding (75-269 minutes/week) compared to no exercise: • <11 weeks: HR 1.3 (0.9 to 1.7) • 11-14 weeks: HR 1.7 (1.4 to 2.0) • 15-18 weeks: HR 1.3 (0.9 to 1.9) • 19-22 weeks: HR 0.7 (0.4 to 1.4)	

Table 91: Q6 Adverse effects associated with occupational activities during pregnancy — systematic reviews

Study ref	N	Aim/population/intervention	Results	Comments
Bonde et al 2013[326]	30 studies	**Aim:** To examine the effect of workplace exposures on the risk of miscarriage. **Methods:** A search in Medline and EMBASE 1966–2012 identified 30 primary papers reporting the relative risk (RR) of miscarriage according to ≥1 of 5 occupational activities of interest. Following an assessment of completeness of reporting, confounding, and bias, each risk estimate was characterised as more or less likely to be biased. Studies with equivalent measures of exposure were pooled to obtain a weighted common risk estimate. Sensitivity analyses excluded studies most likely to be biased.	Risk of miscarriage: • Lifting >100 kg/day: RR 1.32 (0.93 to 1.87) • Standing >6 hours/day: RR 1.16 (1.01 to 1.32)	Includes cohort and cross-sectional studies
van Beukering et al 2014[331]	11 cohort studies	**Aim**: To assess the association between physically demanding work and risk of preterm birth. **Methods**: A systematic search in Medline, Embase and Nioshtic for the period 1990 to June 2012 for observational and intervention studies on physically demanding work (prolonged standing, heavy lifting, physical exertion, occupational fatigue and demanding posture) and PTD. Selected studies were assessed for their risk of bias and pooled using a random effects model.	Association with preterm birth in cohort studies • Standing and walking >3 h per day: OR 1.25 (0.99 to 1.57) • Lifting and carrying >5 kg: OR 1.24 (1.00 to 1.54) • Lifting and carrying >5 kg in the third trimester: OR 1.30 (1.01 to 1.67) • Physical effort or exertion: OR 1.30 (1.05 to 1.61)	

Table 92: Q6 Adverse effects associated with occupational activities during pregnancy — observational studies

Study ref	N	Aim/methods	Results	Comments
Agopian et al 2017[343] United States	887 cleft lip and palate 436 cleft palate 1,932 controls Case-control	**Aim**: To perform a case-control study of maternal occupational physical activity and risk for orofacial clefts in Texas during 1999-2009. **Methods:** We used logistic regression to assess measures of physical activity estimated from a job exposure matrix, using the maternal occupation reported on the birth certificate.	Cleft lip and palate — longest vs shortest time performing: • Bending or twisting: OR 1.22 (0.97 to 1.53) • Climbing: OR 0.91 (0.71 to 1.15) • Keeping or regaining balance: OR 1.32 (1.03 to 1.68) • Standing: OR 1.33 (1.04 to 1.69) Cleft palate — longest vs shortest time performing: • Bending or twisting: OR 0.93 (0.69 to 1.27) • Climbing: OR 1.04 (0.76 to 1.43) • Keeping or regaining balance: OR 1.10 (0.80 to 1.52) • Standing: OR 1.29 (0.95 to 1.77)	
Bonzini et al 2009[333] United Kingdom	1,327 women Cohort	**Aim**: To investigate risks of physical activity at work by pregnancy trimester, including the effects on head and abdominal circumference. **Methods**: At 34 weeks of gestation we interviewed mothers from the prospective Southampton Women's Survey (SWS); we asked about their activities (working hours, standing/walking, kneeling/squatting, trunk bending, lifting and night shifts) in jobs held at each of 11, 19 and 34 weeks of gestation, and subsequently ascertained four birth outcomes (preterm delivery, small for gestational age (SGA) and reduced head or abdominal circumference) blinded to employment history.	Risk of preterm birth was elevated nearly threefold in women whose work at 34 weeks entailed trunk bending for >1 h/day (OR 2.92; 95%CI 1.27 to 6.70). No statistically significant associations were found with small for gestational age or small abdominal circumference, and preterm birth showed little association with long working hours, lifting, standing or shift work.	

Study ref	N	Aim/methods	Results	Comments
Crotaeu et al 2006[340] Canada	1,536 cases 4,441 controls	**Aim**: To evaluate whether some occupational conditions during pregnancy increase the risk of delivering a small-for gestational-age (SGA) infant and whether taking measures to eliminate these conditions decreases that risk. **Methods**: Cases and controls were selected from 43,898 women who had single live births between January 1997 and March 1999 in Québec, Canada. The women were interviewed by telephone after birth.	Association between small-for-gestational age: • standing ≥7 hours a day: OR 1.2; 95%CI 0.9 to 1.6) • lifting ≥7 kg: OR 1.2; 95%CI 0.9 to 1.5)	
El Metwalli et al 2001[329] Egypt	1,762 Case control	**Aim:** To determine the effect of occupational physical activities on the outcome of pregnancy. **Methods:** Occupational physical activity was evaluated through energy expenditure and biomechanic load for women who had experienced spontaneous abortion (cases; n=562) and women who gave birth at full term (control; n=1,200).	Spontaneous abortion group vs completed pregnancy group: • Low intensity score: 226/562 (40.2%) vs 831/1,200 (69.3%) • High intensity score: 336/562 (59.8%) vs 369/1,200 (30.7%) • No lifting: 259/562 (46.1%) vs 762/1,200 (63.5%) • Lifting: 303/562 (53.9%) vs 438/1,200 (36.5%)	
Eunhee et al 2002[338] China	1,222 Cohort	**Aim**: To investigate the association between infant birth weight and standing at work during pregnancy. **Methods**: Various work-related physical activities during pregnancy were assessed using a structured questionnaire, and generalised additive models (GAMs) were performed to examine their association with birth weight.	Birth weight (g): • Standing ≥3 h/day vs <3 h/d: 3,396.0±418.9 vs 3,423.8±432.6; MD -27.80 (-86.34 to 30.74) • Lifting vs not lifting: 3410.6±450.6 vs 3,419.3±433.4; MD -8.70 (-69.13 to 51.73) • Medium or heavy vs light physical exertion: 3,416±435.0 vs 3,417.7±433.4; MD -1.20 (-55.93 to 53.53)	

Study ref	N	Aim/methods	Results	Comments
Juhl et al 2005[342] Denmark	1219 cases 1539 controls	**Aim**: To examine the relation between pelvic pain in pregnancy and physical and psychosocial working conditions. **Methods**: This study used self-reported data on working conditions sampled as a nested case-control study within the Danish national birth cohort. Exposure data were collected prospectively; early in pregnancy and before the onset of pelvic pain. Main outcome measures were odds ratios for pelvic pain in pregnancy as a function of physical and psychosocial working conditions.	Physically strenuous work was associated with an almost 50% increased risk of pelvic pain in pregnancy (OR 1.47; 95%CI 1.17 to 1.84).	
Juhl et al 2005[342]	Cases 1,219 Controls 1,539 Cohort (nested case-control)	**Aim:** to examine the relation between pelvic pain in pregnancy and physical and psychosocial working conditions. **Methods:** Cases and controls were selected on the basis of self-reported pelvic pain intensity, pain localisation, and pain impact on daily living activities. Exposure data were collected prospectively; early in pregnancy and before the onset of pelvic pain. Main outcome measures were odds ratios for pelvic pain in pregnancy as a function of physical and psychosocial working conditions.	Odds ratio of pelvic pain • Predominantly standing or walking: OR 1.04 (0.80 to 1.35) • Physically strenuous work: OR 1.47 (1.17 to 1.84).	

Study ref	N	Aim/methods	Results	Comments
Juhl et al 2013; 2014[327,339] Denmark	SGA: 66,693 Fetal loss: 71,500 Cohort	**Aim**: To examine the association between maternal occupational lifting and small for gestational-age (SGA) and fetal loss. **Methods**: Analysis of information from the Danish Medical Birth Registry according to the mother's self-reported information on occupational lifting from telephone interviews around gestational week 16. Linear and logistic regression models were used and adjustments made for confounders.	Small for gestational age among women who reported person-lifting compared to women with no lifting: • 501-1,000 kg/day: aOR 1.34 (0.98 to 1.83) • >1,000 kg/day: aOR 1.51 (0.83 to 2.76) Small for gestational age lifting with no person lifting: • >1,000 kg/day: aOR 0.99 (0.71 to 1.39) Early miscarriage (≤12 wks) lifting vs no lifting: • 101-200 kg/day: adjusted hazard ratio (aHR) 1.38 (1.10 to 1.74) • 201-500kg/day: aHR 1.46 (1.15 to 1.85) • >1,000 kg/day: aHR 2.02 (1.23 to 3.33) Late miscarriage (13-21 wks) lifting vs no lifting: • 101-200 kg/day: aHR 1.04 (0.80 to 1.35) • 201-500 kg/day: aHR 1.42 (1.15 to 1.76) Stillbirth (≥22 wks) lifting vs no lifting • 101-200 kg/day: aHR 1.23 (0.78 to 1.92) • 201-500 kg/day: aHR 0.72 (0.45 to 1.16)	
Larsen et al 2013[341] Denmark	50,143 women Cohort	**Aim**: To examine the association between occupational lifting and pelvic pain in pregnancy. **Methods:** During pregnancy, women provided information on occupational lifting (weight load and daily frequency) and 6 months postpartum on pelvic pain. Adjusted odds ratios for pelvic pain during pregnancy according to occupational lifting were calculated by logistic regression.	Lifting versus no lifting: • 15-100 kg/day: aOR 1.06; 95%CI 0.99 to 1.13 • 101-200 kg/day: aOR 1.21; 95%CI 1.09 to 1.34 • 201-500 kg/day: aOR 1.45; 95%CI 1.31 to 1.60 • 501-1,000 kg/day: aOR 1.45; 95%CI 1.23 to 1.72 • >1,000 kg/day: aOR 1.31; 95%CI 1.02 to 1.69	

Study ref	N	Aim/methods	Results	Comments
Mocevic et al 2014[328] Denmark	Fetal death: 68,086 Preterm birth: 65,530 Cohort	**Aim:** examined the association between occupational lifting during pregnancy and risk of fetal death and preterm birth using a job exposure matrix (JEM). **Methods:** For occupationally active women in the Danish National Birth Cohort, interview information on occupational lifting was collected around gestational week 16. A JEM was established based on information from women who were still pregnant when interviewed. The JEM provided mean total loads lifted per day within homogeneous exposure groups as informed by job and industry codes. All women were assigned an exposure estimate from the JEM. Cox regression models with gestational age as underlying time variable were used and adjustment for covariates conducted.	Multigravid women with prior fetal death *Early miscarriage (≤12 wks)* • 101-200 kg/day: aHR 1.23 (0.73 to 1.83) • 201-975 kg/day: aHR 1.00 (0.57 to 1.77) *Late miscarriage (13-21 weeks)* • 101-200 kg/day: aHR 1.37 (0.92 to 2.03) • 201-975 kg/day: aHR 1.14 (0.67 to 1.92) *Stillbirth (≥22 weeks)* • 101-200 kg/day: aHR 0.90 (0.36 to 2.24) • 201-975 kg/day: aHR 2.87 (1.37 to 6.01) Multigravid women without prior fetal death *Early miscarriage (≤12 wks)* • 101-200 kg/day: aHR 1.17 (0.88 to 1.56) • 201-975 kg/day: aHR 1.00 (0.68 to 1.48) *Late miscarriage (13-21 weeks)* • 101-200 kg/day: aHR 1.27 (0.97 to 1.68) • 201-975 kg/day: aHR 0.95 (0.64 to 1.40) *Stillbirth (≥22 weeks)* • 101-200 kg/day: aHR 1.23 (0.73 to 2.05) • 201-975 kg/day: aHR 0.75 (0.34 to 1.67) Preterm birth among primigravid women • 101-200 kg/day: aHR 1.34 (1.14 to 1.58) • 201-975 kg/day: aHR 1.43 (1.13 to 1.80) Preterm birth among multigravid women: • 101-200 kg/day: aHR 1.17 (1.00 to 1.36) • 201-975 kg/day: aHR 1.09 (0.89 to 1.33)	

Study ref	N	Aim/methods	Results	Comments
Nelson et al 2009[336] Thailand	938 Case control	**Aim**: To evaluate associations of maternal occupational physical exertion with preterm birth. **Methods**: Maternal occupational exertion during pregnancy was assessed using a structured questionnaire administered after delivery. Logistic regression procedures were used to examine relationships between occupational physical activity and preterm birth.	Adjusted odds ratio for spontaneous preterm birth: • Medium exertion: aOR 0.90 (0.64 to 1.27) • Heavy exertion: aOR 2.42 (1.15 to 5.09)	
Newman et al 2001[330] United States	2,929 Cohort	**Aim:** To prospectively determine the relationship between occupational fatigue and spontaneous preterm birth. **Methods**: Women with singleton pregnancies enrolled at 22 to 24 weeks' gestation reported the number of hours worked per week and answered specific questions designed to determine sources of occupational fatigue. Fatigue was quantified (0-5 index) according to the number of these sources positively reported. Simple and Mantel-Haenszel x_2 tests were used to test the univariate association and hypothesis of a linear trend between sources of occupational fatigue and spontaneous preterm delivery. Covariables were considered by multivariate logistic regression analysis. Women who did not work outside the home were considered separately from those who worked but did not report any sources of occupational fatigue.	Adjusted odds ratios for preterm rupture of membranes (<37 wks) • Physical exertion: OR 1.72 (1.16 to 2.56)	

Study ref	N	Aim/methods	Results	Comments
Pompeii et al 2005[334] United States	1,908 women Cohort	**Aim**: To assess whether exposure to standing, lifting, night work, or long work hours during 3 periods of pregnancy are associated with an increased risk of preterm or small-for-gestational-age birth. **Methods**: The Pregnancy, Infection and Nutrition study is a prospective cohort with a nested case-control component that was conducted through clinic and hospital settings. Women provided information during telephone and face-to-face interviews about physical exertion for the 2 longest-held jobs during pregnancy.	Risk of preterm birth: • Lifting repeatedly: RR 1.3; 95%CI 0.6 to 2.9 • Standing at least 30 hours per week: RR 1.3; 95%CI 0.8 to 2.3 Risk of small-for-gestational age: • Lifting repeatedly: RR 1.0; 95%CI 0.6 to 1.5 • Standing at least 30 hours per week: RR 1.2; 95%CI 0.6 to 2.2	
Ritsmitchai et al 1997[337] Thailand	223 case-control pairs Case-control	**Aim:** To determine whether prolonged standing and/or physical exertion during pregnancy were associated with preterm birth. **Methods**: Indicators of work activity and other potential risk factors were ascertained through medical records and by questionnaire after the birth.	There was an association between preterm birth and: • standing longer than 3 hours a day throughout pregnancy: OR 4.1; 95%CI 1,29 to 13.10 • physical exertion throughout pregnancy: OR 2.91; 95%CI 1.29 to 6.58.	
Salunkhe et al 2018[332] India	380 Cohort	**Aim**: To find out the relationship between occupation of women and the birth weight and gestational age of the baby. **Population**: Pregnant women **Methods**: Data on occupation was collected using a structured interview. Data was analysed using descriptive and inferential statistics.	Sedentary vs moderate vs heavy occupation: • Preterm birth: 7/109 (6.5%) vs 35/248 (12.6%) vs 6/23 (26.1%) • Low birth weight: 27/109 (24.8%) vs 59/248 (23.8%) vs 19/23 (82.6%)	Moderate occupation was defined as farm work; heavy as working as labourer on road construction and stone cutting.

Study ref	N	Aim/methods	Results	Comments
Snijder et al 2012[335] Netherlands	4,680 women Cohort	**Aim**: To examine associations between various aspects of physically demanding work with fetal growth in different trimesters during pregnancy and the risks of adverse birth outcomes. **Methods**: Associations between physically demanding work and fetal growth were studied in a population-based prospective cohort study from early pregnancy onwards. Mothers who filled out a questionnaire during mid-pregnancy (response 77% of enrolment) were included if they conducted paid employment and had a spontaneously conceived singleton live born pregnancy. Questions on physical workload were obtained from the Dutch Musculoskeletal Questionnaire and concerned questions on lifting, long periods of standing or walking, night shifts and working hours. Fetal growth characteristics were repeatedly measured by ultrasound and were used in combination with measurements at birth.	Odds of preterm birth: • Frequent periods of standing: OR 0.95; 95%CI 0.65 to 1.40 • Frequent lifting of >25 kg: OR 0.55; 95%CI 0.13 to 2.28 Odds of small-for gestational age: • Frequent long periods of standing: OR 0.95; 95%CI 0.63 to 1.45 • Frequent lifting of >25 kg: OR 1.85; 95%CI 0.70 to 4.88 Odds of low birth weight: • Frequent long periods of standing: OR 1.02; 95%CI 0.60 to 1.73 • Frequent lifting of >25 kg: OR 1.86; 95%CI 0.44 to 7.77	

4 Weight assessment and management

4.1 Q7: When should maternal weight and height be measured and BMI calculated in pregnant women?

4.1.1 Review of the IOM guidelines for weight gain in pregnancy

A number of studies have suggested that the IOM guidelines may not be applicable to all women or that the weight gain ranges require revision.

- An individual participant-level meta-analysis (25 cohort studies; n=196,670) [345] estimated optimal gestational weight gain ranges for each pre-pregnancy BMI category by selecting the range of gestational weight gain that was associated with lower risk for any adverse outcome. This process identified weight gain ranges for women who are overweight or obese that were considerably lower than the IOM recommendations. However, the authors noted that while the estimates may inform antenatal counselling, the gestational weight gain ranges had limited predictive value for the outcomes assessed.
- A systematic review of the utility of IOM-2009 guidelines among Indian and other Asian pregnant women in terms of maternal and fetal outcomes (n=13 studies)[346] highlighted the need for appropriate gestational weight gain recommendations across the different body mass index levels specifically for Indian women and other Asian populations.
- A retrospective cohort study in China (n=8,209)[347] found that the lowest accumulated risk of low birthweight and macrosomia was not always achieved among women who gained weight within recommendations and suggested that the IOM weight gain ranges are too high for Chinese women.
- A cohort study in the United States (n=181,948)[348] found that adherence to the 2009 IOM guidelines for weight gain during pregnancy reduced risk for various adverse maternal outcomes in all ethnic groups studied. However, the guidelines were less predictive of infant outcomes with the exception of small and large for gestational age.
- A retrospective cohort study in the United States (n=~12,000,000 birth records)[349] found that weight gain lower than the IOM guidelines among obese women reduced the risk of gestational hypertension, eclampsia, induction of labour and Caesarean section but was also associated with increased risks for multiple adverse neonatal outcomes with macrosomia the exception.

4.1.2 Determinants of gestational weight gain

Weight gain below guidelines

A systematic review found that women with lower educational attainment had an increased risk of inadequate weight gain (OR 1.3; 95% CI 1.0 to 1.6, p =0.017).[350]

An analysis of observational data from a longitudinal cohort study of Aboriginal women during pregnancy (n=110)[351] found that 32% of women had inadequate weight gain.

Cohort studies in the United States[352-354] have found that African American women, Hispanic women and women in socially disadvantaged areas are more likely to experience inadequate weight gain.

Weight gain exceeding guidelines

Systematic reviews have found associations between weight gain exceeding recommendations and:

- body image dissatisfaction[355,356]
- lack of social support[355]
- concern about weight gain, negative attitude towards weight gain, inaccurate perceptions regarding weight, higher than recommended target weight gain, less knowledge about weight gain, higher levels of cognitive dietary restraint, and perceived barriers to healthy eating[356]
- lower educational attainment.[350]

There were no clear associations between weight gain exceeding recommendations and:

- anxiety,[355,356] stress,[355,356] self-efficacy,[355] self-esteem[355] or social support[357]
- parity (r 0.04, 95%CI 0.10 to 0.16, p=0.61; 17 studies), including after adjusting for pre-pregnancy BMI (r 0.08, 95% CI 0.19 to 0.03, p=0.16; 16 studies)[358]

The evidence on an association between weight gain exceeding recommendations and depression was inconsistent.[355,356]

Protective factors included an internal locus of control for weight gain, lower than recommended target weight gain and higher self-efficacy for healthy eating.[356]

Cohort studies have found associations between weight gain exceeding guidelines and:

- pre-pregnancy BMI (≥25 vs <25): OR 3.35; 95%CI 2.44 to 4.64; p<0.0001[359]
- stopping smoking (weekly weight gain in second and third trimesters compared to women who never smoked MD 0.09; 95%CI 0.03, 0.15)[360]

There was no clear association between weight gain exceeding guidelines and:

- experiencing hardship in childhood (OR 1.45, 95%CI 0.99 to 2.14), in adulthood (OR 0.72; 95%CI 0.41 to 1.26) or in pregnancy (OR 1.09; 95%CI 0.43 to 2.76)[361]
- maternal age (<30 vs ≥30) (OR 1.02; 95%CI 0.98 to 1.02; p=0.89)[359]
- household income (<$60,000 vs ≥$60,000) (OR 1.06; 95%CI 0.71 to 1.26; p=0.71)[359]
- education level (<university vs ≥university degree) (OR 1.26; 95%CI 0.93 to 1.70; p=0.14)[359]
- country of birth (other countries vs Canada) (OR 1.05; 95%CI 0.78 to 1.41; p=0.73).[359]

An analysis of observational data collected from a longitudinal cohort study of Aboriginal women during pregnancy (n=110)[351] found that 54% of women had weight gain exceeding recommendations.

4.1.3 Risks associated with low or high gestational weight gain

A meta-analysis of individual participant data (n=265,270)[362] found that low or high gestational weight gain was associated with pregnancy complications across all BMI classifications.

Weight gain among women of any BMI

Weight gain lower than recommendations

In a systematic review of cohort studies of pregnant women of any BMI (23 studies; 1,309,136 women)[363], weight gain *lower* than recommendations was associated with an increased risk of:

- preterm birth (OR 1.70; 95%CI 1.32 to 2.20)
- small for gestational age babies (OR 1.53; 95% CI 1.44 to 1.64).

There was an association between weight gain *lower* than recommendations and a lower likelihood of:

- large-for-gestational-age babies (OR 0.59; 95%CI 0.55 to 0.64)
- macrosomia (OR 0.60; 95%CI 0.52 to 0.68).

There was an association between weight gain *lower* than recommendations and a possible lower likelihood of caesarean section (OR 0.98; 95%CI 0.96 to 1.02).

In an analysis of individual participant data from the control arms of 36 RCTs (n=4,429)[364] the odds of preterm birth (aOR 1.94; 95%CI 1.31 to 2.28) and small-for-gestational-age babies (aOR 1.52; 95%CI 1.18 to 1.96) were increased with gestational weight gain *lower* than recommendations. Findings on caesarean section and large-for-gestational-age babies were inconclusive.

Weight gain higher than recommendations

The systematic review of cohort studies[363] found that weight gain *higher* than recommendations was associated with an increased risk of:

- large-for-gestational age babies (OR 1.85; 95%CI 1.76 to 1.95)
- macrosomia (OR 1.95; 95%CI 1.79 to 2.11)
- caesarean section (OR 1.30; 95%CI 1.25 to 1.35).

There was an association between weight gain higher than recommendations and lower likelihood of small-for-gestational-age babies (OR 0.66; 95%CI 0.63 to 0.69) and preterm birth (OR 0.77; 95%CI 0.69 to 0.86).

The analysis of individual participant data from the control arms of RCTs[364] found that weight gain higher than recommendations was associated with increased odds of caesarean section (aOR 1.50; 95%CI 1.25 to 1.80), large-for-gestational-age babies (aOR 2.00; 95%CI 1.58 to 2.54), and reduced odds of small-for-gestational-age babies (aOR 0.66; 0.50 to 0.87). No significant effect on preterm birth was detected.

A meta-analysis of individual participant data (37 studies, 162,129 mothers and children)[365] found that, relative to the effect of maternal pre-pregnancy BMI, excessive gestational weight gain only slightly increased the risk of

childhood overweight/obesity within each clinical BMI category (p-values for interactions of maternal BMI with gestational weight gain: p=0.038, p<0.001, and p=0.637 in early, mid, and late childhood, respectively).

Systematic reviews of cohort studies have found that:

- the risk of urinary incontinence increased with each 10 kg of weight gain (RR 1.34; 95%CI 1.11 to 1.62)[366]
- weight gain exceeding recommendations may increase the risk of autism spectrum disorder (OR 1.23; 95%CI 1.09 to 1.38; p=0.0008) but more studies are needed to confirm this result.[367]

High weight gain in early pregnancy

A secondary analysis of an RCT (n=7,895)[368] found that among women who gained weight exceeding the IOM guidelines by week 15-18, 93% exceeded the recommended total gestational weight gain. In contrast, only 55% of women with early gestational weight gain within recommendations had total gestational weight gain higher than recommendations (p<0.001). Women with excessive early gestational weight gain had higher rates of gestational diabetes (OR 1.4; 95%CI 1.1 to 1.9), large-for-gestational-age babies (OR 1.4; 95%CI 1.2 to 1.6), and macrosomia >4,000 g (OR 1.5; 95%CI 1.3 to 1.8).

Outcomes among women from US/Europe and Asia

Weight gain lower than recommended was associated with preterm birth among women from the USA/Europe (OR 1.35; 95%CI 1.17 to 1.56) but not women from Asia (OR 1.06; 95%CI 0.78 to 1.44)[369]. It was associated with an increase in risk of small-for-gestational-age babies among women from both groups.

Weight gain higher than recommended was associated with large-for-gestational age babies, macrosomia and caesarean section among women from both groups.

Gestational weight gain among underweight women

A meta-analysis of individual participant data (n=265,270)[362] found that among underweight women:

- low weight gain was associated with an increased risk of preterm birth and small for gestational age (both p<0.001) and a reduced risk of gestational hypertension (p<0.05) and large for gestational age (p<0.001)
- high weight gain was associated with a reduced risk of small for gestational age (p<0.05).

Gestational weight gain among women with healthy pre-pregnancy weight

In the meta-analysis of individual participant data (n=265,270)[362], among women with healthy pre-pregnancy BMI:

- low weight gain was associated with an increased risk of preterm birth and small for gestational age and a reduced risk of large for gestational age (all p<0.001)
- high weight gain was associated with an increased risk of gestational diabetes, gestational hypertension, pre-eclampsia, preterm birth and large for gestational age and a reduced risk of small-for-gestational age (all p<0.001).

Gestational weight gain among overweight women

In the meta-analysis of individual participant data (n=265,270)[362], among overweight women:

- low weight gain was associated gestational diabetes, gestational hypertension, pre-eclampsia, small for gestational age (all p<0.001) and preterm birth (p<0.05)
- high weight gain was associated with gestational diabetes, gestational hypertension, pre-eclampsia, preterm birth and large for gestational age (all p<0.001).

Gestational weight gain among obese pregnant women

In the meta-analysis of individual participant data (n=265,270)[362], among obese women both low and high weight gain were associated with increased risk of gestational diabetes, gestational hypertension, pre-eclampsia, preterm birth and large for gestational age (all p<0.001).

Weight gain lower than recommendations

A retrospective cohort study in the United States (n=~12,000,000 birth records)[349] found that weight gain lower than the IOM guidelines among obese women reduced the risk of gestational hypertension, eclampsia, induction of labour and Caesarean section but was also associated with increased risks for multiple adverse neonatal outcomes with macrosomia the exception.

A systematic review of cohort studies of obese pregnant women (18 cohort studies; 99,723 women)[370] found that weight gain *lower* than recommendations was associated with an increase in risk of:

- preterm birth (aOR 1.46; 95%CI 1.07 to 2.00)
- small-for-gestational-age babies (OR 1.24; 95%CI 1.13 to 1.36).

Weight gain lower than recommendations was associated with a lower likelihood of:

- large-for-gestational-age babies (aOR 0.77; 95%CI 0.73 to 0.81)
- macrosomia (aOR 0.64; 95%CI 0.54 to 0.77)
- gestational hypertension (aOR, 0.70; 95%CI 0.53 to 0.93)
- pre-eclampsia (aOR 0.90; 95%CI 0.82 to 0.99).
- caesarean section (aOR 0.87; 95%CI 0.82 to 0.92).

There was no difference in risk of gestational diabetes (aOR 1.15; 95%CI 0.91 to 1.45), low birthweight (aOR1.08; 95%CI 0.76 to 1.54), Apgar score <7 at 5 minutes (aOR 0.92; 95%CI 0.67 to 1.27) or postpartum weight retention (MD -5.3 kg; 95%CI -9.0 to 1.17).

Weight loss

A systematic review of cohort studies (n=60,913)[371] found that, among women who were obese, gestational weight loss compared to weight gain within the guidelines:

- increased the risk of small-for-gestational-age babies (aOR 1.76; 95%CI 1.45 to 2.14; 2 studies) and low birthweight (aOR 1.68; 95%CI 1.10 to 2.57; 1 study)
- was associated with a lower likelihood of large for gestational age (aOR 0.57; 95%CI 0.52 to 0.62; 2 studies), macrosomia (aOR 0.58; 95%CI 0.38 to 0.89; 1 study) and caesarean section (aOR 0.73; 95%CI 0.67 to 0.80; 2 studies).

There was a possible reduction in risk of pre-eclampsia (aOR 0.82; 95%CI 0.66 to 1.02; 1 study) and no clear difference in risk of gestational diabetes (aOR 0.88; 95%CI 0.62 to 1.25; 1 study) or Apgar score <7 at 5 minutes (aOR 1.08; 95%CI 0.81 to 1.44; 2 studies). No studies reported on preterm birth.

4.1.4 Women's views on weight gain during pregnancy

A systematic review[372] found that women are highly motivated to change their behaviour to improve fetal health, but may not recognise the link between excess gestational weight gain and negative fetal health outcomes. Regular, forthright, sensitive counselling geared to individual circumstances was frequently mentioned as a strong facilitator of healthy weight gain in pregnancy.

An Australia cross-sectional study (n=536)[373] found that only half of pregnant women reported accurate gestational weight gain knowledge within the IOM recommendations.

Cross-sectional studies from overseas have found that:

- more than half (57%) of women reported that their healthcare provider talked to them about personal weight gain limits during pregnancy and a third of these were counselled regularly; among those not counselled over half (56%) reported that healthcare provider guidance would have been helpful to achieve their target weight[374]
- two-thirds (67%) of women received advice on gestational weight gain as part of antenatal care and women who reported following this advice had lower odds of weight gain exceeding recommendations (OR 0.18; 95%CI 0.03 to 0.91)(n=91)[375]
- experiences of regular weighing were positive and participants believed it should be part of standard antenatal care, that there was a lack of information provided on gestational weight gain and healthy lifestyle in pregnancy, and that healthcare professionals are ideally placed to provide this advice (n=10)[376]

4.1.5 Health professional's views on regular weighing as part of pregnancy care

An Australian focus group that examined barriers and enablers to the regular weighing of women throughout pregnancy (n=44),[377] found that, while most health professionals supported regular weighing, various concerns were raised. Issues included access to resources and staff; the ability to provide appropriate counselling and evidence-based interventions; and the impact of weighing on women and the therapeutic relationship.

In an Australian study following introduction of a pregnancy weight gain chart (n=42),[378] 63% of health professionals surveyed used the chart, 76% reported that they needed more training in counselling pregnant women about weight gain, and insufficient time was a main barrier to weighing and conversing with women.

An Australian cohort study found that recording of weight is improved by providing scales and in-services (18.9%) and medical record prompts (61.8%) (n=~13,000 per cohort).[379]

A cohort study in the United States (n=733)[380] found that introduction of a "best practice alert" into an electronic medical record (EMR) system improved documentation of pre-pregnancy weight (p=0.02) and pre-pregnancy height (p<0.001) but not BMI (p=0.34). It improved the rate of gestational weight counselling (p<0.001), documented weight gain (p<0.001) and weight gain consistent with guidelines (p=0.003).

4.1.6 Regular weighing

Background

The Guidelines currently include consensus-based recommendations to:

- at the first antenatal visit, calculate women's BMI and give them advice about appropriate weight gain during pregnancy in relation to their pre-pregnancy BMI
- at every antenatal visit, offer women the opportunity to be weighed and encourage self-monitoring of weight gain and discuss weight change, diet and level of physical activity with all women.

A recent commentary noted that it is unclear if the revised pregnancy care guidelines have recommended regular weighing as a screening tool for adverse pregnancy outcomes (eg low or high birth weight) or if it is being employed as a weight management strategy.[381]

Current review

A systematic literature review found no clear difference in weekly weight gain (WMD -0.00; 95%CI -0.03 to 0.02) or weight gain exceeding the IOM guidelines for women who were underweight (OR 1.50; 95%CI 0.14 to 16.54), in the healthy weight range (OR 0.72; 95%CI 0.48 to 1.09), overweight (OR 0.85; 95%CI 0.45 to 1.62) or obese (OR 1.60; 95%CI 0.72 to 3.54).[382] The interventions assessed in the two included studies (n=977) differed in that one involved regular weighing by a health professional[383] and the other involved self-weighing.[384] This review focuses on regular weighing as part of antenatal care.

Regular weighing as part of antenatal care

An Australian RCT (n=782)[383,385] addressed regular weighing at antenatal care visits plus advice on weight gain versus usual care. The study found no clear difference in weight gain, proportion of women gaining more weight than IOM recommended range or secondary outcomes.[383] Among a subset of women who provided feedback (n=586), 73% were comfortable with being weighed routinely.[385]

A pilot study in the United Kingdom (n=76)[386] combined regular weighing by midwives and advice on weight gain with self-weighing between antenatal visits. Compared to usual care, there was no clear difference in the percentage of women gaining excessive weight during pregnancy or in mean depression and anxiety scores. Feedback in a subset of participants showed support for routine weighing among participants (9/12) and midwives (7/7). The same group then conducted a larger study of the intervention (n=656),[387] which also found no clear difference in weight gain exceeding IOM guidelines, depression or anxiety.

When these three trials were pooled, there was no clear difference in weight gain exceeding guidelines (RR 1.01 95% CI 0.92 to 1.12; 3 RCTs; n=1,327; very low certainty; analysis 2.1; page 458) or mean weekly weight gain (0.01 kg per week 95%CI -0.03 to 0.05; 2 RCTs; n=711; very low certainty; analysis 2.2; page 459). When the two United Kingdom studies were pooled, there was a small reduction in the risk of depression (MD -0.77; 95%CI -1.44 to -0.09; low certainty; analysis 2.3; page 459) and anxiety (MD -0.77; 95%CI -1.48 to -0.06; low certainty; analysis 2.4; page 459). There was no indication in the three trials that either excessive gestational weight gain or mean gestational weight gain differed in women of normal weight at the beginning of pregnancy compared with women who were overweight or obese.

Summary of findings

Regular weighing and advice on weight gain compared to usual care for gestational weight gain

Patient or population: Pregnant women
Setting: Australia, United Kingdom
Intervention: Regular weighing and advice on weight gain
Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with usual care	Risk with regular weighing and advice on weight gain			
Weight gain exceeding IOM guidelines	480 per 1,000	**485 per 1,000** (442 to 538)	**RR 1.01** (0.92 to 1.12)	1,327 (3 RCTs)	⨁◯◯◯ VERY LOW a,b,c
Mean weight gain (kg per week)	The mean weight gain (kg per week) - Overall was **0**	MD **0.01 higher** (0.03 lower to 0.05 higher)	-	711 (2 RCTs)	⨁◯◯◯ VERY LOW a,b,c
Gestational diabetes	53 per 1,000	**55 per 1,000** (30 to 98)	**RR 1.03** (0.57 to 1.85)	782 (1 RCT)	⨁◯◯◯ VERY LOW a,b,c
Gestational hypertension/ pre-eclampsia	40 per 1,000	**46 per 1,000** (24 to 90)	**RR 1.15** (0.60 to 2.23)	782 (1 RCT)	⨁◯◯◯ VERY LOW a,b,c
Macrosomia	71 per 1,000	**70 per 1,000** (42 to 117)	**RR 0.99** (0.59 to 1.65)	782 (1 RCT)	⨁◯◯◯ VERY LOW a,b,c
Depression (HADS score)	The mean depression (HADS score) was **0**	MD **0.77 lower** (1.44 lower to 0.09 lower)	-	313 (2 RCTs)	⨁⨁◯◯ LOW a,b
Anxiety (HADS score)	The mean anxiety (HADS score) was **0**	MD **0.77 lower** (1.48 lower to 0.06 lower)	-	324 (2 RCTs)	⨁⨁◯◯ LOW a,b

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **MD:** Mean difference; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

a. High risk of performance and detection bias
b. High risk of attrition bias
c. Confidence interval crosses line of no effect

4.1.7 Evidence statements

Determinants of gestational weight gain

There is evidence from systematic reviews of association between weight gain exceeding guidelines and body image dissatisfaction and lack of social support but not anxiety, stress, self-efficacy, self-esteem of parity. The evidence on depression was inconsistent.

There is evidence from cohort studies of association between weight gain exceeding guidelines and pre-pregnancy BMI and stopping smoking but not maternal age, household income, education level or country of birth or experience of hardship in childhood, adulthood or during pregnancy.

Risks associated with weight gain lower or higher than recommendations

There is high-certainty evidence that gestational weight gain lower than recommendations increases the risk of preterm birth and small-for gestational-age babies and decreases the risk of large-for-gestational-age babies and macrosomia. The risk of caesarean section was decreased among women who were obese and possibly decreased among all women. Among women who were obese, the risk of gestational hypertension and pre-eclampsia was decreased and there was no clear difference in risk of gestational diabetes, low birth weight, Apgar score <7 at 5 minutes and postpartum weight retention.

There is high-certainty evidence that, compared to weight gain within recommendations, gestational weight gain higher than recommendations increased the risk of large-for-gestational-age babies, macrosomia and caesarean section and decreased the risk of small-for-gestational-age babies and preterm birth.

There is evidence from a systematic review of cohort studies that, while gestational weight loss among obese women decreased the risk of large-for-gestational-age babies, macrosomia and caesarean section, it increased the risk of small-for-gestational-age babies and low birth weight and no studies reported on preterm birth.

There is RCT evidence that weight gain higher than recommendations in early pregnancy (15-18 weeks) increases the risk of total gestational weight gain exceeding recommendations, gestational diabetes, large-for-gestational-age babies and macrosomia.

Women's and health professionals' views on gestational weight gain

There is evidence from a systematic review that women are highly motivated to change their behaviour to improve fetal health, but may not recognise the link between excess gestational weight gain and negative fetal health outcomes. There is evidence from cross-sectional studies that women lack accurate knowledge on gestational weight gain and would welcome advice from health professionals.

There is evidence from cross-sectional studies that health professionals would welcome more training in providing appropriate counselling and that resources and time are other barriers to discussing weight gain.

Regular weighing as part of antenatal care

There is very low certainty evidence that regular weighing as part of antenatal care has no clear effect on mean weekly weight gain, total weight gain exceeding guidelines, gestational diabetes, hypertensive disorders of pregnancy or macrosomia but low certainty evidence that it may reduce the risk of depression and anxiety.

4.1.8 Evidence tables

Table 93: Q7 Determinants of gestational weight gain

Study ref	N	Aim/methods	Outcomes	Comments
O'Brien et al 2019[350] SLR	21 trials 5,183 women	**Aim**: To identify if maternal educational attainment is a prognostic factor for gestational weight gain (GWG), and to determine the differential effects of lifestyle interventions (diet based, physical activity based or mixed approach) on GWG, stratified by educational attainment. **Methods**: Individual participant data meta-analysis using the previously established International Weight Management in Pregnancy (i-WIP) Collaborative Group database. Maternal educational attainment was required for inclusion and was categorised as higher education (≥tertiary) or lower education (≤secondary).	Women with lower educational attainment had an increased risk of excessive (OR 1.182; 95% CI 1.008 to 1.385, p =0.039) and inadequate weight gain (OR 1.284; 95% CI 1.045 to 1.577, p =0.017). Among women with lower education, diet-based interventions reduced risk of excessive weight gain (OR 0.515; 95% CI 0.339 to 0.785, p = 0.002) and inadequate weight gain (OR 0.504; 95% CI 0.288 to 0.884, p=0.017), and reduced kg/week gain (B -0.055; 95% CI -0.098 to -0.012, p=0.012). Mixed interventions reduced risk of excessive weight gain for women with lower education (OR 0.735; 95% CI 0.561 to 0.963, p=0.026). Among women with high education, diet-based interventions reduced risk of excessive weight gain (OR 0.609; 95% CI 0.437 to 0.849, p=0.003), and mixed interventions reduced kg/week gain (B -0.053; 95% CI -0.069 to -0.037,p<0.001). Physical activity based interventions did not impact GWG when stratified by education.	

Study ref	N	Aim/methods	Outcomes	Comments
Ratan et al 2020[357] United States Cohort	772	**Aim**: To examine how social support factors affect compliance with gestational weight gain (GWG) recommendations in an obese, low-income, predominantly minority population. **Methods**: A retrospective cohort of pregnant women with BMI >30 was reviewed. Univariate and multinomial logistic regression analyses were used to compare GWG with pregnancy planning, relationship status, participation in group prenatal care, nutritional education, and demographic factors. Subgroup analysis was performed to determine if differences existed in entry into prenatal care.	Social support factors in this study did not individually affect compliance with GWG recommendations in a low-income, obese pregnant population, although some factors were associated with earlier entry to prenatal care.	
Hartley et al 2015[355] SLR	12 studies	**Aim**: To review the existing literature that explores the impact of psychosocial risk factors (psychological distress, body image dissatisfaction, social support, self-efficacy and self-esteem) on excessive gestational weight gain. **Methods**: A systematic review of peer-reviewed English articles using Academic Search Complete, Cumulative Index to Nursing and Allied Health Literature, MEDLINE Complete, PsycINFO, Informit, Web of Science, and Scopus was conducted. Quantitative studies that investigated psychosocial factors of excessive GWG, published between 2000 and 2014 were included. Studies investigating mothers with a low risk of mental health issues and normally-developing foetuses were eligible for inclusion.	Significant associations were found between depression, body image dissatisfaction, and social support with excessive gestational weight gain. No significant relationships were reported between anxiety, stress, self-efficacy, or self-esteem and excessive gestational weight gain.	

Study ref	N	Aim/methods	Outcomes	Comments
Hill et al 2017[358] SLR	17 studies in meta-analysis 41 studies in narrative synthesis	**Aim:** To systematically review and meta-analyse the associations between parity, pre-pregnancy body mass index (BMI), gestational weight gain (GWG) and, when included, postpartum weight retention (PPWR). **Methods**: Papers reporting associations between parity and BMI and/or GWG in adult women were eligible.	The weighted average effect of parity on gestational weight gain was small and non-significant (r 0.04, 95%CI 0.10 to 0.16, p=0.61; 17 studies). After adjusting for pre-pregnancy BMI, the weighted average effect was small and non-significant (r 0.08, 95% CI 0.19 to 0.03, p=0.16; 16 studies).	
Kapadia et al 2015[356] SLR	25 cohort 8 cross-section 2 case-control	**Aim**: To summarise the relation between psychological factors and GWG. **Methods**: Eight databases were searched, and the guidelines on Preferred Reporting Items for Systematic Reviews and Meta-Analyses were followed. Methodological quality of the included studies was assessed using a modified Newcastle-Ottawa scale. Two assessors independently reviewed titles, abstracts and full articles, extracted data and assessed quality.	Negative affective states such as depression, anxiety and stress were not related to excess gestational weight gain. Among weight-related and dietary-related cognitions, risk factors for excess gestational weight gain included concern about weight gain, negative body image and attitude towards weight gain, inaccurate perceptions regarding weight, higher than recommended target weight gain, less knowledge about weight gain, higher levels of cognitive dietary restraint, and perceived barriers to healthy eating. Protective factors included an internal locus of control for weight gain, lower than recommended target weight gain and higher self-efficacy for healthy eating. Only one study examined the relation between personality and excess gestational weight gain.	

Study ref	N	Aim/methods	Outcomes	Comments
Provenzano et al 2015[361] United States Cohort	2,128 women	**Aim**: To examine associations of material hardship with pre-pregnancy body mass index (BMI), gestational weight gain (GWG), and substantial postpartum weight retention (SPPWR; ≥5 kg at 1 year). **Methods**: At recruitment, women reported whether they experienced material hardship, defined as having ever received public assistance, welfare, or lacked basic necessities (food, rent, or medical care) during childhood, in adulthood before pregnancy, and/or in pregnancy. We used multivariable logistic models adjusted for age, race/ethnicity, and parity (and prepregnancy BMI for GWG and SPPWR) to examine associations of material hardship with the three weight-related outcomes (BMI, GWG, and SPPWR).	Weight gain exceeding guidelines: • Hardship in childhood: OR 1.45, 95%CI 0.99 to 2.14 • Hardship in adulthood: OR 0.72; 95%CI 0.41 to 1.26 • Hardship in pregnancy: OR 1.09; 95%CI 0.43 to 2.76	

Study ref	N	Aim/methods	Outcomes	Comments
Schumacher et al 2018[351] Australia Cohort	110	**Aim**: to determine the adequacy of gestational weight gain for a cohort of Indigenous Australian women and investigate whether it is associated with pre-pregnancy body mass index. **Methods**: analysis of observational data collected from a longitudinal cohort study that follows Indigenous Australian women through pregnancy. **Population**: Women who either identified as being an Indigenous Australian or as carrying an Indigenous child recruited through antenatal clinics in regional and remote towns in NSW, Australia to the Gomeroi gaaynggal program. **Outcomes measured**: Measurements included weight and height, self-reported pre-pregnancy weight and smoking status, parity and health conditions that may contribute to gestational weight gain, such as hypertensive or diabetic disorders.	Compared to IOM recommendations for gestational weight gain and based on prepregnancy body mass index, the rate of adequate gestational weight gain in this cohort was very low (15%). 32% of women had inadequate weight gain and 54% had excessive weight gain. The highest rate of excessive gestational weight gain was found in overweight women (74%), with rates of 48% and 50% found in healthy and obese (all classes) categories, respectively. Parity (coefficient 4.5, $p<0.01$) and hypertension (coefficient 4.8, $p=0.04$) were found to be significantly associated with gestational weight gain in mixed model linear regression. Culturally acceptable ways of addressing this issue are needed for this group of women.	
Headen et al 2015[354] United States Cohort	6,849	**Aim**: To investigate whether associations between race/ethnicity and GWG adequacy were modified by pre-pregnancy BMI among all births to African American, Hispanic, and Caucasian women. **Methods**: We used generalised estimating equations, adjusted for marital status, parity, smoking during pregnancy, gestational age, and multiple measures of socioeconomic position.	Inadequate GWG compared to Caucasian women • African American (healthy weight range): RR 1.34, 95%CI 1.18 to 1.52 • Hispanic women (healthy weight range): RR 1.33, 95%CI 1.15 to 1.54) • African American (underweight): RR 1.38, 95%CI 1.07 to 1.79. Differences in risk of inadequate GWG were not significant among overweight and obese women.	

Study ref	N	Aim/methods	Outcomes	Comments
Hulman et al 2017[360] Canada Cohort	509	**Aim:** to compare patterns of GWG based on serial antenatal weight measurements between women who: never smoked, quit during pregnancy, continued to smoke. **Methods**: Participants (N = 509) of our longitudinal study were recruited from seven antenatal clinics in Southwestern Ontario. Serial GWG measurements were abstracted from medical charts, while information on smoking status was obtained from a self-administered questionnaire at a median gestational age of 32 (27-37) weeks. GWG patterns were assessed by fitting piecewise mixed-effects models. First trimester weight gains and weekly rates for the last two trimesters were compared by smoking status.	Weight gain in the first trimester: • Women who never smoked: 1.7 kg (95%CI 1.4 to 2.1) • Women who quit during pregnancy: 1.2 kg (95%CI 0.3 to 2.1) • Women who continued smoking: 3.5 kg, 95%CI 2.4 to 4.6). Women who quit smoking versus those who never smoked: • Weekly weight gain in second and third trimesters: MD 0.09; 95%CI 0.03, 0.15	
Mendez et al 2014[352] United States Cohort	55,608	**Aim**: To explore the relationship between neighbourhood socioeconomic disadvantage (NSED) and gestational weight gain and loss and if the association differed by race. **Methods**: A census tract level NSED index (categorized as low, mid-low, mid-high, and high) was generated from 12 measures from the 2000 US Census data. Gestational weight gain and other individual-level characteristics were derived from vital birth records. Crude and adjusted relative risks were estimated using modified multilevel Poisson regression models to estimate the association between NSED and excessive and inadequate gestational weight gain (GWG) and weight loss (versus adequate GWG).	African American women were more likely than Caucasian women to have inadequate weight gain or weight loss. Mid-high (aRR 1.3, 95%CI 1.2 to 1.3) and high (aRR 1.5, 95%CI 1.5 to 1.6) NSED compared to low NSED was associated with inadequate weight gain while NSED was not associated with excessive weight gain. Among African American women, high versus low NSED was associated with weight loss during pregnancy (RR 1.6, 95%CI 1.1 to 2.5). Among Caucasian women, each level of NSED compared to low NSED was associated with weight loss during pregnancy.	

Study ref	N	Aim/methods	Outcomes	Comments
Mendez et al 2016[353] United States Cohort	73,061	**Aim**: To examine whether neighbourhood racial composition and neighbourhood poverty was associated with weight before pregnancy and weight gain during pregnancy and if this association differed by race. **Methods**: We used vital birth records of singleton births of 73,061 African American and Caucasian women. Maternal race and ethnicity, pre-pregnancy body-mass-index (BMI), gestational weight gain and other individual-level characteristics were derived from vital birth record data, and measures of neighbourhood racial composition (percentage of black residents in the neighbourhood) and poverty (percentage of households in the neighbourhood below the federal poverty) were derived using US Census data. Multilevel log binomial regression models were performed to estimate neighbourhood racial composition and poverty in association with pre-pregnancy weight (ie overweight/obese) and gestational weight gain (ie inadequate and excessive).	African American women as compared to Caucasian women were more likely to be overweight/obese before pregnancy and to have inadequate gestational weight gain (53.6% vs. 38.8%; 22.5% vs. 14.75 respectively). African American women living in predominately African American neighbourhoods were slightly more likely to be obese prior to pregnancy compared to African American women living in predominately Caucasian neighbourhoods (PR 1.10; 95% CI: 1.03, 1.16). African American and Caucasian women living in high poverty areas compared with women living in lower poverty areas were more likely to be obese prior to pregnancy; while only Caucasian women living in high poverty areas compared to low poverty areas were more likely gain an inadequate amount of weight during pregnancy.	

Study ref	N	Aim/methods	Outcomes	Comments
Morisset et al 2017[359] Canada Cohort	1,145 women	**Aim**: To describe adherence to gestational weight gain (GWG) recommendations and identify determinants of excessive GWG in a sample of women from Quebec, Canada. **Methods**: Data were collected from the multi-centre 3D (Design, Develop, Discover) pregnancy cohort study, which included women who delivered between May 2010 and August 2012 at 9 obstetrical hospitals in Quebec, Canada. GWG was calculated for 1145 women and compared to the 2009 Institute of Medicine (IOM) recommendations.	Risk of exceeding gestational weight gain recommendations: • Maternal age (<30 vs ≥30): OR 1.02; 95%CI 0.98 to 1.02; p=0.89 • Pre-pregnancy BMI (≥25 vs <25): OR 3.35; 95%CI 2.44 to 4.64; p<0.0001 • Household income (<$60,000 vs ≥$60,000): OR 1.06; 95%CI 0.71 to 1.26; p=0.71 • Education level (<university vs ≥university degree): OR 1.26; 95%CI 0.93 to 1.70; p=0.14 • Country of birth (other countries vs Canada): OR 1.05; 95%CI 0.78 to 1.41; p=0.73	

Table 94: Q7 Risks associated with weight gain above or below the IOM guidelines

Study ref	N	Aim/methods	Outcomes	Comments
Aune et al 2019[366] SLR	24 cohort studies	**Aim:** To conduct a systematic literature review and dose-response meta-analysis of prospective studies on adiposity and risk of urinary incontinence. **Methods**: We searched PubMed and Embase databases up to 19 July 2017. Prospective cohort studies were included. Data were extracted by one reviewer and checked for accuracy by a second reviewer. Summary relative risks (RRs) and 95% confidence intervals (CIs) were calculated using random effects models. \	Two prospective studies (6,015 cases and 41,679 participants) were included in the analysis of weight gain and risk of urinary incontinence. The summary RR was 1.34 per 10 kg of weight gain (95% CI 1.11 to 1.62).	

Study ref	N	Aim/methods	Outcomes	Comments
Tian et al 2019[367] SLR	5 cohort studies 3,793 children	**Aim**: to evaluate the relationship between gestational weight gain and risk of autism spectrum disorder (ASD) in offspring. **Methods**: Four electronic databases were searched up to August 28 2018 to identify observational studies reporting the association between gestational weight gain and risk of ASD in the offspring. Five studies with a total of 3793 children with ASD were included in the meta-analysis.	The-results indicated that excessive gestational weight gain may increase the risk of ASD in offspring (p=0.0008, OR 1.23, 95%CI 1.09 to 1.38). More high quality cohort studies are needed to confirm this result.	

Study ref	N	Aim/methods	Outcomes	Comments
Santos et al 2019[362] Meta-analysis Europe, North America, and Oceania	39 cohorts 265,270 births	**Aim**: To assess the separate and combined associations of maternal pre-pregnancy body mass index (BMI) and gestational weight gain with the risks of pregnancy complications and their population impact. **Methods**: Information on maternal pre-pregnancy BMI, gestational weight gain, and pregnancy complications was obtained. Multilevel binary logistic regression models were used.	Compared with healthy weight women with medium gestational weight gain, overweight and obese women had higher risks of any pregnancy complication, independent of their gestational weight gain ($P < 0.05$). The highest risk of any pregnancy complication was observed for obese women with high weight gain (OR 2.51, 95%CI 2.31 to 2.74). Low and high gestational weight gain were also, among healthy weight women, associated with a higher risk of any pregnancy complication ($p<0.05$). Obese women with high gestational weight gain had the highest risks of gestational hypertension (OR 4.52, 95%CI 3.86 to 5.31), pre-eclampsia (OR 4.58, 95%CI 3.90 to 5.37), gestational diabetes (OR 7.84, 95% CI 6.38 to 9.62), preterm birth (OR 2.14, 95% CI 1.86–2.46), and large for gestational age at birth (OR 4.77, 95% CI 4.35 to 5.22). Underweight mothers with low gestational weight gain had the highest risk of small for gestational age at birth (OR 3.12, 95% CI 2.75 to 3.54).	

Study ref	N	Aim/methods	Outcomes	Comments
Goldstein et al 2017[363] SLR	23 studies 1,309,136 women	**Aim**: To perform a systematic review, meta-analysis, and metaregression to evaluate associations between gestational weight gain above or below the IOM guidelines and maternal and infant outcomes. **Methods**: Search of EMBASE, Evidence-Based Medicine Reviews, MEDLINE, and MEDLINE In-Process between January 1, 1999, and February 7, 2017, for observational studies stratified by prepregnancy BMI category and total gestational weight gain. Data were extracted by 2 independent reviewers. Odds ratios (ORs) and absolute risk differences (ARDs) per live birth were calculated using a random-effects model based on a subset of studies with available data.	*Gestational weight gain below the recommendations* • Small for gestational age: OR 1.53; 95% CI, 1.44 to 1.64 • Preterm birth: OR 1.70; 95%CI 1.32 to 2.20 • Large for gestational age: OR 0.59; 95%CI 0.55 to 0.64 • Macrosomia: OR 0.60; 95%CI 0.52 to 0.68 • Caesarean section: OR 0.98; 95%CI 0.96 to 1.02 *Gestational weight gain above the recommendations* • Small for gestational age: OR 0.66; 95%CI 0.63 to 0.69 • Preterm birth: OR, 0.77; 95%CI 0.69 to 0.86 • Large for gestational age: OR 1.85; 95%CI 1.76 to 1.95 • Macrosomia: OR 1.95; 95%CI 1.79 to 2.11 • Caesarean section: OR 1.30; 95%CI 1.25 to 1.35	

Study ref	N	Aim/methods	Outcomes	Comments
Goldstein et al 2018[369] SLR	23 studies 1,309,136 women	**Aim**: To explore ethnic differences in maternal prepregnancy body mass index (BMI), GWG and health outcomes across regions. **Methods**: Systematic review, meta-analysis and meta-regression of observational studies were used for the study. MEDLINE, MEDLINE In-Process, Embase and all Evidence-Based Medicine (EBM) Reviews were searched from 1999 to 2017. Studies were stratified by prepregnancy BMI category and total pregnancy GWG. Odds ratio (ORs) 95% confidence intervals (CI) applied recommended GWG within each BMI category as the reference. Primary outcomes were small for gestational age (SGA), preterm birth and large for gestational age (LGA). Secondary outcomes were macrosomia, caesarean section and gestational diabetes.	Gestational weight gain below guidelines versus within guidelines: • Small for gestational age: OR 1.51; 95%CI 1.39 to 1.63 (USA/Europe); OR 1.63; 95%CI 1.45 to 1.82 (Asia) • Preterm birth: OR 1.35; 95%CI 1.17 to 1.56 (USA/Europe); OR 1.06; 95%CI 0.78 to 1.44 (Asia) Gestational weight gain above guidelines versus within guidelines: • Large for gestational age: OR 1.93; 95%CI 1.81 to 2.06 (USA/Europe); OR 1.68; 95%CI 1.51 to 1.87 (Asia) • Macrosomia: OR 1.87; 95%CI 1.70 to 2.06 (USA/Europe); OR 2.18; 95%CI 1.91 to 2.49 (Asia) • Caesarean section: OR 1.26; 95%CI 1.21 to 1.33 (USA/Europe); OR 1.37; 95%CI 1.30 to 1.45 (Asia)	

Study ref	N	Aim/methods	Outcomes	Comments
Carreno et al 2012[368] Secondary analysis of RCT United States	7,895	**Aim**: To estimate whether there is an association between excessive early gestational weight gain and the development of gestational diabetes mellitus (GDM) and excessive fetal growth. **Methods**: This is a secondary analysis of a randomised controlled trial of vitamins C and E in nulliparous low-risk women. Maternal weight gain from prepregnancy (self-reported) to 15-18 weeks of gestation was measured, and expected gestational weight gain was determined using the Institute of Medicine 2009 guidelines for each prepregnancy body mass index category. Excessive early gestational weight gain was defined as gestational weight gain greater than the upper range of the Institute of Medicine guidelines. Rates of GDM, birth weight greater than 4,000 g, and large for gestational age (LGA, birth weight 90 percentile or higher) were calculated and compared between women with excessive early gestational weight gain and early nonexcessive gestational weight gain (within or below Institute of Medicine guidelines).	Excessive early gestational weight gain occurred in 47.5% of women. Ninety-three percent of women with excessive early gestational weight gain had total gestational weight gain greater than Institute of Medicine guidelines. In contrast, only 55% of women with non-excessive early gestational weight gain had total gestational weight gain greater than Institute of Medicine guidelines (P<.001). Rates of GDM (OR 1.4; 95%CI 1.1 to 1.9), LGA (OR 1.4; 95%CI 1.2 to 1.6), and macrosomia >4,000 g (OR 1.5; 95%CI 1.3 to 1.8) were higher in women with excessive early gestational weight gain.	

Study ref	N	Aim/methods	Outcomes	Comments
Kapadia et al 2015[370] SLR	18 cohort studies 99,723 women	**Aim**: To determine the risk of adverse pregnancy outcomes with gestational weight gain (GWG) below the 2009 Institute of Medicine guidelines compared with within the guidelines in obese women. **Methods**: MEDLINE, Embase, Cochrane Register, CINHAL and Web of Science were searched from 1 January 2009 to 31 July 2014. Quality was assessed using a modified Newcastle-Ottawa scale. Three primary outcomes were included: preterm birth, small for gestational age (SGA) and large for gestational age (LGA).	Gestational weight gain below the guidelines vs within the guidelines: • Preterm birth: aOR 1.46; 95%CI 1.07 to 2.00; 2 studies, n=2,660 • Small for gestational age: OR 1.24; 95%CI 1.13 to 1.36; 5 studies; n=11,975 • Large for gestational age: aOR 0.77; 95%CI 0.73 to 0.81; 5 studies; n=11,983 • Low birth weight: aOR1.08; 95%CI 0.76 to 1.54; 2 studies; n=8,680 • Macrosomia: aOR 0.64; 95%CI 0.54 to 0.77; 4 studies; n-9,994 • Gestational hypertension: aOR, 0.70; 95%CI 0.53 to 0.93; 2 studies; n=2,781 • Gestational diabetes: aOR1.15; 95%CI 0.91 to 1.45; 1 study; n=882 • Pre-eclampsia: aOR 0.90; 95%CI 0.82 to 0.99; 4 studies; n=22,500 • Caesarean section: aOR 0.87; 95%CI 0.82 to 0.92; 4 studies; n=27,241 • Apgar score <7 at 5 minutes: aOR 0.92; 95%CI 0.67 to 1.27; 3 studies; n=26,449 • Postpartum weight retention: MD -5.3; 95%CI -9.0 to 1.17; 2 studies; n=31	

Study ref	N	Aim/methods	Outcomes	Comments
Kapadia et al 2015[371] SLR	6 cohort studies 60,913 obese women	**Aim**: To summarise pregnancy outcomes in obese women with gestational weight loss compared to gestational weight gain within the 2009 Institute of Medicine guidelines (5-9 kg). **Methods**: Five databases were searched from 1 January 2009 to 31 July 2014. The Cochrane Handbook for Systematic Reviews of Interventions and the PRISMA Statement were followed. A modified version of the Newcastle-Ottawa scale was used to assess individual study quality. Small for gestational age (SGA), large for gestational age (LGA) and preterm birth were our primary outcomes.	Gestational weight loss versus weight gain within the guidelines: • Small for gestational age: aOR 1.76; 95%CI 1.45 to 2.14; 2 studies • Large for gestational age: aOR 0.57; 95%CI 0.52 to 0.62; 2 studies • Low birth weight: aOR 1.68; 95%CI 1.10 to 2.57; 1 study • Macrosomia: aOR 0.58; 95%CI 0.38 to 0.89; 1 study • Caesarean section: aOR 0.73; 95%CI 0.67 to 0.80; 2 studies • Gestational diabetes: aOR 0.88; 95%CI 0.62 to 1.25; 1 study • Pre-eclampsia: aOR 0.82; 95%CI 0.66 to 1.02; 1 study • Apgar score <7 at 5 minutes: aOR 1.08; 95%CI 0.81 to 1.44; 2 studies No studies reported on preterm birth.	

Study ref	N	Aim/methods	Outcomes	Comments
Voerman et al 2019[365] Meta-analysis	162,129 mothers and their children	**Aim**: To assess the separate and combined associations of maternal BMI and gestational weight gain with the risk of overweight/obesity throughout childhood, and their population impact. **Methods**: We conducted an individual participant data meta-analysis of data from 37 pregnancy and birth cohort studies from Europe, North America, and Australia. We assessed the individual and combined associations of maternal pre-pregnancy BMI and gestational weight gain, both in clinical categories and across their full ranges, with the risks of overweight/obesity in early (2.0-5.0 years), mid (5.0-10.0 years) and late childhood (10.0-18.0 years), using multilevel binary logistic regression models with a random intercept at cohort level adjusted for maternal sociodemographic and lifestyle-related characteristics.	Weight gain exceeding guidelines: • Early childhood overweight/obesity: OR 1.39; 95% CI: 1.30 to 1.49 • Mid childhood overweight/obesity: OR 1.55; 95%CI 1.49 to 1.60 • Late childhood overweight/obesity: OR 1.72; 95%CI 1.56 to 1.91 Relative to the effect of maternal BMI, excessive gestational weight gain only slightly increased the risk of childhood overweight/obesity within each clinical BMI category (p-values for interactions of maternal BMI with gestational weight gain: $p = 0.038$, $p < 0.001$, and $p = 0.637$ in early, mid, and late childhood, respectively).	

Table 95: Q7 Women's perceptions and views on weight gain in pregnancy

Study ref	N	Aim/methods	Outcomes	Comments
Vanstone et al 2017[372] SLR	42 studies 1,339 women	**Aim**: To understand the continuing increase in the proportion of pregnant women gaining weight in excess of national guidelines continues to increase. . **Methods**: We conducted a systematic review of qualitative research on pregnant women's perceptions and experiences of weight gain in pregnancy. We used the methodology of qualitative meta-synthesis to analyse empirical qualitative research studies conducted in high-income countries and published between 2005 and 2015.	Women are highly motivated to change their behaviour to improve fetal health, but may not recognise the link between excess gestational weight gain and negative fetal health outcomes. Weight gain in pregnancy occurs within a complex social environment and is affected by intrapersonal, interpersonal, social, structural, and environmental factors. Women facing social disadvantage may face additional barriers to appropriate weight gain, and may not have access to mitigating resources. Weight gain is a sensitive topic, and thorough counselling takes significant clinician time. Regular, forthright, sensitive counselling geared to individual circumstances was frequently mentioned as a strong facilitator of healthy weight gain in pregnancy.	
Weeks et al 2020[374] Canada, United States Cross-section	1,507 women	**Aim**: To determine pregnant women and new mothers' perceptions of healthcare provider GWG and dietary counselling during the pregnancy period. **Methods**: A reliable and validated cross-sectional electronic survey was administered to currently pregnant women and women who had recently given birth. The web-based questionnaire was self-administered and took 10-25min.	More than half (57%) reported that their healthcare provider talked to them about personal weight gain limits. Of these participants, about a third (34%) of participants were counselled regularly at each or most visits. Among the women that were not counselled on personal GWG limits, over half (56%) reported that healthcare provider guidance would have been helpful to achieve their target weight. Less than half (45%) of participants reported that their healthcare providers discussed dietary requirements or changes in pregnancy.	

Study ref	N	Aim/methods	Outcomes	Comments
Lopez-Cepero et al 2018[375] United States Cross-section	91	**Aim**: To examine associations between pregnant women's report of obstetric provider GWG advice, self-reported adherence to such advice, and GWG. **Methods**: Healthy pregnant women who started obstetric care prior to 17 weeks of gestation completed assessments between 30 and 34 weeks of gestation. These included survey (questions on receipt of and adherence to provider GWG advice, and demographics) and anthropometric measures. GWG data were abstracted from electronic health records. Analyses included Chi square and Mann-Whitney tests, and binary and multivariate logistic regressions.	Sixty-seven percent of women reported having received GWG advice from their obstetric providers and, of those, 54.1% reported that they followed their provider's advice. Controlling for race, education and pre-pregnancy BMI, receipt of GWG advice was marginally associated with increased odds of excessive weight gain (OR 2.52, 95%CI 0.89 to 7.16). However, women who reported following the advice had lower odds of excessive GWG (OR 0.18, 95%CI 0.03 to 0.91) and, on average, gained 11.3 pounds less than those who reported following the advice somewhat or not at all.	
Allen-Walker et al 2017[376] Ireland Cross-section	10	**Aim:** To explore routine weighing in antenatal care and weight management in pregnancy with women who have been weighed during pregnancy. **Population**: Women who gave birth 9 months previously and had been weighed during pregnancy. **Methods**: a qualitative study utilising semi-structured telephone interviews, and thematic analysis.	Experiences of routine weighing were positive, and participants believed it should be part of standard antenatal care. Several benefits to routine weighing were cited, including providing reassurance and minimising postpartum weight retention. It was felt that there was a lack of information provided on gestational weight gain and healthy lifestyle in pregnancy, and that healthcare professionals are ideally placed to provide this advice. Increased information provision was seen as a method to improve healthy lifestyle behaviours in pregnancy.	

Study ref	N	Aim/methods	Outcomes	Comments
Hill et al 2019[373] Australia Cross-section	265 preconception women 271 pregnant women	**Aim**: To explore knowledge and belief formation regarding gestational weight gain for preconception and pregnant women. **Methods**: Women ≥18 years (preconception; pregnant women at 16 weeks gestation) completed questionnaires assessing knowledge and beliefs about gestational weight gain. Responses were categorised according to the 2009 Institute of Medicine gestational weight gain recommendations.	Only half of pregnant women reported accurate gestational weight gain knowledge within the Institute of Medicine recommendations. Beliefs about gestational weight gain were also inaccurate for both preconception and pregnant women, with 34.1% of pregnant and 44.6% of preconception women expecting to gain less than recommendations.	

Table 96: Q7 Health professionals' views on regular weighing in pregnancy

Study ref	N	Aim/methods	Outcomes	Comments
Hasted et al 2016[377] Australia Cross-section	44	**Aim:** To identify clinicians' perspectives of barriers and enablers to routinely weighing pregnant women and variations in current practice, knowledge, and attitudes between different staff groups. **Methods**: Forty-four maternity staff from three professional groups were interviewed in four focus groups. Staff included midwives; medical staff; and dietitians. Transcripts underwent qualitative content analysis to identify and examine barriers and enablers to the routine weighing of women throughout pregnancy.	While most staff supported routine weighing, various concerns were raised. Issues included access to resources and staff; the ability to provide appropriate counselling and evidence-based interventions; and the impact of weighing on patients and the therapeutic relationship.	

Table 97: Q7 Weighing as a stand-alone intervention to reduce weight gain — SLRs

Study ref	N	Aim/methods	Outcomes	Comments
Fealy et al 2017[382] SLR	2 RCTs	**Aim**: To test if routine weighing as a stand-alone intervention can reduce total pregnancy weight gain and, in particular, excessive gestational weight gain. **Methods**: A systematic review and meta-analysis of randomised controlled trials (RCTs) was conducted between November 2014 and January 2016, and reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. Seven databases were searched. A priori eligibility criteria were applied to published literature by at least two independent reviewers. Studies considered methodologically rigorous, as per the Academy of Nutrition and Dietetics Quality Criteria Checklist for Primary Research, were included. Meta-analysis was conducted using fixed-effects models.	Intervention versus control: Gestational weight gain (kg/week): WMD -0.00; 95%CI -0.03 to 0.02 Weight gain exceeding IOM guidelines: • BMI <18.5: OR 1.50; 95%CI 0.14 to 16.54 • BMI 18.5 to 24.9: OR 0.72; 95%CI 0.48 to 1.09 • BMI 25 to 29.9: OR 0.85; 95%CI 0.45 to 1.62 • BMI >30: OR 1.60; 95%CI 0.72 to 3.54	The RCTs assessed different interventions (clinician weighing versus self-weighing).

Table 98: Q7 Regular weighing and advice on weight gain versus usual care — RCTs

Study ref	N	Aim/population/intervention	Outcomes
Brownfoot et al 2016[383] Australia	Intervention 355 Control 288	**Aim**: To assess whether routinely weighing women at each antenatal visit leads to a difference in gestational weight gain and weight gain within the IOM recommendations. **Population**: Healthy women were enrolled during their antenatal booking visit if they were between 18 and 45 years of age, were <21 weeks' gestation with a singleton pregnancy. **Intervention**: The intervention was weighing at each antenatal clinic appointment followed by counselling by their treating clinician according to IOM gestational weight gain guidelines. The control group had standard antenatal care comprising recording weight at booking and then at 36 weeks. Primary analysis was by intention-to-treat.	*Intervention versus control* Weekly weight gain (kg per week): • Overall: 0.54±0.28 (n=355) vs 0.53±0.24 (n=288) • BMI <18.5: 0.68±0.22 (n=5) vs 0.71±0.21 (n=6) • BMI 18.5 to 24.9: 0.56±0.26 (n=192) vs 0.54±0.22 (n=152) • BMI 25 to 19.9: 0.53±0.3 (n=104) vs 0,53±0,24 (n=93) • BMI >30: 0.48±0.26 (n=56) vs 0.42±0.28 (n=37) Weight gain exceeding IOM guidelines: • Overall: 267/355 vs 204/288 • BMI <18.5: 3/5 vs 3/6 • BMI 18.5–24.9: 131/190 vs 96/152 • BMI 24.9–30: 87/104 vs 77/93 • BMI >30: 46/56 vs 28/37 Intervention vs control: • Gestational hypertension/pre-eclampsia: 18/386 vs 16/288

Study ref	N	Aim/population/intervention	Outcomes
Brownfoot et al 2016[385] Australia	586	**Aim**: To assess the opinions of pregnant women regarding their weight gain and to assess the level of satisfaction and anxiety provoked by being weighed in clinic. **Population**: In all, 782 healthy pregnant women participated in the randomised controlled trial and 586 responded to the questionnaire. **Intervention**: Questionnaires were given to women participating in a randomised controlled trial comparing routine weighing in the antenatal clinic with standard care. A questionnaire was offered to all participants at 36 weeks of gestation gauging their satisfaction with their weight gain during pregnancy. The intervention group was asked about their level of satisfaction and anxiety provoked by being weighed in clinic. The control group was asked whether they would have liked to be weighed in clinic. Both groups were questioned about the influences on their weight gain.	Women in both groups were satisfied with their weight gain during pregnancy. Of women in the intervention group. 73% were very comfortable with being weighed in clinic. Approximately half of those in the control group would have favoured being weighed. Twenty-one percent of women said other people influenced their weight gain; mostly family members and two-thirds of them encouraged weight gain. Less than half of the women in the study used weighing scales at home. Women were satisfied with being weighed antenatally and it did not cause anxiety. Pregnant women accepted the re-introduction of weighing in the antenatal clinic.

Study ref	N	Aim/population/intervention	Outcomes
Daley et al 2015[386] United Kingdom	Intervention 34 Control 34	**Aim**: to establish the feasibility and acceptability of incorporating regular weighing, setting maximum weight gain targets and feedback by community midwives. **Population**: Low risk pregnant women at 10–14 weeks. **Intervention**: Community midwives weighed and plotted weight on a weight gain chart, setting weight gain limit targets, giving brief feedback at each antenatal appointment and encouraging women to weigh themselves weekly between antenatal appointments. Women and midwives were interviewed about their views of the intervention.	*Intervention versus control* Gestational weight gain: • Overall: 12.0±4.5 (n=34) vs 12.1±5.9 (n=34) • BMI 18.5 to 24.9: 12.3±4.0 (n=18) vs 12.6±5.1 (n=19) • BMI 25 to 29.9: 11.6±5.1 (n=16) vs 11.6±7.0 (n=15) Weight gain exceeding IOM guidelines: • Overall: 8/34 vs 10/34 • BMI 18.5 to 24.9: 2/18 vs 2/19 • BMI 25 to 29.9: 6/16 vs 8/15 Depression (HADS score): 3.8±2.7 (n=20) vs 5.4±3.4 (n=24) Anxiety (HADS score): 4.7±2.7 (n=31) vs 5.7±3.0 (n=24) Most women in a subset (9/12) commented the intervention was useful in encouraging them to think about their weight and believed it should be part of routine antenatal care. A subset of community midwives (7/7) felt the intervention could be implemented within routine care without adding substantially to consultation length.

Study ref	N	Aim/population/intervention	Outcomes
Daley et al 2019[387] United Kingdom	Intervention 329 Control 327	**Aim**: To assess the effectiveness of a brief behavioural intervention based on routine antenatal weighing to prevent excessive gestational weight gain (defined by US Institute of Medicine). **Population**: Women between 10(+0) and 14(+6) weeks gestation, not requiring specialist obstetric care. **Intervention**: Participants were randomised to usual antenatal care or usual care (UC) plus the intervention. The intervention involved community midwives weighing women at antenatal appointments, setting maximum weight gain limits between appointments and providing brief feedback. Women were encouraged to monitor and record their own weight weekly to assess their progress against the maximum limits set by their midwife. The comparator was usual maternity care.	*Intervention versus control* Weight gain exceeding IOM guidelines • Overall: 81/305 (27.6%) versus 90/311 (28.9%) Anxiety: 5.18±3.09 (n=136) vs 5.89±3.58 (n=133) Depression: 3.93±3.04 (n=136) vs 4.56±3.04 (n=133)

4.2 Q8: What specific risk assessments are required for pregnant women with high or low BMI at the first antenatal visit?

4.2.1 Risks associated with pre-pregnancy underweight

Systematic reviews are consistent in finding that low pre-pregnancy BMI is associated with an increased risk of preterm birth[388,389], small for gestational age[389-392] and low birthweight[388-390,392]. Systematic reviews have also found a possible increase in risk of miscarriage[393] and placental abruption[394] and a decreased risk of gestational diabetes.[395] There was no clear effect on risk of congenital heart defects.[396]

4.2.2 Risks associated with pre-pregnancy healthy weight

A meta-analysis of individual participant data (n=265,270)[362] found that among women with healthy pre-pregnancy BMI:

- low weight gain was associated with an increased risk of 'any pregnancy complication' ($p<0.05$), preterm birth ($p<0.001$) and small for gestational age ($p<0.001$) and a reduced risk of large for gestational age ($p<0.001$)
- high weight gain was associated with an increased risk of 'any pregnancy complication', gestational diabetes, gestational hypertension, pre-eclampsia, preterm birth and large for gestational age and a reduced risk of small-for-gestational age (all $p<0.001$).

4.2.3 Risk associated with pre-pregnancy overweight and obesity

Systematic reviews were consistent in finding that pre-pregnancy overweight and obesity was associated with large for gestational age[389,390,392], macrosomia,[389,390,392] and childhood overweight/obesity[392.365]

Systematic reviews have also found associations between high pre-pregnancy BMI and:

- increased risk of gestational diabetes,[395] preterm birth, neonatal asphyxia,[390] admission to neonatal intensive care, stillbirth,[389] and congenital heart defects[396,397]
- reduced risk of small for gestational age[391] and placental abruption.[394]

Systematic reviews also found a decreased likelihood of initiating breastfeeding among obese women.[398,399]

Table 99: Q8 Risks associated with low pre-pregnancy BMI — SLRs

Study ref	N	Aim/methods	Outcomes	Comments
Zhu et al 2018[396]	13 case-control studies 4 cohort studies	**Aim**: To address the open question of a possible association between maternal body mass index (BMI) and congenital heart defects (CHDs) in infants. **Methods**: We conducted a comprehensive computerised search of PubMed, Web of Science, Medline, and Embase databased (January 1980 through August 2017). We assessed the association between maternal BMI and the risk for congenital heart defects in their offspring. Study-specific relative risk estimates were polled according to random-effect or fixed-effect models.	Risk of congenital heart defects relative to healthy weight: • Underweight OR 1.0 (95%CI 0.98 to 1.05; P=0.085	

Study ref	N	Aim/methods	Outcomes	Comments
Han et al 2011[388]	78 cohort studies 1,025,794 women	**Aim**: To determine the relationship between maternal underweight and preterm birth (PTB) and low birth weight (LBW) in singleton pregnancies in developing and developed countries. **Methods**: We searched MEDLINE and EMBASE from their inceptions. We included studies that assessed the effect of maternal underweight compared with normal weight according to body mass index in singleton gestations on our two primary outcomes: PTB (<37 weeks) and LBW (<2500 g). Two assessors independently reviewed citations, extracted data and assessed quality.	Underweight women had a higher risk of: • preterm birth: RR 1.29, 95%CI 1.15 to 1.46 • spontaneous preterm birth: RR 1.32, 95%CI 1.10 to 1.57 • induced preterm birth: RR 1.21, 95%CI 1.07 to 1.36 • low birthweight: RR 1.64, 95%CI 1.38 to 1.94. Risk of preterm birth among underweight women: • developed countries: RR 1.22, 95%CI 1.15 to 1.30 • developing countries (RR 0.99, 95%CI 0.67 to 1.45). Risk of low birthweight: • Developed countries: RR 1.48, 95%CI 1.29 to 1.68, • Developing countries: RR 1.52, 95%CI 1.25 to 1.85.	
Liu et al 2016[389]	60 cohort studies 1,392,799 women	**Aim**: To quantify the association between maternal pre-pregnancy body mass index (BMI) and perinatal outcomes. **Methods**: We systematically reviewed and collected studies on maternal pre-pregnancy BMI and perinatal outcomes published up to 31 August 2015. For each study, we constructed separate two-by-two tables to calculate the odds ratios (ORs) and 95% confidence intervals (CI).	When mothers were underweight, their infants had a higher risk of: • preterm birth: OR 1.30, 95%CI, 1.13 to 1.49 • small for gestational age: OR 1.67, 95%CI 1.49 to 1.87) • low birth weight: OR 1.67, 95%CI, 1.39 to 2.02	

Study ref	N	Aim/methods	Outcomes	Comments
Liu et al 2019[390]	46 cohort studies	**Aim**: To evaluate maternal BMI and the risk of harmful neonatal outcomes in China. **Methods**: Six databases identified 2454 articles; 46 met the inclusion criteria for this study. The dichotomous data on maternal BMI and harmful neonatal outcomes were extracted. Pooled statistics (odds ratios, ORs) were derived from Stata/SE, ver. 12.0. Sensitivity analyses assessed the robustness of the results. Meta-regression and subgroup meta-analyses explored heterogeneity.	Compared with healthy BMI, maternal underweight increased the risk of • low birth weight: OR 1.61, 95% CI 1.33 to 1.93 • small for gestational age: OR 1.75, 95% CI 1.51 to 2.02	
Torloni et al 2009[395]	70 studies (59 cohorts and 11 case-controls) 671 945 women	**Aim**: To assess and quantify the risk for gestational diabetes mellitus (GDM) according to prepregnancy maternal body mass index (BMI). **Methods**: Four electronic databases were searched for publications (1977-2007). BMI was elected as the only measure of obesity, and all diagnostic criteria for GDM were accepted. Studies with selective screening for GDM were excluded. There were no language restrictions. The methodological quality of primary studies was assessed. Most studies were of high or medium quality.	Risk in underweight women compared with women with a healthy BMI: • gestational diabetes: OR 0.75; 95%CI 0.69 to 0.82)	

Study ref	N	Aim/methods	Outcomes	Comments
Goto et al 2017[391]	323,243 women	**Aim**: To determine the dose-response relationships between maternal anthropometric variables and risk of small for gestational age (SGA). **Methods**: Linear and nonlinear dose-response meta-analyses were performed to summarize the adjusted relative risks of SGA. Ten databases, including PubMed (MEDLINE), were searched. Study quality was assessed using the Newcastle-Ottawa scale.	Risk of SGA relative to the mean (21.5 kg/m2): • 12.5 kg/m: RR 1.907 (1.477 to 2.461) • 15.5 kg/m2: RR 1.514 (1.282 to 1.786) • 18.5 kg/m2: RR 1.210 (1.119 to 1.309)	
Yu et al 2013[392]	45 studies	**Aim**: To determine if pre-pregnancy body mass index (BMI) is related to infant birth weight (BW) and offspring overweight/obesity. **Methods**: Three electronic bibliographic databases (MEDLINE, EMBASE and CINAHL) were searched systematically from January 1970 to November 2012. The dichotomous data on pre-pregnancy overweight/obesity and BW or offspring overweight/obesity were extracted. Summary statistics (odds ratios, ORs) were used by Review Manager, version 5.1.7.	Compared with healthy-weight women, pre-pregnancy underweight increased the risk of: • small for gestational age: OR 1.81; 95%CI 1.76 to 1.87 • low birthweight: OR 1.47; 95%CI 1.27 to 1.71.	

Study ref	N	Aim/methods	Outcomes	Comments
Balsells et al 2016[393]	32 studies (30 cohort, 2 case control) 265,760 women	**Aim:** To review the literature and summarise the risk of miscarriage in underweight women vs those with healthy weight. **Methods**: A Medline Search (1st January 1990-20th November 2015, human, in English, French, Italian, Spanish or Portuguese) was conducted. Both spontaneous pregnancies and pregnancies after assisted reproduction techniques were considered. Cohort and case control studies were included if they reported data on the outcome of interest (clinical miscarriage), in underweight and normal weight women. Information on clinical miscarriage in other body mass index categories was collected when available. Two investigators reviewed the abstracts, full text papers and extracted data. Review Manager 5.1 software was used to summarize the results.	Risk of miscarriage among underweight women: • cohort studies: RR 1.08, 95% CI 1.05 to 1.11; p<0.0001 • case control studies: OR 1.02, 95% CI 0.46 to 2.30; p=0.95.	

Study ref	N	Aim/methods	Outcomes	Comments
Adane et al 2019[394]	15 observational studies	**Aim**: To evaluate the associations between pre-pregnancy body mass index and gestational weight gain and placental abruption. **Methods**: Relevant studies were identified from PubMed, EMBASE, Scopus and CINAHL. Unpublished findings from analyses of linked population-based data sets from Western Australia (2012–2015, n = 114,792) were also included. Studies evaluating pre-pregnancy body mass index and/or gestational weight gain and placental abruption were included. Two independent reviewers evaluated studies for inclusion and quality. Data including odds ratios (ORs) and 95% confidence intervals (CIs) were extracted and analysed by random effects meta-analysis.	Risk of placental abruption compared to healthy weight women: • Underweight: OR 1.4; 95% CI 1.1 to 1.7	

Table 100: Q8 Risks associated with high pre-pregnancy BMI — SLRs

Study ref	N	Aim/methods	Outcomes	Comments
Adane et al 2019[394]	15 observational studies	**Aim**: To evaluate the associations between pre-pregnancy body mass index and gestational weight gain and placental abruption. **Methods**: Relevant studies were identified from PubMed, EMBASE, Scopus and CINAHL. Unpublished findings from analyses of linked population-based data sets from Western Australia (2012–2015, n = 114,792) were also included. Studies evaluating pre-pregnancy body mass index and/or gestational weight gain and placental abruption were included. Two independent reviewers evaluated studies for inclusion and quality. Data including odds ratios (ORs) and 95% confidence intervals (CIs) were extracted and analysed by random effects meta-analysis.	Risk of placental abruption compared to healthy weight women: • Overweight: OR 0.8; 95% CI 0.8 to 0.9 • Obese: OR 0.8; 95% CI 0.7 to 0.9	
Huang et al 2019[398]	30 cohort studies	**Aim**: To explore the effect of different prepregnancy BMI and gestational weight gain (GWG) categories on breastfeeding initiation and cessation. **Methods**: Cohort studies were systematically searched in Embase, Web of Science, PubMed, and CINAHL databases from database establishment to February 2019. Summary risk ratio (RR) on breastfeeding initiation and cessation was estimated with the use of a random-effects model.	Prepregnancy obesity was associated with increased likelihood of: • not initiating breastfeeding: RR 1.49, 95%CI 1.33 to 1.67 • not initiating exclusive breastfeeding: RR 1.26, 95%CI 1.17 to 1.36 • lower duration of any breastfeeding: RR 1.34 95%CI 1.16 to 1.56.	

Study ref	N	Aim/methods	Outcomes	Comments
Liu et al 2016[389]	60 studies 1,392,799 women	**Aim**: To quantify the association between maternal pre-pregnancy body mass index (BMI) and perinatal outcomes. **Methods**: We systematically reviewed and collected studies on maternal pre-pregnancy BMI and perinatal outcomes published up to 31 August 2015. For each study, we constructed separate two-by-two tables to calculate the odds ratios (ORs) and 95% confidence intervals (CI).	When mothers were overweight, their infants had a significantly higher risk of: • large for gestational age: OR, 1.45, 95%CI 1.29 to 1.63 • macrosomia: OR, 1.70, 95%CI 1.55 to 1.87 • admission to the neonatal intensive care unit: OR, 1.29, 95%CI 1.12 to 1.48 • stillbirth: OR, 1.27, 95%CI 1.18 to 1.36 When mothers were obese, their infants had a significantly higher risk of: • low birth weight: OR, 1.24, 95%CI 1.09 to 1.41 • large for gestational age: OR 1.88, 95%CI 1.67 to 2.11 • macrosomia: OR 2.92, 95%CI 2.67 to 3.20 • admission to neonatal intensive care unit: OR 1.91, 95%CI 1.60 to 2.29 • stillbirth: OR 1.81, 95%CI 1.69-1.93,	
Liu et al 2019[390]	46 cohort studies	Aim: To evaluate maternal BMI and the risk of harmful neonatal outcomes in China. **Methods**: Six databases identified 2454 articles; 46 met the inclusion criteria for this study. The dichotomous data on maternal BMI and harmful neonatal outcomes were extracted. Pooled statistics (odds ratios, ORs) were derived from Stata/SE, ver. 12.0. Sensitivity analyses assessed the robustness of the results. Meta-regression and subgroup meta-analyses explored heterogeneity.	Compared with normal BMI, high maternal BMI is associated with: • macrosomia ≥4000 g: OR 1.91, 95% CI 1.75 to 2.09 • large for gestational age: OR 1.88, 95% CI 1.64 to 2.15 • preterm birth: OR 1.38, 95% CI 1.25 to 2.52 • neonatal asphyxia: OR 1.74, 95% CI 1.39 to 2.17	

Study ref	N	Aim/methods	Outcomes	Comments
Torloni et al 2009[395]	70 studies (59 cohorts and 11 case-controls) 671 945 women	**Aim**: To assess and quantify the risk for gestational diabetes mellitus (GDM) according to prepregnancy maternal body mass index (BMI). **Methods**: Four electronic databases were searched for publications (1977-2007). BMI was elected as the only measure of obesity, and all diagnostic criteria for GDM were accepted. Studies with selective screening for GDM were excluded. There were no language restrictions. The methodological quality of primary studies was assessed. Most studies were of high or medium quality.	Compared with women with a healthy BMI, risk of gestational diabetes: • overweight: 1.97; 95% CI 1.77 to 2.19 • moderately obese: 3.01; 95% CI 2.34 to 3.87 • morbidly obese: 5.55; 95% CI 4.27 to 7.21. For every 1 kg m(-2) increase in BMI, the prevalence of GDM increased by 0.92% (95% CI 0.73 to 1.10).	
Goto et al 2017[391]	323,243 women	**Aim**: To determine the dose-response relationships between maternal anthropometric variables and risk of small for gestational age (SGA). **Methods**: Linear and nonlinear dose-response meta-analyses were performed to summarize the adjusted relative risks of SGA. Ten databases, including PubMed (MEDLINE), were searched. Study quality was assessed using the Newcastle-Ottawa scale.	Risk of SGA relative to the mean (21.5 kg/m2): • 24.5 kg/m2: RR 0.876 (0.814 to 0.942) • 27.5 kg/m2: RR 0.805 (0.693 to 0.936) • 30.5 kg/m2: RR 0.763 (0.603 to 0.964)	

Study ref	N	Aim/methods	Outcomes	Comments
Yu et al 2013[392]	45 studies	**Aim**: To determine if pre-pregnancy body mass index (BMI) is related to infant birth weight (BW) and offspring overweight/obesity. **Methods**: Three electronic bibliographic databases (MEDLINE, EMBASE and CINAHL) were searched systematically from January 1970 to November 2012. The dichotomous data on pre-pregnancy overweight/obesity and BW or offspring overweight/obesity were extracted. Summary statistics (odds ratios, ORs) were used by Review Manager, version 5.1.7.	Pre-pregnancy overweight increased the risk of: • large for gestational age: OR 1.53; 95% CI, 1.44 to 1.63 • high birthweight: OR 1.53; 95% CI 1.44 to 1.63 • macrosomia: OR 1.67; 95% CI 1.42 to 1.97 • subsequent offspring overweight/obesity: OR 1.95; 95% CI 1.77 to 2.13. Pre-pregnancy obesity increased the risk of: • large for gestational age: OR 2.08; 95% CI 1.95 to 2.23 • high birthweight: OR 2.00; 95% CI 1.84 to 2.18 • macrosomia: OR 3.23; 95% CI 2.39 to 4.37 • subsequent offspring overweight/obesity: OR 3.06; 95% CI 2.68 to 3.49.	Sensitivity analyses revealed that sample size, study method, quality grade of study, source of pre-pregnancy BMI or birthweight had a strong impact on the association between pre-pregnancy obesity and large for gestational age.

Study ref	N	Aim/methods	Outcomes	Comments
Voerman et al 2019[365] Meta-analysis	162,129 mothers and their children	**Aim**: To assess the separate and combined associations of maternal BMI and gestational weight gain with the risk of overweight/obesity throughout childhood, and their population impact. **Methods**: We conducted an individual participant data meta-analysis of data from 37 pregnancy and birth cohort studies from Europe, North America, and Australia. We assessed the individual and combined associations of maternal pre-pregnancy BMI and gestational weight gain, both in clinical categories and across their full ranges, with the risks of overweight/obesity in early (2.0-5.0 years), mid (5.0-10.0 years) and late childhood (10.0-18.0 years), using multilevel binary logistic regression models with a random intercept at cohort level adjusted for maternal sociodemographic and lifestyle-related characteristics.	Maternal overweight pre-pregnancy: • Early childhood overweight/obesity: OR 1.66; 95%CI 1.56 to 1.78 • Mid childhood overweight/obesity: OR 1.91; 95%CI 1.85 to 1.98 • Late childhood overweight/obesity: OR 2.28; 95%CI 2.08 to 2.50 Maternal obesity pre-pregnancy: • Early childhood overweight/obesity: OR 2.43; 95%CI 2.24 to 2.64 • Mid childhood overweight/obesity: OR 3.12; 95%CI 2.98 to 3.27 • Late childhood overweight/obesity: OR 4.47; 95%CI 3.99 to 5.23	

Study ref	N	Aim/methods	Outcomes	Comments
Zhu et al 2018[396]	13 case-control studies 4 cohort studies	**Aim**: To address the open question of a possible association between maternal body mass index (BMI) and congenital heart defects (CHDs) in infants. **Methods**: We conducted a comprehensive computerised search of PubMed, Web of Science, Medline, and Embase databased (January 1980 through August 2017). We assessed the association between maternal BMI and the risk for congenital heart defects in their offspring. Study-specific relative risk estimates were polled according to random-effect or fixed-effect models.	Risk of congenital heart defects relative to healthy weight: • Overweight: 1.06; 95%CI 1.02 to 1.10; P=0.001) • Obesity: OR: 1.174; 95%CI 1.15 to 1.2, P=0.161	
Cai et al 2014[397]	14 observational studies	**Aim**: To investigate the relationship between maternal body mass index and all congenital heart defects (CHDs) combined and 11 individual defects. **Methods**: PubMed, ELSEVIER ScienceDirect, and Springer Link (up to February 2013) were searched, and the reference list of retrieved articles was reviewed. Three authors independently extracted the data. Statistical software was used to perform all statistical analyses. Fixed-effects or random-effects model was used to pool the results of individual study (expressed as odds ratios [ORs] with 95% confidence intervals [CIs]).	Risk of CHD compared to women of healthy weight: • Overweight: OR 1.08; 95% CI, 1.02 to 1.15 • Moderate obesity (BMI 30.1-34.9): OR 1.15; 95% CI 1.11 to 1.20 • Severe obesity (BMI ≥35): OR 1.39; 95% CI 1.31 to 1.47	

Study ref	N	Aim/methods	Outcomes	Comments
Garcia et al 2016[399]	81 studies	**Aim**: To examine the associations between maternal weight status or dietary characteristics and breastfeeding or complementary feeding. **Methods**: A systematic literature search of the Embase, Cochrane Library, Google Scholar, MEDLINE, PubMed, and Web of Science databases was performed. Interventional and cohort studies in healthy mothers and infants that reported on maternal weight status, diet, or supplement use were selected. Outcomes assessed included delayed onset of lactogenesis; initiation, exclusivity, duration, and cessation of breastfeeding; and timing of complementary feeding.	Compared to women of healthy weight, obese women had increased risk of: • not initiating breastfeeding: RR 1.23; 95%CI 1.03 to 1.47 • delayed onset of lactogenesis: RR 2.06; 95%CI 1.18 to 3.61 The RR for breastfeeding cessation was 1.11 (95%CI, 1.07-1.15) per increase in category of body mass index.	

5 Interventions to prevent excessive weight gain in pregnancy

5.1 Q9: What lifestyle interventions are effective in preventing excessive weight gain and other adverse outcomes in pregnant women?

5.1.1 Dietary interventions

Types of study

The review included 7 studies reported in 9 papers and including 1,664 women. Study populations were heterogeneous and included women of mixed risk,[400] women at low risk,[240,401] women with uncomplicated pregnancies and BMI ≥29[402] or ≥30 kg,[403,404] and women without gestational diabetes who had previously had a baby weighing >4,000 g.[405,406]

Most studies were small with between 100 and 200 participants (n=4). One study had fewer than 100 participants[404] and the Walsh et al study had 759 participants.[405,406]

Studies were conducted in Egypt,[400] Ireland,[405-407] Italy,[401] Finland[240] and the United States.[403] One multicentre study[402] was conducted in the United Kingdom, Ireland, Netherlands, Austria, Poland, Italy, Spain, Denmark and Belgium.

Types of intervention

Interventions included dietary counselling[240,400,402,404-406] or a personalised diet plan with dietician follow-up.[401,403]

One study used current dietary recommendations for pregnancy,[240] one based advice on a nutrition regimen used for gestational diabetes[403] and three had a focus on kilocalorie intake.[401-403] One study advised a low glycaemic index diet from early pregnancy.[405,406]

Common themes in dietary advice provided included reducing intake of saturated fats,[240,400-402] carbohydrates[402] and sugar (eg in soft drinks)[400] and increasing consumption of fruit and vegetables,[400] protein[402] and fibre.[400,402]

Maternal outcomes

Mean gestational weight gain was significantly lower in the intervention groups than in the standard care groups (MD -3.76 kg; 95%CI -6.38 to -1.13; 6 RCTs; n=1,432; very low certainty; analysis 3.1; page 459).

Compared to women in the control groups, among women in the intervention groups, there was a clear reduction in risk of:

- weight gain exceeding IOM guidelines (RR 0.65; 95%CI 0.54 to 0.77; 4 RCTs; n=538; very low certainty; analysis 3.2; page 460)
- gestational hypertension (RR 0.29; 95%CI 0.13 to 0.61; 3 RCTs; n=429; moderate certainty; analysis 3.4; page 460).

There was no clear difference in:

- gestational diabetes (RR 0.86; 95%CI 0.64 to 1.17; 6 RCTs; n=1,424; very low certainty; analysis 3.3; page 460)
- pre-eclampsia (RR 0.61; 95%CI 0.25 to 1.46; 2 RCTs; n=282; low certainty; analysis 3.5; page 461)
- caesarean section (RR 0.85; 95%CI 0.64 to 1.11; 6 RCTs; n=1,461; very low certainty; analysis 3.6; page 461)
- postnatal weight retention (MD -0.22; 95%CI -1.17 to 0.72; 2 RCTs; n=556; very low certainty; analysis 3.7; page 461).

Infant outcomes

The risk of preterm birth was lower in the intervention group than in the usual care group (RR 0.43; 95%CI 0.24 to 0.79; 4 RCTs; n=1,296; moderate certainty; analysis 3.8; page 462).

There was no clear difference in risk of:

- macrosomia >4,000 g (RR 0.97; 95%CI 0.84 to 1.11; 3 RCTs; n=1,138; very low certainty; analysis 3.9; page 462)
- early childhood weight (MD -0.03; 95%CI -0.26 to 0.31; 2 RCTs; n=565; low certainty; analysis 3.10; page 462).

A single study found no clear difference in rates of small for gestational age (RR 0.59; 95%CI 0.22 to 1.69; n=131) or large for gestational age (RR 0.89; 95%CI 0.35 to 2.25; n=131).

Summary of findings

Dietary interventions compared to usual care in pregnancy — maternal outcomes

Patient or population: Pregnant women with low or high risk pregnancies

Setting: Austria, Belgium, Denmark, Egypt, Finland, Ireland, Italy, Netherlands, Poland, Spain, United Kingdom, United States

Intervention: Dietary intervention

Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with standard care	**Risk with Diet**			
Mean gestational weight gain	The mean gestational weight gain was **0**	MD **3.76 lower** (6.38 lower to 1.13 lower)	-	1,432 (6 RCTs)	⨁◯◯◯ VERY LOW [a,b]
Weight gain exceeding IOM guidelines	607 per 1,000	**395 per 1,000** (328 to 468)	**RR 0.65** (0.54 to 0.77)	538 (4 RCTs)	⨁◯◯◯ VERY LOW [a,b]
Gestational diabetes	118 per 1,000	**102 per 1,000** (76 to 138)	**RR 0.86** (0.64 to 1.17)	1,424 (6 RCTs)	⨁⨁◯◯ LOW [a,c]
Gestational hypertension	130 per 1,000	**38 per 1,000** (17 to 79)	**RR 0.29** (0.13 to 0.61)	429 (3 RCTs)	⨁⨁⨁◯ MODERATE [a]
Pre-eclampsia	84 per 1,000	**51 per 1,000** (21 to 123)	**RR 0.61** (0.25 to 1.46)	282 (2 RCTs)	⨁⨁◯◯ LOW [a,c]
Caesarean section	320 per 1,000	**272 per 1,000** (205 to 355)	**RR 0.85** (0.64 to 1.11)	1,461 (6 RCTs)	⨁◯◯◯ VERY LOW [a,c,d]
Postnatal weight retention	The mean postpartum weight retention was **0**	MD **0.22 lower** (1.17 lower to 0.72 higher)	-	556 (2 RCTs)	⨁◯◯◯ VERY LOW [a,d,e]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **MD:** Mean difference; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

a. High or unclear risk of performance bias in all studies
b. Considerable heterogeneity
c. Confidence interval crosses line of no effect
d. Substantial heterogeneity
e. Weight measured at different time points

Dietary intervention compared to usual care in pregnancy — infant outcomes

Patient or population: pregnant women

Setting: Austria, Belgium, Denmark, Egypt, Finland, Ireland, Italy, Netherlands, Poland, Spain, United Kingdom, United States

Intervention: Dietary intervention

Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with standard care	**Risk with Diet**			
Preterm birth	49 per 1,000	**21 per 1,000** (12 to 39)	**RR 0.43** (0.24 to 0.79)	1,296 (4 RCTs)	⨁⨁⨁◯ MODERATE [a]
Macrosomia	377 per 1,000	**366 per 1,000** (317 to 419)	**RR 0.97** (0.84 to 1.11)	1,138 (3 RCTs)	⨁◯◯◯ VERY LOW [a,b,c]
Childhood weight	The mean childhood weight was **0**	MD **0.03 higher** (0.26 lower to 0.31 higher)	-	565 (2 RCTs)	⨁⨁◯◯ LOW [a,b]

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **MD:** Mean difference; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

a. High or unclear risk of performance bias in all studies

b. Confidence interval crosses line of no effect

c. Substantial heterogeneity

Comparability of results with other reviews

Other systematic reviews have included some RCTs that were excluded from this review due to wrong study population (eg women with high risk pregnancies for reasons other than BMI) or wrong comparator (eg not standard care). However, the results are largely comparable with those of this review, with most reviews finding a lower weight gain among women with mixed BMIs.

Table 101: Q9 Findings of systematic reviews of dietary interventions — maternal outcomes

Ref	Population	Effect (95% CI)	# studies
Mean gestational weight gain			
Current review	Mixed BMIs	MD -3.76 (-6.38 to -1.13)	6
*Zhang et al 2018[408]	Mixed BMis	MD -0.69 (-1.74 to 0.36)	9
Rogozińska et al 2017[409]	Mixed BMIs	MD −0.72 (−1.48 to 0.04)	4
Shieh et al 2018[410]	Mixed BMIs	MD -5.77 (-9.34 to -2.21)	4
Thangaratinam et al 2012a[411]	Mixed BMIs	MD -3.36 (-4.73 to -1.99)	9
Thangaratinam et al 2012b[412]	Mixed BMIs	MD -3.84 (-5.22 to -2.45)	10
Tieu et al 2017[413]	Mixed BMIs	MD -4.70 (-8.07 to -1.34)	5
*Tieu et al 2017[413]	Mixed BMIs	MD -1.23 (-4.08 to 1.61)	4
Walker et al 2018	Mixed BMIs	MD -3.27 (-4.96 to -1.58)	9
Craemer et al 2019[414]	Mixed BMIs	MD −1.81 (−2.61 to −1.02)	6
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	MD −0.72 (−1.48 to 0.04)	4
	Mixed BMIs; IPD and non-IPD	MD −2.84 (−4.77 to −0.491)	12
Dodd et al 2010[416]	Overweight and obese	MD -3.10 (-8.32 to 2.13)	4
Weight gain exceeding IOM guidelines			
Current review	Mixed BMIs	RR 0.65 (0.54 to 0.77)	4
*Muktabhant et al 2015[417]	Mixed BMIs	RR 0.74 (0.55 to 0.99)	2
Gestational diabetes			
Current review	Mixed BMIs	RR 0.86 (0.64 to 1.17)	6
Bennett et al 2018[418]	Mixed BMIs	RR 0.56 (0.32 to 0.96)	6
Guo et al 2019[419]	Mixed BMIs	RR 0.75 (0.59 to 0.95)	11
Bennett et al 2018[418]	Overweight and obese	RR 0.54 (0.27 to 1.07)	2
Madhurvata et al 2015[420]	Overweight and obese	OR 0.33 (0.14 to 0.76)	3
Song et al 2016[421]	Mixed BMIs	RR 0.80 (0.58 to 1.10)	5
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 1.03 (0.30 to 3.61)	4
	Mixed BMIs; IPD and non-IPD	OR 0.79 (0.37 to 1.69)	8
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 0.52 (0.27 to 1.03)	2
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 0.39 (0.23 to 0.69)	3
Tieu et al 2017[413]	Mixed BMIs	RR 0.93 (0.64 to 1.36)	2
Tieu et al 2017[413]	BMI ≥25	RR 0.39 (0.19 to 0.79)	3
*Tieu et al 2017[413]	Mixed BMIs	RR 0.91 (0.63 to 1.31)	4
Dodd et al 2010[416]	Overweight and obese	RR 0.57 (0.30 to 1.08)	3
Gestational hypertension			
Current review	Mixed BMIs	RR 0.29 (0.13 to 0.61)	3
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 0.59 (0.07 to 4.65)	3
	Mixed BMIs; IPD and non-IPD	OR 0.57 (0.18 to 1.79)	5
Thangaratinam et al 2012[411,412]	Mixed BMIs	RR 0.30 (0.10 to 0.88)	2
Tieu et al 2017[413]	Mixed BMIs	RR 0.30 (0.10 to 0.88)	2
Dodd et al 2010[416]	Overweight and obese	RR 0.70 (0.30 to 1.61)	4

Ref	Population	Effect (95% CI)	# studies
Pre-eclampsia			
Current review	Mixed BMIs	RR 0.61 (0.25 to 1.46)	2
Allen et al 2014[422]	Mixed BMIs	RR 0.67 (0.53 to 0.85)	6
Syngelaki et al 2019[423]	Mixed BMIs	RR 1.00 (0.79 to 1.27)	11
Thangaratinam et al 2012[411,412]	Mixed BMIs	RR 0.67 (0.53 to 0.85)	6
Tieu et al 2017[413]	Mixed BMIs	RR 0.61 (0.25 to 1.46)	2
Dodd et al 2010[416]	Overweight and obese	RR 0.80 (0.49 to 1.31)	5
Caesarean section			
Current review	Mixed BMIs	RR 0.85 (0.64 to 1.11)	6
*Muktabhant et al 2015[417]	Mixed BMIs	RR 0.99 (0.33 to 3.01)	2
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 0.78 (0.50 to 1.22)	4
	Mixed BMIs; IPD and non-IPD	OR 0.88 (0.65 to 1.17)	7
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 0.093 (0.84 to 1.04)	5
Tieu et al 2017[413]	Mixed BMIs	RR 0.98 (0.78 to 1.24)	4
*Tieu et al 2017[413]	Mixed BMIs	RR 1.27 (0.79 to 2.04)	2
Dodd et al 2010[416]	Overweight and obese	RR 1.09 (0.93 to 1.28)	3

Table 102: Q9 Findings of systematic reviews of dietary interventions — infant outcomes

Ref	Population	Effect (95% CI)	# studies
Preterm birth			
Current review	Mixed BMIs	RR 0.43 (0.24 to 0.79)	4
*Muktabhant et al 2015[417]	Mixed BMIs	RR 0.33 (0.11 to 1.02)	2
Thangaratinam et al 2012a[411,412]	Mixed BMIs	RR 0.68 (0.48 to 0.96)	4
Tieu et al 2017[413]	Mixed BMIs	RR 0.51 (0.21 to 1.25)	3
Dodd et al 2010[416]	Overweight and obese	RR 0.58 (0.19 to 1.70)	2
Macrosomia			
Current review	Mixed BMIs	RR 0.97 (0.84 to 1.11)	3
*Muktabhant et al 2015[417]	Mixed risk	RR 0.93 (0.75 to 1.17)	2
*Muktabhant et al 2015[417]	High risk	RR 2.47 (0.68 to 8.95)	2
*Tieu et al 2017[413]	Mixed BMIs	RR 0.73 (0.49 to 1.09)	2
Small for gestational age			
Current review	Mixed BMIs	RR 0.89 (0.35 to 2.25)	1
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 0.92 (0.45 to 1.88)	4
	Mixed BMIs; IPD and non-IPD	OR 1.05 (0.62 to 1.77)	6
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 1.02 (0.75 to 1.37)	3
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 1.02 (0.75 to 1.37)	3
*Tieu et al 2017[413]	Mixed BMIs	RR 0.88 (0.53 to 1.45)	3
Large for gestational age			
Current review	Mixed BMIs	RR 0.89 (0.35 to 2.25)	1
*Zhang et al 2018[408]	Mixed BMIs	RR 0.52 (0.31 to 0.89)	8
*Oostdam et al 2011[424]	Mixed BMIs	RR 0.14 (0.05 to 0.41)	3
Dodd et al 2010[416]	Overweight and obese	RR 2.02 (0.84, 4.86)	3
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 0.91 (0.60 to 1.37)	4
	Mixed BMIs; IPD and non-IPD	OR 0.82 (0.54 to 1.22)	6
Thangaratinam et al 2012[411,412]	Mixed BMIs	RR 0.78 (0.51 to 1.19)	5
*Tieu et al 2017[413]	Mixed BMIs	RR 0.60 (0.19 to 1.86)	3

* Low glycaemic index diet

5.1.2 Exercise interventions

Types of study

The review included 42 studies reported in 59 papers and including 9,057 women. Among the studies, 27 included an aerobic and resistance exercise intervention,[269,294-296,304,402,425-447] 11 an aerobic exercise intervention[270-273,292,299,448-452] and 2 a resistance exercise intervention.[313,453] Study populations were heterogeneous and included women of mixed BMI,[270-272,292,294-296,299,313,425-432,434-436,440-442,444-446,453] BMI ≤25,[443] BMI 24-28,[452] BMI ≥25,[273,438,439,443,449] BMI ≥26,[437] BMI ≥28,[304] BMI ≥29,[402] BMI ≥30[269,433,448,450,451]

Most studies were small with fewer than 100 participants (n=15), between 100 and 200 participants (n=15) or between 201 and 400 participants (n=5). There were seven larger studies — Barakat et al 2013[428] (n=428), , Barakat et al 2018[294] (n=429), da Silva et al 2017a[432] (n=639), Stafne et al[445] (n=855), SongØYgard et al 2012[444] (n=719), Barakat et al 2016[430] (n=765), Ruiz et al 2013[443] (n=962).

Studies were conducted in Argentina (n=1),[425] Australia (n=3),[271,448,450] Brazil (n=4),[270,292,432,437] Canada (n=1),[269] China (n=1),[452] Colombia (n=1),[441] Denmark (n=1),[451] Iran (n=1),[434] Japan (n=1),[299] Kosovo (n=1),[436] the Netherlands (n=1),[438] New Zealand (n=2),[272,273] Norway (n=4),[304,435,444,445] Spain (n=15),[294-296,313,427-431,439,440,446,447,454] Sweden (n=1),[453] United Kingdom (n=1),[433] United States (n=2).[442,449] One multicentre study[402] was conducted in the United Kingdom, Ireland, Netherlands, Austria, Poland, Italy, Spain, Denmark and Belgium.

Types of intervention

Aerobic and resistance exercise interventions generally comprised warm-up and cool-down periods with a core segment of aerobic (treadmill, stationary cycling, walking, dance, circuit training, swimming) and muscle strengthening exercises (including pelvic floor exercises). The exercise session was supervised in 78% of studies. In most studies, exercise was carried out for around 60 minutes, three times a week. Some included additional home-based sessions. The timing of initiation of intervention varied but most continued until close to the time of birth (weeks 36-39). Most studies specified an intensity of 60-80% of maximum heart rate or 12-14 on the Borg scale.

Aerobic exercise interventions included walking, stationary cycling or swimming. The exercise session was supervised in 64% of studies. Duration ranged from 15 minutes, three times a week to 60 minutes, three times a week. In a little more than half of the studies (57%), the intervention was continued until close to the time of birth (weeks 37 to birth). In the remainder, the intervention was discontinued at 27-32 weeks. Intensity was in the range of 60-80% of maximum heart rate or Borg scale 12-16.

Resistance exercise interventions included toning and joint mobilisation and weight training. The timing, duration and intensity of interventions varied. All interventions were supervised.

Maternal outcomes

Mean gestational weight gain was significantly lower in the intervention groups than in the standard care groups (MD -0.95 kg; 95%CI -1.20 to -0.69; 29 RCTs; n=5,680; moderate certainty; analysis 2.1; page 463).

Compared to women in the control groups, among women in the intervention groups, there was a clear reduction in risk of:

- weight gain exceeding IOM guidelines (RR 0.77; 95%CI 0.69 to 0.87; 16 RCTs; n=4,333; low certainty; analysis 4.2; page 464).
- gestational diabetes (RR 0.74; 95%CI 0.60 to 0.90; 20 RCTs; n=5,592; low certainty; analysis 4.3; page 464).
- gestational hypertension (RR 0.51; 95%CI 0.37 to 0.71; 7 RCTs; n=3,060; moderate certainty; analysis 4.4; page 465).
- caesarean section (RR 0.85; 95%CI 0.74 to 0.98; 25 RCTs; n=5,704; moderate certainty; analysis 4.6; page 466).
- antenatal depression (RR 0.44; 95%CI 0.32 to 0.61; 6 RCTs; n=798; moderate certainty; analysis 4.7; page 466)
- postnatal depression (RR 0.47; 95%CI 0.34 to 0.65; 5 RCTs; n=1,613; moderate certainty; analysis 4.8; page 467).

There was no clear difference in:

- risk of pre-eclampsia between groups (RR 0.78; 95%CI 0.53 to 1.15; 7 RCTs; n=2,855; moderate certainty; analysis 4.5; page 465)
- postnatal weight retention (RR -0.20; 95%CI -1.48 to 1.09; 5 RCTs; n=388; moderate certainty; analysis 4.9; page 467).

Infant outcomes

The risk of macrosomia (>4,000 g) was lower in the intervention group than in the standard care group (RR 0.75; 95%CI 0.59 to 0.96; 15 RCTs; n=4,759; moderate certainty; analysis 4.12; page 468).

There was no clear difference in risk of:

- preterm birth (RR 0.95; 95%CI 0.74 to 1.22; 15 RCTs; n=4,388; moderate certainty; analysis 4.10; page 467)
- low birth weight (RR 0.94; 95%CI 0.68 to 1.28; 11 RCTs; n=3,247; moderate certainty; analysis 4.11; page 468)
- small for gestational age (RR 0.76; 95%CI 0.50 to 1.17; 10 RCTs; n=1,581; moderate certainty; analysis 4.13; page 469)
- large for gestational age (RR 0.91; 95%CI 0.61 to 1.36; 9 RCTs; n=1,600; moderate certainty; analysis 4.14; page 469)
- Apgar score <7 at 5 minutes (RR 1.23; 95%CI 0.44 to 3.42; 5 RCTs; n=1,918; moderate certainty; analysis 4.15; page 469).

A small study reporting on outcomes among women who were overweight or obese found no clear difference in infant weight at 1 month (MD –0.19; 95%CI –0.54 to 0.16; n=36) or 6 months (MD –0.04; 95%CI –1.51 to 1.44; n=33).

Summary of findings

Exercise interventions compared to usual care in pregnancy — maternal outcomes

Patient or population: Pregnant women with low or high risk pregnancies

Setting: Argentina, Australia, Austria, Belgium, Brazil, Canada, China, Colombia, Denmark, Iran, Ireland, Italy, Japan, Kosovo, Poland, Netherlands, New Zealand, Norway, Spain, Sweden, United Kingdom, United States

Intervention: Exercise intervention

Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with standard care	**Risk with Any exercise intervention**			
Gestational weight gain	The mean gestational weight gain was **0**	The mean gestational weight gain in the intervention group was 0.95 kg lower (1.20 lower to 0.69 lower)	-	5,680 (29 RCTs)	⨁⨁⨁◯ MODERATE [a]
Weight gain exceeding IOM guidelines	402 per 1,000	**310 per 1,000** (278 to 350)	**RR 0.77** (0.69 to 0.87)	4,333 (16 RCTs)	⨁⨁◯◯ LOW [a,b]
Gestational diabetes	122 per 1,000	**90 per 1,000** (73 to 109)	**RR 0.74** (0.60 to 0.90)	5,592 (20 RCTs)	⨁⨁◯◯ LOW [a,b]
Gestational hypertension	70 per 1,000	**36 per 1,000** (26 to 50)	**RR 0.51** (0.37 to 0.71)	3,060 (7 RCTs)	⨁⨁⨁◯ MODERATE [a]
Pre-eclampsia	39 per 1,000	**35 per 1,000** (24 to 51)	**RR 0.78** (0.53 to 1.15)	2,855 (7 RCTs)	⨁⨁⨁◯ MODERATE [a]
Caesarean section	220 per 1,000	**187 per 1,000** (163 to 216)	**RR 0.85** (0.74 to 0.98)	5,704 (25 RCTs)	⨁⨁⨁◯ MODERATE [a]
Antenatal depression	235 per 1,000	**104 per 1,000** (75 to 144)	**RR 0.44** (0.32 to 0.61)	798 (6 RCTs)	⨁⨁⨁◯ MODERATE [a]
Postnatal depression	114 per 1,000	**53 per 1,000** (39 to 74)	**RR 0.47** (0.34 to 0.65)	1,613 (5 RCTs)	⨁⨁⨁◯ MODERATE [a]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **MD:** Mean difference; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

a. High or unclear risk of performance bias in all studies
b. Moderate heterogeneity

Exercise interventions compared to usual care in pregnancy — infant outcomes

Patient or population: Pregnant women with low or high risk pregnancies

Setting: Argentina, Australia, Austria, Belgium, Brazil, Canada, China, Colombia, Denmark, Iran, Ireland, Italy, Japan, Kosovo, Poland, Netherlands, New Zealand, Norway, Spain, Sweden, United Kingdom, United States

Intervention: Exercise intervention

Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with usual care	Risk with exercise intervention			
Preterm birth	61 per 1,000	**58 per 1,000** (45 to 75)	**RR 0.95** (0.74 to 1.22)	4,388 (15 RCTs)	⨁⨁⨁◯ MODERATE [a]
Low birth weight	49 per 1,000	**46 per 1,000** (34 to 63)	**RR 0.94** (0.68 to 1.28)	3,247 (11 RCTs)	⨁⨁⨁◯ MODERATE [a]
Macrosomia >4,000 g	103 per 1,000	**77 per 1,000** (61 to 99)	**RR 0.75** (0.59 to 0.96)	4,759 (15 RCTs)	⨁⨁⨁◯ MODERATE [a]
Small for gestational age	72 per 1,000	**64 per 1,000** (42 to 99)	**RR 0.76** (0.50 to 1.17)	1,581 (10 RCTs)	⨁⨁⨁◯ MODERATE [a]
Large for gestational age	130 per 1,000	**128 per 1,000** (98 to 170)	**RR 0.91** (0.61 to 1.36)	1,600 (9 RCTs)	⨁⨁⨁◯ MODERATE [a]
Apgar score <7 at 5 min	6 per 1,000	**8 per 1,000** (3 to 22)	**RR 1.23** (0.44 to 3.42)	1,918 (5 RCTs)	⨁⨁⨁◯ MODERATE [a]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **MD:** Mean difference; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

a. High or unclear risk of performance bias in all studies

Comparability of results with other reviews

Other systematic reviews have included some RCTs that were excluded from this review due to wrong study population (eg women with high risk pregnancies for reasons other than BMI) or wrong comparator (eg not standard care). However, the results are largely comparable with those of this review, with most reviews finding a lower weight gain among women with mixed BMIs. While this review found that intervention appeared to reduce gestational weight gain among women who were overweight or obese, other reviews found no clear difference in weight gain in this group.

Table 103: Q9 Findings of systematic reviews of exercise interventions — maternal outcomes

Ref	Population	Effect (95% CI)	Number of studies
Mean gestational weight gain			
Current review	Mixed BMIs	MD −0.95 kg (−1.20 to −0.69)	29
	BMI ≥25	MD −0.84 kg (−1.51 to −0.17)	14
Bernabé et al 2018[455]	Mixed BMIs	MD −0.28 kg (−0.37 to −0.19)	42
da Silva et al 2017b[456]	Mixed BMIs	MD −1.11 (−1.53 to −0.69)	18
Chatzakis et al 2019[457]	Mixed BMIs	MD −0.96 (−1.66 to −0.27)	11
Kramer & McDonald 2006[291]	Mixed BMIs	MD 0.79 (−0.73 to 2.31)	4
Sanabria-Martínez et al 2015[458]	Mixed BMIs	MD −1.14 kg (−1.50 to −0.78)	13
Wiebe et al 2015[459]	Mixed BMIs	MD −1.12 (−1.61 to -0.62)	15
Choi et al 2013[460]	Mixed BMIs	MD −1.74 kg (−3.66 to 0.19)	2
Elliott-Sale et al 2015[461]	Mixed BMIs	MD −2.2 kg (−3.13 to −1.30)	5
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	MD −0.73 (−1.11 to −0.34)	15
	Mixed BMIs; IPD and non-IPD	MD −0.72 (−1.04 to −0.41)	37
Muktabhant et al 2015[417]	Mixed BMIs	MD −1.00 (−2.01 to 0.01)	4
Streuling et al 2011[462]	Mixed BMIs	MD −0.61 (−1.17 to −0.06)	12
Thangaratinam et al 2012a[411]	Mixed BMIs	MD −0.07 (−1.08 to 0.93)	15
Thangaratinam et al 2012b[412]	Mixed BMIs	MD −0.72 (−1.20 to −0.25)	14
Walker et al 2018[463]	Mixed BMIs	MD □−1.02 (−1.56 to −0.49)	27
Wang et al 2019[464]	Mixed BMIs	MD −1.02 (−1.35 to −0.70)	23
Rogozińska et al 2017[409]	Mixed BMIs	MD −0.73 (−1.11 to −0.08)	15
Craemer et al 2019[414]	Mixed BMIs	MD −0.37 (−0.66 to −0.24)	11
Muktabhant et al 2015[417]	BMI ≥25	MD −0.34 (−1.15 to 0.47)	5
Wiebe et al 2015[459]	BMI ≥25	MD −0.3 (−1.13 to 0.52)	3
Shieh et al 2018[410]	BMI ≥25	MD −0.28 (−1.50 to 0.94)	6
Weight gain exceeding IOM guidelines			
Current review	Mixed BMIs	RR 0.77 (0.69 to 0.87)	16
Muktabhant et al 2015[417]	Low risk	RR 0.69 (0.47 to 1.02)	2
Muktabhant et al 2015[417]	Mixed risk	RR 0.77 (0.66 to 0.88)	3
Ruchat et al 2018[465]		RR 0.68 (0.57 to 0.80)	15
Song et al 2016[421]	Mixed BMIs	RR 0.77 (0.54 to 1.09)	10
Muktabhant et al 2015[417]	High risk	RR 0.84 (0.73 to 0.95)	5
Gestational diabetes			
Current review	Mixed BMIs	RR 0.74 (0.60 to 0.90)	20
Chatzakis et al 2019[457]	Mixed BMIs	RR 0.80 (0.60 to 1.07)	10
Davenport et al 2018a[466]	Mixed BMIs	RR 0.62 (0.52 to 0.75)	26
Guo et al 2019[419]	Mixed BMIs	RR 0.70 (0.59 to 0.84)	19
da Silva et al 2017b[456]	Mixed BMIs	RR 0.67 (0.49 to 0.92)	10

Ref	Population	Effect (95% CI)	Number of studies
Bennett et al 2018[418]	Mixed BMIs	RR 0.65 (0.50 to 0.85)	5
Han et al 2012[467]	Mixed BMIs	RR 1.10 (0.66 to 1.84)	3
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 0.67 (0.46 to 0.95)	10
	Mixed BMIs; IPD and non-IPD	OR 0.66 (0.53 to 0.83)	27
Russo et al 2015[468]	Mixed BMIs	RR 0.72 (0.58 to 0.91)	10
Sanabria-Martinez et al 2015[458]	Mixed BMIs	RR 0.69 (0.52 to 0.91)	8
Zheng et al 2017[469]	Mixed BMIs	OR 0.62 (0.43 to 0.89)	4
Ming et al 2018[470]	Healthy weight	RR 0.58 (0.37 to 0.90)	8
Nasiri-Amiri et al 2019[471]	Mixed BMIs	RR 0.76 (0.56 to 1.03)	8
Bennett et al 2018[418]	Overweight and obese	RR 0.62 (0.37 to 1.02)	6
Madhurvata et al 2015[420]	Obese	OR 0.77 (0.33 to 1.79)	3
Gestational hypertension			
Current review	Mixed BMIs	RR 0.51 (0.37 to 0.71)	7
Chatzakis et al 2019[457]	Mixed BMIs	RR 0.63 (0.37 to 1.06)	5
Davenport et al 2018a[466]	Mixed BMIs	RR 0.59 (0.37 to 0.94)	15
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 0.74 (0.42 to 1.33)	7
	Mixed BMIs; IPD and non-IPD	OR 0.68 (0.49 to 0.93)	20
Magro-Malosso et al 2017[472]	Mixed BMIs	RR 0.54 (0.40 to 0.74)	17
Pre-eclampsia			
Current review	Mixed BMIs	RR 0.78 (0.53 to 1.15)	7
Chatzakis et al 2019[457]	Mixed BMIs	RR 0.87 (0.58 to 1.32)	6
Davenport et al 2018a[466]	Mixed BMIs	RR 0.61 (0.43 to 0.85)	23
da Silva et al 2017b[456]	Mixed BMIs	RR 0.93 (0.55 to 1.57)	3
Han et al 2012[467]	Mixed BMIs	RR 1.00 (0.51 to 1.97)	2
Magro-Malosso et al 2017[472]	Mixed BMIs	RR 0.79 (0.45 to 1.38)	7
Muktabhant et al 2015[417]	Mixed BMIs	RR 0.99 (0.58 to 1.66)	4
Syngelaki et al 2019[423]	Mixed BMIs	RR 1.13 (0.45 to 2.86)	3
Zheng et al 2017[469]	Mixed BMIs	OR 1.05 (0.53 to 2.07)	2
Caesarean section			
Current review	Mixed BMIs	RR 0.85 (0.74 to 0.98)	25
Chatzakis et al 2019[457]	Mixed BMIs	RR 0.99 (0.85 to 1.17)	9
Davenport et al 2019d[473]	Mixed BMIs	OR 0.91 (0.79 to 1.05)	46
Domenjoz et al 2014[474]	Mixed BMIs	RR 0.85 (0.73 to 0.99)	16
Poyatos-Leon et al 2015[475]	Mixed BMIS	RR 0.78 (0.58 to 1.05)	10
Han et al 2012[467]	Mixed BMIs	RR 1.33 (0.97 to 1.84)	2
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 0.82 (0.67 to 1.01)	13
	Mixed BMIs; IPD and non-IPD	OR 0.83 (0.73 to 0.95)	32
Magro-Malosso et al 2017[472]	Mixed BMIs	RR 0.84 (0.73 to 0.98)	14
Muktabhant et al 2015[417]	Mixed risk	RR 0.96 (0.76 to 1.22)	6
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 0.92 (0.68 to 1.24)	4
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 0.88 (0.66 to 1.17)	5
Muktabhant et al 2015[417]	High risk	RR 0.98 (0.81 to 1.20)	5
Antenatal depression			
Current review	Mixed BMIs	RR 0.44 (0.32 to 0.61)	6
Davenport et al 2019e[476]	Mixed BMIs	OR 0.33 (0.21 to 0.53)	5

Ref	Population	Effect (95% CI)	Number of studies
Postnatal depression			
Current review	Mixed BMIs	RR 0.47 (0.34 to 0.65)	5
Nakamura et al 2019[477]	Mixed BMIs	SMD −0.58 (−1.09 to −0.08)	6
Postnatal weight retention			
Current review	Mixed BMIs	MD −0.20 (−1.48 to 1.09)	5
Ruchat et al 2018[465]	Mixed BMIs	MD −0.92 (−1.84 to 0.00)	3

Table 104: Q9 Findings of systematic reviews of exercise interventions — infant outcomes

Ref	Population	Effect (95% CI)	Number of studies
Preterm birth			
Current review	Mixed BMIs	RR 0.95 (0.74 to 1.22)	15
Aune et al 2017[478]	Mixed BMIs	RR 0.91 (0.72 to 1.15)	21
Chatzakis et al 2019[457]	Mixed BMIs	RR 1.11 (0.57 to 2.19)	6
Davenport et al 2018b[479]	Mixed BMIs	RR 1.12 (0.88 to 1.42)	27
Di Mascio et al 2016[480]	Normal weight range	RR 1.01 (0.68 to 1.50)	8
Zheng et al 2017[469]	Mixed BMIs	OR 0.93 (0.44 to 1.99)	2
Muktabhant et al 2015[417]	Mixed risk	RR 1.92 (0.75 to 4.93)	3
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 1.12 (0.44 to 2.85)	4
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 1.22 (0.51 to 2.90)	5
Muktabhant et al 2015[417]	High risk	RR 1.34 (0.51 to 3.55)	3
Magro-Malosso et al 2017[480]	High risk	RR 0.62 (0.41 to 0.95)	10
Low birthweight			
Current review	Mixed BMIs	RR 0.94 (0.68 to 1.28)	11
Davenport et al 2018b[479]	Mixed BMIs	RR 0.91 (0.70 to 1.20)	15
Macrosomia >4,000g			
Current review	Mixed BMIs	RR 0.75 (0.59 to 0.96)	15
Davenport et al 2018b[479]	Mixed BMIs	RR 0.97 (0.83 to 1.13)	15
Han et al 2012[467]	Mixed BMIs	RR 0.91 (0.68 to 1.22)	2
Muktabhant et al 2015[417]	Mixed risk	RR 0.81 (0.64 to 1.02)	7
Oostdam et al 2011[424]	Mixed BMIs	RR 0.36 (0.13 to 0.99)	2
Muktabhant et al 2015[417]	High risk	RR 0.65 (0.22 to 1.91)	3
Small for gestational age			
Current review	Mixed BMIs	RR 0.76 (0.50 to 1.17)	10
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 1.05 (0.84 to 1.34)	14
	Mixed BMIs; IPD and non-IPD	OR 1.01 (0.83 to 1.24)	21
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 1.31 (0.50 to 3.42)	3
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 1.28 (0.52 to 3.15)	4
da Silva et al 2017b[456]	Mixed BMIs	RR 1.08 (0.66 to 1.76)	4
Wiebe et al 2015[459]	Low risk	OR 1.10 (0.73 to 1.66)	8
Wiebe et al 2015[459]	Overweight and obese	OR 0.90 (0.31 to 2.63)	2
Large for gestational age			
Current review	Mixed BMIs	RR 0.91 (0.61 to 1.36)	9
Chatzakis et al 2019[457]	Mixed BMIs	RR 1.00 (0.66 to 1.49)	7
Guillemette et al 2018[481]	Mixed BMIs	RR 0.85 (0.51 to 1.44)	7

Ref	Population	Effect (95% CI)	Number of studies
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 0.96 (0.59 to 1.54)	15
	Mixed BMIs; IPD and non-IPD	OR 0.96 (0.67 to 1.37)	21
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 0.37 (0.06 to 2.30)	2
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 0.52 (0.25 to 1.09)	4
da Silva et al 2017b[456]	Mixed BMIs	RR 0.51 (0.30 to 0.87)	3
Wiebe et al 2015[459]	Low risk	OR 0.68 (0.54 to 0.87)	13
Wiebe et al 2015[459]	Overweight and obese	OR 0.71 (0.36 to 1.41)	3
Apgar score <7 at 5 min			
Current review	Mixed BMIs	RR 1.23 (0.44 to 3.42)	5
Han et al 2012[467]	Mixed BMIs	RR 1.00 (0.27 to 3.65)	2
Zheng et al 2017[469]	Mixed BMIs	OR 0.78 (0.21 to 2.91)	2

5.1.3 Lifestyle counselling on weight gain, diet, exercise and self-monitoring

Types of study

This review includes 42 studies described in 64 papers and including 13,618 women. Study populations were heterogeneous and included women with BMI in the healthy weight range,[482-484] of mixed BMIs,[485-498] with BMI ≥25,[499-509] BMI ≥29[402,510,511] or BMI ≥30[451,512-515] or women at increased risk of gestational diabetes — defined as one or more risk factors for gestational diabetes (including BMI ≥25)[516-518] or as BMI≥30 and at risk.[519,520] Most studies were small with fewer than 200 participants (n=25) or between 200 and 400 participants (n=12). There were six larger studies — Pears in Ireland (n=565),[506] Fit for Delivery in Norway (n=591),[487] OPTIMISE in Australia (n=629),[484] UPBEAT in the United Kingdom (n=1,555),[513] GeLis in Germany (n=2,009),[497] and LIMIT in Australia (n=2,212).[521]

The studies were conducted in Australia (n=4),[484,500,520,521] Belgium (n=2),[510,511] Canada (n=3),[482,490,491] China (n=2,[492,517] Denmark (n=2),[451,515] Finland (n=3),[516,519,522] Germany (n=2),[496,497] Hong Kong (n=1),[518] India (n=1),[493] Iran (n=1),[498] Ireland (n=1),[506] Italy (n=2),[499,504] the Netherlands (n=1),[485] Norway (n=1),[487] Puerto Rico (n=1),[509] Sweden (n=1),[486] Turkey (n=1),[489] United Kingdom (n=2),[512,513] and United States (n=10).[483,488,494,495,502,503,505,507,508,514] One multicentre study[402] was conducted in the United Kingdom, Ireland, Netherlands, Austria, Poland, Italy, Spain, Denmark and Belgium.

Types of intervention

Of the 42 studies included in this meta-analysis, the majority (n=38) were counselling interventions with a focus on gestational weight gain, diet and exercise. Six studies also involved some form of supervised physical activity.

Weight gain recommendations were based on IOM guidelines in 33 studies.[402,451,482-492,494-500,502,504-508,510,511,513-515,520,522]

Most studies encouraged some form of self-monitoring.[402,451,483,484,486,490,491,494-496,500-505,508,513-515,520,522] This included providing women with weight gain charts,[486,495,507,508,520] log books,[490,491,494,496,503,508,513,514,522] pedometers,[402,451,494,502-504,507,508,513-515,520] self-monitoring text messages[500] or a smart phone app.[505,506]

Dietary components

Some studies provided specific recommendations on fat, carbohydrate and protein intake[482,488,508,510,511,522] and some on kilocalorie intake.[451,482,494,504,509,516] There was little consistency in approach between these studies.

Common themes in other studies included reducing intake of saturated fats[402,451,482,484,485,493,495,496,498,499,505,509,512,513,519,521] and sugar (eg in soft drinks)[485,487,496,498,500,505,512,513,519] and increasing consumption of fruit and vegetables,[484,487,493,495,496,498,500,503,505,519,521] low glycaemic index foods,[482,499,506] and fibre intake[402,483,484,496,503,505,509,519,521]

Not all studies provided detail on the diet promoted through the intervention.

Exercise component

Six studies included supervised exercise programs, which ranged from 60 minutes of moderate intensity exercises twice weekly[487] to weekly sessions of 60-90 minutes,[493] 60 minutes[515] or 45 minutes.[490,491] Two studies

described weekly access to swimming pools and/or guided exercise groups[519] or monthly meetings including group exercise[522] but did not describe content or duration.

The goals of exercise counselling included:

- 30 minutes of moderate intensity exercise daily,[486,505,506,514,517] most days,[485,494,496,498,500,503,508,516] every second day,[489] three or more times a week,[482,488,499,518] or three times a week[504]
- moderate intensity exercise 30 to 60 minutes daily[515]
- a minimum of 800 MET (multiples of resting metabolic equivalents) minutes weekly[522]
- a daily step count of 5,000 (women with BMI≥25) or 11,000 (women with BMI≥30)[451]
- 150 min of moderate-intensity exercise per week.[519]

Other studies did not specify the amount of exercise but were consistent in promoting an increase in physical activity in general[402,483,484,502,509-513,520] and walking specifically.[495,512,513,521]

Maternal outcomes

Mean gestational weight gain was significantly lower in the intervention groups than in the usual care groups (MD -1.25 kg; 95%CI -1.64 to -0.86; 36 RCTs; n=9,083; low certainty; analysis 5.1; page 470).

Compared to women in the control groups, among women in the intervention groups, there was a clear reduction in risk of:

- weight gain exceeding IOM guidelines (RR 0.83; 95%CI 0.78 to 0.89; 29 RCTs; n=7,905; low certainty; analysis 5.2; page 471)
- postnatal weight retention (at last time reported) (MD -1.19; 95%CI -1.62 to -0.76; 11 RCTs; n=2,483; moderate certainty; analysis 5.8; page 474).

There was a probable reduction in risk of:

- gestational diabetes (RR 0.90; 95%CI 0.81 to 1.01; 26 RCTs; n=9,011; moderate certainty; analysis 5.3; page 472)
- caesarean section (RR 0.95; 95%CI 0.89 to 1.02; 25 RCTs; n=9,049; low certainty; analysis 5.6; page 473).

There was no clear difference in:

- gestational hypertension (RR 0.99; 95%CI 0.77 to 1.28; 13 RCTs; n=4,890; low certainty; analysis 5.4; page 472)
- pre-eclampsia (RR 1.06; 95%CI 0.87 to 1.29; 14 RCTs; n=7,069; low certainty; analysis 5.5; page 473)
- antenatal depression (RR 0.99; 95%CI 0.80 to 1.22; 2 RCTs; n=2,908; low certainty; analysis 5.7; page 474)

A single study found no clear difference in antenatal anxiety (RR 1.14; 95%CI 0.88 to 1.46; n=1,382) or postnatal (at 4 months) depression (RR 1.20; 95%CI 0.8 to 1.79; n=1,221) or anxiety (RR 1.24; 95%CI 0.92 to 1.67; n=1,220).

Infant outcomes

Compared to usual care, among women in the intervention groups, there was a clear reduction in risk of macrosomia >4,500 g (RR 0.67; 95%CI 0.46 to 0.97; 5 RCTs; n=3,435; moderate certainty; analysis 5.11; page 476).

There was a probable reduction in risk of:

- preterm birth (RR 0.85; 95%CI 0.72 to 1.01; 18 RCTs; n=7,497; moderate certainty; analysis 5.9; page 475)
- macrosomia >4,000 g (RR 0.91; 95%CI 0.82 to 1.01; 17 RCTs; n=7,644; low certainty; analysis 5.11; page 476)
- low birth weight (RR 0.87; 95%CI 0.65 to 1.17; 3 RCTs; n=3,665; low certainty; analysis 5.10; page 475)
- large for gestational age (RR 0.89; 95%CI 0.79 to 1.00; 22 RCTs; n=8,455; moderate certainty; analysis 5.13; page 477)

There was no clear difference in risk of:

- small for gestational age (RR 1.05; 95%CI 0.89 to 1.25; 16 RCTs; n=5,072; low certainty; analysis 5.12; page 476)
- Apgar score <7 at 5 minutes (RR 0.80; 95%CI 0.48 to 1.32; 3 RCTs; n=2,864; low certainty; analysis 5.14; page 477)
- weight in early childhood (MD −0.09; 95%CI −0.26 to 0.08; 4 RCTs; n=985; low certainty; analysis 5.15; page 477).

Cost-effectiveness

One study[522] (n=93) reported on costs associated with counselling sessions during routine antenatal visits among women at risk of gestational diabetes in Finland. The study found no clear difference in costs to families for care during labour and birth (MD3.00€; 95%CI −10.82 to 16.82) or neonatal care (MD3.00€ 95%CI −13.67 to 19.67). There were also no clear differences in total intervention costs (MD 769.00€; 95%CI −1032.23 to 2570.23) or in costs of maternal primary health care (MD -43.00€; 95%CI -127.61 to 41.61), maternal specialist health care (MD -47.00€;

95%CI -195.33 to 101.33), diabetes nurse visits (MD 6.00€; 95% CI -7.02 to 19.02), dietitian visits (not estimable), costs of use of insulin/other diabetes medications (MD -1.00€; 95%CI -7.83 to 5.83), costs of hospital days before and after birth (MD 101.00€; 95% CI -206.71 to 408.71), birthing cost to the municipality (MD 22.00€; 95% CI -234.43 to 278.43), costs of absence from work (MD 128.00€; 95%CI -1295.58 to 1551.58) or neonatal care cost to municipality (MD 453.00€; 95%CI -298.20 to 1204.20).

The study indicated that intensive lifestyle counselling among women at risk of gestational diabetes was not significantly cost-effective compared to usual care for birth weight, quality of life on a 15-dimension questionnaire or perceived health as measured with a visual analogue scale.

Summary of findings

Lifestyle counselling (weight, diet, exercise, self-monitoring) compared to usual pregnancy care — maternal outcomes

Population: Pregnant women

Setting: Australia, Austria, Belgium, Canada, China, Denmark, Finland, Germany, Hong Kong, India, Ireland, Italy, Netherlands, Norway, Puerto Rico, Poland, Spain, Sweden, Turkey, United Kingdom, United States

Intervention: Diet and exercise intervention

Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with usual care	Risk with diet and exercise intervention			
Gestational weight gain		The mean gestational weight gain in the intervention group was 1.25 kg lower (1.64 lower to 0.86 lower)	-	9,083 (36 RCTs)	⨁⨁◯◯ LOW [a,b]
Weight gain >IOM guidelines	481 per 1,000	**399 per 1,000** (375 to 428)	**RR 0.83** (0.78 to 0.89)	7,905 (29 RCTs)	⨁⨁◯◯ LOW [a,b]
Gestational diabetes	180 per 1,000	**162 per 1,000** (145 to 181)	**RR 0.90** (0.81 to 1.01)	9,011 (26 RCTs)	⨁⨁⨁◯ MODERATE [a]
Gestational hypertension	84 per 1,000	**83 per 1,000** (64 to 107)	**RR 0.99** (0.77 to 1.28)	4,980 (13 RCTs)	⨁⨁◯◯ LOW [a,c]
Pre-eclampsia	51 per 1,000	**54 per 1,000** (44 to 65)	**RR 1.06** (0.87 to 1.29)	7,069 (14 RCTs)	⨁⨁◯◯ LOW [a,c]
Caesarean section	282 per 1,000	**268 per 1,000** (251 to 287)	**RR 0.95** (0.89 to 1.02)	9,049 (25 RCTs)	⨁⨁◯◯ LOW [a,c]
Antenatal depression	104 per 1,000	**103 per 1,000** (83 to 127)	**RR 0.99** (0.80 to 1.22)	2,908 (2 RCTs)	⨁⨁◯◯ LOW [a,c]
Postnatal weight retention (latest time reported)		The mean postnatal weight retention (latest time reported) in the intervention group was 1.19 kg lower (1.62 lower to 0.76 lower)	-	2,483 (11 RCTs)	⨁⨁⨁◯ MODERATE [a]

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **MD:** Mean difference; **RR:** Risk ratio

GRADE Working Group grades of evidence

High certainty: We are very confident that the true effect lies close to that of the estimate of the effect

Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect

Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

a. Risk of performance bias high or unclear in all studies

b. Considerable heterogeneity

c. Confidence interval crosses line of no effect

Lifestyle counselling (weight, diet, exercise, self-monitoring) compared to usual pregnancy care — infant outcomes

Population: Pregnant women
Setting: Australia, Austria, Belgium, Canada, Denmark, Finland, Germany, Hong Kong, Ireland, Italy, Netherlands, Norway, Puerto Rico, Poland, Spain, Sweden, United Kingdom, United States
Intervention: Diet and exercise intervention
Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with usual care	Risk with lifestyle counselling			
Preterm birth	68 per 1,000	**58 per 1,000** (49 to 69)	**RR 0.85** (0.72 to 1.01)	7,497 (18 RCTs)	⨁⨁⨁◯ MODERATE [a]
Low birth weight	50 per 1,000	**44 per 1,000** (33 to 59)	**RR 0.87** (0.65 to 1.17)	3,665 (3 RCTs)	⨁⨁◯◯ LOW [a,b]
Macrosomia - >4000 g	160 per 1,000	**146 per 1,000** (132 to 162)	**RR 0.91** (0.82 to 1.01)	7,664 (17 RCTs)	⨁⨁◯◯ LOW [a,b]
Macrosomia - >4500 g	38 per 1,000	**26 per 1,000** (18 to 37)	**RR 0.67** (0.46 to 0.97)	3,435 (5 RCTs)	⨁⨁⨁◯ MODERATE [a]
Small for gestational age	94 per 1,000	**98 per 1,000** (83 to 117)	**RR 1.05** (0.89 to 1.25)	5,072 (16 RCTs)	⨁⨁◯◯ LOW [a,b]
Large for gestational age	117 per 1,000	**104 per 1,000** (92 to 117)	**RR 0.89** (0.79 to 1.00)	8,445 (22 RCTs)	⨁⨁⨁◯ MODERATE [a]
Apgar score <7 at 5 minutes	23 per 1,000	**19 per 1,000** (11 to 31)	**RR 0.80** (0.48 to 1.32)	2864 (3 RCTs)	⨁⨁◯◯ LOW [a,b]
Childhood weight		The mean childhood weight in the intervention group was 0.09 kg lower (0.26 lower to 0.08 higher)	-	985 (4 RCTs)	⨁⨁◯◯ LOW [a,c]

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **MD:** Mean difference; **RR:** Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

a. Risk of performance bias high or unclear in all studies
b. Confidence interval crosses line of no effect
c. Weights measured at different times

Comparability of results with other reviews

Other systematic reviews have included some RCTs that were excluded from this review due to being outside the timeframe of this review, wrong study population (eg women with high risk pregnancies for reasons other than BMI) or wrong comparator (eg not usual care). However, the results for the primary outcome are largely comparable with those of this review, with most reviews finding a lower weight gain in women in the intervention groups.

Table 105: Q9 Findings of systematic reviews of lifestyle counselling interventions — maternal outcomes

Ref	Population	Effect (95% CI)	Number of studies
Mean gestational weight gain			
Current review	Mixed BMIs	MD -1.25 kg (-1.64 to -0.86)	36
O'Brien et al 2016[523]	BMI in healthy range	MD -1.25 kg (-2.39 to -0.11)	4
Muktabhant et al 2015[417]	Low risk	MD -0.92 kg (-2.12 to 0.29)	2
Choi et al 2013[460]	Mixed BMIs; supervised	MD -1.17 (-2.14 to -0.21)	2
	Mixed BMIs; unsupervised	MD 0.44 (-1.86 to 2.74)	3
Gardner et al 2011[524]	Mixed BMIs	MD -1.19 kg (-1.74 to -0.65)	10
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	MD −0.71 (−1.10 to −0.31)	15
	Mixed BMIs; IPD and non-IPD	MD −1.00 (−1.39 to −0.61)	35
Morison et al 2018[525]	Mixed BMIs	MD −0.21 (−0.34 to −0.08)	10
Muktabhant et al 2015[417]	Mixed risk	MD -1.80 kg (-3.36 to -0.24)	3
Rogozińska et al 2017[409]	Mixed BMIs	MD -0.71 (-1.10 to -0.31)	15
Shepherd et al 2017[526]	Mixed BMIs	MD -0.89 kg (-1.39 to -0.40)	16
Thangaratinam et al 2012a[411]	Mixed BMIs	MD -0.57 (-1.60 to 0.65)	7
Thangaratinam et al 2012b[412]	Mixed BMIs	MD −1.06 (−1.67 to −0.46)	10
Craemer et al 2019[414]	Mixed BMIs	MD −0.37 (−0.49 to −0.24)	22
*Vincze et al 2019[527]	Mixed BMIs	MD -0.76 (-2.01 to 0.49)	13
Walker et al 2018[463]	Mixed BMIs	MD -0.84 (-1.29 to -0.39)	24
Shieh et al 2018[410]	BMI≥25	MD -0.82 (-1.28 to -0.36)	11
Muktabhant et al 2015[417]	High risk	MD -0.71 kg (-1.34 to -0.08)	11
Oteng-Ntim 2012[528]	Overweight and obese women	MD -2.21 kg (-2.86 kg to -1.59)	10
Weight gain exceeding IOM guidelines			
Current review	Mixed BMIs	RR 0.83 (0.78 to 0.89)	29
Muktabhant et al 2015[417]	Low risk	RR 0.72 (0.55 to 0.95)	2
O'Brien et al 2016[523]	BMI in normal range	RR 0.72 (0.60 to 0.86)	5
Muktabhant et al 2015[417]	Mixed risk	RR 0.98 (0.83 to 1.15)	1
Ruchat et al 2018[465]	Mixed risk	RR 0.66 (0.54 to 0.82)	19
Shepherd et al 2017[526]	Mixed BMIs	RR 0.87 (0.79 to 0.96)	11
Thangaratinam 2012a[411]	Mixed BMIs	RR 0.92 (0.49 to 1.72)	2
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 0.89 (0.71 to 1.13)	4
Muktabhant et al 2015[417]	High risk	RR 0.85 (0.71 to 1.02)	9
Gestational diabetes			
Current review	Mixed BMIs	RR 0.90 (0.81 to 1.01)	26
Bennett et al 2018[418]	Normal weight range	RR 0.79 (0.51 to 1.22)	4
Davenport et al 2018a[466]	Mixed BMIs	RR 0.90 (0.74 to 1.10)	22
Guo et al 2019[419]	Mixed BMIs	RR 0.86 (0.71 to 1.04)	18
Bennett et al 2018[418]	Mixed BMIs	RR 0.73 (0.43 to 1.22)	4
International Weight Management in	Mixed BMIs; IPD	OR 1.02 (0.79 to 1.32)	14

Ref	Population	Effect (95% CI)	Number of studies
Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD and non-IPD	OR 0.88 (0.72 to 1.07)	27
Madhuvrata et al 2015[420]	Mixed BMIs	OR 1.44 (0.96 to 2.14)	6
Shepherd et al 2017[526]	Mixed BMIs	RR 0.85 (0.71 to 1.01)	19
Song et al 2016[421]	Mixed BMIs	RR 0.85 (0.70 to 1.03)	14
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 0.96 (0.49 to 1.86)	3
Thangaratinam 2012b[412]	Mixed BMIs	RR 1.18 (0.78 to 1.77)	6
Bennet et al 2018[418]	Overweight and obese women	RR 0.96 (0.82 to 1.14)	14
Oteng-Ntim 2012[528]	Overweight and obese women	OR 0.80 (0.58 to 1.10)	6
Gestational hypertension			
Current review	Mixed BMIs	RR 0.99 (0.77 to 1.28)	13
Davenport et al 2018a[466]	Mixed BMIs	RR 0.95 (0.72 to 1.27)	11
O'Brien et al 2016[523]	BMI in normal range	RR 0.34 (0.13 to 0.91)	2
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 1.05 (0.86 to 1.28)	13
	Mixed BMIs; IPD and non-IPD	OR 1.01 (0.87 to 1.17)	21
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 1.19 (0.74 to 1.90)	3
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 1.08 (0.75 to 1.55)	4
Shepherd et al 2017[526]	Mixed BMIs	RR 0.46 (0.16 to 1.29)	4
Pre-eclampsia			
Current review	Mixed BMIs	RR 1.06 (0.87 to 1.29)	14
Allen et al 2014[422]	Mixed BMIs	RR 0.93 (0.66 to 1.32)	6
Davenport et al 2018a[466]	Mixed BMIs	RR 0.89 (0.73 to 1.08)	12
Muktabhant et al 2015[417]	Mixed BMIs	RR 1.00 (0.75 to 1.34)	7
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 1.48 (0.56 to 3.94)	3
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 1.16 (0.70 to 1.90)	4
Shepherd et al 2017[526]	Mixed BMIs	RR 098 (0.79 to 1.22)	8
Caesarean section			
Current review	Mixed BMIs	RR 0.95 (0.89 to 1.02)	25
Davenport et al 2019d[473]	Mixed BMIs	OR 0.87 (0.79 to 0.97	21
Muktabhant et al 2015[417]	Mixed BMIs	RR 0.89 (0.80 to 1.00)	9
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 0.95 (0.84 to 1.08)	16
	Mixed BMIs; IPD and non-IPD	OR 0.92 (0.80 to 1.06)	28
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 0.95 (0.7 to 1.28)	5
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 0.94 (0.79 to 1.13)	8
Shepherd et al 2017[526]	Mixed BMIs	RR 0.95 (0.88 to 1.02)	14
Oteng-Ntim 2012[528]	Overweight and obese women	OR 0.96 (0.68 to 1.36)	6
Postnatal weight retention			
Current review	Mixed BMIs	MD −1.19 (−1.62 to −0.76)	11
Ruchat et al 2018[465]	Mixed risk	MD −0.85 (−1.46 to −0.25)	8

* Includes one study that involved only dietary advice.

Table 106: Q9 Findings of systematic reviews of lifestyle counselling interventions — infant outcomes

Ref	Population	Effect (95% CI)	Number of studies
Preterm birth			
Current review	Mixed BMIs	RR 0.85 (0.72 to 1.01)	18
Davenport et al 2018b[479]	Mixed BMIs	RR 0.88 (0.67 to 1.16)	14
Muktabhant et al 2015[417]	Mixed BMIs	RR 0.94 (0.57 to 1.55)	7
Thangaratinam et al 2012a[411]	Mixed BMIs	RR 1.02 (0.47 to 2.21)	3
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 0.90 (0.55 to 1.47)	4
Shepherd et al 2017[526]	Mixed BMIs	RR 0.80 (0.65 to 0.98)	11
Low birthweight			
Current review	Mixed BMIs	RR 0.87 (0.65 to 1.17)	3
Davenport et al 2018b[479]	Mixed BMIs	RR 0.90 (0.62 to 1.33)	5
Macrosomia > 4,000g			
Current review	Mixed BMIs	RR 0.91 (0.82 to 1.01)	17
Davenport et al 2018b[479]	Mixed BMIs	RR 0.97 (0.83 to 1.13)	16
Muktabhant et al 2015[417]	Mixed BMIs	RR 0.92 (0.77 to 1.11)	10
Madhuvrata et al 2015[420]	Mixed BMIs	OR 0.99 (0.72 to 1.36)	5
Shepherd et al 2017[526]	Mixed BMIs	RR 0.89 (0.78 to 1.01)	9
Macrosomia > 4,500g			
Current review	Mixed BMIs	RR 0.67 (0.46 to 0.97)	5
Shepherd et al 2017[526]	Mixed BMIs	RR 0.63 (0.42 to 94)	4
Small for gestational age			
Current review	Mixed BMIs	RR 1.05 (0.89 to 1.25)	16
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 1.08 (0.92 to 1.28)	16
	Mixed BMIs; IPD and non-IPD	OR 1.08 (0.93 to 1.27)	20
Shepherd et al 2017[526]	Mixed BMIs	RR 1.20 (0.95 to 1.52)	6
Thangaratinam 2012a[411]	Mixed BMIs	RR 0.76 (0.39 to 1.48)	2
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 0.88 (0.53 to 1.44)	4
Large for gestational age			
Current review	Mixed BMIs	RR 0.89 (0.79 to 1.00)	22
Madhuvrata et al 2015[420]	Mixed BMIs	OR 0.88 (0.38 to 2.02)	2
Morison et al 2018[525]	Mixed BMIs	OR 0.58 (0.36 to 0.94)	5
Muktabhant et al 2015[417]	Mixed BMIs	RR 1.39 (0.75 to 2.56)	1
International Weight Management in Pregnancy Collaborative 2017[415]	Mixed BMIs; IPD	OR 0.89 (0.67 to 1.17)	16
	Mixed BMIs; IPD and non-IPD	OR 0.83 (0.62 to 1.10)	21
Thangaratinam 2012a[411]	Mixed BMIs	RR 0.75 (0.41 to 1.38)	5
Thangaratinam et al 2012b[412]	Mixed BMIs	RR 1.05 (0.79 to 1.40)	9
Shepherd et al 2017[526]	Mixed BMIs	RR 0.93 (0.81 to 1.07)	11
Oteng-Ntim 2012[528]	Overweight and obese women	OR 0.91 (0.62 to 1.32)	6
Apgar score <7 at 5 minutes			
Current review	Mixed BMIs	RR 0.80 (0.48 to 1.32)	3
Thangaratinam 2012a[411]	Mixed BMIs	RR 0.45 (0.04 to 4.87)	1
Shepherd et al 2017[526]	Mixed BMIs	RR 0.80 (0.48 to 1.32)	3
Weight in early childhood			
Current review	Mixed BMIs	MD -0.09 (-0.26 to 0.08)	4
Shepherd et al 2017[526]	Mixed BMIs	MD -0.05 (-0.33 to 0.22)	3

5.1.4 Cost-effectiveness

A systematic review that assessed cost-effectiveness analyses of lifestyle interventions compared with usual care found that results were inconsistent and further research is required to determine the effective components of lifestyle interventions and to guide future cost-effectiveness analyses.[529]

Three studies examined the cost-effectiveness of interventions to promote healthy eating and/or exercise among pregnant women at risk of gestational diabetes[530,531] or women who were overweight or obese.[532]

- The cost-effectiveness analyses of the FitFor2 exercise program[530] showed that it was not cost-effective in comparison to the control group for blood glucose levels, insulin sensitivity, infant birth weight or quality-adjusted life years.
- In the DALI program, women were randomised to a healthy eating and physical activity intervention, a healthy eating intervention, a physical activity intervention or usual care. The cost-effectiveness analyses of the program,[531] found that between-group total cost and effect differences were not significant, other than significantly less gestational weight gain in the healthy eating and physical activity group compared with the usual care group at 35–37 weeks. Cost-effectiveness acceptability curves indicated that the healthy eating and physical activity intervention was the preferred intervention strategy. At 35–37 weeks, it depends on the decision-makers' willingness to pay per kilogram reduction in gestational weight gain whether the HE + PA intervention is cost-effective for gestational weight gain, whereas it was not cost-effective for fasting glucose and HOMA-IR. After birth, the healthy eating and physical activity intervention was cost-effective for quality-adjusted life years, which was predominantly caused by a large reduction in birth-related costs.
- A cost-effectiveness analysis of Pears dietary and exercise advice intervention, found that such an intervention could be cost-effective but a better understanding of the short- and long-term costs of large for gestational age and weight gain exceeding IOM recommendations is necessary to confirm the results.[532]

5.1.5 Evidence summary

This review and meta-analysis assessed the effectiveness in reducing weight gain and other adverse outcomes among pregnant women of dietary interventions with no exercise component, exercise interventions, and lifestyle counselling about weight gain, diet, exercise and self-monitoring.

Databases searched included Embase, CINAHL, Pubmed (1998 to 6/7/18) and Cochrane Library (01/01/2016 to 17/08/2018). Studies were included if they were randomised controlled trials, in English, the population studied was healthy pregnant women (ie women who do not have identified pre-existing conditions and are not at higher risk of complications such as in multiple pregnancy), a dietary, exercise or lifestyle counselling intervention was compared to usual care and any of the pre-specified outcomes were reported.

Outcomes

Maternal outcomes were mean gestational weight gain, weight gain exceeding Institute of Medicine (IOM) guidelines, gestational diabetes, gestational hypertension, pre-eclampsia, caesarean section, depression and postnatal weight retention. Infant outcomes were preterm birth, low birth weight, macrosomia, small for gestational age, large for gestational age, Apgar score <7 at 5 minutes and early childhood weight.

Results

The evidence shows a lower mean gestational weight gain among women participating in a dietary intervention (very low certainty), exercise intervention (moderate certainty) or lifestyle counselling intervention (low certainty). These interventions also lowered the risk of weight gain exceeding guidelines (very low to low certainty).

Dietary interventions showed no clear difference in risk of gestational diabetes (very low certainty), exercise interventions showed reduced risk (low certainty) and lifestyle counselling showed a probable reduction in risk (moderate certainty).

There was a reduction in risk of gestational hypertension with dietary intervention or exercise intervention (moderate certainty) but no clear difference in risk with lifestyle counselling (low certainty). There was no clear difference in risk of pre-eclampsia with any type of intervention (low to moderate certainty).

There was no clear difference in risk of caesarean section with a dietary intervention (very low certainty) but a reduction in risk with exercise intervention (moderate certainty) and a probable reduction in risk with lifestyle counselling (low certainty).

There was a reduction in risk of antenatal and postnatal depression with exercise intervention (moderate certainty) and no clear difference with lifestyle counselling.

There was no clear difference in postnatal weight retention with a dietary intervention (very low certainty) or exercise intervention (moderate certainty) and a reduction with lifestyle counselling (moderate certainty).

The risk of preterm birth was reduced with a dietary intervention, probably reduced with lifestyle counselling and not changed exercise intervention (moderate certainty). There was no clear difference in risk of macrosomia >4,000g with dietary intervention (very low certainty) but a reduction in risk with exercise intervention (moderate certainty) and a probable reduction in risk with lifestyle counselling (low certainty). There was a reduction of risk of macrosomia >4,500 g with lifestyle counselling (moderate certainty). There was no clear difference in risk of low birth weight with an exercise intervention (moderate certainty) but a possible reduction in risk with lifestyle counselling (low certainty). There was a possible reduction in risk of large-for-gestational age with lifestyle counselling (moderate certainty) but no clear difference in risk with the other interventions.

There was no clear difference in risk of small-for-gestational age, Apgar score <7 at 5 minutes or weight in early childhood with any intervention.

Table 107: Q9 Summary of maternal outcomes by intervention

Outcome	Intervention	Effect	Certainty
Gestational weight gain	Diet	MD -3.76 kg; 95%CI -6.38 to -1.13	⨁◯◯◯
	Exercise	MD -0.95 kg; 95%CI -1.20 to -0.69	⨁⨁⨁◯
	Lifestyle counselling	MD -1.25 kg; 95%CI -1.64 to -0.86	⨁⨁◯◯
Weight gain exceeding guidelines	Diet	RR 0.65; 95%CI 0.54 to 0.77	⨁◯◯◯
	Exercise	RR 0.77; 95%CI 0.69 to 0.87	⨁⨁◯◯
	Lifestyle counselling	RR 0.83; 95%CI 0.78 to 0.89	⨁⨁◯◯
Gestational diabetes	Diet	RR 0.86; 95%CI 0.64 to 1.17	⨁◯◯◯
	Exercise	RR 0.74; 95%CI 0.60 to 0.90	⨁⨁◯◯
	Lifestyle counselling	RR 0.90; 95%CI 0.81 to 1.01	⨁⨁⨁◯
Gestational hypertension	Diet	RR 0.29; 95%CI 0.13 to 0.61	⨁⨁⨁◯
	Exercise	RR 0.51; 95%CI 0.37 to 0.71	⨁⨁⨁◯
	Lifestyle counselling	RR 0.99; 95%CI 0.77 to 1.28	⨁⨁◯◯
Pre-eclampsia	Diet	RR 0.61; 95%CI 0.25 to 1.46	⨁⨁◯◯
	Exercise	RR 0.78; 95%CI 0.53 to 1.15	⨁⨁⨁◯
	Lifestyle counselling	RR 1.05; 95%CI 0.85 to 1.29	⨁⨁◯◯
Caesarean section	Diet	RR 0.85; 95%CI 0.64 to 1.11	⨁◯◯◯
	Exercise	RR 0.85; 95%CI 0.74 to 0.98	⨁⨁⨁◯
	Lifestyle counselling	RR 0.95; 95%CI 0.89 to 1.02	⨁⨁◯◯
Antenatal depression	Exercise	RR 0.44; 95%CI 0.32 to 0.61	⨁⨁⨁◯
	Lifestyle counselling	RR 0.99; 95%CI 0.80 to 1.22	⨁⨁◯◯
Postnatal depression	Exercise	RR 0.47; 95%CI 0.34 to 0.65	⨁⨁⨁◯
Postnatal weight retention	Diet	MD -0.55; 95%CI -2.02 to 0.92	⨁◯◯◯
	Exercise	MD -0.20; 95%CI -1.48 to 1.09	⨁⨁⨁◯
	Lifestyle counselling	MD -1.19; 95%CI -1.62 to -0.76	⨁⨁⨁◯

Table 108: Q9 Summary of infant outcomes by intervention

Outcome	Intervention	Effect	Certainty
Preterm birth	Diet	RR 0.43; 95%CI 0.24 to 0.79	⨁⨁⨁◯
	Exercise	RR 0.95; 95%CI 0.74 to 1.22	⨁⨁⨁◯
	Lifestyle counselling	RR 0.85; 95%CI 0.72 to 1.01	⨁⨁⨁◯
Macrosomia >4,000 g	Diet	RR 0.97; 95%CI 0.84 to 1.11	⨁◯◯◯
	Exercise	RR 0.75; 95%CI 0.59 to 0.96	⨁⨁⨁◯
	Lifestyle counselling	RR 0.91; 95%CI 0.82 to 1.01	⨁⨁◯◯
Macrosomia >4,500 g	Lifestyle counselling	RR 0.67; 95%CI 0.46 to 0.97	⨁⨁⨁◯
Low birth weight	Exercise	RR 0.94; 95%CI 0.68 to 1.28	⨁⨁⨁◯
	Lifestyle counselling	RR 0.87; 95%CI 0.65 to 1.17	⨁⨁◯◯
Small for gestational age	Diet	RR 0.59; 95%CI 0.22 to 1.69	Single study
	Exercise	RR 0.76; 95%CI 0.50 to 1.17	⨁⨁⨁◯
	Lifestyle counselling	RR 1.10; 95%CI 0.12 to 1.32	⨁⨁◯◯
Large for gestational age	Diet	RR 0.89; 95%CI 0.35 to 2.25	Single study
	Exercise	RR 0.91; 95%CI 0.61 to 1.36	⨁⨁⨁◯
	Lifestyle counselling	RR 0.89; 95%CI 0.79 to 1.00	⨁⨁⨁◯
Apgar score <7 at 5 minutes	Exercise	RR 1.23; 95%CI 0.44 to 3.42	⨁⨁⨁◯
	Lifestyle counselling	RR 0.80; 95%CI 0.48 to 1.32	⨁⨁◯◯
Weight in early childhood	Diet	MD -0.03; 95%CI -0.26 to 0.31	⨁⨁◯◯
	Lifestyle counselling	MD -0.09 kg; 95%CI -0.26 to 0.08	⨁⨁◯◯

Conclusions

Dietary interventions

The evidence suggests that, among pregnant women, a dietary approach that focuses on healthy eating and includes reducing saturated fats and sugars and increasing consumption of fruit and vegetables, protein and fibre reduces mean gestational weight gain. It also appears to reduce the risk of gestational weight gain exceeding the IOM guidelines, gestational hypertension and preterm birth. There was no clear difference in the risk of other adverse outcomes (gestational diabetes, pre-eclampsia, caesarean section or macrosomia). There was no clear effect on postnatal weight retention or early childhood weight. The certainty of the evidence ranged from very low to moderate.

Exercise interventions

The evidence suggests that, among pregnant women, a combination of moderate (60-80% of maximum heart rate or Borg scale 12-16) aerobic and resistance exercise for 180 minutes per week reduces gestational weight gain. It also appears to reduce the risk of gestational weight gain exceeding the IOM guidelines, gestational diabetes, gestational hypertension, having a caesarean section, experiencing depression during pregnancy and having a baby with macrosomia. There was no clear difference in the risk of other adverse outcomes (pre-eclampsia, preterm birth, low birth weight, small for gestational age, large for gestational age, Apgar score lower than 7 at 5 minutes). The certainty of the evidence ranged from low to moderate.

Lifestyle counselling and self-monitoring

The evidence suggests that, among pregnant women, antenatal lifestyle counselling about weight gain, diet and exercise and advice on self-monitoring may reduce gestational weight gain. It may also reduce the risk of gestational weight gain exceeding the IOM guidelines, postnatal weight retention, preterm birth and macrosomia >4,500 g. It probably reduces the risk of gestational diabetes, caesarean section, macrosomia >4,000g, low birthweight and large for gestational age. It was not clear if lifestyle counselling influences the risk of other adverse outcomes (gestational hypertension, pre-eclampsia, depression, anxiety, small for gestational age, Apgar score lower than 7 at 5 minutes and childhood weight). The certainty of the evidence ranged from very low to moderate.

Consumer summary

A healthy diet during pregnancy reduces weight gain and the risk of some pregnancy complications (such as high blood pressure and preterm birth). Dietary approaches include increasing the amount of vegetables, fruit and fibre (eg through wholegrain foods) and reducing intake of saturated fats (eg by replacing them with polyunsaturated fats) and sugar (eg in soft drinks). These approaches do not appear to change the risk of gestational diabetes, pre-eclampsia, caesarean section or having a large baby and do not appear to affect weight retention after the birth or early childhood weight.

Exercise during pregnancy reduces weight gain and the risk of some pregnancy complications (such as gestational diabetes, high blood pressure, caesarean section and having a large baby). It also reduces the risk of experiencing depression during pregnancy. These benefits are gained from a combination of moderate intensity physical activity (eg brisk walking, swimming, dancing, stationary cycling) and muscle strengthening exercises for 3 hours a week throughout pregnancy. These activities do not appear to change the risk of giving birth preterm or having a small baby.

When women receive lifestyle counselling about recommended weight gain, diet, exercise and self-monitoring as part of pregnancy care, they are more likely to gain an appropriate amount of weight during pregnancy, to retain less weight after the birth; and probably less likely to have gestational diabetes or a caesarean birth. The risk of giving birth preterm or having a baby with a high birth weight may also be reduced. These activities do not appear to change the risk of experiencing high blood pressure, depression or anxiety. They do not appear affect the growth of the baby or weight in early childhood.

5.1.6 Evidence tables

Table 109: Q9 Outcomes associated with dietary intervention versus usual care in randomised controlled trials

Study ref	N	Aim/population/setting/intervention	Outcomes
Abdel-Aziz et al 2018[400] Egypt	Intervention 75 Control 72	**Aim**: To assess the effect of dietary counselling on excessive gestational weight gain. **Population**: Primigravidae aged between 20 and 30 years <12 weeks gestation. **Intervention**: Women in the intervention group received standard care and attended six extra counselling sessions with the nutrition counsellor, with face-to-face appointments every 2 weeks during the implementation phase. All women in the intervention group received three brief (10–15 minutes) supportive phone calls from the nutrition counsellor during the intervention. The nutrition counsellor educated participants on how to choose healthier foods (whole grains, fruits and vegetables, healthy fats, and protein sources); how to limit intake of unhealthy foods (refined grains and sweets) and beverages (sugary drinks); and how to get rid of the unhealthy habits (frying food, eating fast food, skipping meals, and eating unhealthy snacks between meals).	Intervention vs control: • Weight gain exceeding IOM guidelines: 38/75 vs 54/72 • Gestational diabetes: 2/75 vs 5/72 • Pregnancy-induced hypertension: 4/75 vs 14/72 • Caesarean section: 10/75 vs 21/72 • Preterm birth: 7/75 vs 18/72 • Macrosomia: 5/75 vs 14/72

Study ref	N	Aim/population/setting/intervention	Outcomes
Di Carlo 2014[401] Italy	Intervention 61 Control 59	**Aim**: To compare the efficacy of a personal dietary intervention on gestational weight gain control with a general intervention promoting healthy eating. **Population**: Low-risk pregnant women. **Intervention**: Women received a personalised diet plan and close follow-up by a dietician. Individualised diet plans had an average daily caloric intake of 1,916 kcal. A typical weekly diet plan included five meals per day, distributed throughout the day as follows: breakfast (milk or yoghurt, biscuits or toasted bread), snack (fruits or crackers), lunch (pasta or rice with vegetables, limiting the association of potatoes and tomato sauce, and a side-dish with vegetables), snack (fruits), and dinner (white meat or fish, limiting to once a week dairy products, cheese, eggs, and ham, associated with a side-dish of vegetables and bread). The only fat allowed, as a preparation or dressing for all meals, was olive oil. Women were scheduled for monthly follow-up appointments with a dietician who monitored their weight gain, discussed any potential issues, gave further suggestions and answered questions, as needed.	Intervention vs control: • Gestational weight gain: 8.2±4.0 vs 13.4±4.2 kg; p<0.001 • Weight gain exceeding 12 kg: 3/61 vs 34/59 • Caesarean section: 26/61 vs 33/59

Study ref	N	Aim/population/setting/intervention	Outcomes
Laitinen et al 2009[240] Finland	Intervention 69 Control 66	**Aim**: To examine whether supplementation of probiotics with dietary counselling affects glucose metabolism in normoglycaemic pregnant women. **Population**: Women who were less than 17 weeks' gestation and had no metabolic or chronic diseases such as diabetes. **Intervention**: At 1st trimester 256 pregnant women were allocated to 3 groups: modification of dietary intake according to current recommendations with probiotics or placebo and a control group receiving placebo only. Dietary counselling given by a dietitian at each study visit aimed to modify dietary intake to conform with that currently recommended, particular attention being paid to the quality of dietary fat.	Intervention (diet plus placebo) vs control (placebo only): • Gestational weight gain: 14.8±5.1 (n=86) vs 14.8±5.1 (n=85) • Weight gain exceeding IOM guidelines: 35/86 vs 39/85 • Gestational diabetes: 27/76 vs 25/73 • Caesarean section: 12/77 vs 11/76 • Preterm birth: 1/79 vs 1/79 • Childhood weight: 8.23±0.986 (n=73) vs 8.26±
Simmons et al 2017[402] United Kingdom, Ireland, Netherlands, Austria, Poland, Italy, Spain, Denmark and Belgium	Intervention 113 Control 105 4-armed; control group divided by three	**Aim:** to compare the effectiveness of 3 lifestyle interventions [healthy eating (HE), physical activity (PA), and both HE and PA (HE+PA)] with usual care (UC) in reducing GDM risk. **Population**: pregnant women at with a body mass index (BMI) of ≥29 kg/m, ≤19±6 and aged ≥18 years and without GDM using the International Association of Diabetes and Pregnancy Study Group criteria. **Intervention**: The HE intervention promoted lower simple and complex carbohydrates, lower fat, higher fibre and higher protein, including a focus on portion size and, therefore, a more limited intake of total calories.	Intervention vs control: • Gestational weight gain: 8.0±4.7 (n=74) vs 8.8±4.7 (n=26) • Weight gain >IOM guidelines: 53/74 vs 20/26 • Gestational diabetes: 27/84 vs 11/31 • Small for gestational age: 10/101 vs 2/30 • Large for gestational age: 15/101 vs 5/30

Study ref	N	Aim/population/setting/intervention	Outcomes
Thornton et al 2009[403] United States	Intervention 116 Control 116	**Aim**: to assess the outcomes of placing nondiabetic, obese, pregnant women on a monitored, calorie-appropriate nutritional regimen for fear of fetal growth restriction, low birth weight, or starvation ketosis **Population**: Obese women (BMI ≥30 kg/m2) with singleton pregnancy, between 12 and 28 weeks of gestation **Intervention**: Dietary advice focused on healthy eating. Women were prescribed a balanced nutritional diet based on their weight at study entry and were asked to record all food and drink consumed each day in a food diary; these records were reviewed at each prenatal visit by the physician. Women were counselled at least once by registered dietitian regarding conventional nutrition guidelines, with more detailed dietary intake advice compared with the control group women; the nutrition regimen was similar to that used for GDM at the time: 18 to 24 kcal/kg consisting of 40% carbohydrates, 30% protein and 30% fat; at least 2000 calories	Intervention vs control: • Gestational weight gain: 4.99±6.79 (n=116) vs 14.06±7.4 (n=116) • Gestational diabetes: 11/116 vs 19/116 • Gestational hypertension: 3/116 vs 10/116 • Pre-eclampsia: 7/116 vs 11/116 • Caesarean section: 91/116 vs 83/116 • Preterm birth: 3/116 vs 5/116 • Macrosomia (>4500g): 9/116 vs 4/116 • Apgar score >7 at 5 minutes: 1/116 vs 0/116
Walsh et al 2012[405-407] ROLO Ireland	Intervention 372 Control 387	**Aim**: To determine if a low glycaemic index diet in pregnancy could reduce the incidence of macrosomia in an at-risk group. **Population**: Women without diabetes, all in their second pregnancy, having previously had an infant weighing greater than 4 kg. **Intervention**: A low glycaemic index diet from early pregnancy. The dietary intervention involved a single 1–2 h session with a fully trained dietician for groups of 2–6 women. Verbal and written information and advice was given on overall healthy eating and low GI diet.	Intervention vs control: • Gestational weight gain: 12.2±4.4 (n=372) vs 13.7±4.9 (n=387) • Gestational diabetes: 12/350 vs 18/371 • Caesarean section: 66/373 vs 85/387 • Postnatal weight retention at 3 months: -14.25±5.52 (n=88) vs -13.9±4.23 (n=77) • Postnatal weight retention at 5 years: -0.09±6.18 (n=185) vs 0.10±5.94 (n=181) • Preterm birth: 3/372 vs 8/387 • Macrosomia >4000 g: 189/372 vs 199/387 • Childhood weight at 3 months: 6.99±4.36 (n=211) vs 6.76±0.98 (n=211)

Study ref	N	Aim/population/setting/intervention	Outcomes
Wolff et al 2008[404] Denmark	Intervention 23 Control 30	**Aim**: To determine whether gestational weight gain in obese women can be restricted by 10-h dietary consultations and whether this restriction affects the pregnancy-induced changes in glucose metabolism. **Population**: Caucasian pregnant women with uncomplicated pregnancy, aged 18-45 years, 12-18 weeks gestation, BMI ≥30 kg/m2. **Intervention**: Dietary consultations (healthy diet, restriction of energy intake);10 consultations of 1 hr each with a dietician during the pregnancy.	Intervention vs control: • Gestational weight gain: 6.6±5.5 (n=23) vs 13.3±7.5 (n=27) • Gestational diabetes: 0/23 vs 3/30 • Gestational hypertension: 1/23 vs 4/27 • Pre-eclampsia: 0/23 vs 1/27 • Caesarean section: 2/23 vs 3/27 • Postnatal weight retention at 4 weeks: -4.5±12.6 (n=16) vs 2.4±12.6 (n=19)

Table 110: Q9 Outcomes associated with exercise intervention versus usual care in randomised controlled trials

Study ref	N	Aim/population/intervention	Outcomes
Aguilar-Condero et al 2018[447] Spain SWEP	Intervention 65 Control 64	**Aim**: To determine whether physical activity during pregnancy alleviates postnatal depression. **Population**: Women with uncomplicated and singleton pregnancies and no contraindications to physical activity at 12 to 20 weeks. Mixed BMIs. **Intervention**: • *Supervised*: Yes • *Type and duration*: Physical exercise in an aquatic environment (1-hour sessions, 3 days a week) from week 20 to week 37. The sessions consisted of three phases: warm-up; the main phase, in which the activity is divided into an aerobic session followed by strength and endurance exercises; and final stretching and relaxation. • *Intensity*: Moderate; Borg rating 12-14	Intervention vs control: • Risk of postnatal depression: 14/65 vs 38/64
Bacchi et al 2018[425] Argentina NCT02602106	Intervention: 49 Control: 62	**Aim**: To examine the influence of a supervised and regular program of aquatic activities throughout gestation on maternal weight gain and birth weight. **Population**: Women with uncomplicated and singleton pregnancies and no contraindications to physical activity. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Aquatic; 55-60 minute 3xweekly sessions from weeks 10 to 12 until weeks 38 to 39 • *Intensity*: Light to moderate; Borg rating from 10-12	Intervention vs control: • Gestational weight gain kg 12.7±2.6 vs 13.9±4.3 p=0.10 • Weight gain >IOM guidelines: 12 (24.5%) vs 28 (45.2) p=0.02; OR 0.39; 95%CI 0.17 to 0.89 • Preterm birth: 2 (4.1%) vs 3 (4.8%) p=0.84 • Low birthweight (<2500g): 1 (2.0%) vs 2 (3.2%) p=0.53 • Macrosomia (>4000): 4 (8.2%) vs 9 (14.5%)

Study ref	N	Aim/population/intervention	Outcomes
Baciuk et al 2008;[292] Cavalcante et al 2009[312] Brazil	Intervention: 34 Control: 37	**Aim**: To evaluate the association between water aerobics, maternal cardiovascular capacity during pregnancy, labour and neonatal outcomes. **Population**: Women of < 20 weeks of pregnancy with a singleton pregnancy and no gestational risk factors. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic; Aquatic; 50 min 3 times a week from <20 wks to birth • *Intensity*: Moderate 70% predicted HR	Intervention vs control: • Gestational weight gain: 14.3±2.1 vs 15.1±1.6 p=0.38 • Caesarean section: 12 (36.4%) vs 17 (45.9%) p=0.57 • Preterm birth (% <37 weeks): 2/33 vs 3/37 p=0.56 OR 0.84 (0.28-2.53) • Low birth weight (<2500 g): 3/33 vs 2/37 p=0.44 OR 1.30 (0.61-2.79)
Barakat et al 2008;[293] Barakat et al 2009a;[313] Barakat et al 2009b;[303] Spain NCT00813657	Intervention: 72 Control: 70	**Aim**: to examine the effect of light intensity resistance exercise training performed during the second and third trimester of pregnancy. **Population**: Healthy sedentary pregnant women; mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Resistance; Toning and joint mobilisation; 35-40 min 3 times a week from weeks 12-13 to 38-39. • *Intensity*: Light; ≤80% of age-predicted maximum HR	Gestational weight gain intervention vs control by BMI: • 18.5–24.9 kg/m2:12.2±2.9 vs 12.6±3.5 P>0.1 • 25.0–29.9 kg/m2: 10.9±4.9 vs 12.3±3.9 P>0.1 • ≥30.0 kg/m2: 8.4±4.14 vs 9.7±1.2 P>0.1 • All: 11.5±3.7 12.4±3.4 P>0.1 Neonatal outcomes (g) intervention vs control: • Low birthweight <2500 g: 4 (5.6%) vs 4 (5.7%) P>40.1 • Macrosomia >4000 g: 1 (1.4%) vs 7 (10%) P>0.1 Caesarean section: 11 (15.3%) vs 11 (15.7%)

Study ref	N	Aim/population/intervention	Outcomes
Barakat et al 2011;[426] Barakat et al 2012a[454] Spain	Intervention: 40 Control: 43	**Aim**: To examine the influence of an exercise programme on maternal glucose tolerance. **Population**: Healthy women with uncomplicated singleton pregnancies. Mixed BMIS. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Land and aquatic; 35–45-min 3 times a week from weeks 6-9 to 38-39 • *Intensity*: Light to moderate, HR<70%	Intervention vs control: • Gestational weight gain (kg): 12.5±3.2 vs 13.8±3.1 p>0.05 • Gestational diabetes (n/%): 0/0 vs 3/7 p>0.05 • Caesarean section (n/%): 12/30 vs 6/14
Barakat et al 2012b;[427] Barakat et al 2014a[533] Spain	Intervention: 138 Control: 152	**Aim**: To assess the effects of a structured, moderate-intensity exercise program during the entire length of pregnancy on a woman's method of delivery. **Population**: Healthy pregnant Caucasian (Spanish) women with a singleton pregnancy. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance and muscle strengthening; 40–45-min 3 times a week, from weeks 6–9 to 38–39 • *Intensity*: Moderate, HR<70%	Intervention vs control (n/%): • Gestational weight gain (kg): 11.9±3.7 vs 13.7±4.1 p=0.0001 • Gestational diabetes: 6/4.3 vs 12/7.9 p=0.21 • Caesarean section: 22/15.9 vs 35/23 • Preterm birth: 9/6.5 vs 10/6.6 p=0.98

Study ref	N	Aim/population/intervention	Outcomes
Barakat et al 2013[428] Pelaez et al 2019[534] Spain NCT01477372	Intervention 210 Control 218	**Aim**: To examine the effect of regular moderate-intensity exercise (three training sessions/week) on the incidence of gestational diabetes mellitus (GDM, primary outcome). **Population**: Healthy pregnant women. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance and muscle strengthening; 50-55-min 3 times a week, from weeks 10-12 to 38–39 • *Intensity*: Light to moderate, HR<70%; Borg 10-12	Intervention vs control: • GDM (WHO criteria): 41 (19.5%) vs 61 (28%) p=0.040 • GDM (IADPSG criteria): 29 (13.8%) 32 (14.7%) p=0.797 Intervention (n=169) vs control (n=157) (no GDM WHO criteria): • Caesarean section (n, %) 24 (14.2) 28 (17.8) • Gestational weight gain (kg) 11.8±3.6 vs 13.3±4.3 Intervention (n=100 women attending 80% of sessions) vs control (n=201) (Note that these results have not been included in the meta-analysis): • Gestational weight gain: 11.5±3.5 vs 13.72±4.1 • Weight gain exceeding IOM guidelines: 22/100 vs 69/201 • Gestational diabetes: 3/100 vs 13/201 • Macrosomia: 0/100 vs 10/201 • Caesarean section: 17/100 vs 48/201
Barakat et al 2014b[429] Spain NCT01696201	Intervention 107 Control 93	**Aim**: To examine the influence of a program of moderate physical exercise throughout pregnancy on maternal and fetal parameters. **Population**: Pregnant women with uncomplicated and singleton pregnancies. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance and muscle strengthening; 50-55-min 3 times a week, from weeks 9-13 to 39–40 • *Intensity*: Light to moderate; 55% to 60% maximal heart rate	Intervention vs control: • Gestational weight gain (kg): 11.72±4.06 vs 13.66±9.62 p=0.06 • Weight gain >IOM guidelines (n/%): 22/21.2 vs 31/35.6 p=0.02 • Gestational diabetes (n/%): 5/4.7 vs 5/5.6. • Preterm birth (n/%): 4/3.8 vs 4/4.4 p=0.82 • Caesarean section (n/%): 18/17.1 vs 26/28.6

Study ref	N	Aim/population/intervention	Outcomes
Barakat et al 2016[430] Spain NCT01723098	Intervention 383 Control 382	**Aim**: To examine the impact of a program of supervised exercise throughout pregnancy on the incidence of pregnancy-induced hypertension. **Population**: Women with singleton uncomplicated pregnancies. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance and muscle strengthening, flexibility; 50-55-min 3 times a week, from weeks 9-11 to 38–39 • *Intensity*: Moderate, HR<70%; Borg 12-14	Intervention vs control: • Gestational weight gain (kg): 12.1±3.7 vs 12.9±4.5 p=0.01 • Weight gain >IOM guidelines (n/%): 101/26.4 vs 131/34.2 p=0.03 • Gestational diabetes (n/%): 9/2.4 vs 21/5.5 p=0.03 • Maternal hypertension (n/%): 8/2.1 vs 22/5.7 p=0.009 • Pre-eclampsia (n/%): 2/0.5 vs 9/2.3 p=0.03 • Preterm birth, <37 wk (n/%) 29/7.6 vs 37/9.7 p=0.31 • Caesarean section: 73/19.1 vs 83/21.7 p=0.38 • Low birthweight <2500 (n/%): 16/4.2 vs 25/6.5 p=0.15 • Macrosomia >4000 (n/%): 7/1.8 vs 18/4.7 p=0.03 • Apgar score >7 at 5 min (n/%): 380/99.2 381/99.7 p=0.31
Barakat et al 2018[294] Spain NCT02109588	Intervention 227 Control 202	**Aim**: To examine the influence of an exercise program throughout pregnancy on the duration of labour. **Population**: Healthy pregnant women. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Aquatic; 50-55-min 3 times a week, from weeks 9-11 to 38–39 • *Intensity*: Moderate, HR<70%; Borg 12-14	Intervention vs control: • Gestational weight gain: 12.26±3.6 vs 13.27±4.1 p=0.015 • Weight gain >IOM guidelines: 47 (20.7%) vs 61 (30.2%) p=0.024 • Preterm birth (<37 weeks): 10 (4.4%) vs 7 (3.5%) p=0.618 • Macrosomia (>4,000 g) (n/%) 8 (3.5%) vs 14 (6.9%) p=0.110[a] Note that a later report of this study[535] reported slightly different results; the results from the earlier article are included here as it specified that intention to treat analysis was conducted.

Study ref	N	Aim/population/intervention	Outcomes
Bisson et al 2015[269] Canada	Intervention 23 Control 22	**Aim**: To evaluate whether a 12-week supervised exercise program promotes an active lifestyle throughout pregnancy in pregnant women with obesity. **Population**: Pregnant women with BMI ≥30 kg/m2) and a singleton pregnancy. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Stationary cycling, treadmill, muscle strengthening; 60 min 3 times a week from week 15 to 27 • *Intensity*: Moderate; 70% HR or perceived exertion score of 3-5/10	Intervention vs control: • Gestational weight gain, *kg* 12.3±4.0 vs 12.2±5.9 • Weight gain >IOM guidelines: 21 (88) vs 17 (71) • Caesarian section: 8 (33) vs 8 (33) • Gestational diabetes: 3 (13) vs 5 (21) • Gestational hypertension: 2 (8) vs 3 (13) • Large for gestational age: 4 (17) vs 3 (13) • Small for gestational age: 0 vs 2 (8)
Cordero et al 2015[431] Spain NCT01790412	Intervention 101 Control 156	**Aim**: to assess the effectiveness of a moderate to vigorous maternal exercise program (land/aquatic activities, both aerobic and muscular conditioning) in preventing gestational diabetes mellitus (GDM). **Population**: Pregnant women without obstetric contraindications. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Land and aquatic; 50-60 min 3 times a week from week 10-14 until birth • *Intensity*: Moderate to vigorous; HR <60%; Borg scale 12-14	Intervention vs control: • Weight gain >IOM guidelines (n/%): 23/22.8 vs 54/34.8 p=0.04 • Caesarean section (n%): 26/25.7 vs 33/21.2 • Low birthweight (n%): 3/3 vs 9/5.8 • Macrosomia (> 4000 g) (n%): 5/5 vs 7/4.5 Intervention (n=100) vs control (n=146): • Gestational diabetes (n%): 1/1 vs 13/8.9 p=0.009 OR 0.103 (0.013-0.803)

Study ref	N	Aim/population/intervention	Outcomes
da Silva et al 2017[432] Coll et al 2019[536] Brazil PAMELA NCT02148965	Intervention 213 Control 426	**Aim**: To evaluate the efficacy of an exercise intervention to prevent negative maternal and newborn health outcomes. **Population**: Low risk women whose pregnancy exercise levels did not include self-reported participation in an exercise program, were <18 and BMI <30. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Stationary cycling, treadmill, muscle strengthening; 60 min 3 times a week from weeks 16-20 to 32-36 • *Intensity*: Moderate; Borg scale 12-14	Intervention (n=205) vs control (n=407) • Gestational weight gain(kg)[b] 12.4±5.7 vs 12.9±6.5 p=0.43 MD 0.4 (−0.6; 0.8) Intervention (n=176) vs control (n=407) • Weight gain >IOM guidelines: 67 (38.0) vs 136 (38.8) MD 1.1 (0.7;1.6) Intervention (n=205) vs control (n=407) • Gestational diabetes (n%): 16 (7.8) vs 31 (7.6) OR 1.0 (0.6 to 1.9) • Pre-eclampsia (n%): 11 (5.4) vs 22 (5.4) OR 1.0 (0.5 to 2.1) Intervention (n=198) vs control (n=396): • Preterm birth <37 wk: 26 (13.1) vs 48 (12.1) OR 1.1 (0.7-1.8) Intervention (n=204) vs control (n=407): • Small-for-gestational age (n%): 8 (3.9) vs 22 (5.4) p=0.42 OR 0.7 (0.3 to 1.6) • Large-for-gestational age (n%): 24 (11.8) vs 53 (13.0) p=0.66 OR 0.9 (0.5 to 1.5) • Birthweight <2500 (n%): 12 (5.9) vs 20 (4.9) OR 1.2 (0.6 to 2.5) • Birthweight ≥4000 (n%): 9 (4.4) vs 21 (5.2) OR 0.9 (0.4 to 1.9) Intervention vs control: • Postpartum depression: 12/192 vs 36/387

Study ref	N	Aim/population/intervention	Outcomes
Daly et al 2017[433] United Kingdom	Intervention 43 Control 44	**Aim**: To evaluate whether an intensive, medically supervised exercise intervention improved maternal glycaemia and gestational weight gain in obese pregnant women. **Population**: Women with singleton uncomplicated pregnancies and a BMI >30. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Not described; 50-60 min, 3 times a week from 134±12 for the duration of their pregnancy and for up to 6 weeks postpartum • *Intensity*: Increase in HR and Borg scale	Intervention (n=43) vs control (n=43): • Gestational diabetes at 24-28 weeks (n%): 25 (58.1) vs 21 (48.8) p=0.51 Intervention (n=36) vs control (n=44) • Weight gain >IOM guidelines (n%): 8 (22.2) vs 19 (43.2) p=0.05 Intervention (n=33) vs control (n=36) • Weight retention at 6 weeks (n%): −1.6±1.2 kg vs 0.2±5.4 P=0.22) Intervention (n=34) vs control (n=42): • Gestational weight gain at 36 weeks: 6.2±6.0 vs 7.9±4.8 p=0.15 Intervention (n=43) vs control (n=44) • Emergency caesarean section (n%): 9 (20.9) vs 8 (18.2) p=0.75 • Low birthweight (<2500 g)(n%): 1 (2.3) vs 0 p=0.75 • Macrosomia (>4500 g)(n%): 0 vs 1 (2.3) =0.51 • Apgar score <7 at 5 min (n%): 1 (2.3) vs 0 p=0.49
de Oliveria Melo et al 2012[270] Brazil	Intervention 13 weeks 62 Intervention 20 weeks 63 Control 62 3-armed; control group halved	**Aim**: To estimate the effect of supervised physical exercise on maternal physical fitness, fetoplacental blood flow, and fetal growth. **Population**: healthy pregnant women who were sedentary at admission to the study, gestational age 13 weeks with an uncomplicated singleton pregnancy. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic; 15 min walking, 3 times weekly, increasing according to woman's ability from 13 weeks (Group A) or 20 weeks (Group B) until birth • Intensity: Moderate; 60-80% maximum HR; Borg scale 12-16	Intervention (initiated at 13 weeks; n=54) vs control (n=28): • Pre-eclampsia (n%): 3 (5.6) vs 5 (8.8) RR 0.63 (0.16 to 2.52) • LGA (n%): 3 (0.6) vs 7 (12.3) RR 0.45 (0.12 to 1.66) • SGA (n%): 4 (7.4) vs 4 (7.0) RR 1.06 (0.28 to 4.01) Intervention (initiated at 20 weeks; n=60) vs control (n=28): • Pre-eclampsia (n%): 6 (10) vs 5 (8.8) RR 1.14 (0.37 to 3.53) • LGA (n%): 4 (6.7) vs 7 (12.3) RR 0.57 (0.17 to 1.82) • SGA (n%): 4 (6.7) vs vs 4 (7.0) RR 0.98 (0.26 to 3.74).

Study ref	N	Aim/population/intervention	Outcomes
Dekker Nitert et al 2015[448] Australia	Intervention 19 Control 16	**Aim**: To investigate the effects of exercise on gestational weight gain, maternal circulating lipids, IL-8, MCP-1 and leptin levels in obese pregnant women. **Population**: Pregnant women with BMI ≥30 **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic; Individualised to meet energy expenditure requirements; From week 12 • *Intensity*: Based on individual preferences and ability.	Intervention vs control: • Gestational weight gain at 36 weeks: 7.87±4.00 vs 8.28±6.10 • Caesarean section (n) (% of group): 9 (47%) vs 4 (25%)
Garnaes et al 2016;[304] Garnaes et al 2017;[314] Garnæs et al 2018[315] Garnaes et al 2019[537] ETIP Norway	Intervention 38 Control 36	**Aim**: to assess whether regular supervised exercise training in pregnancy could reduce gestational weight gain in women with prepregnancy overweight/obesity. **Population**: Pregnant women with a prepregnancy body mass index (BMI) ≥28 kg/m2. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Treadmill walking/jogging and muscle strengthening; 60 min, 3 times weekly plus 50 min home exercise program 2 times a week. • *Intensity*: Moderate; 80% maximal capacity, Borg scale 12-15.	Intervention (n=38) vs control (n=36) • Gestational weight gain: 10.5 kg vs 9.2 kg MD 0.92 kg (95% CI -1.35 to 3.18; p=0.43) • Preterm birth (n%): 2 (5) vs 0 (0) p=0.49 • GDM (2009 WHO definition): 2 (6.1%) vs 9 (27.3%)OR 0.1 (95% CI 0.02 to 0.95; p=0.04). Intervention (n=37) vs control (n=36): • Birth weight >4000 g (n%): 13 (35) vs 19 (53) MD 1.4 (0.88 to 2.36) p=0.16 • Postpartum weight retention (body weight at 3 months postpartum minus early pregnancy weight): −0.8±5.6 (n=36) vs −1.6±5.4 (n=34). Intervention (n=36) vs control (n=34): • Minor depression (EPDS score 10-12): 2/36 vs 3/34

Study ref	N	Aim/population/intervention	Outcomes
Garshasbi & Faghih Zadeh 2005[434] Iran	Intervention 107 Control 105	**Aim**: To investigate the effect of exercise during pregnancy on the intensity of low back pain and kinematics of spine. **Population**: Sedentary pregnant women aged 20-28 years without contraindications to physical activity in pregnancy. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Not specified; 60 min, 3 times a week from 17-22 weeks for 12 weeks • *Intensity*: Pulse rate <140.	Intervention vs control: • Gestational weight gain: 14.1±3.8 vs 13.8±5.2 p=0.63
Guelfi et al 2016[271] Australia NCT01283854	Intervention 84 Control 85	**Aim**: To investigate the effect of a supervised home-based exercise program on the recurrence and severity of gestational diabetes mellitus (GDM) together with other aspects of maternal health and obstetric and neonatal outcomes. **Population**: Women with a history of gestational diabetes. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic; Stationary cycling 20-60 min, 3 times a week for 14 weeks from 13±1 weeks • *Intensity*: Moderate; 75–85% maximum HR; Borg scale 14-16.	Intervention vs control: • GDM: 34 (40.5%) vs 34 (40.0%) Intervention (n=81) vs control (n=76) • Gestational weight gain at 28 wks: 6.4±2.1 vs 6.7±2.6 • EPDS score >12: 1 (1.2%) vs 3 (3.5%) • Emergency caesarean section: 10 (11.9) vs 11 (12.9) • Pre-eclampsia: 2 (2.4) vs 1 (1.2) p=1.000 • Preterm birth: 3 (3.6) vs 4 (4.7) p=1.000 • Apgar score <7 at 5 min: 1 (1.2) vs 1 (1.2) p=1.000 • Large for gestational age: 12 (14.2) vs 10 (11.8) p=0.336 • Small for gestational age 0 vs 2 (2.4)

Study ref	N	Aim/population/intervention	Outcomes
Haakstad & Bo 2011a;[435] Haakstad & Bo 2011b;[538] Haakstad et al 2016[278] Haakstad et al 2019[539] Norway	Intervention 52 Control 53	**Aim**: to examine the effect of a supervised exercise-program on birth weight, gestational age at delivery and Apgar-score. **Population**: Sedentary, nulliparous pregnant women, mean age 30.7±4.0 years, pre-pregnancy BMI 23.8±4.3. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance and strength training; 60 min, 2 times a week for a minimum of 12 weeks plus 30 min home-based activity, 3 times a week, from week 17-18 • *Intensity*: Moderate; Borg scale 12–14.	Intervention vs control: • Gestational weight gain: 13±4 vs 13.8±4 MD 0.8 p=0.31 • Weight gain >IOM guidelines (n%): 17 (33) vs 20 (38) p=0.59 • Birth weight <2500 (g): 1 (1.9) vs 1 (1.9) • Birth weight ≥4000 (g): 5 (9.6) vs 9 (17.0) p=0.5 • Antenatal depression: 3 (5.8%) vs 9 (17%) • Postpartum weight retention 6 weeks postpartum: 3.3±3.9 (n=33) vs 3.3±4.1 (n=37) • Postpartum weight retention 6 years postpartum: 1.3±4.3 (n=40) vs 1.5±6.9 (n=40)
Hopkins et al 2010;[272] Hopkins et al 2011[540] New Zealand	Intervention 47 Control 37	**Aim**: to determine the effects of aerobic exercise training in the second half of pregnancy on maternal insulin sensitivity and neonatal outcomes. **Population**: Healthy nulliparous women (age, 30±4 yr; BMI 25.5±4 kg/m2). **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic; Stationary cycling; 40 min, up to 5 times a week • *Intensity*: Moderate; 65% of predicted capacity.	Intervention vs control: • Gestational weight gain: 8.3±2.7 vs 8.9±3.3 • Small for gestational age: 4 (8.5) vs 3 (8.1)

Study ref	N	Aim/population/intervention	Outcomes
Kong et al 2014a;[449] Kong et al 2014b[541] United States	Intervention 18 Control 19	**Aim**: to promote MPA among overweight and obese pregnant women, via walking, and to evaluate the effect of the intervention on maternal and birth outcomes. **Population**: non-exercising, overweight or obese pregnant women; BMI ≥25. **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic; Walking; 150 min per week from week 15 to at least week 35. • *Intensity*: Moderate; ≥ 80 steps per minute in 8 minute blocks.	Overweight women: intervention (n=9) vs control (n=9) • Gestational weight gain (kg): 10.53±5.37 vs 9.94±6.14 • Gestational diabetes: 1 vs 1 • Birth weight >4000 g: 3 vs 1 • Preterm birth: 0 vs 1 • Caesarean section: 0 vs 4 Obese women: intervention (n=9) vs control (n=10): • Gestational weight gain (kg): 12.07±9.01 vs 12.48±8.51 • Gestational diabetes: 0 vs 0 • Birth weight >4000g: 2 vs 5 • Preterm birth: 0 vs 0 • Caesarean section: 5 vs 5 • Pre-eclampsia: 1 vs 0 Overweight women: intervention (n=8) vs control (n=10): • Weight retention at 1 month (kg): 5.34±6.05 vs 1.62 ± 5.58 • Weight retention at 6 months (kg): 1.64±2.09 vs –0.94±5.60 Obese women: intervention (n=7) vs control (n=9): • Weight retention at 1 month (kg): 1.43 ± 5.36 vs 3.05 ± 8.24 • Weight retention at 6 months (kg): -0.10±8.11 vs 6.35±7.47 Infants of overweight women: • Weight at 1 month: 4.49±0.4 (n=9) vs 4.63±0.59 (n=9) • Weight at 6 months: 7.94±0.98 (n=8) vs 7.94±2.1 (n=9) Infants of obese women: • Weight at 1 month: 4.37±0.7 (n=9) vs 4.63±0.42 (n=9) • Weight at 6 months: 7.85±0.79 (n=7) vs 8.35±1.24 (n=9)

Study ref	N	Aim/population/intervention	Outcomes
Murtezani et al 2014[436] Kosovo	Intervention 30 Control 33	**Aim**: To examine the effect of aerobic and strength conditioning exercise performed during the second and the third trimester of pregnancy. **Population**: Nulliparous, previously inactive women. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Treadmill, stationary cycling, muscle strengthening; 40-45 min, 3 times a week from week 18-19 until the end of pregnancy. • *Intensity*: Moderate; Borg scale 12-14.	Intervention vs control: • Birthweight <2500 (g): 3 (10.0%) vs 0 • Birthweight ≥4000 (g): 2 (6.7%)vs 1 (3.0%)
Nascimento et al 2011b[437] Brazil	Intervention 39 Control 41	**Aim:** To evaluate the effectiveness and safety of physical exercise in terms of maternal/perinatal outcomes and the perception of quality of life (QoL). **Population:** Pregnant women (age ≥18 years; pre-gestational body mass index ≥26 kg/m2; gestational age 14–24 weeks). **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Stretching and strengthening; 40 min, 1 time a week from week 17-18 until the end of pregnancy plus home-based exercise (duration not specified) 5 times a week. • *Intensity*: Light to moderate; HR<140/min.	Combined groups intervention vs control: • Gestational weight gain: 10.3 ± 5.0 vs 11.5 ± 7.4 p=0.543 • Caesarean section (n %): 25/38 (65.8) vs 29/40 (72.5) p=0.521 • Apgar score <7: 1/36 (2.8) vs 0/37 (0) • Large for gestational age: 8/33 (24.2) vs 8/33 (24.2) • Small for gestational age: 2/33 (6.1) vs 1/33 (3.0) Overweight women intervention (n=9) vs control (n=5): • Gestational weight gain: 10.0 ± 1.7 vs 16.4 ± 3.9 p=0.001 Obese women intervention (n=30) vs control (n=36): • Gestational weight gain: 10.4 ± 5.6 vs 10.9 ± 7.6 p=0.757

Study ref	N	Aim/population/intervention	Outcomes
Ong et al 2009[450] Australia	Intervention 6 Control 6	**Aim**: To investigate the effect of a supervised 10-week, home-based, exercise programme, beginning at week 18 of gestation, on glucose tolerance and aerobic fitness. **Population**: Previously sedentary obese women; BMI ≥30 kg/m2. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic; Stationary cycling; 35-50 min, 3 times a week from week 18 until week 28. • *Intensity*: Moderate; 50-60% HR_{max} increasing to 60-70% HR_{max}.	Intervention vs control: • Gestational weight gain: 3.7±3.4 vs 5.2±1.3 MD −1.50 (−4.41 to 1.41)
Oostdam et al 2012[438] Netherlands	Intervention 62 Control 59	**Aim**: To evaluate the effectiveness of an exercise programme. **Population**: pregnant women with BMI ≥25 kg/m2 and at risk for gestational diabetes mellitus (GDM). **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Individualised; 60 min, 2 times a week from week 16 until birth. • *Intensity*: Light to moderate; Borg scale 12.	Intervention (n=43) vs control (n=41): • Gestational weight gain: 6.2±5.0 vs 5.6±3.5 Intervention (n=47) vs control (n=50): • LGA: 6 (12.8%) vs 1 (2.0%) RR 6.38 (0.79–51.1) Intervention (n=30) vs control (n=34): • Caesarean section: 7(23.3%) vs 8 (23.5%) p=0.99 RR 0.99 (0.41 to 2.41) Intervention (n=48) vs control (n=51): • Gestational diabetes: 7 (14.6%) vs 11 (21.6%) p=0.37 RR 0.65 (0.27–1.55)

Study ref	N	Aim/population/intervention	Outcomes
Perales et al 2015a[439] Spain	Intervention 52 Control 54	**Aim**: To assess the effectiveness of a regular physical exercise program on the prevention of depression **Population**: Overweight and obese healthy pregnant women (BMI ≥25 kg/m2), with uncomplicated and singleton gestation. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 55-60 min, 3 times a week from week 8-11 to 38-39. • *Intensity*: Light to moderate; 55-60% of aerobic capacity.	Intervention (n=45) vs control (n=53)— entire group • CES-D score ≥16: 8 (17.8%) vs 25 (47.2%) **p=0.002** Intervention (n=37) vs control (n=44) — Overweight women • CES-D score ≥16: 6 (16.2%) vs 21 (47.7%) **p=0.003** Intervention (n=8) vs control (n=9) — Obese women • CES-D score ≥16: 2 (25%) vs 4 (44.4%) p=0.402
Perales et al 2015b[440] Spain NCT01696201	Intervention 90 Control 77	**Aim**: to examine whether a supervised exercise program (EP) reduces depressive symptoms in pregnant women. **Population**: Healthy pregnant women (31.37+3.62 years) with uncomplicated singleton pregnancies. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 55-60 min, 3 times a week from week 9-12 to 39-40. • *Intensity*: Light to moderate; 55-60% maximal HR.	Intervention vs control: • CES-D score ≥16: 11 (12.2%) vs 19 (24.7%) **p=0.04** • Gestational weight gain: 11.850 ±4.19 vs 13.890±10.23 p=0.08 • Weight gain >IOM guidelines: 12 (13.25) vs 20 (26.7%) p=**0.03** • Caesarean section: 14 (15.6%) vs 19 (24.7%)

Study ref	N	Aim/population/intervention	Outcomes
Perales et al 2016a[295] Spain	Intervention 83 Control 83	**Aim**: To examine the influence of moderate physical exercise throughout pregnancy on the duration of labour stages. **Population**: Pregnant women (31.6±3.8 years) with uncomplicated and singleton pregnancies. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 55-60 min, 3 times a week from week 9-11 to 39-40. • *Intensity*: Light to moderate; 55-60% maximal HR.	Intervention vs control: • Gestational weight gain (kg): 11.6±3.6 vs 12.8±4.4 p=0.06 • Weight gain >IOM guidelines: 14 (16.9) vs 25 (30.1) p=0.04
Perales et al 2016b[296] Spain NCT01723098	Intervention 83 Control 59	**Aim:** To examine the effects of pregnancy exercise on echocardiographic indicators of haemodynamics, cardiac remodelling, left ventricular function, and cardiovascular disease risk factors. **Population**: Pregnant women with no obstetric complications, no serious medical condition preventing them from exercising safely,<16 wk gestation and not exercising regularly for more than 30 min on 3 d·wk^{-1}. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 55-60 min, 3 times a week from week 9-11 to 39-40. • *Intensity*: Light to moderate; 55-60% maximal HR.	Intervention vs control: • Weight gain >IOM guidelines: 15 (18%) vs 23 (40%) **p=0.005** • Gestational hypertension 34 wks: 2 (2%) vs 3 (5%) p=0.649 • Gestational diabetes 24-28 wks: 5 (6%) vs 5 (8%) p=0.741 • CES-D score ≥16: 36-40 wks: 10 (12%) vs 16 (27%) p=0.029

Study ref	N	Aim/population/intervention	Outcomes
Petrov Fieril et al 2015[453] Sweden	Intervention 38 Control 34	**Aim**: To assess the effect and safety of moderate-to-vigorous resistance exercise during pregnancy. **Population**: Healthy pregnant women. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Resistance; Weight training; 60 min, 2 times a week from week 14 to 25. • *Intensity*: Moderate to vigorous; Borg scale rating not described.	Intervention vs control: • Caesarean section: 5 (14%) vs 5 (15%)
Pinzon et al 2012[441] Colombia	Intervention 18 Control 17	**Aim**: To examine the effect of pregnant Latin-American women engaging in vigorous exercise during the second and third trimester. **Population**: Nulliparous pregnant women who had not participated in a structured exercise program beforehand, aged 16-30 years, had a live fetus in routine ultrasound scan, a normal pregnancy and 16 to 20 weeks' gestational age. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Circuit training; 60 min, 3 times a week from week 16-20 to 32-36 weeks. • *Intensity*: Vigorous; 55-75% maximal HR.	Intervention vs control: • Caesarean section: 7 (38.9) vs 3 (17.6)

Study ref	N	Aim/population/intervention	Outcomes
Price et al 2012[442] United States	Intervention 31 Control 31	**Aim:** to assess the benefits and possible risks of aerobic exercise during pregnancy. **Population**: Sedentary (no aerobic exercise more than once a week in the past 6 months), pregnant women at 12-14 wks with BMI <39 kg/m2 and no chronic conditions or history of preterm birth or SGA. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Walking, stationary cycling, circuit training, weight training; 45–60 min, 4 times per week plus individual 30-60 minute walk once weekly, from week 12-14 to at least week 36. • *Intensity*: Moderate; Borg scale 12-14.	Intervention vs control: • Gestational weight gain: 12.4±5.3 vs 10.5 ±5.13 • Gestational diabetes: 3 (9.6%) vs 4 (12.9%) p=0.66 • Caesarean section: 2 (6.4%) vs 10 (32.2%) p=0.001 • Small for gestational age: 4 (12.9%) vs 5 (16.1%) • Postpartum weight retention (6-8 weeks): 2.5 vs 0.7
Renault et al 2014[451] Denmark	Intervention 125 Control 134	**Aim**: to assess physical activity intervention assessed by a pedometer with or without dietary intervention on gestational weight gain (GWG). **Population**: Obese pregnant women (BMI ≥30 kg/m2) older than 18 years, a singleton pregnancy, and a normal scan in weeks 11-14, gestational age <16 weeks. **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic; Walking; Daily step count of 11,000, (150% of the average step count in healthy lean pregnant women) from <16 weeks gestation until birth. • *Intensity*: Not described.	Intervention vs control: • Weight gain >IOM guidelines (>9kg): 64 (51%) vs 84 (63%) • Gestational diabetes: 2 (1.6) vs 7 (5.2) • Hypertensive disease: 9 (7.2) vs 12 (9.0) • Caesarean section (unplanned): 27 (22) vs 32 (24) • Gestational age: 278±14 vs 278±12 • Preterm birth 28-34 weeks: 3 (2) 1 (1) • Preterm birth 34-37 wks: 5 (4) 5 (4) • SGA: 4 (3.2) vs 2 (1.5) • LGA: 8 (6.4) vs 9 (6.7) • Birthweight >4000 g: 37 (30) vs 33 (25)

Study ref	N	Aim/population/intervention	Outcomes
Ruiz et al 2013[443] Spain NCT01790347	Intervention 481 Control 481	**Aim**: To study the effect on maternal weight gain of a supervised light- to moderate-intensity exercise-based intervention performed from the ninth week of pregnancy. **Population**: Sedentary women with a singleton uncomplicated pregnancy. BMI ≤25 kg/m2; BMI ≥25 kg/m2. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening; 50-55 min, 3 times a week. • *Intensity*: Moderate; <60% of age-predicted maximum HR; Borg scale 10 to 12.	Normal weight range intervention (n=335) vs control (n=352) • Gestational weight gain: 12.3±3.6 vs 13.8±4.1 p<0.001 • Weight gain >IOM guidelines: 42 (12.6%) vs 78 (22.1%) p<0.002 • Low birth weight (<2500g): 19 (5.7%) vs 15 (4.3%) • Macrosomia (>4000g): 8 (2.4%) vs 14 (4.0%) • Preterm birth (<36 wks): 8 (2.3%) vs 2 (0.6%) • Caesarean section: 55 (16.5%) vs 66 (18.7%) • Gestational diabetes: 7 (2.1%) vs 18 (5.1%) • Gestational hypertension: 5 (1.5%) vs 20 (5.7%) Overweight or obese women intervention (n=146) vs control (n=129): • Gestational weight gain: 11.1±4.3 vs 11.6±4.2 • Weight gain >IOM guidelines: 72 (49.3%) vs 76 (58.9%) • Low birth weight (<2500g): 5 (3.4%) vs 6 (4.6%) • Macrosomia (>4000g): 2 (1.4%) vs 12 (9.3%) • Preterm birth (<36 wks): 4 (2.7%) vs 2 (1.5%) • Caesarean section: 38 (25.9%) vs 29 (22.1%) • Gestational diabetes: 9 (6.2%) vs 12 (9.3%) • Gestational hypertension: 8 (5.5%) vs 10 (7.8%)
Seneviratne et al 2016[273] New Zealand	Intervention 37 Control 37	**Aim:** To assess whether antenatal exercise in overweight/obese women would improve maternal and perinatal outcomes. **Population:** Pregnant women with body mass index ≥25 kg/m2. **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic; Stationary cycling; 25-45 min, 3-5 times a week depending on stage of pregnancy, from week 25 to 35. • *Intensity*: Moderate (40–59% VO_2 reserve).	Intervention vs control: • LGA: 9 (24%) vs 4 (11%) p=0.170 • SGA: 4 (11%) vs 3 (8%) p=0.745 • Macrosomia (>4,000 g): 10 (26%) vs 7 (19%) p=0.429 • Low birthweight (<2,500 g): 1 (3%) vs 1 (3%) p=0.860

Study ref	N	Aim/population/intervention	Outcomes
Simmons et al 2017[402] United Kingdom, Ireland, Netherlands, Austria, Poland, Italy, Spain, Denmark and Belgium	Intervention 98 Control 94 4-armed; control group divided by three	**Aim:** to compare the effectiveness of 3 lifestyle interventions [healthy eating (HE), physical activity (PA), and both HE and PA (HE+PA)] with usual care (UC) in reducing GDM risk. **Population**: pregnant women at with a body mass index (BMI) of ≥29 kg/m, ≤19±6 and aged ≥18 years and without GDM using the International Association of Diabetes and Pregnancy Study Group criteria. **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic and resistance; Coaching sessions. • *Intensity*: Not described.	Intervention (n=76) vs control (n=26): • Gestational weight gain: 8.5±5.0 vs 8.8±4.7 • Weight gain >IOM guidelines: 55 (72%) vs 20 (76%) Intervention vs control • Gestational diabetes 30 (34%) (n=89) vs 12 (39%) (n=31) • SGA: 5 (6%) (n=87) vs 2 (6%) (n=30) • LGA: 12 (14%) (n=88) vs 5 (18%) (n=30)
SongØYgard et al 2012[444] Norway	Intervention 379 Control 340	**Aim**: To study whether exercise during pregnancy reduces the risk of postnatal depression. **Population**: Women ≥18 years with a singleton uncomplicated pregnancy. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Not specified; 60 min, 1 time a week for 12 weeks between weeks 20 and 36, plus 45 home-based activity at least twice a week. • *Intensity*: Not described.	Intervention vs control 3 months postpartum (all women): • EPDS score of ≥10: 14 (3.7%) vs 17 (5.0%) (p=0.46) • EPDS score of ≥13: 4 (1.2%) vs 8 (2.4%) (p=0.25) Intervention (n=100) vs control (n=90) 3 months postpartum among women who did not exercise regularly before pregnancy: • EPDS score of ≥10: 2 (2.0%) vs 9 (9.5%) OR 0.2 (0.04 to 0.93) p=0.03 • EPDS score of ≥13: 0 (0%) vs 3 (3.2%) p=0.11

Study ref	N	Aim/population/intervention	Outcomes
Stafne et al 2012[445] Norway	Intervention 429 Control 426	**Aim**: To assess whether exercise during pregnancy can prevent gestational diabetes and improve insulin resistance. **Population**: Women >18 years with a singleton pregnancy. Mixed BMIs. **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic and resistance; Dance, muscle strengthening (including pelvic floor muscle exercises); 55-70 min, 3 times a week from week 20 to 36 plus 45 min home exercise program at least twice a week. • *Intensity*: Moderate; Borg scale 13-14.	Intervention vs control: • Gestational diabetes: 25/375 (7%) vs 18/327 (6%) (P=0.52). • Macrosomia (>4,000 g): 71/426 (16.7) vs 78/425 (18.4) OR 0.9 (0.7 to 1.2) p=0.52 • Gestational hypertension: 11/385 (2.9) vs 11/340 (3.2) OR 0.9 (0.4 to 2.0) p=0.77 • Preeclampsia 16/426 (3.8) vs 16/426 (3.8) OR 1.0 (0.5-2.0) p=0.99 • Caesarean section: 45/426 (10.6) vs 50/425 (11.8) OR 0.9 (0.6 to 1.3) p=0.58 • Apgar score <7 after 5 min: 3/422 (0.7) vs 4/414 (1.0) OR 0.7 (0.2 to 3.3) p=0.69
Taniguchi & Sato 2016[299] Japan	Intervention 54 Control 53	**Aim**: To examine the effects of home-based walking on sedentary women's pregnancy outcomes and mood. **Population**: Pregnant women with a healthy singleton pregnancy aged 20–30 years; sedentary in daily life by self-report; no physical, mental or social problems by self-report; no psychiatric drug use; in at least the 30th week of pregnancy. Mixed BMIs. **Intervention:** • *Supervised*: No • *Type and duration*: Aerobic; Walking; 30 min, 3 times a week from 30 weeks until birth. • *Intensity*: Not described.	Intervention vs control: • Gestational weight gain: 10.1±3.7 vs 10.4±2.6 MD 0.43 (1.65 to 0.80) p=0.49 • Preterm birth: 0 (0.0%) vs 2 (3.8%) • Pre-eclampsia: 0 (0.0%) vs 1 (1.9%) • Caesarean section: 3 (5.6%) vs 4 (7.5%) p=0.49

Study ref	N	Aim/population/intervention	Outcomes
Vargas-Terrones et al 2018[446] Spain NCT02420288	Intervention 70 Control 45	**Aim**: To examine the effect of an exercise programme during pregnancy on the risk of perinatal depression. **Population**: Healthy women who were <16 weeks pregnant **Intervention**: • *Supervised*: Yes • *Type and duration*: Aerobic and muscle strengthening exercises for 60 min 3 days per week from week 12 to 16 to week 38 to 40 • *Intensity*: Moderate; 55-60% heart rate	Intervention vs control: • Antenatal depression (38 weeks):13/70 vs 16/45 • Postnatal depression (6 weeks postpartum): 10/69 vs 14/47
Wang et al 2016;[542]Wang et al 2017[452] China	Intervention 132 Control 133	**Aim**: To test the efficacy of regular exercise in early pregnancy to prevent gestational diabetes mellitus. **Population**: Non-smoking women age >18 years with a singleton pregnancy who met the criteria for overweight/obese status (BMI 24≤28 kg/m(2)) and had an uncomplicated pregnancy at <12(+6) weeks of gestation **Intervention:** • *Supervised*: Yes • *Type and duration*: Aerobic; Stationary cycling; 30 min, 3 times a week, from weeks 10 to 37. • *Intensity*: Moderate; Borg scale 12-14.	Intervention vs control: • Gestational diabetes: 29 (22.0) vs 54 (40.6) OR 0.412 (0.240 to 0.705) p<0.001 • Gestational weight gain: 8.38±3.65 vs 10.47±3.33 p<0.001 • Hypertensive disorders of pregnancy: 19/112 (17.0) vs 22/114 (19.3) OR 0.854 (0.434 to 1.683) p=0.6 • Caesarean section: 33/112 (29.5) vs 37/114 (32.5) OR 0.869 (0.494 to 1.529) p=0.6

Table 111: Q9 Outcomes associated with lifestyle counselling interventions versus usual care

Ref/setting	N	Aim/population/intervention	Outcomes
Asci & Rathfisch 2016[489] Turkey	Intervention 45 Control 45	**Aim**: to determine the effect of lifestyle interventions on improving dietary habits and lifestyle behaviours, ensuring gestational weight gain (GWG) within recommended levels and limiting postpartum weight retention. **Population**: Pregnant women aged over 18, who had no health problem, did not intend to lose weight in pre-pregnancy period, got pregnant in natural ways for two times at most, and were pregnant for a period of 3 months or less. Mixed BMIs. **Intervention**: Individualised lifestyle intervention focusing on healthy lifestyle, diet (portions and amounts required to be consumed from all food groups), exercise (mild-moderate safe exercise types, which increase the heart rate to maximum 140 beats/min while being easily able to talk, for 30 min every other day and maintain a more active lifestyle) and weight monitoring with the aim of remaining within IOM guidelines over four sessions at 12-15, 16-18, 20-24, and 37 weeks gestation.	Intervention vs control: • Gestational weight gain: 12.45±5.04 vs 12.29±4.8 • Postpartum weight retention (6 wks): 5.19±4.71 vs 5.95±4.79 • Caesarean section: 17/45 vs 15/45

Ref/setting	N	Aim/population/intervention	Outcomes
Altazan et al 2019[507] United States SmartMoms Part of LIFE-Moms consortium NCT01610752	Intervention 37 Control 17	**Aim**: To quantify changes in mental and physical quality of life and depressive symptoms across pregnancy and the postpartum period, to determine the association between gestational weight gain and change in mood and quality of life, and to assess the effect of a behavioural intervention targeting excess gestational weight gain on these outcomes. **Population**: Pregnant women who were overweight or obese. **Intervention**: Individuals randomised to the intervention were provided with behavioural weight management counselling by interventionists either in clinic (In-Person, n=18) or remotely through a smartphone application (Phone, n=19). Participants received a personalised IOM 2009 gestational weight gain graph, a wireless internet-connected bathroom scale, and a pedometer.	Intervention vs control: • Gestational weight gain: 8.7±0.9 vs 12.8±1.5 • Weight gain exceeding IOM guidelines: 18/32 vs 9/11 Outcomes relevant to mental health and quality of life were reported as degrees of change and were therefore not included in the meta-analysis.

Ref/setting	N	Aim/population/intervention	Outcomes
Althuizen et al 2013[485] New Life(style) study Netherlands	Intervention 106 Control 113	**Aim**: To evaluate the effects of a counselling intervention on excessive weight gain during pregnancy and postpartum weight retention. **Population**: Healthy nulliparous women <14 weeks gestation. Mixed BMIs. **Intervention**: Four face-to-face individual counselling sessions about weight gain (based on IOM guidelines), physical activity and diet during pregnancy, and one session by telephone after birth. Women had counselling sessions at 18, 22, 30 and 36 weeks of pregnancy and at 8 weeks postpartum, all with a personal counsellor. The first session lasted approximately 30 minutes, to explain the aim of the study and the intervention. The content of the first module was summarised in an information brochure. Subsequent sessions lasted 15 minutes. The information and feedback about physical activity was based on the US Centers for Disease Control and Prevention and American College of Sports Medicine recommendations, which promote 30 minutes of at least moderate intensity activity on five or all days of the week. The dietary intervention focused on optimising energy-intake, adjusting energy-intake to physical activity and taking away misconceptions about nutritional requirements during pregnancy (eg "the need to eat for two"). Special attention was given to decreasing intake of high-fat foods, such as fast food items and sugar-containing soft drinks.	Intervention vs control: • Gestational weight gain: 11.6±4.1 (n=106) vs 11.1±3.2 (n=113) • Weight gain exceeding IOM guidelines: 75/106 vs 82/113 • Preterm birth: 6/103 vs 7/107 • Caesarean section: 18/103 vs 22/107 • Macrosomia (>4,000g): 15/103 vs 20/107

Ref/setting	N	Aim/population/intervention	Outcomes
Asbee et al 2009[488] United States NCT00792480	Intervention 57 Control 43	**Aim:** To estimate whether an organised, consistent program of dietary and lifestyle counselling prevents excessive weight gain in pregnancy. **Population:** Women who established antenatal care at 6 to 16 weeks gestation, were aged between 18 and 49 years, and had a singleton pregnancy. **Intervention**: At the initial visit women met with a registered dietitian to receive a standardised counselling session including information on pregnancy-specific diet and lifestyle choices. Diet counselling consisted of recommendations for a patient-focused caloric value divided in a 40% carbohydrate, 30% protein, and 30% fat. Women were instructed to engage in moderate-intensity exercise >3 times per week, preferably 5 times. Women also received information on the appropriate gestational weight gain using the IOM guidelines.	Intervention vs control: • Gestational weight gain: 13.02±5.67 (n=57) vs 16.65±7.03 (n=43) • Caesarean section: 8/57 vs 12/43
Bogaerts et al 2013[510] Belgium	Intervention 76 Control 63 3-arm study; control group halved	**Aim**: To evaluate whether a targeted antenatal lifestyle intervention programme for obese pregnant women influences gestational weight gain (GWG) and levels of anxiety or depressed mood. **Population**: Obese pregnant women (BMI ≥29 kg/m$_2$) <15 weeks gestation. **Intervention**: Four prenatal group counselling sessions (at <15 wks, 18-22 wks, 24-28 wks, 30-34 wks) led by a midwife trained in motivational lifestyle intervention and focussing on nutritional advice (50–55% carbohydrate intake, 30–35% fat intake and 9–11% protein energy intake) and physical activity ("methods for increasing physical activity were discussed") during pregnancy with information to limit excessive gestational weight gain. Women also received a purpose-designed brochure.	Intervention vs control: • Gestational weight gain: 10.6±7.4 (n=76) vs 13.5±7.3 (n=32) • Excess gestational weight gain: 47/76 vs 23/32 • Gestational diabetes: 7/76 vs 5/32 • Gestational hypertension: 8/76 vs 3/32 • Pre-eclampsia: 2/76 vs 2/32 • Caesarean section: 20/76 vs 7/32

Ref/setting	N	Aim/population/intervention	Outcomes
Bruno et al 2017[499] Italy	Intervention 69 Control 62	**Aim**: to determine whether the prescription of a detailed lifestyle programme in overweight/obese pregnant women influences the occurrence of gestational diabetes (GDM), and if this kind of prescription increases the adherence to a healthier lifestyle in comparison to usual care. **Population**: Women at 9-12 weeks of pregnancy with a BMI ≥25kg/m2. **Intervention**: Women received personalised counselling and the dietary intervention was a hypocaloric, low-glycaemic, low-saturated fat diet. Women were advised to participate in moderate intensity physical activity three times a week.	Intervention vs control: • Gestational weight gain: 10.1±7.4 vs 9.4±6.8 • Gestational diabetes: 13/69 vs 23/62 • Gestational hypertension: 2/69 vs 13/62 • Preterm birth: 0/69 vs 5/62 • Caesarean section: 17/69 vs 25/62 • Macrosomia (>4000 g): 2/69 vs 7/62 • Large for gestational age: 1/69 vs 7/62 • Small for gestational age: 6/69 vs 5/62
Buckingham-Schutt et al 2019[483] United States NCT02168647	Intervention 23 Control 24	**Aim**: To determine whether a multi-component behavioural intervention with a Registered Dietitian Nutritionist significantly improves the proportion of women who adhere to the 2009 Institute of Medicine weight-gain guidelines. **Population**: Healthy women aged 18–45 y with a singleton pregnancy, and between weeks 8 and 14 of gestation. **Intervention**: Women received counselling and a wearable fitness tracker including dietary software. The intervention was targeted towards increasing physical activity and modifying carbohydrate intake. Participants took part in a minimum of six 15- to 30-min one-on-one visits with n dietitian from no later than gestation wk 14 to childbirth. Participants were weighed at each face-to-face session and weight gain was plotted on an IOM weight-gain chart.	Intervention versus control: • Mean gestational weight gain: 5.3±1.8 vs 5.9±1.5 • Weight gain exceeding IOM guidelines: 7/23 vs 15/24 • Gestational diabetes: 0/23 vs 1/24 • Gestational hypertension: 2/23 vs 0/24 • Pre-eclampsia: 0/23 vs 1/24 • Caesarean section: 3/23 vs 2/24 • Preterm birth: 0/23 vs 1/24 • Low birthweight: 0/23 vs 1/24 • Macrosomia (>4,000 g): 4/23 vs 6/24

Ref/setting	N	Aim/population/intervention	Outcomes
Chan et al 2018[518] Hong Kong NCT02368600	Intervention 80 Control 86	**Aim**: To examine whether a clinically proven lifestyle modification program (LMP) in early pregnancy was superior to routine antenatal care in improving GDM, maternal and infant outcomes. **Population**: Chinese pregnant women at risk of GDM at or before 12 weeks gestation. **Intervention**: The intervention group participated in a dietitian-led lifestyle intervention from ≤12 weeks to 24 weeks of gestation. Participants received bi-weekly face-to-face or phone consultations in the first 2 months and monthly face-to-face consultations afterwards till the end of the intervention. At the first face-to-face session, the dietitian discussed the specific dietary and lifestyle advices to achieve a desirable weight status with the participant. Each participant was given an individualised menu plan and healthy lifestyle booklets aiming at achieving a varied balanced diet with an emphasis on fruit and vegetables consumption, and intake of moderate-carbohydrate, low-fat, low-glycaemic index (GI) and low-calorific products in appropriate portions. Participants were encouraged to see the exercise instructor at least once during the LMP. During the exercise consultation (~30 minutes), the exercise instructor designed a suitable exercise regime for the participant based on international guidelines. Participants were generally advised to do a 30-minute of light to moderate intensity of low impact aerobic exercise at least three times a week.	Intervention versus control: • Gestational weight gain: 11.6±4.0 (n=76) vs 11.8±5.9 (n=81) • Weight gain exceeding IOM guidelines: 14/76 vs 21/81 • Gestational diabetes: 20/80 vs 23/86 • Gestational hypertension: 2/77 vs 1/84 • Pre-eclampsia: 0/77 vs 1/84 • Caesarean section: 24/69 vs 16/78 • Small for gestational age: 12/77 vs 12/84 • Large for gestational age: 8/77 vs 6/84 • Macrosomia (>4,000 g): 1/78 vs 2/85

Ref/setting	N	Aim/population/intervention	Outcomes
Dodd et al 2014a;[501] Dodd et al 2014b;[521] Dodd et al 2015;[543] Dodd et al 2016[544] LIMIT Australia	Intervention 1108 Control 1104	**Aim**: To determine the effect of antenatal dietary and lifestyle interventions on health outcomes in overweight and obese pregnant women. **Population**: Women with a singleton pregnancy, BMI ≥25 between 10+0 and 20+0 weeks. **Intervention**: A comprehensive dietary and lifestyle intervention over the course of pregnancy including a combination of dietary (maintain balance of carbohydrates, fat and protein; reduce intake of foods high in refined carbohydrates and saturated fats; increase intake of fibre; aim for 2 servings of fruit, 5 servings of vegetables and 3 servings of dairy daily), exercise (increase walking and incidental activity), and behavioural strategies (goal setting, self-monitoring), delivered by a research dietitian and trained research assistants.	Intervention vs control: • Gestational weight gain: 9.39±5.74 (n=897) vs 9.44±5.77 (n=871) • Excess gestational weight gain: 380/897 vs 368/871 • Gestational diabetes: 148/1080 vs 120/1073 • Gestational hypertension: 101/1080 vs 94/1073 • Pre-eclampsia: 56/1080 vs 53/1073 • Large for gestational age: 203/1075 vs 224/1067 • Macrosomia (>4000 g): 164/1075 vs 201/1067 • Macrosomia (>4500g): 23/1075 vs 39/1067 • Low birth weight (<2500 g): 43/1075 vs 56/1067 • Apgar score <7 at 5 minutes: 22/1075 vs 22/1067 • Antenatal depression (EPDS score ≥12 at 36 weeks): 65/695 vs 62/687 • Antenatal anxiety (STAI score ≥15 at 36 weeks): 110/694 vs 96/688 • Postnatal depression (EPDS score ≥12 at 4 months): 47/597 vs 41/624 • Postnatal anxiety (STAI score ≥15 at 4 months): 83/596 vs 70/624

Ref/setting	N	Aim/population/intervention	Outcomes
Dodd et al 2019[484] OPTIMISE Australia	Intervention 316 Control 313	**Aim**: To evaluate the effect of dietary and exercise advice among pregnant women of normal body mass index (BMI), on pregnancy and birth outcomes. **Population**: Pregnant women with a body mass index in the healthy weight range (BMI 18.5-24.9). **Intervention**: The dietitian-led dietary and lifestyle intervention over the course of pregnancy was based on the Australian Guide to Healthy Eating, while specifically maintaining a balance of carbohydrates, fat and protein, and encouraging women to reduce their intake of energy dense and non-core foods high in refined carbohydrates and saturated fats. Women were advised to increase their intake of fibre, and to consume two servings of fruit, five servings of vegetables and three servings of dairy each day. The initial planning session with a research dietitian provided women with written dietary and activity information, an individual diet and physical activity plan, recipe book and example menu plans. Women were encouraged to set achievable goals for dietary and exercise change, supported to make these lifestyle changes and to self-monitor their progress, using a SMART goals approach.	Intervention vs control: • Gestational weight gain: 11.32±3.96 vs 11.70±3.78 • Weight gain exceeding IOM guidelines: 28/316 vs 41/313 • Gestational diabetes: 39/316 vs 39/313 • Gestational hypertension: 5/316 vs 4/313 • Pre-eclampsia: 6/316 vs 9/313 • Caesarean section: 41/316 vs 45/313 • Preterm birth: 23/316 vs 20/313 • Macrosomia (>4,000g): 24/316 vs 26/313 • Low birthweight: 20/316 vs 15/313 • Large for gestational age: 22/316 vs 25/313 • Small for gestational age: 21/316 vs 25/313

Ref/setting	N	Aim/population/intervention	Outcomes
Gallagher et al 2018[502] LIFT United States	Intervention 103 Control 105	**Aim**: To determine the effectiveness of controlling maternal gestational weight gain in the second and third trimesters on neonate body composition. **Population**: Healthy women with a singleton pregnancy, BMI ≥25 at weeks 9_0 to 15_6. **Intervention**: Immediately following randomisation, women attended an individual 60-minute 'Introduction' session with a nutritionist followed by individual visits every two weeks until birth. At the first session, several "tools" were provided including a calorie book, food scale, set of measuring cups and spoons, a portable, insulated food pouch, and a pedometer and self-monitoring was encouraged. The website of the USDA's Center for Nutrition and Policy Promotion was used to develop the individualised meal plans for each participant, in addition to using the nutrition guidelines from the Academy of Nutrition and Dietetics. Between visits, women self-monitored diet and exercise/physical activity. During the weeks when the participant did not have an individual face-to-face meeting with the nutritionist, there were one-to-two contacts per week by telephone or email. Voluntary group sessions open to all intervention participants were offered once every eight weeks. A session on adapting physical activity to different seasons and related challenges during pregnancy was taught by a certified prenatal exercise specialist.	Intervention vs control: • Gestational weight gain: 7.89±4.07 (n=94) vs 9.67±4.17 (n=93) • Caesarean section: 29/97 vs 31/99 • Preterm birth: 5/97 vs 7/99 • Small for gestational age: 8/97 vs 13/99 • Large for gestational age: 10/97 vs 6/99

Ref/setting	N	Aim/population/intervention	Outcomes
Guelinckx et al 2010[511] Belgium	Intervention 42 Control 43	**Aim**: to study whether a lifestyle intervention based on a brochure or on active education can improve dietary habits, increase physical activity (PA), and reduce GWG in obese pregnant women. **Population**: Pregnant women with BMI >29. **Intervention**: The intervention group received a brochure with nutritional advice and lifestyle education from a nutritionist in three group sessions scheduled at 15, 20, and 32 weeks. The sessions provided women with recommendations on a balanced, healthy diet, based on the official National Dietary Recommendations (9–11% of the energy should come from proteins, 30–35% from fat, and 50–55% from carbohydrates). The dietary intervention aimed at limiting the intake of energy-dense foods by substituting them with healthier alternatives, increasing low-fat dairy products, increasing whole-wheat grains, and reducing saturated fatty acids. Moreover, more general topics such as energy balance, body composition, Nutrition Facts Labels, and how to increase physical activity were discussed.	Intervention vs control: • Gestational weight gain: 9.8±7.6 vs 10.6±6.9 • Gestational hypertension: 18/42 vs 14/43 • Pre-eclampsia: 2/42 vs 1/43 • Caesarean section: 11/42 vs 7/43 • Macrosomia (>4000 g): 5/42 vs 3/43

Ref/setting	N	Aim/population/intervention	Outcomes
Harrison et al 2013;[520] Harrison et al 2014[545] Australia	Intervention 121 Control 107	**Aim**: to reduce postpartum weight retention following a low-intensity, self-management intervention integrated with routine antenatal care during pregnancy. **Population**: Women 12-15 weeks gestation, overweight (BMI 25 or 23 kg/m2 if high-risk ethnicity [Polynesian, Asian, and African populations]) or obese (BMI ≥30 kg/m2), and at increased risk for developing gestational diabetes identified by a validated risk prediction tool **Intervention**: Four, 45-minute individual behaviour change lifestyle sessions delivered by a health coach at 14–16, 20, 24 and 28 weeks. Content focused on pregnancy-specific healthy eating and physical activity messages as well as encouraging healthy gestational weight gain according to the IOM guidelines supported by behaviour change strategies designed to optimise lifestyle and reduce post-partum weight retention. Self-monitoring strategies included pedometers and the use of weight gain charts based on IOM recommendations for weight gain throughout pregnancy.	Intervention vs control • Gestational weight gain (26-28 wks): 6.0±2.8 kg (n=106) vs 6.9±3.3 kg (n=97) • Postpartum weight retention (6 weeks): 0.51 ± 4.48 kg (n=104) vs 1.96 ± 5.74 kg (n=98)

Ref/setting	N	Aim/population/intervention	Outcomes
Hawkins et al 2015[503] United States	Intervention 32 Control 34	**Aim**: To pilot the feasibility of a prenatal lifestyle intervention to modify physical activity and diet among pregnant overweight and obese Hispanic women, with the aim of reducing risk factors for gestational diabetes mellitus. **Population**: Pregnant Hispanic women with BMI ≥25 at <15 weeks **Intervention**: The intervention consisted of six monthly in-person behavioural counselling sessions and five telephone-delivered booster sessions delivered by bicultural and bilingual health educators. The overall goal of the exercise component was to encourage pregnant women to achieve the American College of Obstetricians and Gynecologists' guidelines for physical activity during pregnancy (≥ 30 min of moderate-intensity activity on most days of the week) through increasing walking and developing a more active lifestyle. The health educators assisted the women in developing personalized physical activity goals and they were given a digital pedometer and a physical activity log to track their progress. The overall goal of the dietary component was to decrease intake of foods high in saturated fat and increase dietary fibre as recommended by the American Dietetic Association.	Intervention vs control • Gestational weight gain: 17.73±4.06 vs 17.87±2.39

Ref/setting	N	Aim/population/intervention	Outcomes
Hui et al 2012[490] Canada NCT00486629	Intervention 102 Control 88	**Aim**: To examine the effect of an exercise and dietary intervention during pregnancy on excessive gestational weight gain (EGWG), dietary habit and physical activity in pregnant women. **Population**: Nondiabetic urban-living pregnant women (<26 weeks of gestation). **Intervention**: Participants in the intervention group were provided with community-based group exercise sessions, instructed home exercise and dietary counselling between 20 and 36 weeks of gestation. Dietary interviews and counselling were provided twice to each woman by registered dietitians, at enrolment and 2 months after enrolment. The dietary interview was assisted with a Food Choice Map, a computerised dietary interview tool. Floor aerobic, stretching and strength exercises were led by licensed fitness trainers in group sessions. An exercise instruction video was provided to women to assist their home exercise. Women recorded daily physical activities in logbook.	Intervention vs control: • Gestational weight gain: 14.1±6 vs 15.2±5.9 • Weight gain >IOM guidelines: 36/102 vs 48/88 • Gestational diabetes: 2/102 vs 3/88 • Caesarean section: 2/102 vs 3/88 • Large for gestational age: 12/102 vs 15/88

Ref/setting	N	Aim/population/intervention	Outcomes
Hui et al 2014[491] Canada	Intervention 57 Control 56	**Aim**: To assess the efficacy of lifestyle intervention on gestational weight gain in pregnant women with normal and above normal body mass index (BMI). **Population**: Pregnant women at <20 weeks gestation without diabetes. Mixed BMIs. **Intervention**: Women in the intervention group received weekly trainer-led group exercise sessions, instructed home exercise for 3-5-times/week during 20-36 weeks of gestation, and dietary counselling twice during pregnancy. Dietary interviews and counselling were provided twice to each woman by registered dietitians, at enrolment and 2 months after enrolment. The dietary interview was assisted with a Food Choice Map, a computerised dietary interview tool. Floor aerobic, stretching and strength exercises were led by licensed fitness trainers in group sessions. An exercise instruction video was provided to women to assist their home exercise. Women recorded daily physical activities in logbook.	Intervention vs control • Gestational weight gain – BMI≤24.9: 12.9±3.72 (n=30) vs 16.23±4.38 (n=27) – BMI≥25: 15.21±7.5 (n=27) vs 14.39±7.05 (n=29) • Weight gain >IOM guidelines: 21/57 vs 30/56 • Gestational diabetes: 1/57 vs 3/56 • Caesarean section: 0/57 vs 2/56 • Large for gestational age: 6/57 vs 4/56
Jing et al 2015[492] China	Intervention 115 Control 106	**Aim**: To examine whether personalized interventions could improve dietary intake and physical activity among pregnant women. **Population**: Women with a singleton pregnancy (aged ≥18 years, without pre-existing diabetes) were enrolled at approximately 12 weeks. Mixed BMIs. **Intervention**: Participants received an education manual on diet and physical activity (written by the research team) after randomisation, and one-to-one counselling for at least 20 minutes in a private room with a trained graduate student after group assignment and at 16–20 and 20–24 weeks. The graduate student was also available to answer questions and provide feedback on diet and physical activity until 20–24 weeks either over the phone or via a group established on Tecent instant messenger.	Intervention vs control: • Gestational weight gain: 9.24±3.99 vs 9.69±3.85 • Weight gain >IOM guidelines: 102/115 vs 96/106 • Gestational diabetes: 26/115 vs 37/106

Ref/setting	N	Aim/population/intervention	Outcomes
Kennelly et al 2018[506] Ireland Pears ISRCTN29316280	Intervention 278 Control 287	**Aim:** To evaluate the effect of a healthy lifestyle package (an antenatal behaviour change intervention supported by smartphone application technology) on the incidence of gestational diabetes mellitus (GDM) in overweight and obese women. **Population**: Women with body mass indexes (BMIs) 25-39.9. **Intervention**: The intervention consisted of face-to-face specific dietary and exercise advice that addressed behaviour change supported by a tailor-designed smartphone application. The nutritional component of the intervention focused on healthy eating in pregnancy. Participants were encouraged to swap high glycaemic index foods for low glycaemic index alternatives and were informed about healthy carbohydrate portions. The recommended diet was approximately eucaloric to their typical diet. The exercise component of the intervention focused on promoting the benefits and safety of physical activity in pregnancy. Women were advised to undertake 30 minutes of moderate exercise 5–7 days per week, divided into two 15-minute or three 10-minute periods to maximise metabolic benefit.	Intervention vs control: • Gestational weight gain: 11.3±5.6 (n=278) vs 12.6±5.6 (n=287) • Weight gain exceeding IOM guidelines: 87/171 vs 120/188 • Gestational diabetes: 37/241 vs 36/257 • Caesarean section: 50/270 vs 48/270 • Low birth weight: 8/270 vs 4/275 • Macrosomia (>4,000g): 58/270 vs 67/275 • Small for gestational age: 28/270 vs 26/275 • Large for gestational age: 11/270 vs 24/275

Ref/setting	N	Aim/population/intervention	Outcomes
Kiani-Asiabar et al 2018[498] Iran	Group A 41 Group B 42 Control 40	**Aim**: To evaluate the effectiveness of an educational program with the spouse's participation on the optimal gestational weight gain (GWG) in pregnancy. **Population**: nulliparous women. **Intervention**: Participants randomly allocated into two groups of interventions and one control group. In group A, the women received education with their spouse's participation. In group B, the women received education without the participation of the spouses. The dietary intervention aimed at decreasing the intake of energy-dense foods and nutrient-poor foods that are high in sugar and fat (e.g. fast foods, sweets and sugar-sweetened beverages) and increasing the fruit, vegetable and milk or yogurt intakes. Another goal was improving the quality of fat consumed. Women were advised to walk for 30 minutes a day a minimum of 5 days a week.	Intervention Group A vs Group B vs control: • Gestational weight gain: 13.50±3.85 (n=41) vs 13.55±3.20 (n=42) vs 15.53±4.20 (n=40) • Weight gain exceeding IOM guidelines: 12/41 (28.6) 13/42 (31.0) 22/40 (55.0)

Ref/setting	N	Aim/population/intervention	Outcomes
Koivusalo et al 2016[519] Rönö et al 2018 RADIEL Finland	Normoglycaemic women: Intervention 144 Control 125 All women: Intervention 235 Control 229	**Aim**: To assess whether gestational diabetes mellitus (GDM) can be prevented by a moderate lifestyle intervention in pregnant women who are at high risk for the disease. **Population**: Women with a history of gestational diabetes and/or BMI ≥30 at <20 weeks gestation **Intervention**: Each woman in the intervention group received individualised counselling on diet, physical activity, and weight control from trained study nurses, and had one group meeting with dietitian. The dietary counselling focused on optimising participants' consumption of vegetables, fruits and berries, whole-grain products rich in fibre, low-fat dairy products, vegetable fats high in unsaturated fatty acids, fish, and low-fat meat products, and a lower intake of sugar-rich foods. The exercise component aimed for women to achieve a minimum of 150 min of moderate-intensity physical activity per week and to adopt an overall active lifestyle. Participants had access, free of charge, to public swimming pools and/or guided exercise groups once a week provided by the municipalities.	Intervention vs control (normoglycaemic women) • Gestational diabetes: 20/144 vs 27/125 • Gestational hypertension: 19/144 vs 12/125 • Pre-eclampsia: 7/144 vs 3/125 • Caesarean section: 31/144 vs 30/125 • Macrosomia (>4500 g): 6/144 vs 5/125 Intervention vs control (all women) • Gestational diabetes: 107/235 vs 111/229 • Gestational hypertension: 18/235 vs 13/229 • Pre-eclampsia: 14/235 vs 7/229 • Caesarean section: 55/235 vs 59/229 • Preterm birth (<37 weeks): 12/235 vs 7/229 • Large for gestational age: 8/235 vs 13/229

Ref/setting	N	Aim/population/intervention	Outcomes
Korpi-Hyovalti et al 2011;[516] Korpi-Hyovalti et al 2012[546] Finland NCT01130012	Intervention 27 Control 27	**Aim**: To evaluate if a lifestyle intervention from early pregnancy is feasible in improving the glucose tolerance of women at a high-risk for GDM in Finland. **Population**: Pregnant women with one or more risk factors for gestational diabetes. **Intervention**: Dietary advice tailored to each woman individually was provided on six occasions. Recommendation for energy intake was 30 kcal/kg/day for normal weight women and 25 kcal/kg/day for overweight women. Moderate-intensity physical exercise was encouraged; the women had 6 sessions of exercise counselling with the physiotherapist. During the sessions the physiotherapist gave written instructions for exercise and self-care. The goal of the exercise intervention was 30 minutes of daily physical activity if the woman previously exercised < 2.5 hours per week, and 45 minutes if the woman already engaged in 2.5 hours per week. Recommended types of exercise included brisk walking, Nordic walking, swimming, cycling, and cross-country skiing. If the BMI of the woman was >30 kg/m2 and the woman had not been active, exercise was started at 15 minutes/day 3 times a week.	Intervention vs control: • Gestational weight gain: 11.4±6.0 kg vs 13.9±5.1 kg • Gestational diabetes: 3/27 vs 1/27

Ref/setting	N	Aim/population/intervention	Outcomes
Kunath et al 2019[497] Germany GeliS NCT01958307	Intervention 1,018 Control 999 Cluster randomised trial	**Aim**: To examine the effect of a lifestyle intervention during pregnancy on the proportion of women with excessive GWG and pregnancy and obstetric complications, as well as the long-term risk of maternal and infant obesity. **Population**: Women with a pre-pregnancy BMI between 18.5 and 40.0 kg/m(2) recruited from gynaecological and midwifery practices prior to the end of the 12(th) week of gestation. **Intervention**: Four lifestyle counselling sessions covering a balanced healthy diet, regular physical activity and self-monitoring of weight gain were performed by trained healthcare providers alongside routine pre- and postnatal practice visits.	Intervention vs control (adjusted using intracluster correlation co-efficient from Luoto et al 2010):[547] • Gestational weight gain: 14.1±5.3 (n=40) vs 14.1±5.2 (n=40) • Weight gain exceeding IOM guidelines: 18/40 vs 18/40 • Gestational diabetes: 4/41 vs 4/39 • Hypertension: 4/40 vs 3/40 • Pre-eclampsia: 3/40 vs 2/40 • Preterm birth: 3/40 vs 2/40 • Caesarean section: 6/40 vs 6/40 • Large for gestational age: 3/40 vs 3/40 • Small for gestational age: 4/40 vs 3/40 • Weight retention (6-8 weeks postpartum): 4.0±4.8 (n=41) vs 4.3±4.8 (n=39)

Ref/setting	N	Aim/population/intervention	Outcomes
Luoto et al 2011;[522] Kinnunen et al 2012;[548] Kolu et al 2013;[549] Kolu et al 2016[550] NELLI Finland	Intervention 219 Control 180 Cluster-randomised trial	**Aim**: To examine whether a lifestyle intervention designed to prevent GDM was effective in reducing excessive gestational weight gain (GWG). **Population**: Pregnant women with at least one risk factor for GDM (for example, overweight) but no pre-existing diabetes were recruited at 8-12 weeks' gestation. **Intervention**: One counselling session on physical activity at 8-12 weeks' gestation and one for diet at 16-18 weeks' gestation, and three to four booster sessions during other routine visits. Based on Finnish dietary recommendations, the goal of dietary counselling was to help participants achieve a healthy diet containing ≤10% saturated fat, 5%–10% polyunsaturated fat, 25%–30% total fat, and ,10% saccharose of total energy intake, and 25–35 g/d fibre The minimum weekly leisure time physical activity dose, including also light-intensity physical activity, was 800 MET (multiples of resting metabolic equivalents) minutes. Participants were offered an opportunity to participate in monthly thematic meetings on physical activity including group exercise. The participants used follow-up notebooks to set their individual plans for physical activity and dietary changes and to keep a record of their adherence to their plans.	Intervention vs control (data adjusted as per [526]: • Gestational weight gain: 13.8±5.8 (n=51) vs 14.2±5.1 (n=42) • Weight gain >IOM guidelines: 24/51 vs 22/42 • Gestational diabetes: 8/51 vs 5/42 • Pre-eclampsia: 3/51 vs 2/42 • Macrosomia (>4000 g): 9/51 vs 8/42 • Macrosomia (>4500 g): 7/51 vs 8/42 • Small for gestational age: 2/51 vs 1/42 • Large for gestational age: 6/51 vs 8/42

Ref/setting	N	Aim/population/intervention	Outcomes
Pawalia et al 2017[493] India	Intervention 12 Control 12	**Aim**: To investigate the effect of physical activity and diet during prenatal period and its effect on gestational weight gain (GWG), BMI, waist circumference (WC), hip circumference (HC) and post-partum weight retention (PPWR). **Population:** Pregnant women with singleton pregnancy of >16 weeks of gestation, BMI>18.5 Kg/m2 and having a mobile phone. **Intervention**: Women attended weekly antenatal exercise sessions (60-90 minutes of moderate intensity stretching and strengthening exercises) at the hospital during pregnancy and were advised to do the same exercise at home on at least three other days. Women were also encouraged to walk 30 minutes/day for a least 4 days a week throughout pregnancy. Women received regular diet counselling followed by mobile text-messages (reminder, motivational, guidelines and benefits) to maintain adequate diet. Messages encouraged women to include foods such as more fruits and vegetables, dry fruits, to give preference to seasonal foods and to avoid unhealthy foods such as junk, oily, greasy and processed snacks from the market. Importance of home cooked food was explained.	Intervention vs control: • Gestational weight gain: 12.91±3.65 (n=12) vs 13.33±5.33 (n=12)

Ref/setting	N	Aim/population/intervention	Outcomes
Petrella et al 2013[504] Italy	Intervention 33 Control 28	**Aim**: To determine whether changes in lifestyle in women with BMI≥25 could decrease gestational weight gain and unfavourable pregnancy outcomes. **Population**: Pregnant women with BMI ≥25 kg/m2. **Methods**: The Therapeutic Lifestyle Changes (TLC) Program included diet (overweight: 1700 kcal/day, obese: 1800 kcal/day) and moderate physical activity (30 min/day, three times/week). The diet was introduced at randomisation in the presence of both a gynaecologist and a dietitian and further detailed through a one-hour counselling session about the appropriate gestational weight gain at term. Women wore pedometers during walking sessions.	Intervention vs control • Gestational weight gain: 8.8±6.5vs 10.4±5.0 • Weight gain >IOM guidelines: 11/33 vs 17/28 • Gestational diabetes: 7/33 vs 16/28 • Gestational hypertension: 1/33 vs 7/28 • Preterm birth: 0/33 vs 10/28 • Caesarean section: 11/33 vs 9/28
Phelan et al 2011;[494] Phelan et al 2014[551] United States NCT01117961	*Normal weight* Intervention 92 Control 94 *Overweight and obese* Intervention 87 Control 90	**Aim**: To examine whether a behavioural intervention during pregnancy could decrease the proportion of women who exceeded the 1990 Institute of Medicine (IOM) recommendations for gestational weight gain and increase the proportion of women who returned to pregravid weights by 6 months postpartum. **Population**: Women between 10 and 16 wk of gestation, BMI between 19.8 and 40, non-smoking, older than 18 years of age with singleton pregnancy. **Intervention**: The intervention included one face-to-face visit; weekly mailed materials that promoted an appropriate weight gain, healthy eating (20 kcal/kg, with an emphasis on decreasing high fat foods) and exercise (30 min of walking most days of the week); individual graphs of weight gain; and telephone-based feedback. Body-weight scales, food records, and pedometers were provided to promote adherence to daily self-monitoring.	Normal weight intervention (n=92) vs control (n=94): • Gestational weight gain: 15.3±4.4 vs 16.2±4.6 • Weight gain >IOM guidelines: 37/92 vs 49/94 Overweight and obese intervention (n=87) vs control (n=90): • Gestational weight gain: 14.7±6.9 vs 15.1±7.5 • Weight gain >IOM guidelines: 58/87 vs 55/90 All women intervention vs control: • Gestational diabetes: 19/171 vs 13/178 • Gestational hypertension: 20/171 vs 22/178 • Pre-eclampsia: 20/171 vs 20/178 • Caesarean section: 57/171 vs 67/178 • Preterm birth (<36 wk): 16/171 vs 20/178 • Low birth weight: 9/171 vs 9/178 • Macrosomia (>4000 g): 20/171 vs 17/178 • Postnatal weight retention: 1.4±6.8 (n=128) vs 3.0±5.7 (n=133)

Ref/setting	N	Aim/population/intervention	Outcomes
Phelan et al 2018[508] United States Healthy Beginnings Part of LIFE-Moms consortium NCT01545934	Intervention 129 Control 127	**Aim:** To test whether a behavioural lifestyle intervention with partial meal replacement reduces GWG rate in Hispanic and non-Hispanic women with overweight or obesity relative to enhanced usual care. **Population**: Participants were pregnant (13.6±1.8 wk of gestation) with overweight or obesity and had a mean age of 30.3 y; 41.6% of participants were Hispanic. **Intervention**: Each woman received a ~20-min individual, face-to-face counselling session with a study interventionist every 2 wk until 20 wk of gestation and then monthly visits until birth. Women were provided with an individually tailored structured meal plan. The partial meal replacement plan provided a caloric prescription of ~18 kcal/kg body weight at study entry and consisted of 30% of calories from fat, 15–20% from protein, and 50–55% from carbohydrates. Women were instructed to replace 2 meals with the provided meal replacement shakes or bars and to consume ≥1 meal of regular foods and 2–4 healthy snacks/d. Participants were encouraged to aim for a goal of 30 min of activity on most days of the week. They were provided with a pedometer and advised to gradually increase the number of steps walked each day until reaching an ultimate goal of 10,000 steps/d. In addition, at each visit, women were provided with a personalised graph of their weight gain with feedback. Other behavioural strategies included daily recording of food, drink, and caloric intake and physical activity; stimulus control techniques; problem-solving skills; goal-setting; self-reinforcement for goal attainment; and daily self-monitoring of weight by using a scale provided by the study.	Intervention vs control: Gestational weight gain: 9.4±6.9 vs 11.2±7.0 kg; P=0.03) Weight gain exceeding IOM guidelines: 53/129 (41.1%) vs 69/127 (53.9%); P=0.03.

Ref/setting	N	Aim/population/intervention	Outcomes
Polley et al 2002[495] United States	Intervention 57 Control 53	**Aim**: To determine whether a stepped care, behavioural intervention will decrease the percentage of women who gain more than the IOM recommendation. **Population**: Women who had a BMI>19.8, age>18 and <20 weeks gestation. **Intervention**: The intervention group received written and oral information about weight gain, healthy eating, and exercise and individual graphs of their weight gain. The primary focus of the dietary intervention was on decreasing high-fat foods, such as fast food items, and substituting healthier alternatives (fruit and vegetables) The exercise intervention focused on increasing walking and developing a more active lifestyle (eg walking rather than driving short distances). Those exceeding weight gain goals were given more intensive intervention.	Intervention vs control (normal weight): • Gestational weight gain: 15.4±7.1 (n=30) vs 16.4±4.8 (n=31) • Postnatal weight retention (8 wks): 4.4±5.4 (n=18) vs 6.2±4.5 (n=21) Intervention vs control (overweight and obese): • Gestational weight gain: 13.6±7.2 (n=27) vs 10.1±6.2 (n=22) • Postnatal weight retention (8 wks): 3.6±5.6 (n=16) vs 0.3±7.0 (n=19) Intervention vs control (all participants) • Excess gestational weight gain: 26/57 vs 25/53 • Gestational diabetes: 2/57 vs 3/53 • Gestational hypertension: 6/57 vs 8/53 • Pre-eclampsia: 2/57 vs 3/53 • Caesarean section: 4/57 vs 10/53 • Preterm birth: 7/57 vs 5/53 • Macrosomia (>4000 g): 1/57 vs 0/53

Ref/setting	N	Aim/population/intervention	Outcomes
Poston et al 2013[512] UPBEAT pilot United Kingdom	Intervention 86 Control 84	**Aim:** To determine if a) a complex intervention in obese pregnant women leads to anticipated changes in diet and physical activity behaviours, and b) to refine the intervention protocol through process evaluation of intervention fidelity. **Population**: Pregnant women with BMI ≥30 kg/m2, singleton pregnancy and gestational age of 15 to 176 weeks. **Intervention**: Women in the intervention group attended a one-to-one appointment with a 'Health Trainer' and were invited to attend weekly group sessions for 8 consecutive weeks from 19 weeks gestation. The intervention was informed by psychological models of health behaviour. At the initial appointment, women received a handbook, a pedometer, a log-book (for weekly goals and related behaviours) and a DVD of a specifically devised pregnancy exercise regimen. Each group session delivered a different element of the dietary and physical activity intervention. The focus of the dietary advice to the intervention group was therefore on increased consumption of foods with a low dietary GI, including replacement of sugar sweetened beverages with low GI alternatives. Reduction in saturated fats and replacement with monounsaturated and polyunsaturated fat was also recommended. Women in the intervention arm were encouraged to increase daily PA incrementally, setting goals of incremental step counts (monitored by pedometer) and maintaining the achieved PA level after the intervention period. Recommendations included an emphasis on walking at a moderate intensity level	Intervention vs control: • Gestational diabetes: 22/79 vs 24/75 • Macrosomia (>4000 g): 13/86 vs 16/84 • Large for gestational age: 7/86 vs 7/84

Ref/setting	N	Aim/population/intervention	Outcomes
Poston et al 2015;[513] Patel et al 2017[552] Molyneaux et al 2018[553] UPBEAT United Kingdom	Intervention 783 Control 772	**Aim**: to investigate whether a complex intervention addressing diet and physical activity could reduce the incidence of gestational diabetes and large-for-gestational-age infants. **Population**: Women > 16 years with a BMI ≥ 30 kg/m2, a singleton pregnancy, between 15 and 186 weeks gestation. **Intervention**: Women in the intervention group attended a one-to-one appointment with a 'Health Trainer' and were invited to attend weekly group sessions for 8 consecutive weeks from 19 weeks gestation. The intervention was informed by psychological models of health behaviour. At the initial appointment, women received a handbook, a pedometer, a log-book (for weekly goals and related behaviours) and a DVD of a specifically devised pregnancy exercise regimen. Each group session delivered a different element of the dietary and physical activity intervention. The focus of the dietary advice to the intervention group was therefore on increased consumption of foods with a low dietary GI, including replacement of sugar sweetened beverages with low GI alternatives. Reduction in saturated fats and replacement with monounsaturated and polyunsaturated fat was also recommended. Women in the intervention arm were encouraged to increase daily PA incrementally, setting goals of incremental step counts (monitored by pedometer) and maintaining the achieved PA level after the intervention period. Recommendations included an emphasis on walking at a moderate intensity level.	Intervention vs control: • Gestational weight gain: 7.19±4.6 (n=526) vs 7.76±4.6 (n=567) • Excess gestational weight gain: 174/526 vs 212/566 • Gestational diabetes: 160/629 vs 172/651 • Pre-eclampsia: 27/753 vs 27/752 • Caesarean section: 271/765 vs 274/757 • Macrosomia (>4000 g): 105/761 vs 105/751 • Small for gestational age: 95/761 vs 76/751 • Large for gestational age: 71/761 vs 61/751 • Childhood weight: 7.93±1.07 (n=332) vs 8.03±1.08 (n=345) • Postnatal weight retention: -0.37±7.41 (n=344) vs 0.36±6.71 (n=355) • Antenatal depression: 85/769 vs 88/757

Ref/setting	N	Aim/population/intervention	Outcomes
Rauh et al 2013;[496] Rauh et al 2015[554] Germany FeLIPO	Intervention Cluster randomised trial	**Aim**: To evaluate the feasibility and effectiveness of a lifestyle intervention presented to all pregnant women. **Population**: Healthy pregnant women of mixed BMIs. **Intervention**: Two individual counselling modules given by trained researchers at the 20th and 30th week of gestation, respectively. The sessions were structured and comprised the three main topics: nutrition, physical activity, and GWG monitoring. The first session lasted up to 60 minutes (min) and included the main components of the intervention. The second session (about 30 min) repeated topics from the first but was more detailed for selected aspects in a problem-oriented manner. In addition, each session included an individual component where women received personalised feedback on their nutrition and physical activity habits based on 7-day dietary records and physical activity questionnaires. The dietary intervention aimed at decreasing the intake of energy-dense foods and high-fat foods (e.g. fast food, sweets, and sugar-sweetened beverages), increasing fruit, vegetable and wholegrain product consumption, and improving the quality of fat consumed by increasing the amount of fish in the diet and choosing the correct fat/oil for cooking and or use as spreads. The advice on physical activity was in accordance with the current guidelines for physical activity during pregnancy from the Society of Obstetricians and Gynecologists of Canada (SOGC) and the American College of Obstetricians and Gynecologists (ACOG): 30 minutes of moderate intensity activity on most days of the week at an appropriate heart-rate zone. Women were provided with a list of adequate local prenatal exercise programs and advised to participate in programs like these.	Intervention vs control (data adjusted as per Shepherd et al):[526] • Gestational weight gain: 14.1±4.1 (n=33) vs 15.6±5.8 (n=16) • Excess gestational weight gain: 13/33 vs 10/16 • Gestational diabetes: 2/32 vs 2/16 • Caesarean section: 10/34 vs 7/17 • Preterm birth: 1/34 vs 1/17 • Small for gestational age: 1/34 vs 1/17 • Large for gestational age: 2/34 vs 2/17 • Postnatal weight retention: 0.2±3.6 (n=32) vs 0.8±5.7 (n=14) • Childhood weight: 9.38±0.93 (n=33) vs 9.74±1.0 (n=15)

Ref/setting	N	Aim/population/intervention	Outcomes
Renault et al 2014[451] Denmark	Intervention 130 Control 67 3-armed trial; control group halved	**Aim**: to assess physical activity intervention assessed by a pedometer with or without dietary intervention on gestational weight gain (GWG). **Population**: Pregnant women older than 18 years, a singleton pregnancy, and a normal scan in weeks 11-14, gestational age <16 weeks with BMI≥30 kg/m2. **Intervention**: Immediately after randomisation women were individually advised and encouraged by the dietitian to increase physical activity, aiming at a daily step count of 11,000, which corresponds to 150% of the average step count in healthy lean pregnant women. Physical activity was monitored by a validated pedometer. The dietary intervention consisted of contact with an experienced dietitian every 2 weeks, alternating between outpatient visits and phone contacts (11-13, depending on length of gestation). Individual recommendations were provided for a hypocaloric low-fat diet with 1200-1675 kcal (5000-7000 KJ), corresponding to a Mediterranean-style diet which covers preference of polyunsaturated fat by intake of fish and oils. The diet was based on the Danish national recommendations for a healthy diet.	Intervention vs control: • Excess gestational weight gain: 59/130 vs 42/67 • Gestational hypertension: 5/139 vs 5/67 • Pre-eclampsia: 21/130 vs 2/67 • Caesarean section: 32/130 vs 25/67 • Preterm birth: 4/130 vs 3/67 • Macrosomia (>4000 g): 29/130 vs 17/67 • Small for gestational age: 7/130 vs 1/67 • Large for gestational age: 9/130 vs 6/67

Ref/setting	N	Aim/population/intervention	Outcomes
Ronnberg et al 2015;[486] Ronnberg et al 2016;[555] Ronnberg et al 2017[556] Sweden	Intervention 192 Control 182	**Aim**: To evaluate if a feasible, low-cost intervention could decrease the percentage of women gaining weight above the Institute of Medicine (IOM) recommendations on gestational weight gain (GWG) compared with usual maternity care. **Population**: Healthy women with a BMI ≥19 kg/m2, age ≥18 years who signed in for maternity care at ≤16 weeks of gestation. **Intervention**: The intervention programme consisted of individual education/ information about IOM guidelines for recommended GWG according to BMI category at first antenatal visit. The information was supplemented by a personalised graph where recommended interval of weight gain was marked. Women in intervention and control groups received recommendations on dietary intake during pregnancy according to guidelines from the Swedish National Food Administration. The midwife issued a written formalised prescription of physical activity. General recommendation of physical activity during pregnancy was moderate intensity for approximately 30 minutes per day. The midwife was instructed to follow up and renew the prescription of exercise at every antenatal visit during the pregnancy.	Intervention vs control: • Gestational weight gain: 14.19±4.45 (n=192) vs 15.31±5.38 (n=182) • Weight gain >IOM guidelines: 79/192 vs 91/182 • Macrosomia (>4000 g): 47/192 vs 28/182 • Macrosomia (>4500 g): 8/192 vs 8/182 • Large for gestational age: 15/192 vs 11/182 • Small for gestational age: 3/192 vs 3/182 • Postpartum weight retention (<16 weeks postpartum): 1.81±4.52 (n=137) vs 3.19±4.77 (n=130) • Postpartum weight retention (1 year postpartum): 0.30±5.52 (n=87) vs 1.00±5.46 (n=81)

Ref/setting	N	Aim/population/intervention	Outcomes
Ruchat et al 2012[482] Canada	Low intensity 23 Moderate intensity 26 Control 45	**Aim:** To evaluate the effect of an exercise program of two different intensities, with nutritional control, on gestational weight gain (GWG), infant birth weight, and maternal weight retention at 2 months postpartum. **Population**: Pregnant women with prepregnancy BMI 18.5–24.9 between 16 and 20 wk gestation. **Intervention**: Low-intensity (30% HR reserve) or moderate-intensity (70% HR reserve) exercise program that consisted of walking sessions three to four times per week, gradually increasing exercise time from 25 to 40 min per session. Specific nutritional goals as indicated by the modified gestational diabetes meal plan were total daily energy intake of approximately 2000 kcal/d)); daily carbohydrate intake 40%–55% of total energy intake, emphasising complex carbohydrates and low-glycaemic index foods; total daily fat intake 30% of total energy intake (substituting monounsaturated and polyunsaturated fatty acids for saturated and trans-fatty acids), with the remaining 20%–30% of energy intake dedicated to protein; and to meet daily micronutrient and fluid recommendations during pregnancy.	Low intensity vs moderate intensity vs control: • Gestational weight gain: 15.3±2.9 vs 14.9±3.8 vs 18.3±5.3 kg • Weight gain exceeding IOM guidelines: 8/23 vs 8/26 vs 24/45 • Weight retention at 2 months postpartum: 5.4±3.9 vs 4.6±3.3 vs 7.2±3.8

Ref/setting	N	Aim/population/intervention	Outcomes
Sagedal et al 2017a;[487] Sagedal et al 2017b;[557] Fit for Delivery Norway	Intervention 296 Control 295	**Aim**: To examine whether a lifestyle intervention in pregnancy limits gestational weight gain (GWG) and provides measurable health benefits for mother and newborn. **Population**: Pregnant women who were nulliparous, with a singleton pregnancy at ≤20 weeks of gestation, had a pre-pregnancy body mass index (BMI) of ≥19 kg/m2. **Intervention**: Dietary counselling was performed by telephone, with an initial consultation and then a follow-up 4–6 weeks later, each of approximately 20 minutes. Counsellors were either experienced clinical dieticians or graduate students in public health. Nutritional advice was based on recommendations from the Norwegian Directorate for Health with specific attention given to intake of fruits and vegetables, drinking water instead of drinks containing energy, regular meal patterns, and limiting consumption of snack foods and foods/drinks containing added sugar. The physical activity component consisted of access to twice-weekly exercise classes at a local gym, all following the same pattern: 10 minutes of warm-up, 40 minutes of strength training and cardiovascular exercise at moderate intensity (using aerobics, calisthenics, and weight training), and 10 minutes of stretching. The intensity of the exercise was self-monitored using Borg's scale with a target of 12-14. Classes were led by physical therapists or students in sports science.	Intervention vs control: • Gestational weight gain: 14.4±6.2 (n=267) vs 15.8±5.7 (n=266) • Excess gestational weight gain: 111/267 vs 133/266 • Gestational diabetes: 32/275 vs 25/272 • Pre-eclampsia: 10/293 vs 28/154 • Caesarean section: 38/296 vs 36/295 • Preterm birth: 17/296 vs 17/295 • Macrosomia (>4000 g): 33/279 vs 39/278 • Macrosomia (>4500 g): 2/279 vs 5/278 • Small for gestational age: 31/296 vs 27/295 • Large for gestational age: 7/296 vs 11/295 • Postnatal weight retention: 0.66±5.48 (n=203) vs 1.42±4.96 (n=188) • Apgar score >7 at 5 minutes: 1/296 vs 6/295

Ref/setting	N	Aim/population/intervention	Outcomes
Simmons et al 2017[402] DALI United Kingdom, Ireland, Netherlands, Austria, Poland, Italy, Spain, Denmark and Belgium	Intervention 108 Control 105 4-armed; control group divided by three	**Aim:** To compare the effectiveness of 3 lifestyle interventions [healthy eating (HE), physical activity (PA), and both HE and PA (HE+PA)] with usual care (UC) in reducing GDM risk. **Population**: Pregnant women at with a body mass index (BMI) of ≥29 kg/m, ≤19±6 and aged ≥18 years and without GDM using the International Association of Diabetes and Pregnancy Study Group criteria. **Intervention**: The dietary component promoted lower simple and complex carbohydrate, lower fat, higher fibre, higher protein diet, including a focus on portion size and, therefore, a more limited intake of total calories. The PA component promoted both aerobic and resistance physical activity. Women received five face-to-face coaching sessions of approximately 30–45 minutes, #4 telephone calls of #20 minutes or contacts using electronic mail. The intervention recommended a limitation in GWG to 5 kg. The messages were supported by a "toolkit" for each participant, including the participant handbook, educational materials based on the American College of Obstetricians and Gynecologists guidelines, pedometers and flexible elastic Dyna-Bands. The message delivery was built on the principles of patient empowerment and cognitive behavioural techniques inspired by motivational interviewing. The number of contacts and time taken included 5 face-to-face sessions of approximately 30 to 45 minutes duration, and #4 telephone calls of #20 minutes or contacts using electronic mail. Face-to-face sessions occurred largely in the hospital or midwife practice, depending on the local arrangements. At least 4 face-to-face coaching sessions were expected to occur before the second measurement session (24 to 28 weeks), and the intervention was completed by 35 weeks of gestation.	Intervention vs control • Gestational weight gain: 6.5±3.8 (n=75) vs 8.8±4.7 (n=26) • Weight gain >IOM guidelines: 45/75 vs 20/26 • Gestational diabetes: 27/84 vs 11/31 • Small for gestational age: 7/86 vs 2/30 • Large for gestational age: 8/86 vs 5/30

Ref/setting	N	Aim/population/intervention	Outcomes
Trak-Fellermeie et al 2019[509] Puerto Rico PEARLS NCT01771133	Intervention 15 Control 16	**Aim**: To evaluate the impact of a lifestyle intervention on achieving appropriate GWG and on improving birthweight among high-risk pregnant women. **Population**: **O**verweight/obese women with a singleton pregnancy before 16 gestational weeks. **Intervention**: The lifestyle intervention was delivered by registered dietitians and promoted individual goal-setting and self-efficacy through group and individual sessions. The intervention encouraged participants to meet gestational weight gain recommendations through monitoring diet, physical activity, and weight trajectory. The primary focus of the dietary intervention was on total calories. Women were given individualised guidelines for food quantity and total calories for distinct pregnancy phases. Additional key components of the diet intervention included improving carbohydrate and fat quality, reducing salt and replacing red meat with low-mercury fish, nuts, and beans. The primary focus of the physical activity component was to increase movement and reduce sedentary time. Participants were encouraged to set goals for a daily exercise routine considered safe during pregnancy, according to the American Congress of Obstetrics and Gynecology.	Intervention vs control: • Weight gain exceeding IOM recommendations: 4/15 vs 9/16 • Small-for-gestational age: 1/15 vs 4/16 • Large-for-gestational age: 1/15 vs 0/16

Ref/setting	N	Aim/population/intervention	Outcomes
Van Horn et al 2018[505] United States MOMFIT NCT01631747	Intervention 140 Control 141	**Aim**: To determine whether technology-enhanced antenatal diet and lifestyle intervention could prevent excess gestational weight gain and benefit mother and child. **Population**: Overweight and obese ethnically diverse pregnant women at 16 weeks gestation. **Intervention**: Dietitian-led Dietary Approaches to Stop Hypertension diet and physical activity coaching that was received as three individual and six group counselling sessions by phone and webinar. The DASH diet is especially well-suited to pregnancy because of its high nutrient density including low-fat milk and dairy products, fish, skinless poultry, lean meat and vegetable protein, unsaturated fats, fibre-rich whole grains, fruits, vegetables, and legumes. Conversely, intake of sugar-sweetened beverages, other sweets, and non-nutrient-dense snack foods was discouraged. The activity goal was to engage in >30 minutes of activity or walking >10,000 steps per day. A commercially available smartphone application was used for self-monitoring diet and physical activity. Telephone, text message prompts, and e-mail reminders encouraged adherence and website viewing. Usual-care, "web-watcher" participants were e-mailed biweekly newsletters and publicly available maternity website links.	Intervention vs control: • Gestational weight gain (kg): 10±6 (n=140) vs 12±6 (n=141) • Weight gain exceeding IOM guidelines: 96/140 (68.6%) vs 119/141 (84.4%) • Gestational diabetes: 7/133 (5.3%) vs 9/127 (7.1%) • Preterm birth: 6/139 (4.3%) vs 12/136 (8.8%) • Caesarean section: 55/140 (39.6%) vs 37/137 (27%) • Small-for-gestational age: 25/130 (18%) vs 27/121 (19.9%) • Large for gestational age: 8/130 (5.8%) vs 12/121 (8.8%)

Ref/setting	N	Aim/population/intervention	Outcomes
Vesco et al 2012;[514] Vesco et al 2014;[558] Vesco et al 2016[559] United States	Intervention 54 Control 57	**Aim**: To test the efficacy of a group-based weight management intervention for limiting GWG among obese women. **Population**: Women who were obese (BMI ≥30 kg/m2) and aged 18 years or older, randomised between 7 and 21 weeks. **Intervention**: The intervention program included a combination of dietary and exercise recommendations, as well as the use of behavioural self-management techniques to help participants initiate and maintain behaviour changes. The study dietician advised intervention participants to follow an energy reduced eating plan, based on Dietary Approaches to Stop Hypertension (DASH) dietary pattern without sodium restriction. Participants were encouraged to accumulate at least 30 minutes of moderate physical activity per day in the absence of medical or obstetrical complications, a goal consistent with the recommendations of the American College of Obstetricians and Gynecologists (ACOG), given a pedometer, and encouraged to record their physical activity in their daily food and activity records. The intervention did not involve an exercise component that was directly observed by the study team.	Intervention vs control: • Gestational weight gain (34 weeks): 5.0±4.1 (n=54) vs 8.4±4.7 (n=57) • Weight gain > IOM guidelines: 24/54 vs 47/57 • Gestational diabetes: 6/56 vs 7/58 • Gestational hypertension (including pre-eclampsia): 5/56 vs 6/58 • Caesarean section: 21/56 vs 26/58 • Preterm birth (<37 wk): 4/56 vs 1/58 • Large for gestational age: 5/56 vs 15/58 • Small for gestational age: 3/56 vs 4/58 • Macrosomia (>4000 g): 6/56 vs 13/58 • Postpartum weight retention (2 weeks): -2.6±5.5 (n=54) vs 1.2±5.6 (n=58) • Childhood weight (12 months): 9.83±0.93 (n=51) vs 10.01±1.24 (n=52)

Ref/setting	N	Aim/population/intervention	Outcomes
Vinter et al 2011;[515] Vinter et al 2014a;[560] Vinter et al 2014b[561] LiP Denmark	Intervention 150 Control 154	**Aim**: To study the effects of lifestyle intervention on gestational weight gain (GWG) and obstetric outcomes. **Population**: Healthy pregnant women with BMI ≥30. **Intervention**: Dietary counselling was performed by trained dietitians on 4 separate occasions, at 15, 20, 28 and 35 weeks gestation, to limit GWG to 5 kg. The counselling included dietary advice based on the official Danish recommendations. Energy requirements were individually estimated according to weight and level of activity. Women were encouraged to be moderately physically active 30 to 60 minutes daily and were equipped with a pedometer to motivate and improve daily activity. They also had free full membership to a fitness centre for 6 months where they had closed training classes with physiotherapists for 1 hour each week. Training consisted of aerobic (low-step), training with light weights and elastic bands, and balance exercises. After training women were grouped 4 to 6 times with a physiotherapist using coaching inspired methods for improving integration of activity into daily life.	Intervention vs control: • Gestational weight gain: 7.4±4.6 (n=144) vs 8.6±4.4 (n=148) • Gestational diabetes: 9/150 vs 8/154 • Pre-eclampsia: 23/150 vs 28/154 • Caesarean section: 40/150 vs 39/154 • Preterm birth: 5/82 vs 2/75 • Macrosomia (>4000 g): 40/150 vs 39/154 • Large for gestational age: 23/150 vs 18/154 • Childhood weight (2.8 years): 14.7±1.82 (n=82) vs 14.4±1.3 (n=75)

Ref/setting	N	Aim/population/intervention	Outcomes
Wang et al 2015[517] China	Intervention 134 Control 138	**Aim**: To examine whether gestational diabetes mellitus (GDM) can be prevented by early trimester lifestyle counselling in a high-risk population. **Population**: Women with at least one risk factor for gestational diabetes **Intervention**: Women in the intervention group received routine antenatal care plus a standardised lifestyle intervention delivered at 6 to 8 weeks gestation, and enforcement interventions informed by maternal anthropometrics at 12 to 13 gestational weeks. The standardised courses were delivered by 1 physician and included 3 courses: 'What is a balanced diet?' (according to the dietary pagoda of pregnant women in China); 'Proper physical activity is beneficial during pregnancy' (walking 30 minutes after meal at least once a day); and 'Standard weight-gain during pregnancy'. Each course was group based (< 6 women per group) and lasted 40 to 60 minutes.	Intervention vs control: • Gestational weight gain: 5.51±2.18 (n=134) vs 5.66 (n=138) • Gestational diabetes: 23/134 vs 33/138

Ref/setting	N	Aim/population/intervention	Outcomes
Willcox et al 2017[500] txt4two Australia	Intervention 45 Control 46	**Aim**: To determine the feasibility and effectiveness of an mHealth intervention promoting healthy diet, physical activity and gestational weight gain in pregnant women. **Population**: Women with a singleton pregnancy between 10_0 and 17_6 weeks; self-reported pre-pregnancy BMI >25 kg/m2; able to speak, read and write English; and owning a mobile phone. **Intervention**: At baseline the trained researcher discussed appropriate GWG targets, individual GWG monitoring and recording, and asked the woman to set a nutrition or physical activity goal to work towards the recommendations. Intervention participants then received four to five individually tailored, interactive text messages per week. The texts delivered information specific to the individual's gestational week, encouragement of positive health behaviours, monitoring of individual goals and encouragement of self-monitoring of GWG. Texts were developed and mapped according to the behaviour change techniques by the authors. Women chose the frequency of texts that aimed to: prompt review of their weight (weekly or fortnightly); and check their behavioural goals (weekly or fortnightly). Advice was based on current Australian guidelines: the Australian Dietary Guidelines emphasise the replacement of sugar-sweetened beverages, increased fruit and vegetable intake, reduction of discretionary food groups and consumption of regular meals; the physical activity guidelines emphasise 30 minutes of moderate intensity physical activity on most, if not all, days of the week, reduction of sedentary behaviour.	Intervention versus control: • Gestational weight gain: 11.0±5.92 (n=45) vs 13.6±5.6 (n=46) • Weight gain >IOM guidelines: 21/45 vs 28/46

6 Additional considerations

6.1 Q10: What are the additional needs of Aboriginal and Torres Strait Islander women?

These studies have been included in relevant sections of the review.

6.2 Q11: What are the additional considerations for migrant and refugee women?

No studies were identified to specifically answer this question.

Appendices

A Search strategies

Dietary advice

Diet and pregnancy (research questions 1, 2 and 9)

Date of searches: 4-June-2019

Embase:

('diet'/exp OR 'dietary pattern'/exp OR 'vegetarian' OR 'vegan' OR 'fibre') AND ('pregnant woman'/syn OR 'pregnancy'/syn) AND [humans]/lim AND [english]/lim AND [2013-2019]/py01/01/2014 to 31/12/2019 = Results: 4233

CINAHL:

(MH "Diet+") OR (MM "Diet, Paleolithic") OR (MM "Diet, Fat-Restricted") OR (MH "Diet, Antineoplastic") OR (MM "Diet, Western") OR (MM "Diet, Sodium-Restricted") OR (MM "Diet, Low Carbohydrate") OR (MM "Diet, Gluten-Free") OR (MM "Diet, Reducing") OR (MM "Diet, Nordic") OR (MM "Restricted Diet") OR (MM "Diet, Ketogenic") OR (MM "Diet, High Protein") OR (vegetarian OR fiber OR fibre OR vegan)

AND (((MH "Pregnancy+") OR (Pregnan*) OR (MM "Pregnancy Outcomes") OR (MH "Pregnancy Trimesters+"))

01/01/2014 to 31/12/2019 = Results 1490

Pubmed:

("Diet"[Mesh] OR "vegetarian" OR "fibre" OR "vegan") AND (("Pregnant Women"[Mesh]) OR ("Pregnancy"[Mesh]))

Humans and english language

01/01/2014- 31/12/2019 = Results = 2233

Informit: Indigenous Peoples

(Pregnancy and Diet)

2014-2019

Results = 1

Cochrane Library

#1	MeSH descriptor: [Pregnancy] explode all trees	MeSH	7295
#2	MeSH descriptor: [Pregnant Women] explode all trees	MeSH	211
#3	Pregnancy	Limits	52312
#4	#1 OR #2 OR #3	Limits	52546
#5	MeSH descriptor: [Diet] explode all trees	MeSH	17123
#6	MeSH descriptor: [Vegetarians] in all MeSH products	MeSH	4
#7	MeSH descriptor: [Vegans] in all MeSH products	MeSH	3
#8	#5 Or #6 OR #7 OR vegan OR vegetarian OR fiber OR fibre	Limits	26204
#9	#4 AND #8	Limits	819

in Cochrane Reviews, Trials and Special collections

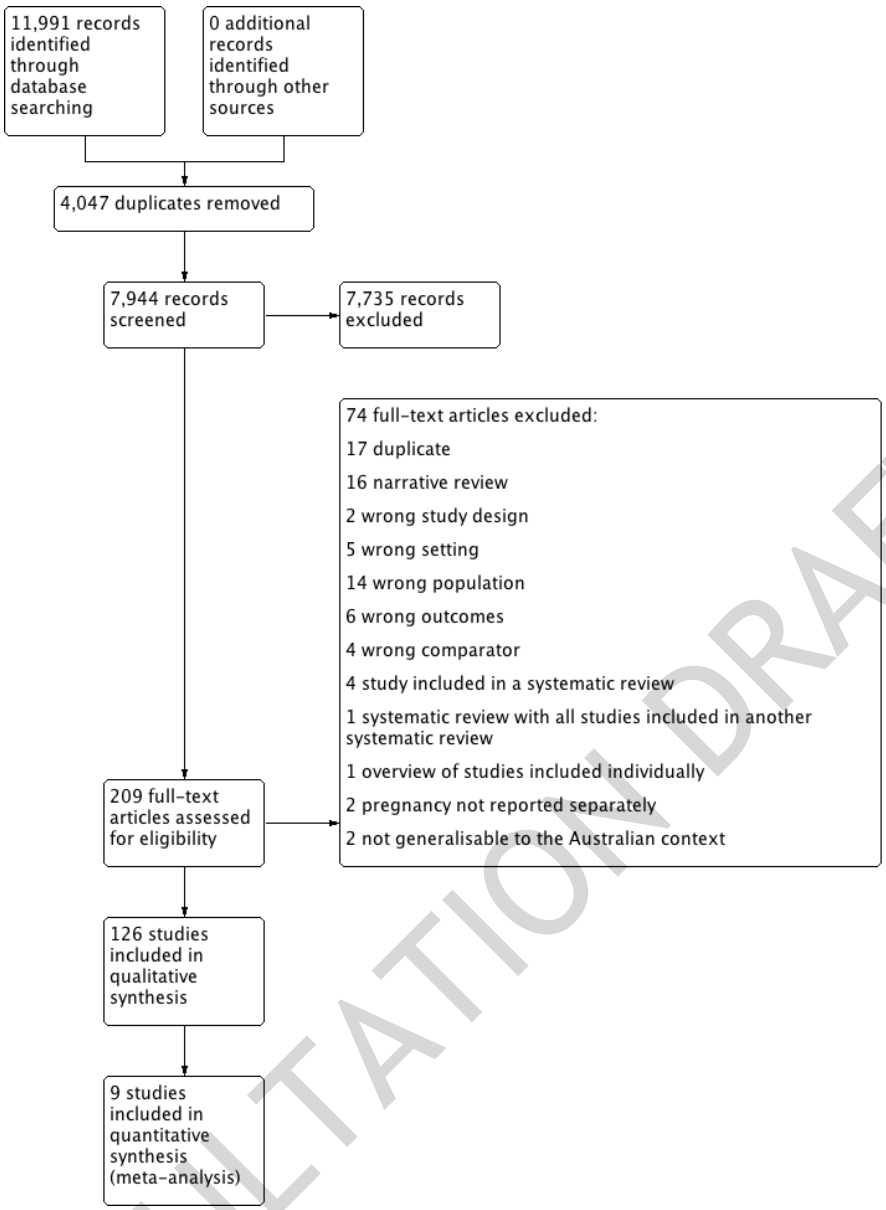
Top-up search- 01/01/2014-04/06/2019 = Review Results 819

Scopus

((TITLE-ABS-KEY((("Pregnan*") OR ("prenatal*") OR ("gestation*"))) AND TITLE-ABS-KEY((("Weight") W/1 (("gain") OR ("change"))))) AND PUBYEAR > 2013)

Search results = 3201

Dates searched – 2013 (jan) to 2019 (4/6/19)



PRISMA diagram: diet

Folic acid supplementation (research question 3)

Previous Folic acid supplementation in pregnancy Cochrane search date: 31 December 2012

Lassi ZS, Salam RA, Haider BA, Bhutta ZA. Folic acid supplementation during pregnancy for maternal health and pregnancy outcomes. Cochrane Database of Systematic Reviews 2013, Issue 3. Art. No.: CD006896. DOI: 10.1002/14651858.CD006896.pub2.

Synonyms for Folic acid;

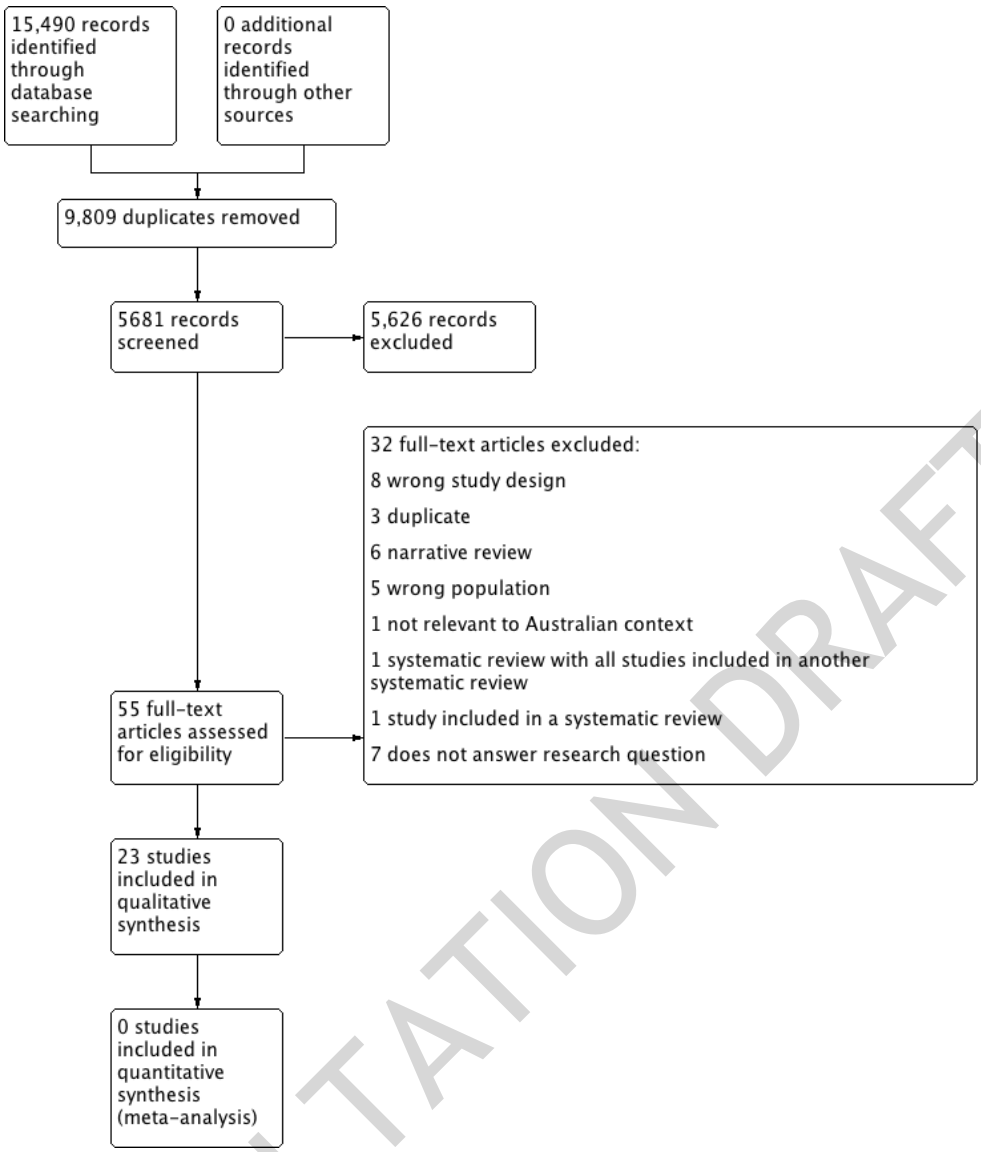
- Vitamin M
- Vitamin B9
- B9, Vitamin
- Pteroylglutamic Acid
- Folic Acid, Monopotassium Salt
- Folic Acid, Monosodium Salt
- Folic Acid, Potassium Salt
- Folic Acid, (DL)-Isomer
- Folvite
- Folacin

- Folate
- Folic Acid, (D)-Isomer
- Folic Acid, Calcium Salt (1:1)
- Folic Acid, Sodium Salt

Current search dates:

31-Dec-2012-current

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	("pregnancy"[Mesh] OR "pregnan*"[All Fields] OR "prenatal*"[All Fields]) AND ("Folic Acid"[Mesh] OR "Folic Acid"[Title/Abstract] OR "vitamin M"[Title/Abstract] OR "Vitamin B9"[Title/Abstract] OR "Folate"[Title/Abstract] OR "Folvite"[Title/Abstract] OR "Pteroylglutamic Acid"[Title/Abstract])	31-Dec-2012 to 31-Dec-2019	Human English Language	1468	24-June-19
Ovid medline	(exp Folic Acid/ OR (folate or folic acid or Vitamin M or Vitamin B9 or folvite or pteroylglutamic acid).mp.) AND Pregnancy/syn or Pregnan*.mp.	2012-Current	English Language Human	1829	24-June-19
Embase	('pregnancy'/exp OR pregnan*) AND ('folic acid'/exp OR 'vitamin B9' or 'folic acid' OR 'folate' OR 'pteroylglutamic acid')	2012-2019	English Language Human	4601	24-June-19
CINAHL	((MM "Folic Acid") OR (AB "Folate") OR (AB "Vitamin M") OR (AB "Vitamin B9")) AND ((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*"))	2012-2019	English	759	24-June-19
SCOPUS	TITLE-ABS-KEY ((("pregnan*") OR (prenatal*)) AND (("folic acid") OR ("folate")))	2012 - 2019	English	3423	24-June-19
Health Infonet	Ascorbic Acid – title and abstract Pregnancy - keyword	2012-current = 0	None	0	24-June-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR 'pregnan*') AND (Folate OR (Folic NEXT Acid) OR (Vitamin NEXT M) OR (Vitamin NEXT B9) OR (MeSH descriptor: [Folic Acid] explode all trees))	Dec 2012 to Dec 2019	Reviews: 95 Protocols: 21 Trials: 717 Spec. Collections: 1 Answers: 18	852	24-June-19



PRISMA diagram: Folic acid

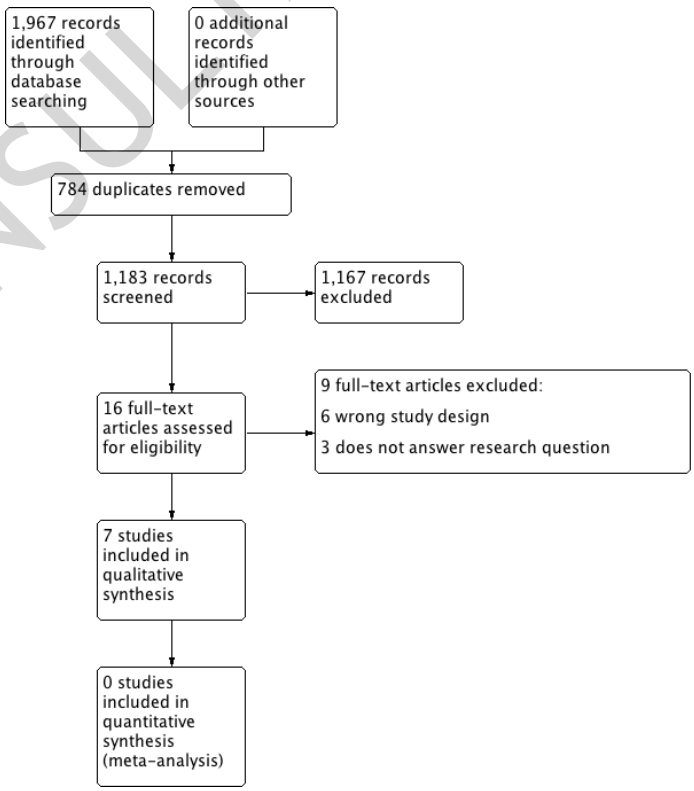
Vitamin B supplementation during pregnancy (research question 3)

Current search dates:

All

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	((((("pregnancy"[Mesh]) OR ("pregnan*"[All Fields]) OR ("prenatal*"[All Fields])))) AND ((("Vitamin B Complex"[Mesh]) OR ("Vitamin" NEXT "B") OR ("Vitamin B Deficiency"[Mesh]) OR ("Vitamin B 6"[Mesh]) OR ("Vitamin B 12"[Mesh]) OR ("Nicotamin") OR ("Pantothenic" NEXT "acid") OR ("biotin")))	2014 to 30-sep-19	Human English	473	5-Oct-19
Ovid medline	(Pregnan* and Vitamin B).mp.	2014-30-Sep-19	English Languag e Human	363	30-sep-19
Embase	('pregnancy'/exp OR 'pregnan*') AND ('biotin derivative'/exp OR 'nicotinamide'/exp OR 'pantothenic acid'/exp OR 'vitamin B complex'/exp) AND [2014-2019]/py AND [humans]/lim AND [english]/lim	2014 to 30-sep-19	English Languag e Human	199	5-Oct-19

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
CINAHL	((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*")) AND (MH "Vitamin B Complex+") OR (MM "Pantothenic Acid") OR "vitamin B" OR (MH "Vitamin B Deficiency+") OR (MM "Vitamin B6 Deficiency") OR (MH "Vitamin B12 Deficiency+")	2014 to 30-Sep-19	English	780	5-Oct-19
SCOPUS	(TITLE-ABS-KEY ((("pregnan*") OR (prenatal*))) AND TITLE-ABS-KEY (("Vitamin Pre/1 B") OR ("Thiamine") OR ("riboflavin") OR ("niacin") OR ("Pantothenic") OR ("pyridoxine") OR ("biotin") OR ("cobalamin"))) AND PUBYEAR > 2013	2014 to 30-Sep-19	English	725	30-sep-19
Health Infonet	Vitamin B – title and abstract Vitamin – title and abstract		None		5-Oct-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR 'pregnan*') AND ((MeSH descriptor: [Pantothenic Acid] explode all trees) OR (MeSH descriptor: [Niacinamide] explode all trees) OR (MeSH descriptor: [Biotin] explode all trees) OR (MeSH descriptor: [Biotin] explode all trees))	01/01/2014-31/12/2019	Cochrane reviews	8	5-Oct-19



Prisma diagram: B vitamins

Vitamin C Supplementation (research question 3)

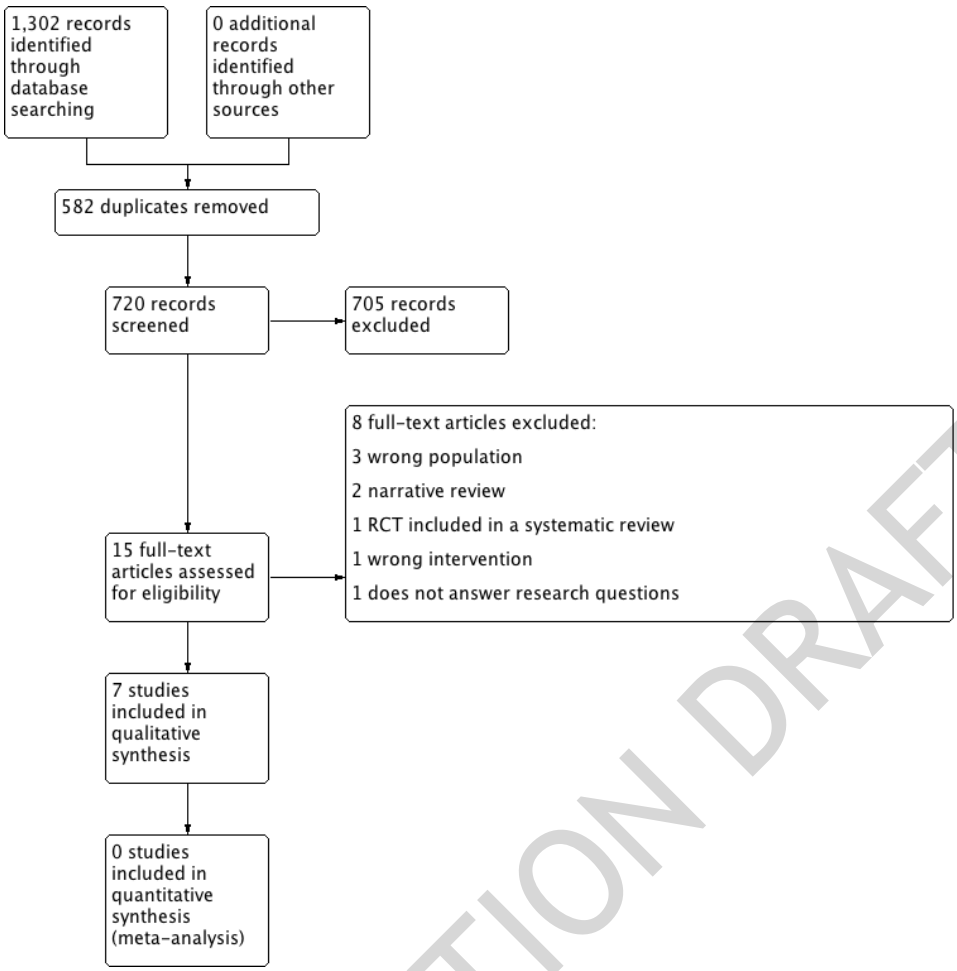
Previous vitamin c supplementation in pregnancy Cochrane search date: 31 March 2015

Citation: Rumbold A, Ota E, Nagata C, Shahrook S, Crowther CA. Vitamin C supplementation in pregnancy. Cochrane Database of Systematic Reviews 2015, Issue 9. Art. No.: CD004072. DOI: 10.1002/14651858.CD004072.pub3.

Current search dates:

31-Mar-2015-current

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	("pregnancy"[Mesh] OR "pregnan*"[All Fields] OR "prenatal*"[All Fields]) AND ("Ascorbic Acid"[Mesh] OR "vitamin c"[All Fields] OR "ascorbic acid"[All Fields])	31-Mar-2015 to 31-Dec-2019	Human English Language	88	19-June-19
Ovid medline	(Pregnancy/syn or Pregnan*.mp.) and (vitamin C.mp. or ascorbic acid/syn or ascorbic acid.mp.)	2015-Current	English Language Human	106	19-June-19
Embase	('pregnancy'/exp OR pregnan*) AND ('ascorbic acid'/exp OR 'vitamin c' or 'ascorbic acid')	2015-2019	English Language Human	431	19-June-19
CINAHL	((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*")) AND TX ((MM "Ascorbic acid deficiency") OR (MM"Ascorbic acid") OR (AB "vitamin C"))	2015-2019	English	129	19-June-19
SCOPUS	TITLE-ABS-KEY ((("pregnan*") OR (prenatal*)) AND (("ascorbic acid") OR ("vitamin c")))	2015 - 2019	English	497	19-June-19
Health Infonet	Ascorbic Acid – title and abstract Pregnancy - keyword	2015-current = 0	None	0	19-June-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR 'pregnan*') AND (MeSH Descriptor: [Ascorbic Acid] explode all trees)	Mar 2015 to Dec 2019	Trials + Cochrane reviews	100	19-June-19



PRISMA diagram: vitamin C

Vitamin E Supplementation (research question 3)

Previous vitamin c supplementation in pregnancy Cochrane search date: 31 March 2015

Rumbold A, Ota E, Hori H, Miyazaki C, Crowther CA. Vitamin E supplementation in pregnancy. Cochrane Database of Systematic Reviews 2015, Issue 9. Art. No.: CD004069. DOI: 10.1002/14651858.CD004069.pub3.

Synonyms for vitamin E:

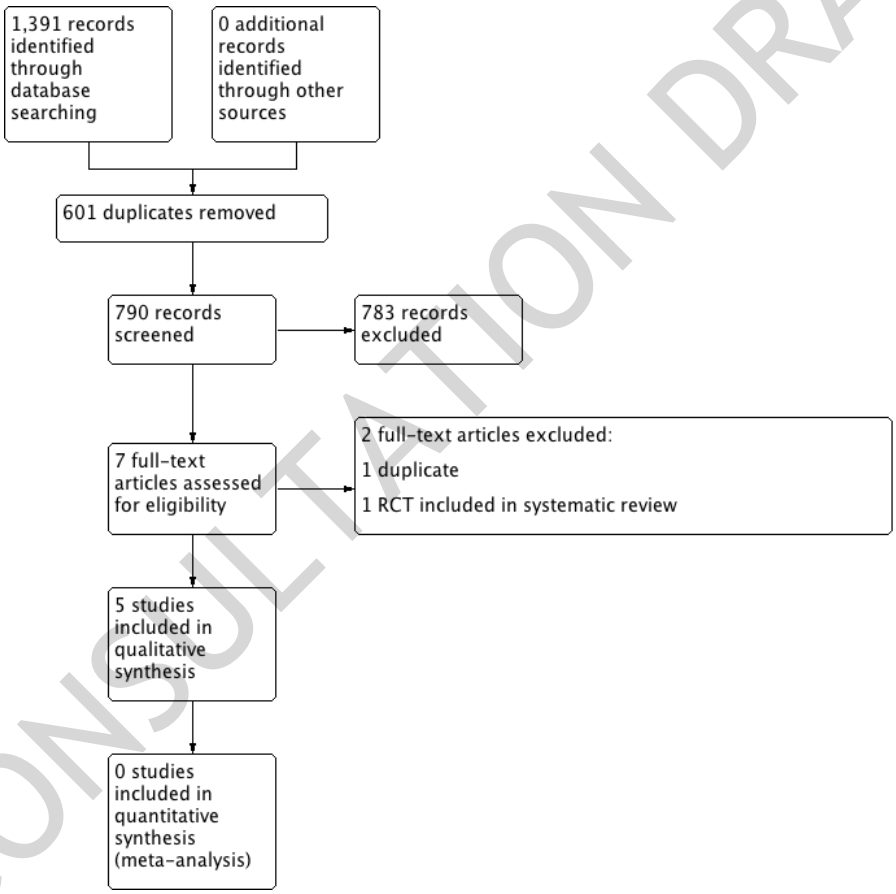
- gamma-tocopherol
- alpha-tocopherol
- tocopherol

Current search dates:

31-Mar-2015-current

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	(("pregnancy"[Mesh]) OR ("pregnan*"[All Fields]) OR ("prenatal*"[All Fields])) AND ("Vitamin E"[Mesh] OR "vitamin E"[All Fields] OR "tocopherol"[All Fields])	31-Mar-2015 to 31-Dec-2019	Human English Language	86	19-June-19
Ovid medline	(Pregnancy/syn or Pregnan*.mp.) AND (Vitamin E or tocopherol).mp.	2015-Current	English Language Human	108	19-June-19
Embase	('pregnancy'/exp OR pregnan*) AND ('Vitamin E' OR 'tocopherol'/exp OR 'tocopherol')	2015-2019	English Language Human	404	19-June-19
CINAHL	((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR	2015-2019	English	67	19-

	(MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*")) AND TX ((MM "Vitamin E") OR (AB "Vitamin E") OR (AB "tocopherol"))				June-19
SCOPUS	TITLE-ABS-KEY ((("pregnan*") OR (prenatal*)) AND (("vitamin E") OR ("gamma-tocopherol") OR ("alpha-tocopherol") OR ("tocopherol")))	2015 - 2019	English	504	19-June-19
Health Infonet	Vitamin E - title and abstract Pregnancy - keyword	2015-current = 0	None	0	19-June-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR 'pregnan*') AND (MeSH descriptor: [Vitamin E] explode all trees) OR (tocopherol)	Mar 2015 to Dec 2019	Cochrane reviews and Trials	222	19-June-19



Prisma diagram: Vitamin E

Vitamin A supplementation (research question 3)

Previous vitamin A supplementation in pregnancy Cochrane search date: 30 March 2015

McCauley ME, van den Broek N, Dou L, Othman M. Vitamin A supplementation during pregnancy for maternal and newborn outcomes. Cochrane Database of Systematic Reviews 2015, Issue 10. Art. No.: CD008666. DOI: 10.1002/14651858.CD008666.pub3.

Synonyms for vitamin A:

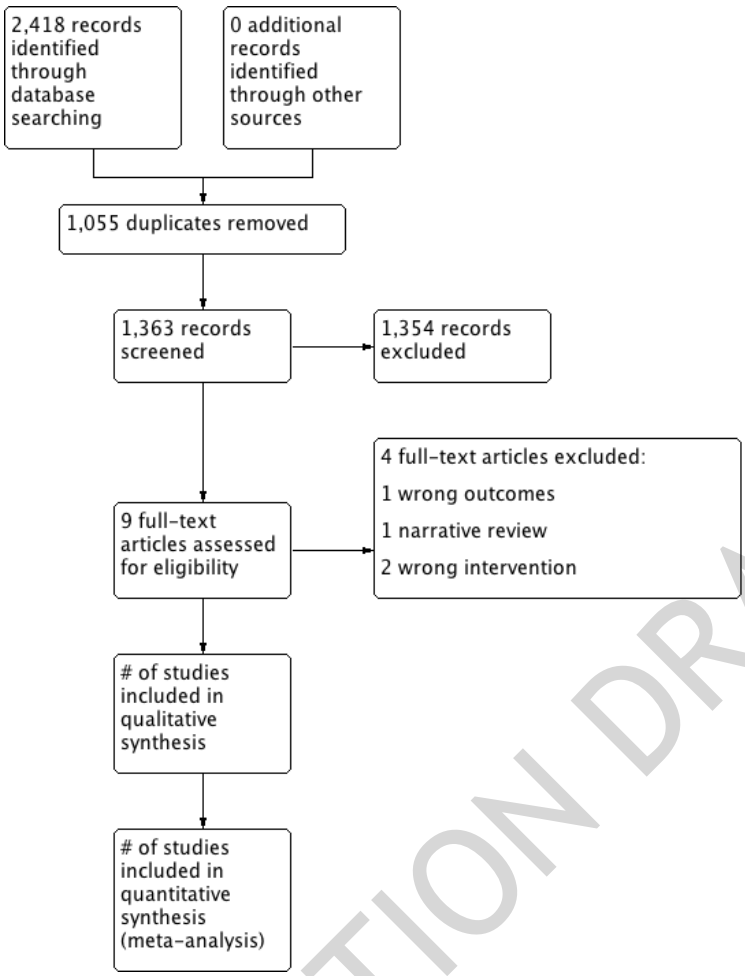
- Aquasol A
- Retinol
- 3,7-dimethyl-9-(2,6,6-trimethyl-1-cyclohexen-1-yl)-2,4,6,8-nonatetraen-1-ol, (all-E)-Isomer

- All-Trans-Retinol
- All Trans Retinol
- Vitamin A1
- 11-cis-Retinol

Current search dates:

30-Mar-2015-current

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	((((("pregnancy"[Mesh]) OR ("pregnan*"[All Fields]) OR ("prenatal*"[All Fields])))) AND (("Vitamin A"[Mesh] OR "vitamin A*"[All Fields] OR "retinol"[All Fields] OR "All*Trans*Retinol"[All Fields] OR "Retinol"[All Fields] OR "11-cis-Retinol"[All Fields] OR "3,7-dimethyl-9-(2,6,6-trimethyl-1-cyclohexen-1-yl)-2,4,6,8-nonatetraen-1-ol, (all-E)-Isomer"[All Fields]))	30-Mar-2015 to Current	Human English Language	199	20-June-19
Ovid medline	(Pregnancy/syn or Pregnan*.mp.) and (Vitamin A or retinol or All*Trans*Retinol or Retinol or 11-cis-Retinol).mp.	2015-Current	English Language Human	238	20-June-19
Embase	('pregnancy'/exp OR pregnan*) AND ('vitamin A' OR 'retinol'/exp OR 'retinol' OR 'all*trans*retinol or retinol' OR '11-cis-retinol')	2015-2019	English Language Human	626	20-June-19
CINAHL	((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*")) AND ((MH "Retinoids+") OR (MM "Vitamin A") OR (AB "vitamin" NEXT A") OR (AB "retinol") OR (AB "all*trans*retinol") OR (AB "11-cis-Retinol") OR (AB "3,7-dimethyl-9-(2,6,6-trimethyl-1-cyclohexen-1-yl)-2,4,6,8-nonatetraen-1-ol, (all-E)-Isomer"))	2015-2019	English	150	20-June-19
SCOPUS	TITLE-ABS-KEY ((("pregnan*") OR (prenatal*)) AND (("Retinoids") OR ("Vitamin A") OR ("vitamin" Next/2 "A") OR ("retinol") OR ("all*trans*retinol"))	2015 - 2019	English	943	20-June-19
Health Infonet	Vitamin – Keyword Pregnancy - keyword	2015-current = 0	None	0	20-June-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR 'pregnan*') AND (MeSH descriptor: [Vitamin A] explode all trees) OR ((Retinoids) OR (vitamin NEXT A) OR (retinol) OR (all*trans*retinol))	Mar 2015 to Dec 2019	Cochrane reviews, protocols and Trials	262	20-June-19



PRISMA diagram: Vitamin A

Multiple micronutrient supplementation (research question 3)

Citation:

Wolf, HT, Hegaard, HK, Huusom, LD & Pinborg, AB 2017, 'Multivitamin use and adverse birth outcomes in high-income countries: a systematic review and meta-analysis', *American Journal of Obstetrics and Gynecology*, vol. 217, no. 4, pp. 404.e1-404.e30.

Current search dates:

01 Jan 2015 – Jan 2020

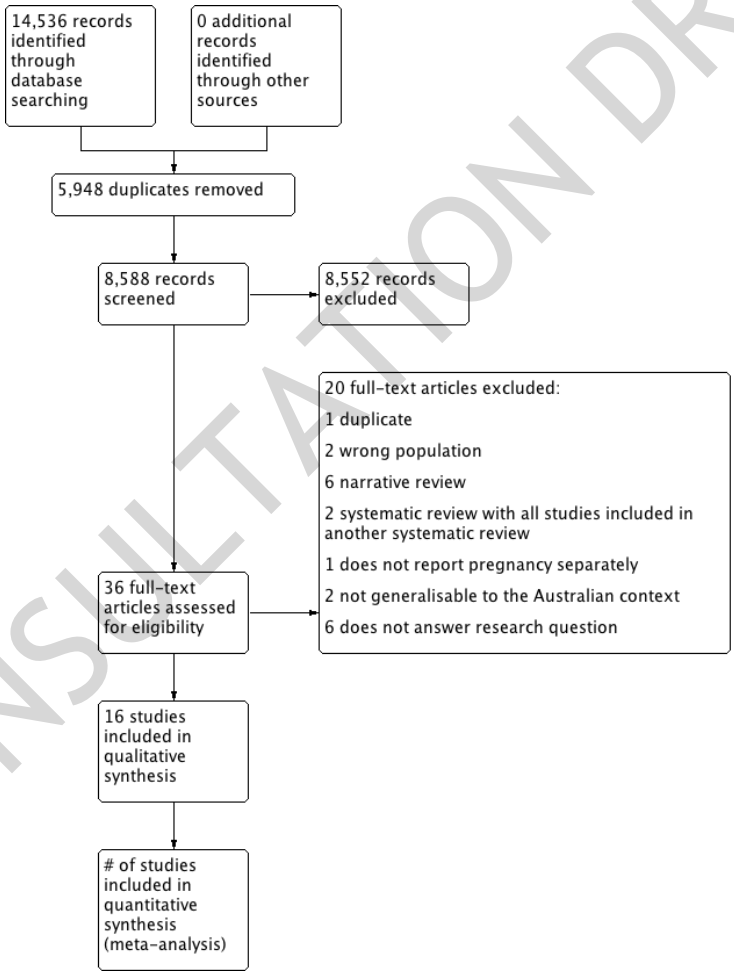
Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	See below	2015-2020	English Humans	3136	21 Jan 2020
Ovid medline	(Exp Pregnant women/ OR exp Pregnancy/ OR Pregnancy.mp. OR gravid.mp. OR obstetric.mp. OR pregnan*.mp. OR antenatal.mp. OR antepartum.mp. OR gestation*.mp.) AND (*dietary supplements/ OR exp Micronutrients/ OR multivitamin.mp. OR micronutrient.mp. OR supplementation*.mp. OR multivitamin-mineral*.mp.)	2015-2020	English Humans	4610	21-Jan-20
Embase	'pregnant woman'/exp OR 'pregnancy'/exp OR 'pregnancy':ti,ab,kw OR 'gravid':ti,ab,kw OR 'obstetric':ti,ab,kw OR 'pregnan*':ti,ab,kw OR 'antenatal':ti,ab,kw OR 'antepartum':ti,ab,kw OR 'gestation*':ti,ab,kw	2015-2020	English Humans	5311	24-Jan-20

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
	AND 'multivitamin'/exp OR 'dietary supplement'/exp OR 'multivitamin':ti,ab,kw OR 'micronutrient':ti,ab,kw OR 'supplementation*':ti,ab,kw OR 'multivitamin-mineral':ti,ab,kw				
CINAHL	((MH "Pregnancy+") OR (MH "Expectant Mothers")) OR (("pregnancy") OR ("gravid") OR ("obstetric") OR ("pregnan*") OR ("antenatal") OR ("antepartum") OR ("gestation*")) AND ((MH "Dietary Supplementation") OR (MH "Dietary Supplements") OR) OR ((multivitamin") OR ("micronutrient") OR ("supplementation*") OR ("multivitamin-mineral*"))	2015-2020	English	1193	24-Jan-20
SCOPUS	(("pregnancy") OR ("gravid") OR ("obstetric") OR ("pregnan*") OR ("antenatal") OR ("antepartum") OR ("gestation*")) AND (("multivitamin") OR ("micronutrient") OR ("supplementation*") OR ("multivitamin-mineral*") OR ("dietary supplement*"))	2015-2020	English Articles	5584	24-Jan-20
Health Infonet	Multivitamin OR supplement	2015-2020	All	0	28-Jan-20
Cochrane	ID Search Hits #1 MeSH descriptor: [Pregnancy] explode all trees 7524 #2 MeSH descriptor: [Pregnant Women] explode all trees 236 #3 MeSH descriptor: [Dietary Supplements] explode all trees 11667 #4 MeSH descriptor: [Micronutrients] explode all trees 5006 #5 ('multivitamin') OR ('micronutrient') OR ('supplementation*') OR ('multivitamin-mineral') 39457 #6 ('pregnancy') OR ('gravid') OR ('obstetric') OR ('pregnan*') OR ('antenatal') OR ('antepartum') OR ('gestation*') 74030 #7 #1 OR #2 OR #6 74209 #8 #3 OR #4 OR #5 44938 #9 #7 AND #8 with Cochrane Library publication date Between Jan 2015 and Feb 2020, in Cochrane Reviews 250	2015-2020	Reviews	250	28-Jan-20

Pubmed search

Search	Query
#22	Search (#18 AND #11) Filters: Publication date from 2015/01/01 to 2020/12/31; Humans; English
#21	Search (#18 AND #11) Filters: Publication date from 2015/01/01 to 2020/12/31; Humans
#20	Search (#18 AND #11) Filters: Publication date from 2015/01/01 to 2020/12/31
#19	Search (#18 AND #11)
#18	Search (#12 OR #13 OR #14 OR #15 OR #16 OR #17)
#17	Search multivitamin-mineral[Title/Abstract]

#16	Search supplementation[Title/Abstract]
#15	Search micronutrient[Title/Abstract]
#14	Search multivitamin[Title/Abstract]
#13	Search micronutrients[MeSH Terms]
#12	Search dietary supplement[MeSH Terms]
#11	Search (#2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10)
#10	Search gestation[Title/Abstract]
#9	Search antepartum[Title/Abstract]
#8	Search Antenatal[Title/Abstract]
#7	Search Pregnan*[Title/Abstract]
#6	Search obstetric[Title/Abstract]
#5	Search gravid[Title/Abstract]
#4	Search Pregnancy[Title/Abstract]
#3	Search Pregnancy[MeSH Terms]
#2	Search "Pregnant Women"[Mesh]



PRISMA diagram: multiple micronutrients

Iron supplementation (research question 3)

Previous Iron supplementation in pregnancy Cochrane search date: 10 Jan 2015

Peña-Rosas JP, De-Regil LM, Gomez Malave H, Flores-Urrutia MC, Dowswell T. Intermittent oral iron supplementation during pregnancy. Cochrane Database of Systematic Reviews 2015, Issue 10. Art. No.: CD009997. DOI: 10.1002/14651858.CD009997.pub2.

And

Peña-Rosas JP, De-Regil LM, Garcia-Casal MN, Dowswell T. Daily oral iron supplementation during pregnancy. Cochrane Database of Systematic Reviews 2015, Issue 7. Art. No.: CD004736. DOI: 10.1002/14651858.CD004736.pub5.

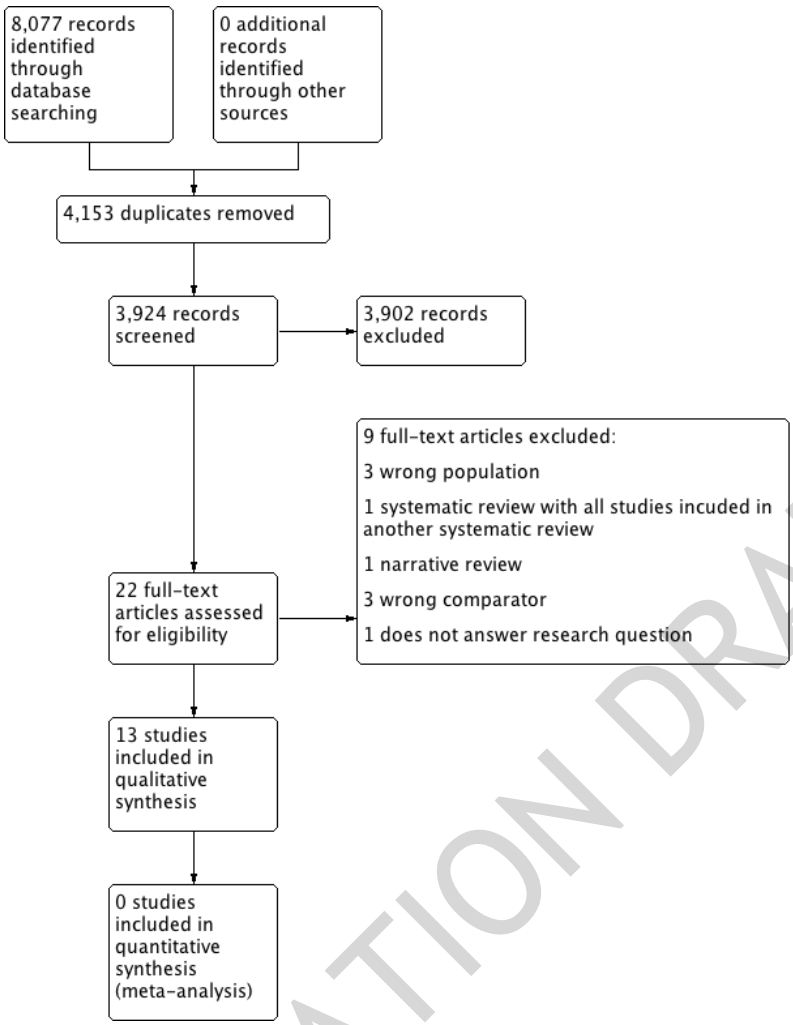
Synonyms for Iron;

Iron-56

Current search dates:

10-Jan-2015-current

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	("pregnancy"[Mesh] OR "pregnan*"[All Fields] OR "prenatal*"[All Fields]) AND ("Iron, Dietary"[Mesh] OR "Iron"[Mesh] OR "Iron"[All Fields])	10-Jan-2015 to 31-Dec-2019	Human English Language	891	1-July-19
Ovid medline	(Iron/ or Iron, Dietary/) OR Iron.mp. AND Pregnancy/syn or Pregnan*.mp.	2015-Current	English Language Human	975	2-July-19
Embase	('pregnancy'/exp OR pregnan*) AND ('iron'/exp OR 'Iron')	2015-2019	English Language Human	2752	1-July-19
CINAHL	(MH "Iron+") OR ("Iron") AND ((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*"))	2015-2019	English	1421	1-July-19
SCOPUS	TITLE-ABS-KEY (((("pregnan*") OR (prenatal*)) AND (("Iron")))) AND (LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015)) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (EXACTKEYWORD , "Human"))	2015 - 2019	English Human	1961	2-July-19
Health Infonet	Iron – title and abstract Pregnancy - title and abstract	2015-current = 0	None	0	2-July-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR 'pregnan*') AND ((MeSH descriptor: [Iron] explode all trees) OR (Iron))	Dec 2012 to Dec 2019	Reviews : 77	77	22-July-19



Prisma diagram: iron

Calcium supplementation (research question 3)

Previous Calcium supplementation in pregnancy Cochrane search date: 30-Sep-2014

Buppasiri P, Lumbiganon P, Thinkhamrop J, Ngamjarus C, Laopaiboon M, Medley N. Calcium supplementation (other than for preventing or treating hypertension) for improving pregnancy and infant outcomes. Cochrane Database of Systematic Reviews 2015, Issue 2. Art. No.: CD007079. DOI: 10.1002/14651858.CD007079.pub3.

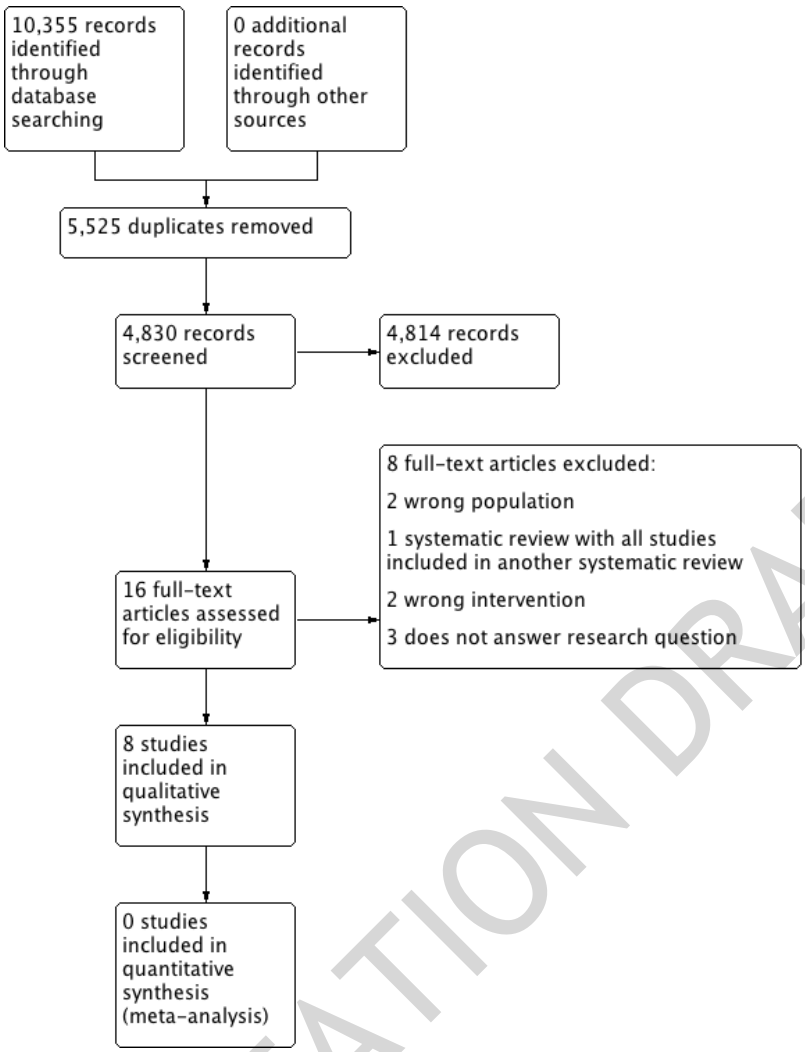
Synonyms for Calcium;

- Blood Coagulation Factor IV
- Coagulation Factor IV
- Factor IV, Coagulation
- Calcium-40
- Calcium 40
- Factor IV

Current search dates:

30-Sep-2014-current

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	("pregnancy"[Mesh] OR "pregnan*"[All Fields] OR "prenatal*"[All Fields]) AND ("Calcium"[Mesh] OR "Calcium"[All Fields] OR "Factor IV"[All Fields])	30-Sep-2014 to Current	Human English Language	723	1-July-19
Ovid medline	exp Calcium, Dietary/ or exp Calcium/ OR (Calcium or 'Factor IV').mp. AND Pregnancy/syn or Pregnan*.mp.	2014-Current	English Language Human	936	2-July-19
Embase	('pregnancy'/exp OR pregnan*) AND ('calcium'/exp OR 'factor IV' OR 'calcium')	2014-2019	English Language Human	2902	2-July-19
CINAHL	(MH "Calcium+") OR ("Calcium") OR ("Factor IV") AND ((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*"))	2014-2019	English	1534	2-July-19
SCOPUS	TITLE-ABS-KEY (((("pregnan*") OR (prenatal*)) AND (("Calcium") OR ("Factor" PRE/0 "IV")))) AND (LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014)) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (EXACTKEYWORD , "Human"))	2014 - 2019	English Human	2332	2-July-19
Health Infonet	Calcium – title and abstract Pregnancy - title and abstract	2014-current = 0 (1 in 2013)	None	0	2-July-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR 'pregnan*') AND ((MeSH descriptor: [Calcium] explode all trees) OR Calcium OR (Factor IV))	Dec 2014 to Dec 2019	Reviews: 221	221	2-July-19



PRISMA diagram: Calcium

Iodine supplementation (research question 3)

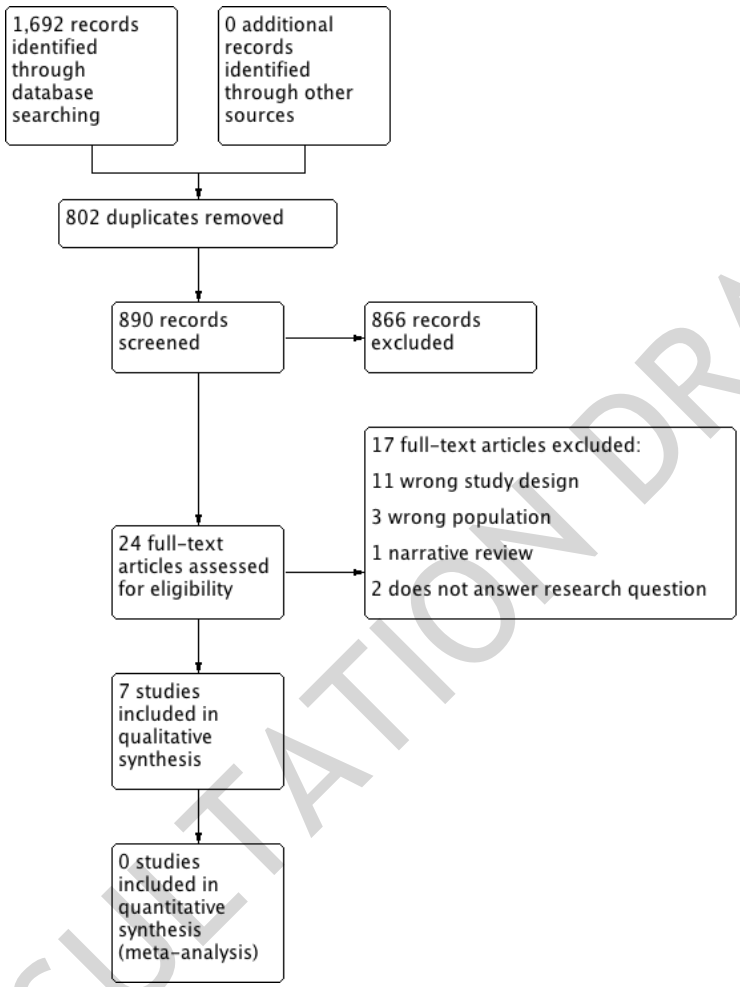
Previous Iodine supplementation in pregnancy Cochrane review search date: 17 November 2016

Citation: Harding KB, Peña-Rosas JP, Webster AC, Yap CMY, Payne BA, Ota E, De-Regil LM. Iodine supplementation for women during the preconception, pregnancy and postpartum period. Cochrane Database of Systematic Reviews 2017, Issue 3. Art. No.: CD011761

Current search dates: 18-Nov-2016-current

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	("pregnancy"[MeSH Terms] OR "pregnan*"[All Fields] OR "prenatal*"[All Fields]) AND ("iodine"[MeSH Terms] OR "iodine"[All Fields])	18-Nov-2016 to 31-Dec-2019	Human	**138**	16-Jan-19
Ovid medline	(Pregnancy/syn or Pregnan*.mp.) and iodine.mp.	2016-Current	English Language Human	**242**	16-Jan-19
Embase	('pregnancy'/exp OR pregnan*) AND (iodine OR 'iodine'/exp) NOT ('radioactive iodine' OR 'povidone iodine')	2016-2019	English Language Human	**574**	16-Jan-19
CINAHL	TX ((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*")) AND TX ((MM "Iodine") OR ("Iodine"))	01-Nov-2016 to 31-Dec-2019	Human English	**109**	16-Jan-19

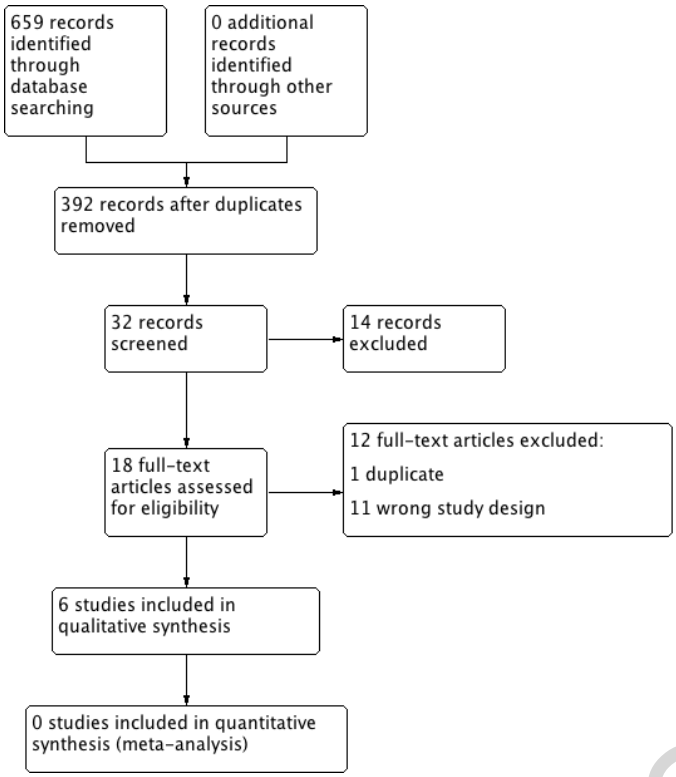
SCOPUS	TITLE-ABS-KEY (("Pregnan*") OR ("prenatal*") AND ("Iodine"))	2016-2019	English	**621**	16-Jan-19
Health Infonet	Iodine – title and abstract	2016-current=1	None	**1**	16-Jan-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (Prenatal)) AND (Iodine)	Nov 2016 to Dec 2019	Trials	**8**	16-Jan-19



Prisma diagram: Iodine

Iodine top-up search

Search date: 11 March 2020



PRISMA diagram: Iodine top-up search

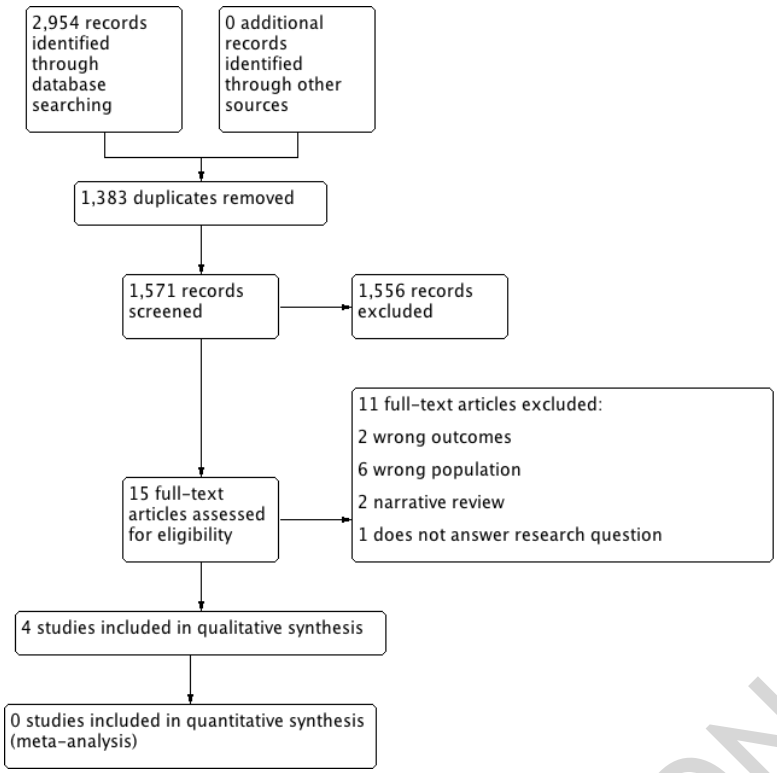
Zinc supplementation (research question 3)

Previous zinc supplementation in pregnancy Cochrane search date: 31 October 2014

Citation: Ota E, Mori R, Middleton P, Tobe-Gai R, Mahomed K, Miyazaki C, Bhutta ZA. Zinc supplementation for improving pregnancy and infant outcome. Cochrane Database of Systematic Reviews 2015, Issue 2. Art. No.: CD000230.

Current search dates: 1-Nov-2014-16-Jan-19

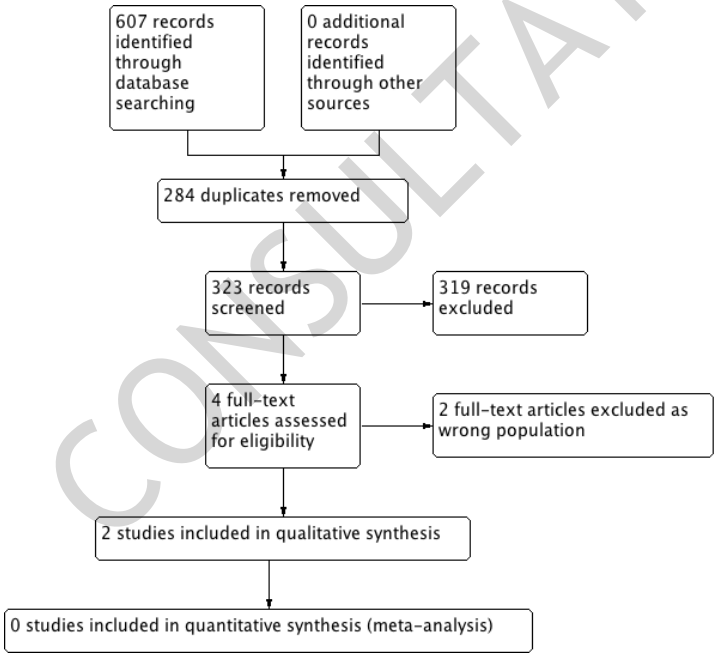
Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	("pregnancy"[MeSH Terms] OR "pregnan*"[All Fields] OR "prenatal*"[All Fields]) AND ("zinc"[MeSH Terms] OR "zinc"[All Fields])	1-Nov-2014 to 31-Dec-2019	Human	**280**	16-Jan-19
Ovid medline	(Pregnancy/syn or Pregnan*.mp.) and zinc.mp.	2014-Current	English Language Human	**336**	16-Jan-19
Embase	('pregnancy'/exp OR pregnan*) AND (zinc OR 'zinc'/exp)	2014-2019	English Language Human	**948**	16-Jan-19
CINAHL	((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*")) AND TX ((MM "Zinc") OR ("Zinc"))	01-Jan-2014 to 31-Dec-2019	Human	**124**	16-Jan-19
SCOPUS	TITLE-ABS-KEY (("Pregnan*") OR ("prenatal*") AND ("Zinc"))	2014-2019	English	**1232**	16-Jan-19
Health Infonet	Zinc - title and abstract Pregnancy - keyword	2014-current=0 All dates=15	None	**0**	16-Jan-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (Prenatal)) AND (Zinc)	Nov 2014 to Dec 2019	Trials	**34**	16-Jan-19



PRISMA diagram: Zinc

Zinc top-up search

Search date: 12 March 2020



PRISMA diagram: Zinc top-up

Magnesium supplementation (research question 3)

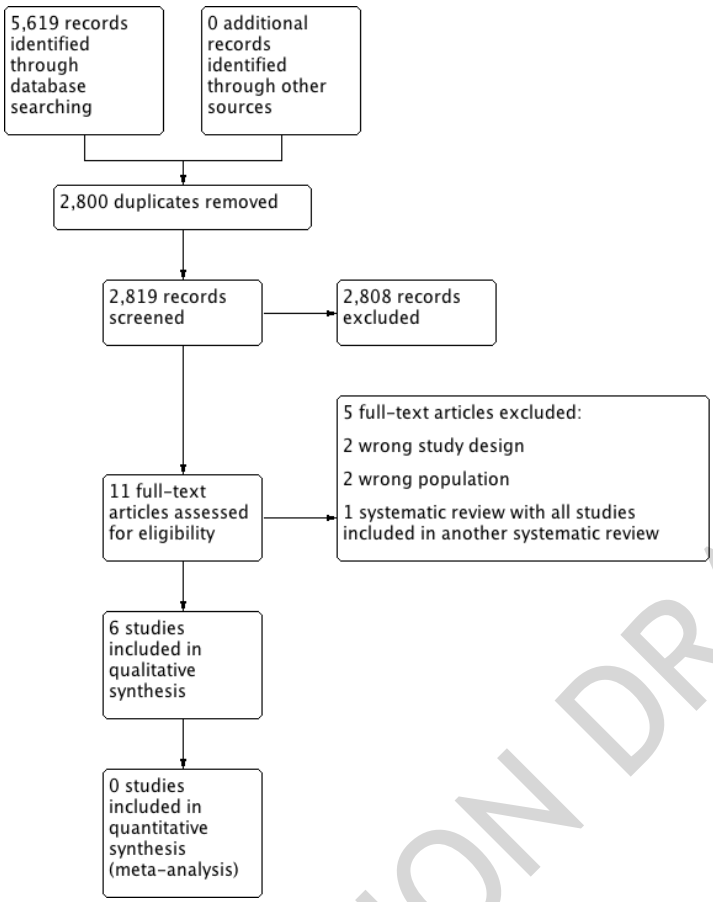
Previous Magnesium supplementation in pregnancy Cochrane search date: 31 March 2013

Citation: Makrides M, Crosby DD, Bain E, Crowther CA Magnesium supplementation in pregnancy, Cochrane Database of Systematic Reviews 2014, Issue 4. Art. No.: CD000937.

Current search dates:

31-Mar-2013-current

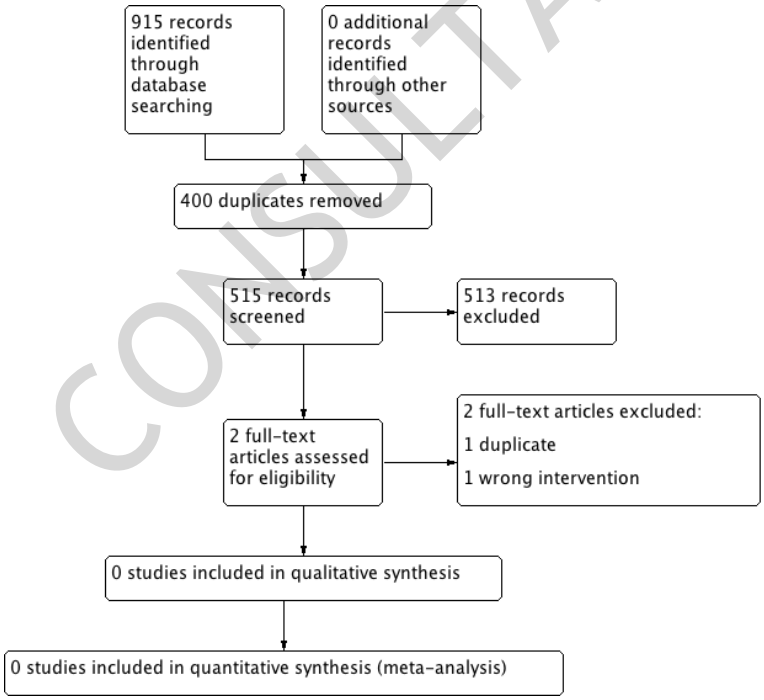
Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	("pregnancy"[MeSH Terms] OR "pregnan*"[All Fields] OR "prenatal*"[All Fields]) AND ("magnesium"[MeSH Terms] OR "magnesium"[All Fields])	31-Mar-2013 to 31-Dec-2019	Human English Language	**492**	13-Feb-19
Ovid medline	(Pregnancy/syn or Pregnan*.mp.) and magnesium.mp.	2013-Current	English Language Human	**530**	13-Feb-19
Embase	('pregnancy'/exp OR pregnan*) AND (magnesium OR 'magnesium'/exp)	2013-2019	English Language Human	**1947**	25-Feb-19
CINAHL	((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*")) AND TX ((MM "Magnesium") OR ("Magnesium"))	01-Jan-2013 to 31-Dec-2019	Human English	**341**	13-feb-19
SCOPUS	TITLE-ABS-KEY (("Pregnan*") OR ("prenatal*") AND ("Magnesium"))	201432019	English	**1872**	13-Feb-19
Health Infonet	Magnesium – title and abstract Pregnancy - keyword	2014-current=0 All dates=0	None	**0**	13-Feb-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR (MeSH descriptor: [Pregnancy Outcomes] explode all trees) OR 'pregnan*' OR 'Prenatal') AND (Magnesium)	Mar 2013 to Dec 2019	Trials	**204**	13-feb-19
Psychinfo	(Pregnancy/syn or Pregnan*.mp.) and magnesium.mp.	2013-Current	English Language Human	**11**	13-Feb-19



PRISMA diagram: Magnesium

Magnesium top-up search

Search date: 12 March 2020

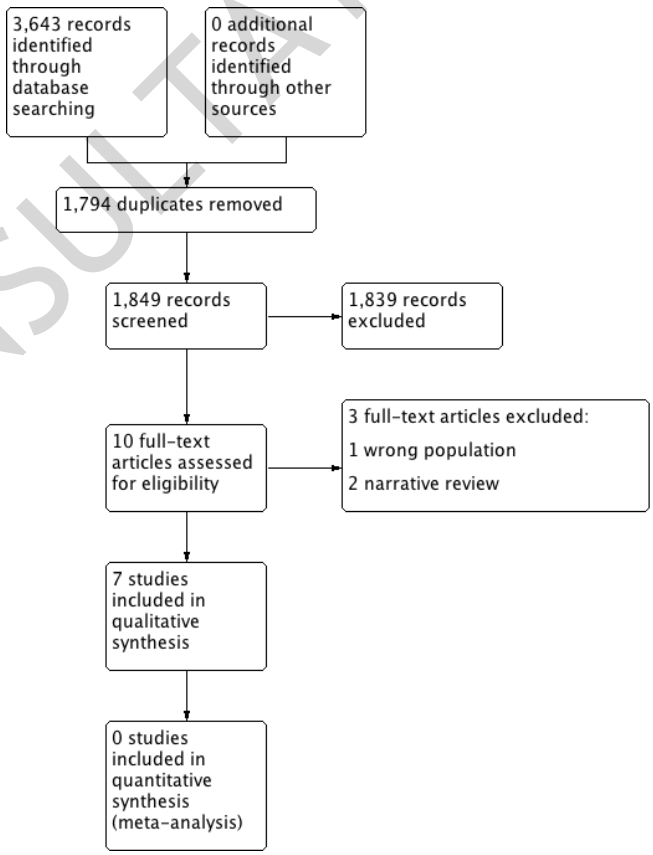


PRISMA diagram: Magnesium top-up

Selenium supplementation (research question 3)

Search dates: 1-Jan-2000-28-Feb-2019

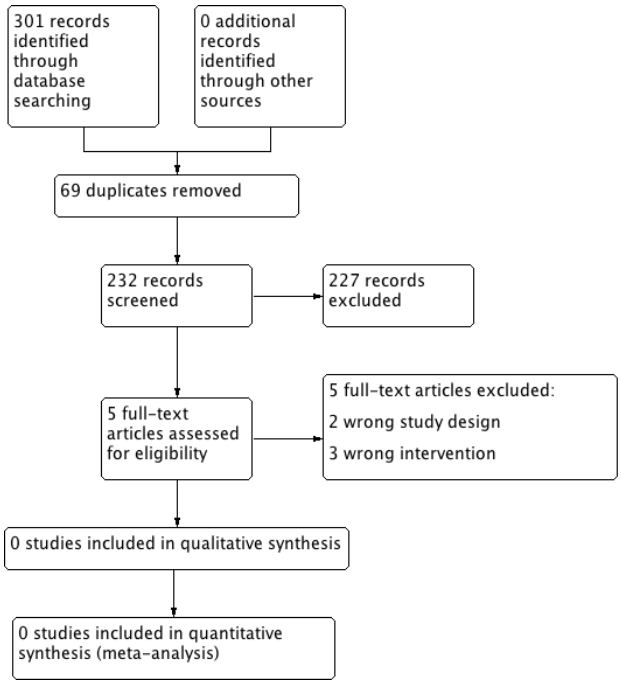
Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	("pregnancy"[MeSH Terms] OR "pregnant women"[MeSH Terms] OR "pregnan*"[All Fields] OR "prenatal*"[All Fields]) AND ("selenium"[MeSH Terms] OR "selenium"[All Fields])	1-jan-2000 to 31-Dec-2019	Human English language	**423**	28-Feb-19
Ovid medline	(Pregnancy/syn or Pregnan*.mp.) and selenium.mp.	2000-Current	English Language Human	**434**	28-Feb-19
Embase	('pregnancy'/exp OR pregnan*) AND (selenium OR 'selenium'/exp)	2000-2019	Human	**966**	28-Feb-19
CINAHL	((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*")) AND TX ((MM "Selenium") OR ("Selenium"))	01-Jan-2000 to 31-Dec-2019	English	**813**	28-Feb-19
SCOPUS	TITLE-ABS-KEY (("Pregnan*") OR ("prenatal*") AND ("selenium"))	2000-2019	English Human	**910**	28-Feb-19
Health Infonet	Selenium – all fields	2000-current=0	None	**0**	28-Feb-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR Pregnancy) AND (MeSH descriptor: [Selenium] explode all trees OR Selenium)	Nov 2000 to Dec 2019	Trials	**28 reviews** **114 trials** **10 protocols**	28-Feb-19



PRISMA diagram: Selenium

Selenium top-up search

Search date: 12 March 2020



PRISMA diagram: Selenium top-up

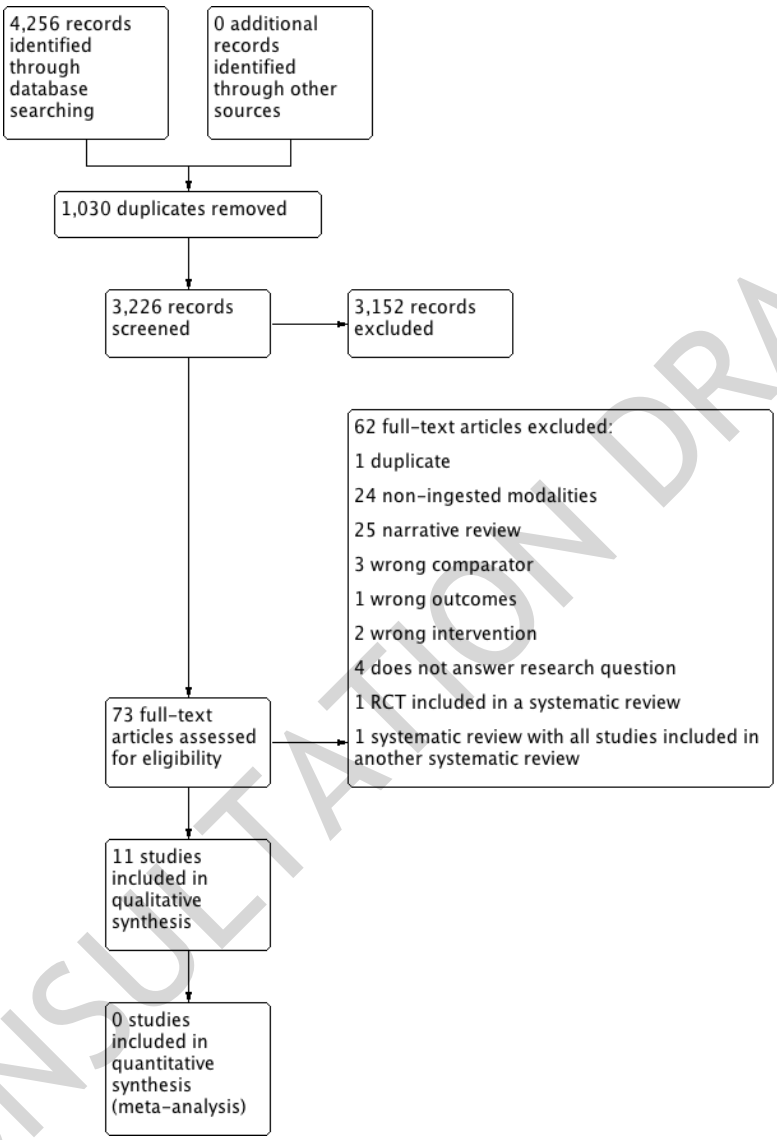
Herbal preparations (research question 4)

Current search dates:

2014-2019

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	(("pregnancy"[Mesh]) OR ("pregnan*"[All Fields]) OR ("prenatal*"[All Fields])) AND (("Herbal" OR "Alternative" OR "Complementary") NEXT ("Medicin*" OR "Therap*" OR "Remed*")) OR ("Herbal Medicine"[Mesh]) OR "Drugs, Chinese Herbal"[Mesh]) OR "Complementary Therapies"[Mesh]	5 years	Human	725	5-August-19
Ovid medline	(Pregnancy/syn or Pregnan*.mp.) AND ((exp Plants, Medicinal/ or exp Herbal Medicine/ or exp Medicine, East Asian Traditional/ or exp Medicine, Chinese Traditional/) OR (((Herbal or Alternative) and (Medicin* or Therap*)).mp))	2014-Current	English Language Human	1141	19 July 2019
Embase	(('alternative medicine'/exp) OR ('herbal medicine'/exp) OR ('herbaceous agent'/exp)) AND ('pregnancy'/exp OR pregnan*)	2014-current	English Language Human	752	5-Aug-19
CINAHL	((MH "Alternative Therapies+") OR (MH "Plants, Medicinal+") OR ("alternative NEXT medicine")) AND ((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects"))	2014 - current	English	774	5-Aug-19
SCOPUS	((*"Pregnan*"*) OR (*"prenatal*"*))) AND (ABS ((*"Herbal"* OR *"alternative"* OR *"plants"* OR *"Herbaceous"* OR *"Chinese"* OR *"Traditional"*) PRE/1 (*"Medicine"* OR *"Therap*"* OR *"Agent"*))))	2014 - current	English	757	5-Aug-19
Health Infonet	Tradition medicine pregnancy Publications on traditional medicine did not mention pregnancy			0	5-Aug-19

Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR (MeSH descriptor: [Pregnancy Outcomes] explode all trees) OR 'pregnan*' OR 'Prenatal') AND (MeSH descriptor: [Complementary Therapies] explode all trees)	2014 - current	Cochrane reviews	107	5-Aug-19



PRISMA diagram: Herbal preparations

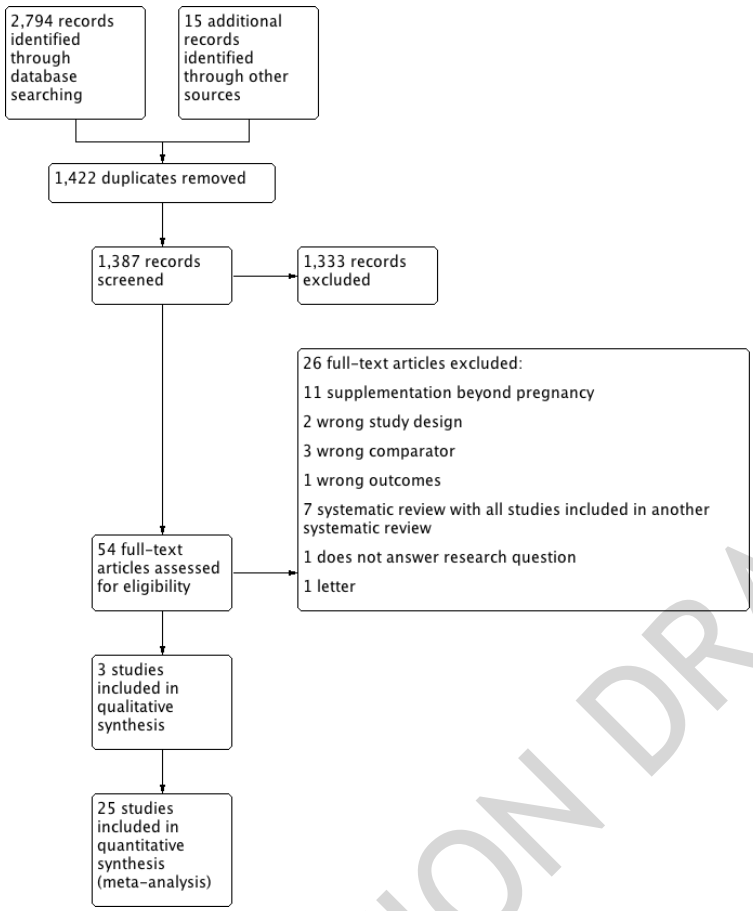
Probiotics (research question 4)

Citation for previous review: 2014

Current search dates:

2014 onwards

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	((((("pregnancy"[Mesh]) OR ("pregnan*"[All Fields]) OR ("prenatal*"[All Fields]))))) AND ((“probiotic*”) OR (“lactobacillus”) OR (“bifidobacter*”) OR (“saccharomyces”))	01/01/14 to 18/10/2019	Human English	247	18-Oct-19
Ovid medline	(Pregnan*).mp. OR (exp Pregnancy/) AND (((probiotic*) OR (lactobacillus) OR (bifidobacter*) OR (saccharomyces)).mp. OR (prebiotics/) or (probiotics/))	01/01/2014 to 18/10/2019	Human	419	18-Oct-19
Embase	('pregnancy'/exp OR 'pregnan*') AND ('probiotic agent'/exp OR (('probiotic*') OR ('lactobacillus') OR ('bifidobacter*') OR ('saccharomyces')))	01/01/2014 to 18/10/2019	English Language Human	1048	18-Oct-19
CINAHL	((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*")) AND (MM "Probiotics") OR (MM "Prebiotics") OR (MM "Bifidobacterium") OR ((“probiotic*”) OR (“lactobacillus”) OR (“bifidobacter*”) OR (“saccharomyces”))	01/01/2014 to 18/10/2019	English	245	18-Oct-19
SCOPUS	((("pregnan*") OR (prenatal*)) AND (("probiotic*") OR ("lactobacillus") OR ("bifidobacter*") OR ("saccharomyces"))) AND PUBYEAR > 2016 AND (LIMIT-TO (EXACTKEYWORD , "Human")) AND (LIMIT-TO (LANGUAGE , "English"))	01/01/2014 to 18/10/2019	English Human	800	18-Oct-19
Health Infonet	Probiotics – Publications = 2 reviewing probiotics in otitis media Probiotics and pregnancy – publications = 0 publications	All dates	None	0	18-Oct-19
Cochrane	((MeSH descriptor: [Pregnancy] explode all trees) OR (MeSH descriptor: [Pregnant Women] explode all trees) OR ‘pregnan*’) AND ((MeSH descriptor: [Probiotics] explode all trees) OR ('probiotic*') OR ('lactobacillus') OR ('bifidobacter*') OR ('saccharomyces'))	01/01/2014-31/12/2019	Cochrane reviews	35	18-Oct-19



PRISMA diagram: Probiotics

Physical activity advice (research questions 5, 6 and 9)

Embase:

('exercise'/exp OR 'exercis*' OR 'laziness'/de OR 'physical activity'/exp OR 'physical inactivity'/de OR 'physical performance'/de OR 'sedentary lifestyle'/syn) AND ('pregnant woman'/syn OR 'pregnancy'/syn OR 'pregnan*') AND [english]/lim AND [humans]/lim

1998 to 6/7/18=Results: 11,981

CINAHL:

TX ((MH "Therapeutic Exercise") OR (MH "Physical Fitness+") OR (MH "Exercise+") OR ("Physical Activit*") OR (MH "Physical Activity+") OR (MH "Activities of Daily Living")))

AND TX (((MH "Pregnancy+") OR (Pregnan*) OR (MM "Pregnancy Outcomes") OR (MH "Pregnancy Trimesters+"))

1998 to 6/7/18=Results 7,871

Pubmed:

(("Exercise"[Mesh]) OR ("Sedentary Lifestyle"[Mesh])) AND (("Pregnant Women"[Mesh]) OR ("Pregnancy"[Mesh]) OR Pregnan*)

Humans and English

1998 to 6/7/18=Results=2,177

Health infonet

Pregnan* AND (exercis* OR (Physical activit*) OR Lifestyle)

Results=0

Pregnan* AND exercis*

Results=0

Pregnancy AND exercise

Results=0

Pregnancy

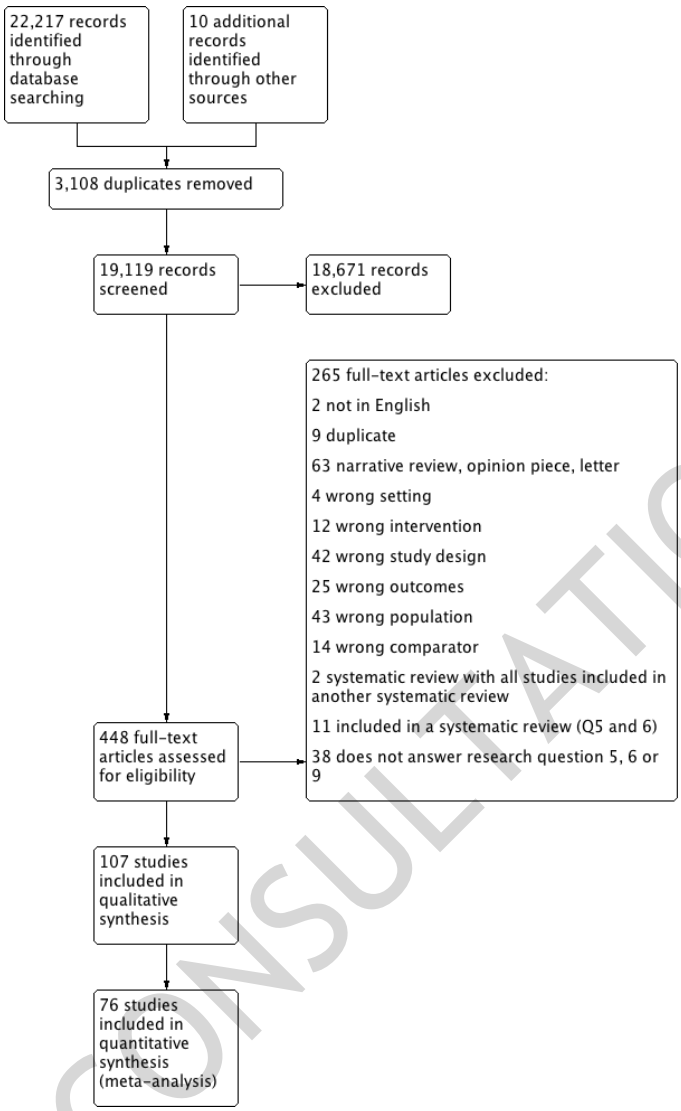
Results=22 (1 related to sociodemographics of smoking in pregnancy – but no exercise/activity included.)

Exercise

1998 to 6/7/18=Results=0

Cochrane Library	
#1	MeSH descriptor: [Pregnant Women] explode all trees
#2	MeSH descriptor: [Pregnancy] explode all trees
#3	Pregnancy
#4	Exercise
#5	MeSH descriptor: [Exercise] explode all trees
#6	(#1 OR #2 OR #3) AND (#4 OR #5)

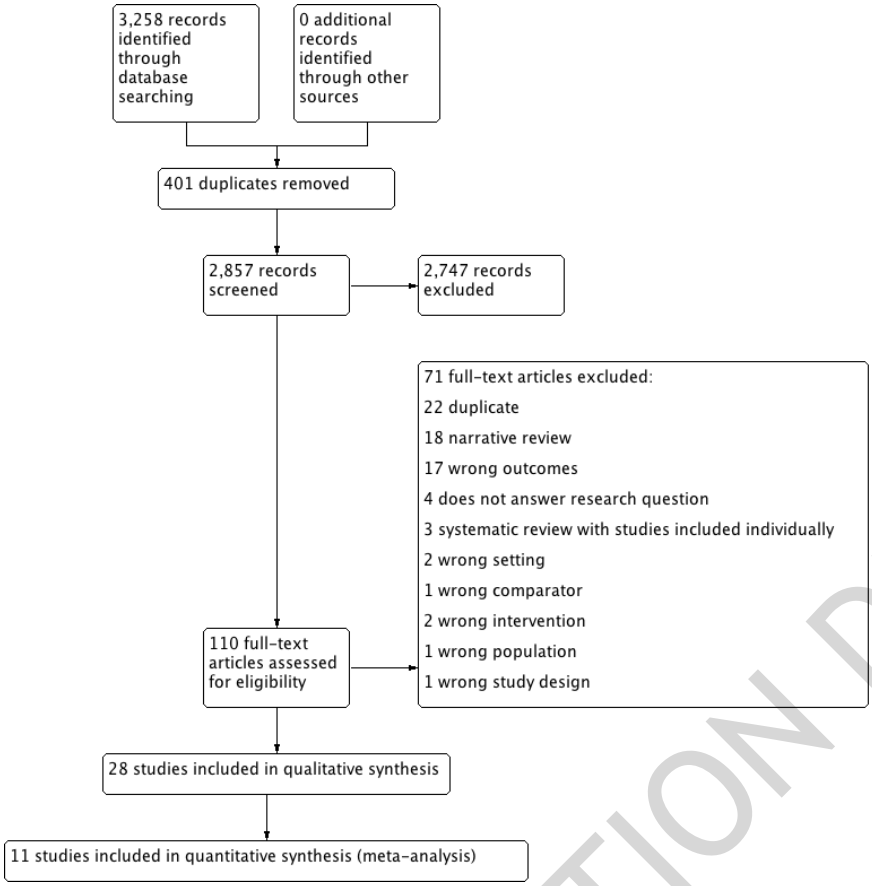
01/01/2016 to 17/08/2018=Review Results 88



PRISMA diagram: physical activity

Physical activity top-up search

Search date: 12 March 2020



PRISMA diagram: Physical activity top-up

Weight assessment and management

Gestational weight gain (research question 7)

Citation for search strategy used (partial):

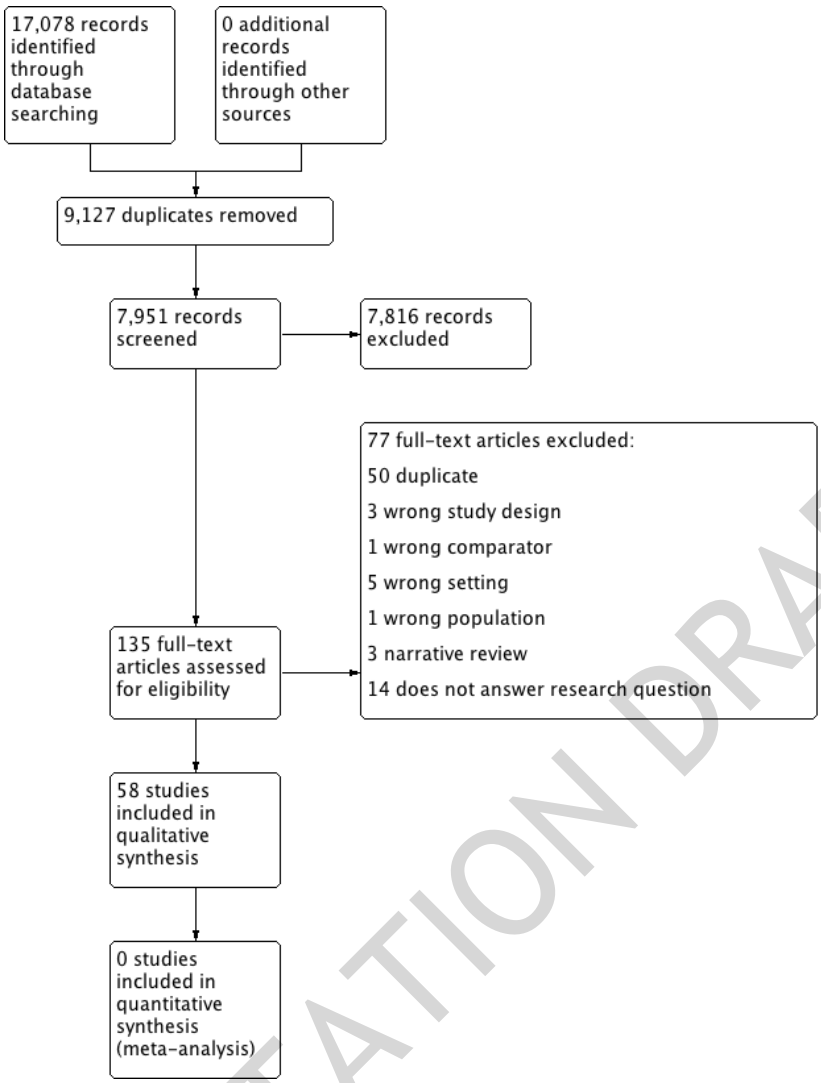
Goldstein RF, Abell SK, Ranasinha S, Misso ML, Boyle JA, Harrison CL, Black MH, Li N, Hu G, Corrado F, Hegaard H, Kim YJ, Haugen M, Song WO, Kim MH, Bogaerts A, Devlieger R, Chung JH, Teede HJ. **Gestational weight gain across continents and ethnicity: systematic review and meta-analysis of maternal and infant outcomes in more than one million women.** BMC Med. 2018 Aug 31;16(1):153.

Current search dates:

2014-9-Apr-19

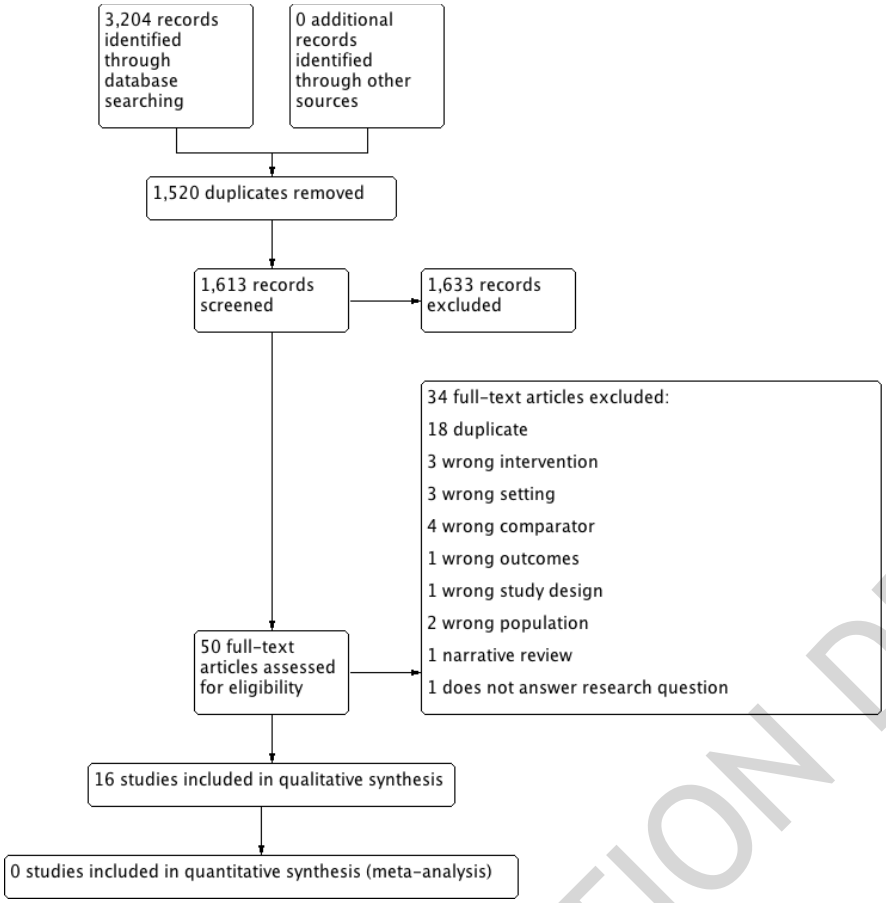
Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	(("Weight Gain"[Mesh]) OR (("weight" w1 ("gain" OR "change")))) AND (("pregnancy"[Mesh]) OR ("Pregnan*" OR "Gestation*"))	1-Jan-2014 to 31-Dec-2019	Human	1378	9-Apr-19
Ovid medline	Weight Gain/ or (weight adj1 (Gain or Change)).mp. AND Pregnancy/ or Pregnan*.mp. or Gestation*.mp.	2014-Current	English Language Human	2348	9-Apr-19
Embase*	('gestational weight gain'/exp OR (weight NEXT/2 (change OR gain))) AND ('pregnancy'/exp OR pregnan* OR gestat*) AND [english]/lim AND [humans]/lim AND [2014-2019]/py	2014-7-Apr-19	English Human	5942	7-Apr-19

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
CINAHL	"TX (((MM "Gestational Weight Gain") OR ("weight" W1 ("change" OR "gain"))) AND TX (((MH "Pregnancy+") OR (MH "Pregnancy Trimesters+") OR (MM "Prenatal Nutritional Physiology") OR (MM "Prenatal Exposure Delayed Effects") OR ("Pregnan*") OR (Gestation*))) Published Date: 20140101-20191231; Human on 2019-04-06 11:48 PM"	Jan-2014-7-Apr-19	English Human	1916	7-Apr-19
SCOPUS**	((TITLE-ABS-KEY((("Pregnan*") OR ("prenatal*") OR ("gestation*"))) AND TITLE-ABS-KEY((("Weight") W/1 (("gain") OR ("change"))))) AND PUBYEAR > 2013)	2014-2019	Human English	4151	7-Apr-19
Health Infonet	Pregnancy Weight	2014-2019	None	1	8-Apr-19
Cochrane	Date Run:09/04/2019 04:43:16 ID Search Hits #1 MeSH descriptor: [Pregnant Women] explode all trees 200 #2 MeSH descriptor: [Pregnancy] explode all trees 7229 #3 MeSH descriptor: [Pregnant Women] explode all trees 200 #4 #1 OR #2 OR #3 OR (Pregnan*) 58956 #5 MeSH descriptor: [Body Weight Changes] explode all trees 7655 #6 #5 OR (Weight NEAR/1 (Gain OR Change)) 18550 #7 #4 AND #6 with Cochrane Library publication date Between Jan 2014 and Dec 2019 1346	Jan2014-Dec 2019	None	1346	9-Apr-19



PRISMA diagram: gestational weight gain

Gestational weight gain top-up search



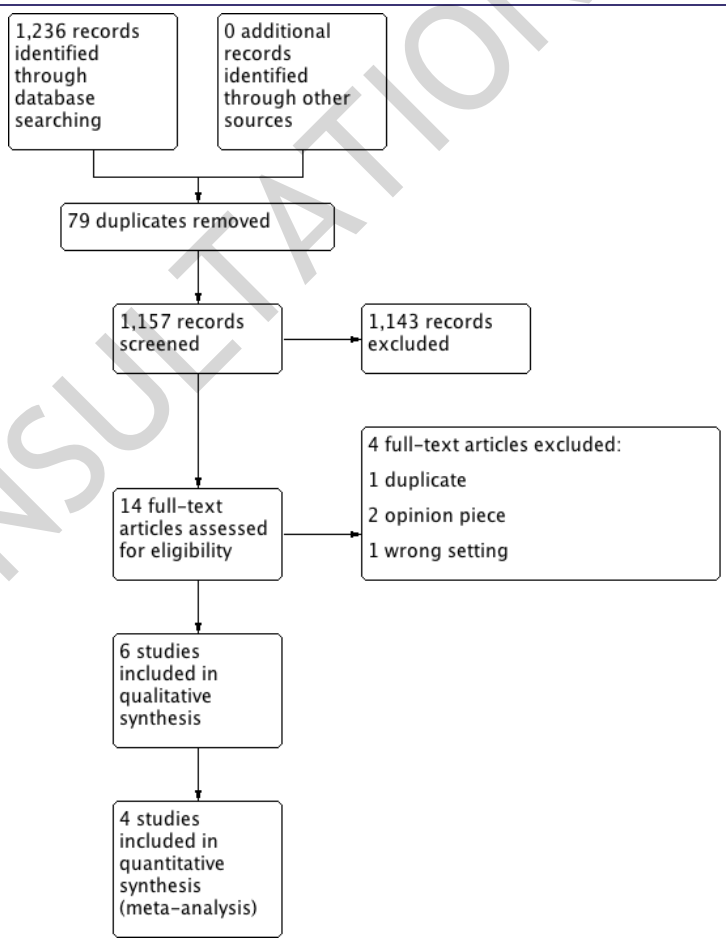
PRISMA diagram: gestational weight gain top-up

Weight monitoring (question 7)

Current search dates: 2-Dec-19

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed	"Pregnancy" Mesh "prenatal care"Mesh "pregnan*" OR "antepart*" OR "prenatal*" OR "antenatal*" OR "obstetric*" OR "maternal*" 1 OR 2 OR 3 "routine weight*" OR "routinely weight*" OR "regular* weight*" OR "repeat* weight*" 4 AND 5	1-Jan-2014 to 2-Dec-19	Human English	1087*	2-Dec-19
Ovid medline	Exp pregnancy/ Exp prenatal care/ (pregnan* or antepart* or prenatal* or antenatal* or obstetric* or maternal*).mp. 1 or 2 or 3 ((routine* or regular* or repeat*) adj3 weigh*).mp. 4 and 5	1 Jan 2014 to 2-Dec-19	English Language	61	2-Dec-19
Embase*	'pregnancy'/exp 'prenatal care'/exp (pregnan* OR antepart* OR prenatal* OR antenatal* OR obstetric* OR maternal*) #1 OR #2 OR #3 (routine* OR regular* OR repeat*) NEXT/3 weigh* #4 AND #5	1 Jan 2014 to 2-Dec-2019	English Human	86	2-Dec-19

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
CINAHL	(MH "Pregnancy+") OR (MH "pregnancy care+") (pregnan* or antepart* or prenatal* or antenatal* or obstetric* or maternal*) S1 OR S2 ((routine* or regular* or repeat*) N3 weigh*) S3 AND S4	01-jan-2014 to 31-dec-2019	English	69	2-Dec-2019
SCOPUS	TITLE-ABS-KEY ((("pregnan*") OR ("prenatal*") OR ("antepart*") OR ("prenatal*") OR ("antenatal*") OR ("obstetric*") OR ("maternal*")) AND (("routine*") OR ("routine*") OR ("repeat*") W/3 "weigh*"))	2014-2019	Human English	78	2-Dec-19
Health Infonet	Title and Policies: weigh*	All	None	0	2-Dec-2019
Cochrane	MeSH descriptor: [Pregnancy] explode all trees MeSH descriptor: [Prenatal Care] explode all trees ((pregnan* or antepart* or prenatal* or antenatal* or obstetric* or maternal*)):ti,ab,kw #1 or #2 or #3 ((routine* or regular* or repeat*) next/3 weigh*) #4 AND #5	2014 to 2019	None	2	2-Dec-19



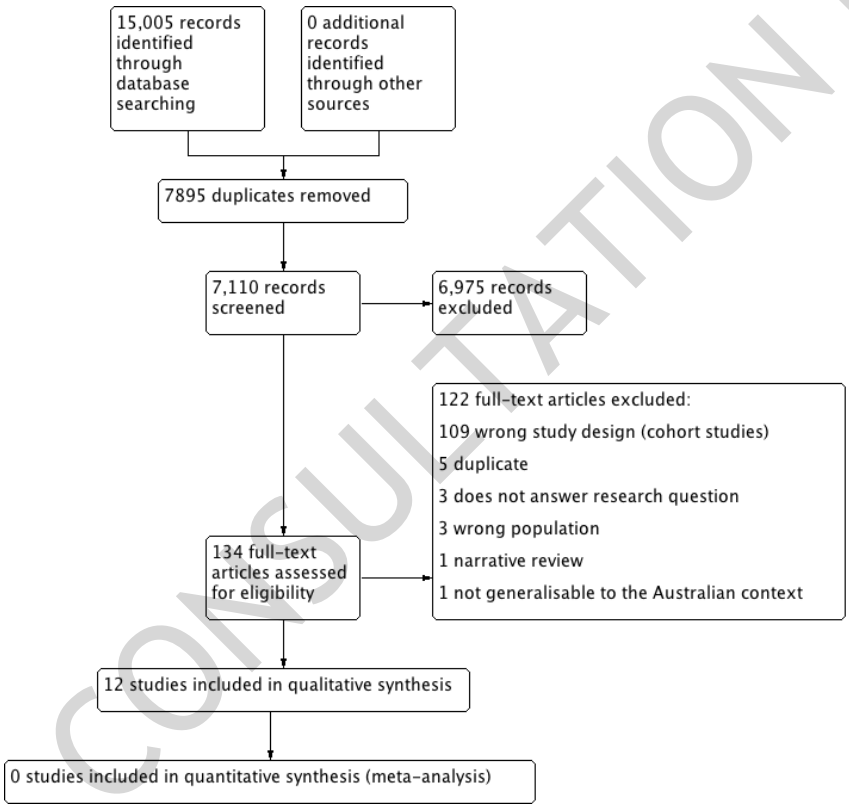
PRISMA diagram: weight monitoring

Risk assessments for women with low or high BMI (question 8)

Current search dates: All to 28-feb-20

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Pubmed *Issues due to lack of proximity syntax	“Pregnancy” Mesh “prenatal care”Mesh "pregnan*" OR "antepart*" OR "prenatal*" OR "antenatal*" OR "obstetric*" OR "maternal*" 1 OR 2 OR 3 “Thinness”[Mesh] ("low* BMI" OR "low* body mass index" OR "underweight" OR "under weight" OR "low* weight") 5 OR 6 4 AND 7	All	English Language Humans	1743	28-Feb-20
Ovid medline	Exp pregnancy/ Exp prenatal care/ (pregnan* or antepart* or prenatal* or antenatal* or obstetric* or maternal*).mp. 1 or 2 or 3 exp Thinness/ ("low* BMI" or "low* body mass index" or "underweight" or "under weight" or "low* weight").mp 5 OR 6 4 and 7	All	English Language Humans	2744	28-Feb-20
Embase*	'pregnancy'/exp OR 'prenatal care'/exp OR ((pregnan* OR antepart* OR prenatal* OR antenatal* OR obstetric* OR maternal*) AND ti,ab,kw) 'underweight'/exp OR ((low* NEXT/1 weigh*):ti,ab,kw) OR ((low* NEXT/2 bmi):ti,ab,kw) OR underweight:ti,ab,kw OR ((under NEXT/1 weigh*):ti,ab,kw) OR ((low* NEXT/2 'body mass index'):ti,ab,kw) #1 AND #7	All	English Language Humans	2537	28-Feb-20
CINAHL	(MH "Pregnancy+") OR (MH "pregnancy care+") (pregnan* or antepart* or prenatal* or antenatal* or obstetric* or maternal*) S1 OR S2 (MM "Thinness") TX (((“low* N0 weigh*”) OR (“low* N0 BMI”) OR “underweight” OR (“Under N0 weigh*”) OR (“low*” N1 (“body mass index”))) S3 AND (S5 OR S6)	All	English Language	3111	28-Feb-20
SCOPUS	TITLE-ABS-KEY ((("pregnan*") OR ("prenatal*") OR ("antepart*") OR (" prenatal*") OR ("antenatal*") OR ("obstetric*") OR ("maternal*")) AND TITLE-ABS-KEY (("low* PRE/0 weigh*") OR ("low* PRE/0 BMI") OR ("underweight") OR ("Under PRE/0 weigh*") OR ("low*" PRE/1 ("body mass index")))	All	English Language human	2573	28-Feb-20
Health Infonet	Title and Policies: weigh*	All	-	7	28-Feb-20

Database	Search Strategy	Dates Searched	Limits set	Results	Date of search
Cochrane	Date Run:28/02/2020 04:02:34 Comment: ID Search Hits #10 MeSH descriptor: [Pregnancy] explode all trees 7585 #11 MeSH descriptor: [Prenatal Care] explode all trees 1395 #12 MeSH descriptor: [Pregnant Women] explode all trees 239 #13 (('pregnan*') or ('antepart*') or ('prenatal*') or ('antenatal*') or ('obstetric*') or ('maternal*')) 91470 #14 (('low*') NEXT/1 ('weigh*')) 1165 #15 (('low*') NEXT/1 ('BMI')) 698 #16 ('underweight') 975 #17 (('Under') NEXT/1 ('weigh*')) 67 #18 (('low*') NEXT2 (('body') NEXT1 ('mass') NEXT1 ('index'))) 302 #19 MeSH descriptor: [Thinness] explode all trees 284 #20 #10 OR #11 OR #12 OR #13 91615 #21 #14 OR #15 OR #16 OR #17 OR #18 OR #19 3311 #22 #20 AND #21 in Cochrane Reviews 224	All	Cochrane trials	224	28-Feb-20



PRISMA diagram: Risk assessment

B Assessment of risk of bias in randomised controlled trials

- *Selection bias*: Studies were considered at low risk of selection bias if the process of randomised sequence generation and allocation concealment was described, at unclear risk if this process was not described and at high risk if sequence generation was not randomised (eg alternate allocation) and/or allocation was not concealed.
- *Performance bias:* Studies were considered at low risk of performance bias if participants were blinded to allocation group, at unclear risk if blinding of participants was not described and at high risk if the study stated that participants were not blinded.
- *Detection bias*: Studies were considered at low risk of detection bias if outcome assessors were blinded to allocation group, at unclear risk if blinding of assessors was not described and at high risk if the study stated that assessors were not blinded.
- *Attrition bias*: Studies were considered at low risk of attrition bias if reasons were given for loss to follow-up, attrition was low and loss to follow-up was balanced between groups, at unclear risk if this could not be determined and at high risk if attrition was high and/or unbalanced between groups.
- *Reporting bias*: Studies were considered at low risk of reporting bias if all pre-specified outcomes were reported, at unclear risk if the study protocol was not available and at high risk if reporting of some outcomes and not others was incomplete or absent.
- *Other potential sources of bias*: Significant differences in participants at baseline was considered another source of bias.

Table 112: Summary of risk of bias across studies — probiotics

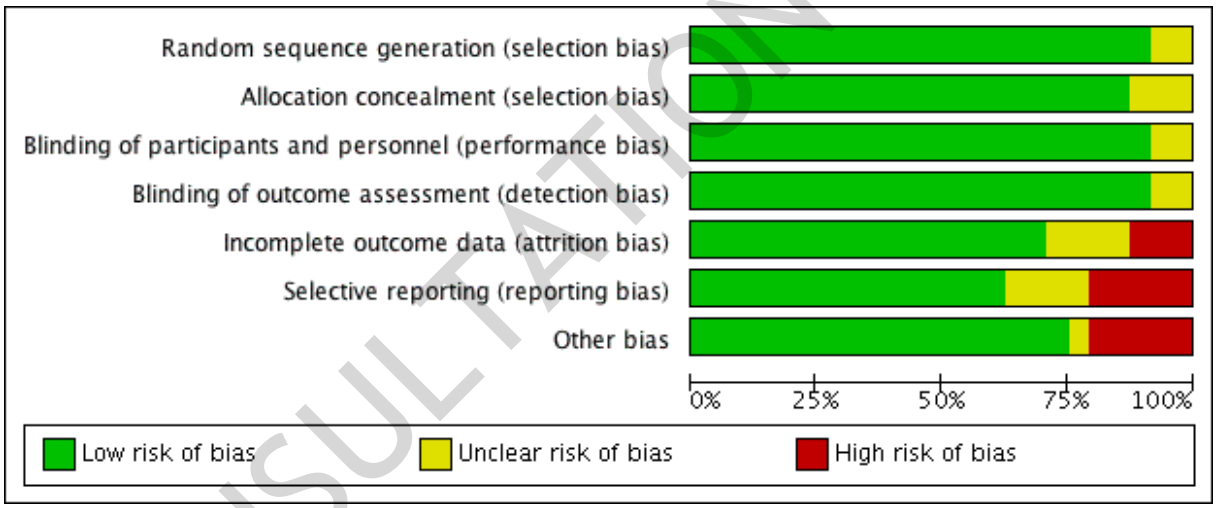


Table 113: Summary of risk of bias across studies — weighing

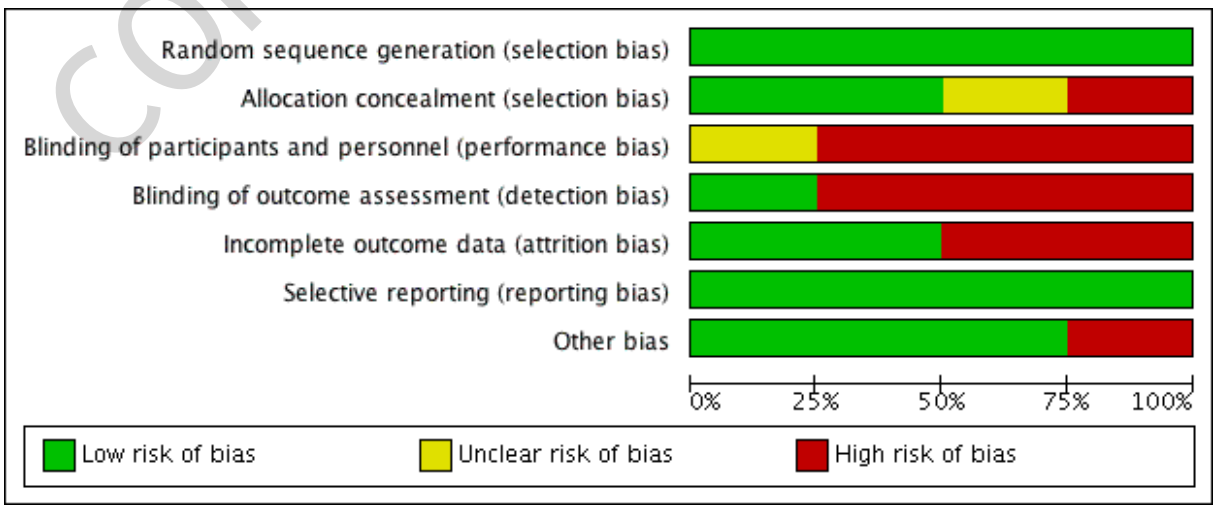


Table 114: Summary of risk of bias across studies — dietary interventions

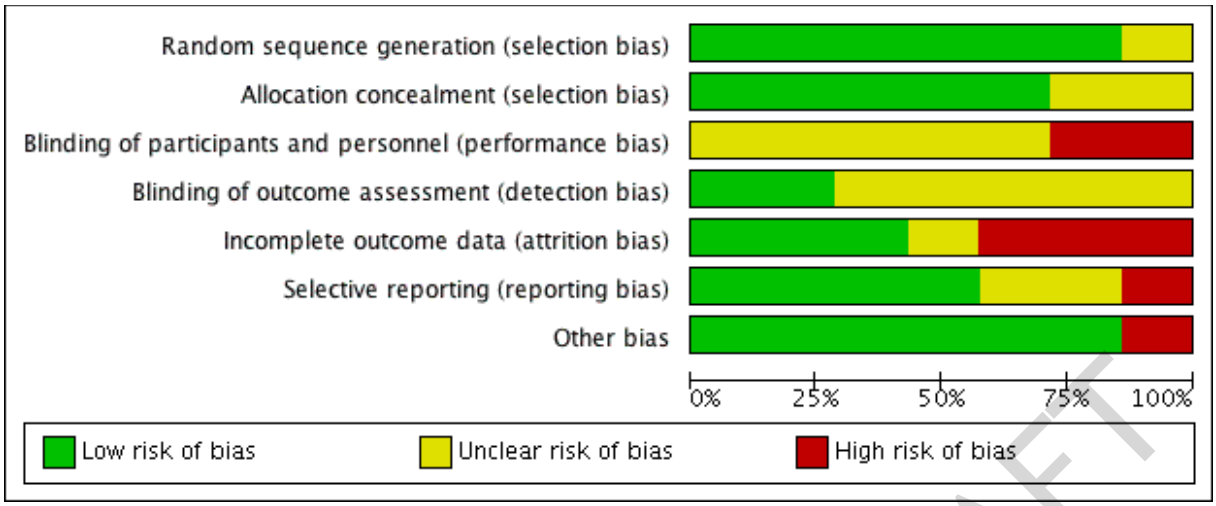


Table 115: Summary of risk of bias across studies — exercise interventions

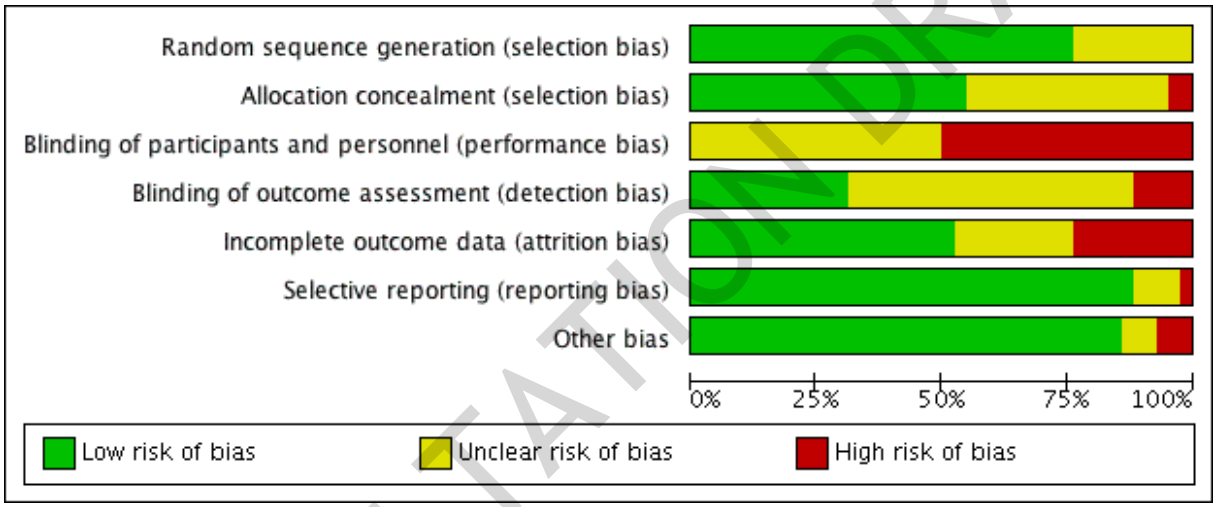
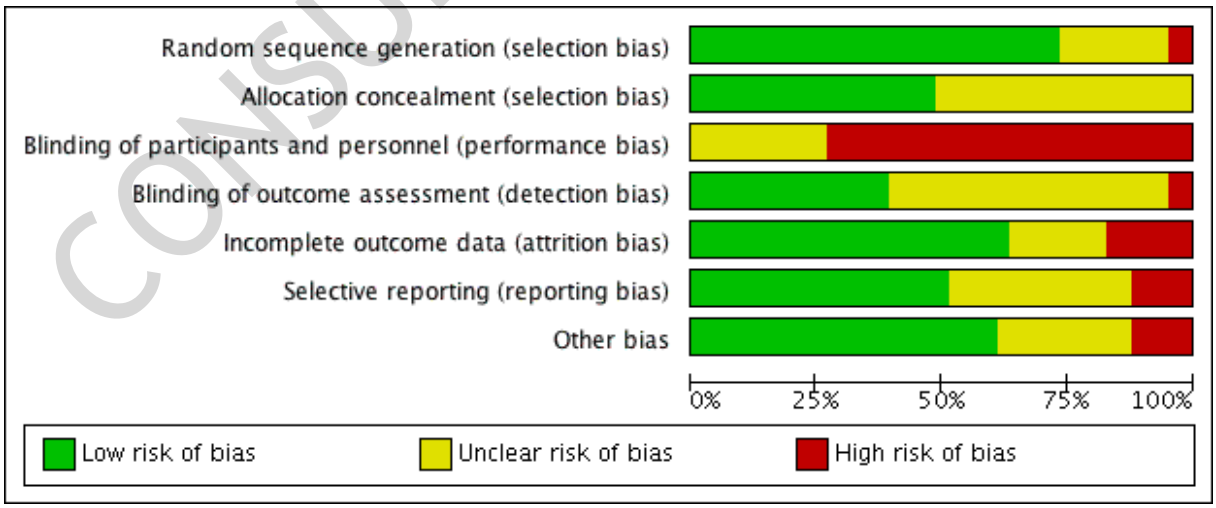


Table 116: Summary of risk of bias across studies — lifestyle counselling interventions



Probiotics studies

Study limitation	Judgement	Support for judgement
Callaway et al 2019[228]		
Random sequence generation	Low risk	Participants were randomised using computer-generated random number codes sealed in opaque envelopes.
Allocation concealment	Low risk	Matching placebo and probiotic capsules were identically packaged in the RBWH pharmacy by independent pharmacists.
Performance bias	Low risk	All study staff and participants were blinded to the randomised allocation.
Detection bias	Low risk	
Incomplete outcome data	Low risk	Reasons for loss to follow-up reported and similar attrition between groups.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant difference between groups at baseline.
Gille et al 2016[229]		
Random sequence generation	Low risk	Randomisation was performed with the use of a computer-generated random number list. Subjects were allocated to study arms with the use of simple block randomisation.
Allocation concealment	Low risk	The placebo was matched to the study drug for taste, colour, and size and was not distinguishable from treatment, neither by visual inspection nor by taste.
Performance bias	Low risk	Recruiting gynaecologists and study centre (administering treatment), subjects, and study centre personnel including the analysing microbiologist (evaluating the response to treatment) were all blinded to group assignment until study completion and final analyses (ie, triple-blind design).
Detection bias	Low risk	
Incomplete outcome data	Low risk	Reasons for loss to follow-up reported and similar attrition between groups.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant difference between groups at baseline.

Study limitation	Judgement	Support for judgement
Ho et al 2016[230]		
Random sequence generation	Low risk	The trial patients were doubled-blind computerized randomised by the hospital pharmacy. Each woman was assigned a number.
Allocation concealment	Low risk	Identical looking probiotic and placebo capsules were prepared and distributed in numbered containers by the pharmacy.
Performance bias	Unclear risk	Not described
Detection bias	Unclear risk	
Incomplete outcome data	Low risk	Reasons for loss to follow-up reported and attrition similar between groups.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant difference between groups at baseline.
Husain et al 2019[231]		
Random sequence generation	Low risk	The random allocation sequence was generated based on permuted blocks of random block sizes of four, six, and eight, stratified by participating site and without adaptive or minimisation strategies. Allocation was done on a 1:1 ratio.
Allocation concealment	Low risk	The sequence was given to a trial support company, Sharp Clinical Services (SCS, Crickhowell, Wales), which labelled and packaged the probiotic and placebo capsules into identical tamper-proof boxes for the study. Only the trial statistician and SCS were aware of the allocation sequence
Performance bias	Low risk	Participants, investigators, and analysing microbiologists were blinded to the study grouping.
Detection bias	Low risk	
Incomplete outcome data	Low risk	Reasons for loss to follow-up reported and similar attrition between groups.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant difference between groups at baseline.

Study limitation	Judgement	Support for judgement
Okesene-Gafa et al 2019[232]		
Random sequence generation	Low risk	Eligible women were allocated randomly by the research midwife using a web-based randomisation program using random permuted blocks of 4-8 participants, stratified by BMI (30 to < 35 or 35 kg/ m_2).
Allocation concealment	Low risk	Christian Hansen (Chr. Hansen A/S, Horsholm, Denmark) provided identically packaged canisters containing either probiotic or placebo capsules. AnQual Laboratories (School of Pharmacy, University of Auckland) labelled the canisters using a pre-allocated random list that was password protected.
Performance bias	Low risk	Participants, researchers, and data analysts were blinded to probiotic and placebo allocation.
Detection bias	Low risk	
Incomplete outcome data	Low risk	Reasons for loss to follow-up reported and similar attrition between groups.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant difference between groups at baseline.
Olsen et al 2018[235]		
Random sequence generation	Low risk	An online randomisation site was utilised to create a table which randomised 100 potential participants
Allocation concealment	HIgh risk	Allocation was not concealed
Performance bias	High risk	Participants and researchers were not blinded.
Detection bias	Low risk	The pathologists were blinded to the research group allocation of the participants.
Incomplete outcome data	Low risk	Reasons for loss to follow-up reported and similar attrition between groups.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant difference between groups at baseline.

Study limitation	Judgement	Support for judgement
Pellonpera et al 2019[233]		
Random sequence generation	Low risk	The stratified randomisation was performed with random permuted blocks of four, and randomisation lists of the three blocks were generated by a statistician who was not involved in either study recruitment or its execution. Women were assigned to the intervention groups according to the randomisation list in their order of recruitment on the first study visit.
Allocation concealment	Low risk	Placebo for the probiotics consisted of microcrystalline cellulose; the capsules were identical to the probiotic capsules in size, shape, and colour.
Performance bias	Low risk	The staff responsible for enrolment of participants, study visits, and assessing outcomes remained blinded to the intervention, as were the participants.
Detection bias	Low risk	
Incomplete outcome data	Low risk	Reasons for loss to follow-up reported and similar attrition between groups.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant difference between groups at baseline.
Sharpe et al 2019[234]		
Random sequence generation	Low risk	Randomisation was conducted by an independent statistician at Ryerson University using a computer-generated schedule at random.org and an allocation ratio of 1:1 and each of the 19 participating practices received a different list of 10 randomised numbers.
Allocation concealment	Low risk	At each clinic, the midwife treating each eligible and consenting client assigned the next available sequentially numbered capsule container.
Performance bias	Low risk	The researchers, practice research collaborators, midwives, and participants were blinded to study allocation.
Detection bias	Low risk	
Incomplete outcome data	Low risk	Reasons for loss to follow-up reported and similar attrition between groups.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Unclear risk	The gestational age at birth was significantly higher in the probiotic group than the placebo group (p=0.01).

Weight assessment studies

Study limitation	Judgement	Support for judgement
Brownfoot et al 2016[383]		
Random sequence generation	Low risk	'The randomisation sequence was generated by an independent organisation.'
Allocation concealment	Unclear risk	'Sealed opaque envelopes.' Ideally should be sequentially numbered sealed opaque envelopes (which they probably were)
Performance bias	High risk	Limitations of our study included an inability to blind participants and their treating team due to the nature of the intervention. All the women recruited and clinicians knew the intervention was weighing and the control group was aware of the IOM guideline on weight gain in pregnancy, which is readily available.
Detection bias	High risk	
Incomplete outcome data	High risk	'Our loss to follow up rate was low at 5% and occurred primarily due to transfer of obstetric care to another provider. Importantly, there were no differences in BMI category, age or parity in those lost to follow up.' Loss to follow-up is not clear and likely to be closer to 18%.
Selective reporting	Low risk	Prespecified outcomes reported.
Other limitations	Low risk	There were no significant differences in baseline characteristics between intervention and control groups.
Daley et al 2015[386]		
Random sequence generation	Low risk	The randomisation list was generated by the trial statistician, independent from researchers involved in recruiting and randomising participants. Participants were randomised on a 1:1 basis to intervention or usual care using random permuted blocks of mixed size (2, 4 or 6) within strata (midwife).
Allocation concealment	Low risk	The researcher allocated women by opening sequentially numbered opaque sealed envelopes. The researcher opened the envelope after eligibility assessment.
Performance bias	High risk	Because of the nature of the intervention, participants, researchers and those delivering the intervention could not be blinded to group allocation.
Detection bias	High risk	
Incomplete outcome data	Low risk	'Our loss to follow up rate was low at 5% and occurred primarily due to transfer of obstetric care to another provider. Importantly, there were no differences in BMI category, age or parity in those lost to follow up.'
Selective reporting	Low risk	Prespecified outcomes reported.
Other limitations	High risk	Baseline characteristics were balanced between intervention and control groups with the exception of ethnicity and null parity where there was an imbalance.

Study limitation	Judgement	Support for judgement
Daley et al 2019[387]		
Random sequence generation	Low risk	The randomisation list was created by an independent statistician using nQuery Advisor V.7.0. Randomisation was stratified by BMI category at recruitment (healthy weight/overweight/obese) and recruitment site. Participants were individually randomised using random permuted blocks of mixed size (2, 4 or 6).
Allocation concealment	High risk	Due to the nature of the intervention, it was not possible to blind participants or community midwives to the intervention.
Performance bias	High risk	
Detection bias	Low risk	The trial statistician remained blinded to group allocation until completion of analyses.
Incomplete outcome data	High risk	High attrition in both groups: 24% in intervention group and 22% in control group.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant difference between groups at baseline.

Dietary intervention studies

Study limitation	Judgement	Support for judgement
Abdel-Aziz et al 2018[400]		
Random sequence generation	Low risk	Randomisation was performed using a computer-generated randomisation allocation table by the researcher without involvement in the study design.
Allocation concealment	Unclear risk	Not described
Performance bias	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	High risk	"During follow-up, 10 women were lost to follow-up, six were unable to be contacted during pregnancy, and 15 cases were excluded (six miscarried, four abortion, and five stillbirth cases). Finally, data were analysed from 147 pregnant women; 75 from the intervention group and 72 from the control group." Does not describe whether women lost to follow-up were from the intervention or control group.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant difference between groups at baseline.

Study limitation	Judgement	Support for judgement
Di Carlo 2014[401]		
Random sequence generation	Unclear risk	”Randomly allocated“ in 1:1 ratio.
Allocation concealment	Low risk	” ...attached a sequentially numbered, opaque sealed and stapled envelope containing the allocation treatment to the patient clinical record.“
Performance bias	High risk	Participants not blinded due to nature of intervention.
Detection bias	Low risk	”The allocation sequence was concealed from the researchers.“
Incomplete outcome data	High risk	22% of participants were excluded due to miscarriages (9 vs 8 in diet and control groups respectively), loss to follow-up (6 vs 7) and preterm births (3 vs 1). ”Analysis was performed per protocol“ but protocol deviations and individual denominators were not reported.
Selective reporting	High risk	Per protocol data reported with individual denominators missing from most results. Results not adjusted for baseline difference in maternal age (older in the intervention group).
Other limitations	High risk	Baseline difference in age of women (average of 3 years older in intervention group).
Laitinen et al 2009[240]		
Random sequence generation	Low risk	Women were randomly assigned to 3 study groups according to computer-generated block randomisation.
Allocation concealment	Low risk	Using sealed envelopes. At the 1st study visit the envelopes were opened. The random allocation sequence was thus concealed until interventions were assigned
Performance bias	Unclear risk	Probiotics/placebo were double-blind in the intervention groups but single blind in the control group. Blinding of intervention group (ie diet counselling vs no diet counselling) not described.
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Low risk	No loss to follow-up (to delivery).
Selective reporting	Low risk	The outcomes reported as in the published protocol.
Other limitations	Low risk	No other bias apparent.

Study limitation	Judgement	Support for judgement
Simmons et al 2017[402]		
Random sequence generation	Low risk	Randomisation to either HE+PA, HE, PA, or UC (Fig. 1) was performed using a computerized electronic random number generator, prestratified for site.
Allocation concealment	Low risk	The trial coordinator (D.S.) prepared and distributed sealed opaque envelopes, containing group allocations to each site. The allocation outcome was communicated to the participants by the coach.
Performance bias	High risk	The staff involved with measurements, but not the participants, were kept unaware of the intervention. Statistical analyses were performed blinded for allocation.
Detection bias	Low risk	
Incomplete outcome data	Low risk	Data were analysed according to intention to treat and according to an a priori statistical analysis plan. Differences between subjects withdrawing from the study and those who stayed in the study were assessed.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Thornton et al 2009[403]		
Random sequence generation	Low risk	Random number table.
Allocation concealment	Low risk	Sealed sequentially numbered envelopes (no comment re: opaque/not opaque)
Performance bias	Unclear risk	Blinding not detailed and considered unlikely particularly for women and personnel in view of the intervention
Detection bias	Unclear risk	As above
Incomplete outcome data	Unclear risk	25/257 lost to follow-up (8/124 in the intervention group and 17/133 in the control group; some suggestion of greater loss in control group)
Selective reporting	Unclear risk	While most of pre-specified outcomes discussed in the methods were subsequently reported, no access to a trial protocol to confidently assess selective reporting. Some outcomes, eg shoulder dystocia, were mentioned and then not reported
Other limitations	Low risk	Groups appeared balanced at baseline for demographic data although women in the control group were heavier and had higher BMI at baseline (P=0.06). No other obvious sources of bias

Study limitation	Judgement	Support for judgement
Walsh et al 2012[405,406]		
Random sequence generation	Low risk	A computer-generated random sequence was used.
Allocation concealment	Low risk	Sealed, opaque envelopes were used.
Performance bias	Unclear risk	Blinding not detailed, and considered unlikely particularly for women and personnel in view of the intervention.
Detection bias	Unclear risk	
Incomplete outcome data	Low risk	Reasons for losses to follow up were documented and similar between groups (10 women in each group 'opted out'; 1 in each group discontinued the intervention; 2 women in each group were found to have twins; 9women in the intervention group and 6 in the control group had early pregnancy losses). Therefore 759 (372 in the intervention group and 387 in the control group) of the 800 (95%) women randomised were included in the final analyses
Selective reporting	Low risk	Outcomes reported as per published trial registration and/or protocol (across a number of separate manuscripts). Data for mode of birth were not reported in Walsh et al. 2012, and for caesarean rate no data were presented: "We found no significant difference in the rate of caesarean delivery between the two groups"; however data were reported in Walsh et al. 2015.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Wolff et al 2008[404]		
Random sequence generation	Low risk	Computerised randomisation.
Allocation concealment	Unclear risk	No details provided.
Performance bias	Unclear risk	The women and dietitians were not blinded.
Detection bias	Unclear risk	Quote: “The physicians and midwives were blinded in regard to the treatment assignment, and the women were asked not to reveal the allocation by the randomization”; unclear whether this was successfully achieved.
Incomplete outcome data	High risk	73 women were recruited to the study; 7 developed“ conditions that made them ineligible to continue participation” (spontaneous abortion, twin pregnancy, smoker, bedridden, diagnosis of GDM at inclusion). It was somewhat unclear whether these exclusions were pre or post randomisation; the unbalanced groups (n=28 and n=38 suggested this was following randomisation). A further 13women dropped out of the study due to lack of time, or disappointment due to being in the control group. 3 additional women developed GDM in the control group were excluded from the analyses (apart from GDM incidence). 50 women were followed to delivery (23 in the intervention group; 27 in the control group). There were missing data for blood samples (3/50), and weight measurements (15/50) postpartum; “The analyses were subsequently controlled for impact of missing values by replacing these with average of the entire group to ensure that the statistical test did not differ, significantly”.
Selective reporting	Unclear risk	Whilst the majority of pre-specified outcomes discussed in the methods were subsequently reported, no access to a trial protocol to confidently assess selective reporting. Some outcomes, e.g. shoulder dystocia, were mentioned and then not reported
Other limitations	Low risk	No other obvious sources of bias identified.

Exercise intervention studies

Study limitation	Judgement	Support for judgement
Aguilar-Cordero et al 2019[447]		
Random sequence generation	Low risk	The sample was randomly assigned using a probabilistic technique without replacement. Each woman who met the inclusion criteria was given a numbered ticket by the researcher responsible for recruitment.
Allocation concealment	Low risk	The numbers assigned were placed inside an urn, from which the principal investigator of the clinical trial extracted the first 70 numbers, which were assigned to the intervention group. The next 70 numbers were assigned to the control group.
Performance bias	High risk	Open label.
Detection bias	High risk	Open label.
Incomplete outcome data	Low risk	After the delivery, six women in the control group (CG) and five in the exercise group (EG)could not be contacted to complete the Edinburgh Postnatal Depression Scale (EPDS) questionnaire. Thus, the final study sample was composed of 65 women in the EG and 64 in the CG, all aged between 21 and 43 years.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Bacchi et al 2018[425]		
Random sequence generation	Low risk	A computer-generated list of random numbers was used to allocate the participants into the 2 study groups (1:1 ratio) according to admission order and following the randomization list. To guarantee the concealment for the randomization procedure, each sequential number corresponded to a sealed opaque envelope containing information about the study group (exercise or control).
Allocation concealment	Low risk	The treatment allocation system was set up so that the researcher who was in charge of randomly assigning participants to each group did not know in advance which treatment the next person would receive, a process termed “allocation concealment.” Allocation concealment prevents researchers from (unconsciously or otherwise) influencing which participants are assigned to a given intervention group.
Performance bias	High risk	Blinding of the study to the randomisation arm was impossible due to the characteristics of intervention program (physical exercise).
Detection bias	Unclear risk	No discussion of whether those assessing outcomes were blinded to allocation.
Incomplete outcome data	High risk	Unbalanced losses; 21 women (30%) in the EG were lost to follow up or excluded. A total of 8 (11%) participants in the CG were excluded from the study.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Baciuk et al 2008[292,312]		
Random sequence generation	Low risk	Volunteers were enrolled sequentially and randomised to one of the two study groups. Each sequential number corresponded to a sealed opaque envelope containing the information on the randomisation group, according to a previously prepared computer-generated randomisation list of numbers, in order to guarantee the concealment.
Allocation concealment	Low risk	
Blinding	High risk	Due to the nature of the study participants were not blinded.
Detection bias	Unclear risk	No discussion of whether those assessing outcomes were blinded to allocation.
Incomplete outcome data	Low risk	Outcome data at time of birth included for all participants in control group and 97% of participants in the intervention group.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Barakat et al 2009[293,303,313]		
Random sequence generation	Unclear risk	Women were randomly assigned to either a training (n=80) or a control group (n=80). No further details provided.
Allocation concealment	Low risk	The treatment allocation system was set up so that the researcher who was in charge of randomly assigning participants to each group did not know in advance which treatment the next person would receive.
Performance bias	High risk	Single blind.
Detection bias	Low risk	Research assistants were blinded to group assignment.
Incomplete outcome data	Unclear risk	Overall attrition 11.25%; 8 (10%) women in the intervention group discontinued the intervention. 10 (12.5%) of women in the control group were lost to follow-up or discontinued participation. No ITT analysis.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Barakat et al 2012a[426,454]		
Random sequence generation	Unclear risk	Not described
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Unclear risk	Overall attrition 17%; 10 women (20%) from the intervention group and 7 (14%) women from the control group were not included in the final analysis; reasons provided. No ITT analysis.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Unclear risk	There was a significant difference in levels of maternal education between groups at baseline.
Barakat et al 2012b[427,533]		
Random sequence generation	Low risk	To allocate participants, a computer-generated list of random numbers was used.
Allocation concealment	Unclear risk	Not described
Blinding	High risk	Not blinded for participants.
Detection bias	Unclear risk	No discussion of whether those assessing outcomes were blind to allocation.
Incomplete outcome data	Unclear risk	Overall attrition 9%; 22 women (14%) from the intervention group and 8 (5%) women from the control group were not included in the final analysis; reasons provided. No ITT analysis.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Barakat et al 2013[428]		
Random sequence generation	Unclear risk	Not described
Allocation concealment	Low risk	The participant randomisation assignment followed an allocation concealment process, that is, the researcher in charge of randomly assigning participants did not know in advance which treatment the next person would receive and did not participate in the assessments.
Blinding	High risk	Participants were explicitly informed on the group to which they were assigned as well as on the study hypotheses and were reminded not to discuss their randomisation assignments with assessment staff.
Detection bias	Low risk	Assessment staff was blinded to the participant randomisation assignment. Owing to the nature of the study, it was not possible to conceal the group assignment from the staff involved in exercise training sessions.
Incomplete outcome data	Unclear risk	Overall attrition 16%; 45 women (18%) from the intervention group and 37 women (14.5%) from the control group were not included in the final analysis; reasons provided. No ITT analysis.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Barakat et al 2014b[429]		
Random sequence generation	Low risk	For allocation of the participants, a computer-generated list of random numbers was used.
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Unclear risk	Overall attrition 20%; 21 women (22%) from the intervention group and 21 women (18%) from the control group were not included in the final analysis; reasons provided. No ITT analysis.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Barakat et al 2016[430]		
Random sequence generation	Low risk	The participant randomization assignment followed an allocation concealment process using a random numbers table.
Allocation concealment	Unclear risk	
Performance bias	Unclear risk	Not described
Detection bias	Low risk	Assessment staff members were blinded to assignment.
Incomplete outcome data	Low risk	Overall attrition 9%; 38 women (9%) from the intervention group and 37 women (9%) from the control group were not included in the final analysis; reasons provided. No ITT analysis.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Barakat et al 2018[294]		
Random sequence generation	Low risk	A computer-generated list of random numbers was used to allocate the participants into the study groups.
Allocation concealment	Low risk	The treatment allocation system was set up so that the researcher who was in charge of randomly assigning participants to each group did not know in advance which treatment the next person would receive.
Performance bias	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	In the intervention group, 51 women were lost to follow-up and 53 were excluded as they had a caesarean section. In the control group, 28 women were lost to follow-up and 51 were excluded due to caesarean section. Reasons for loss to follow-up included. ITT and per protocol analysis included.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Bisson et al 2015[269]		
Random sequence generation	Low risk	Randomisation was stratified according to parity and based on a computer-generated random numbers table.
Allocation concealment	Low risk	Sealed envelopes were kept in a secure place by a research assistant not involved in the study and provided to a kinesiologist at the time of allocation.
Blinding	High risk	Due to the nature of the intervention, kinesiologists in charge of training and participants were not blinded to group assignment.
Detection bias	Unclear risk	No discussion of whether those assessing outcomes were blinded to allocation.
Incomplete outcome data	Low risk	One participant in the intervention group withdrew after randomisation (lack of time). Two participants withdrew from the control group after randomisation (unsatisfied with group allocation). No ITT analysis but bias unlikely.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Cordero et al 2015[431]		
Random sequence generation	Unclear risk	Not described.
Allocation concealment	Unclear risk	Not described.
Blinding	Unclear risk	Not described.
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Unclear risk	Overall attrition 25%; In the intervention group, 2 women were lost to follow-up and 19 discontinued the intervention (17%). In the control group, 43 women were lost to follow-up and 21 withdrew from the study (29%). No ITT analysis.
Selective reporting	Low risk	All pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
da Silva et al 2017[432]		
Random sequence generation	Low risk	Participants were assigned to either an exercise or control group using a computerized random-number generator.
Allocation concealment	Low risk	The staff involved with exercise intervention or outcome assessments had no influence on the randomisation procedure.
Blinding	High risk	The nature of this trial meant that participants and staff were not masked to the type of intervention. However, the principal researcher was not involved in the exercise training and analyses were performed blinded for group allocation.
Detection bias	Low risk	The assessors of the primary study outcomes were blinded.
Incomplete outcome data	Low risk	ITT and per protocol analysis included.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Daly et al 2017[433]		
Random sequence generation	Low risk	The randomisation sequence was computer-generated by an independent statistician and was stratified by parity and World Health Organization BMI category.
Allocation concealment	Low risk	Sequentially numbered opaque sealed envelopes were prepared by an independent research administrator. Women were randomized by another independent research administrator into either the exercise intervention or control arm.
Blinding	Unclear risk	Not described.
Detection bias	Low risk	The clinical teams caring for the women were blinded to the randomisation result.
Incomplete outcome data	Low risk	11 women were excluded or lost to follow-up in the intervention group and 8 in the control group. ITT analysis conducted.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
de Oliveria Melo et al 2012[270]		
Random sequence generation	Low risk	Randomisation sequence was generated in blocks of 10 using the Random Allocation software program 1.0 by another investigator who did not participate directly in the study.
Allocation concealment	Low risk	This investigator also prepared the sealed opaque envelopes containing the randomization group for each participant. Group assignment was defined only after the woman had agreed to participate in the study, thus guaranteeing that allocation remained concealed until the participant had been admitted to the trial.
Blinding	High risk	This was an open study because it was impossible to blind the investigators and the research participants.
Detection bias	Low risk	The investigators involved in monitoring the ultrasound variables and in the statistical analysis were unaware of the group to which the patient had been assigned.
Incomplete outcome data	Low risk	Balanced losses between group. ITT analysis conducted.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Dekker Nitert et al 2015[448]		
Random sequence generation	Low risk	Women were randomised to the intervention or standard care arm by random number allocation through an external service
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	No loss to follow-up reported
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Unclear risk	Levels of physical activity were low and women randomised to the control group also increased their level of physical activity, which further reduces the power of the study to detect differences.

Study limitation	Judgement	Support for judgement
Garnæs et al 2016[304,314,315,537]		
Random sequence generation	Low risk	Participants were randomly allocated 1:1 to the intervention or the control group. Allocation was done using a computer random number generator developed and administrated at the Unit for Applied Clinical Research, NTNU. The randomization had varying block sizes, with the first, the smallest, and the largest block defined by the computer technician at the Unit for Applied Clinical Research.
Allocation concealment	High risk	The investigators enrolling the patients (K. K. G. and T. M.) got the allocation results on screen and by e-mail after registration of each new participant into the study and did not have the full randomization list available.
Performance bias	Unclear risk	Not described
Detection bias	Low risk	Weight measurement at delivery and blood analyses were done by personnel blinded for group allocation. All other assessments and intervention administration were done non-blinded. The statistician conducting the statistical analyses was blinded for group allocation.
Incomplete outcome data	Low risk	The trial and the principal analyses were based on intention to treat. All available data were used at all time points. We also performed, as described in the original protocol, per protocol analyses including only the women in the exercise group who adhered to the exercise protocol
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Garshasbi & Faghih Zadeh 2005[434]		
Random sequence generation	Unclear risk	Not described
Allocation concealment	Low risk	Using sealed envelopes, the women who accepted the offer were randomized into two groups
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Unclear risk	“Fifty-four women in the exercise group were excluded due to exclusion criteria of study”
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Guelfi et al 2016[271]		
Random sequence generation	Low risk	Eligible women were randomized using a custom-designed computer program on a dedicated laptop that stratified by body mass index (calculated as weight (kg)/[height (m)]$_2$, less than 30, 30–34.9, or greater than 35) and maternal age (younger than or 35 years or older).
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	Balanced losses. Statistical analysis was conducted based on intention-to-treat using SPSS.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Haakstad & Bo 2011[278,435,538]		
Random sequence generation	Low risk	Used “a simple (not block) computerised randomisation programme”
Allocation concealment	Low risk	An independent person...assigned the participants to either an exercise group or a control group.
Blinding	High risk	Participant blinding not possible.
Detection bias	Low risk	Principal investigator was blinded to group allocation.
Incomplete outcome data	Low risk	Drop-out rates of 19% and 21% in exercise and control arms, respectively. ITT analysis conducted.
Selective reporting	Unclear risk	Could not determine.
Other limitations	Unclear risk	Denominators in report tables were the total exercise and control group N, despite stating drop-outs in each group of 10 and 11 women, respectively

Study limitation	Judgement	Support for judgement
Hopkins et al 2010[272,540]		
Random sequence generation	Unclear risk	Not described
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Low risk	Not described
Incomplete outcome data	High risk	A total of 14 (14.3%) participants (2 from the intervention group [4%] and 12 from the control group [24%]) lost to follow-up during the study period
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Kong et al 2014[449,541]		
Random sequence generation	Low risk	Participants were randomly assigned to the intervention or control group using a computer-based random number generator (Microsoft Excel 2010, WA)
Allocation concealment	Low risk	Before baseline data collection, all participants and research personnel were blinded to the group allocation. A study coordinator revealed the study groups to women at the baseline data collection visit.
Blinding	High risk	Blinding of participants to intervention was not possible due to the nature of the intervention.
Detection bias	High risk	Study coordinator not blinded.
Incomplete outcome data	Low risk	Balanced losses between groups. No ITT analysis but likely low risk of bias.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Murtezani et al 2014[436]		
Random sequence generation	Low risk	The random assignment procedure was performed using random numbers generated by a computer program.
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	The data were analysed on an intention to treat basis.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Nascimento et al 2011[437]		
Random sequence generation	Low risk	The pregnant women were randomised to the groups using the SAS statistical program (SAS Institute, Cary, NC, USA), which generated a list of random numbers based on a uniform distribution.
Allocation concealment	Low risk	The sequence was randomly distributed in opaque envelopes, which were sealed and sequentially numbered. Each participant received a sequence number corresponding to a sealed envelope.
Blinding	Unclear risk	Not described.
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	1 woman in each group withdrew. For neonatal weight outcome, missing data were >20% but similar numbers missing in each group. Authors indicate that this was because some women delivered at other hospitals
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Ong et al 2009[450]		
Random sequence generation	Unclear risk	Described as "women were randomly allocated into either an exercise intervention group or a control group", no other information available
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	No information available on whether outcome assessors were blinded to group allocation or not
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	No losses to follow-up or post randomisation exclusion.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No obvious risk of other bias.
Oostdam et al 2012[438]		
Random sequence generation	Low risk	Block randomisation, stratified by hospital.
Allocation concealment	Low risk	Women were recruited by midwives and gynaecologists who were unaware of the allocation of other women, with no risk of compromising allocation concealment.
Blinding	Unclear risk	Not described
Detection bias	Low risk	All outcome measures were assessed by independent examiners, unaware of group allocation.
Incomplete outcome data	High risk	High dropout rates, especially at 32 weeks (19/62 [31%] did not respond in intervention group and 12/59 [20%] did not respond in control group). For GWG outcome dropout rate was 31% overall
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	High risk	Poor adherence to the intervention – 'only a small proportion (16.3%) of the women in our intervention group attended at least half of the training sessions' Follow-up weight gain data were collected at 32 weeks (much earlier than most other included studies)

Study limitation	Judgement	Support for judgement
Perales et al 2015a[439]		
Random sequence generation	Low risk	A computer-generated list of random numbers was used to allocate the participants into the groups.
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	10 women were lost to follow-up in each group. 3 women from the intervention group were excluded as they did not meet the minimum attendance requirements. No ITT analysis but likely low risk of bias.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Perales et al 2015b[440]		
Random sequence generation	Low risk	A computer-generated list of random numbers was used
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	Balanced losses. No ITT analysis.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Perales et al 2016a[295]		
Random sequence generation	Low risk	A computer-generated list of random numbers was used
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	Losses of 23% in the intervention group and 17% in the control group. No ITT analysis.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Perales et al 2016b[296]		
Random sequence generation	Low risk	A computer-generated list of random numbers was used
Allocation concealment	Unclear risk	Not described
Blinding	High risk	The study participants and the qualified fitness instructors who supervised the exercise sessions were not blinded to the group allocation
Detection bias	High risk	The study participants and the qualified fitness instructors who supervised the exercise sessions were not blinded to the group allocation
Incomplete outcome data	High risk	Unbalanced losses; 51% in intervention group and 30% in the control group.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Petrov Fieril et al 2015[453]		
Random sequence generation	Unclear risk	Participants were randomly assigned to either the intervention group or the control group (allocation ratio 1:1)“, however the group sizes were significantly different (51 vs 41, respectively)
Allocation concealment	Low risk	The research coordinator performed the randomization by using opaque sealed envelopes, which were randomly picked out before the meeting with each participant.
Blinding	High risk	Not blinded to participants.
Detection bias	Low risk	All data were collected at a primary health care location by an investigator who was blinded to group allocation
Incomplete outcome data	High risk	25% and 18% of participants dropped out of the intervention and control groups, respectively
Selective reporting	High risk	Protocol not seen. GWG and EGWG not reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Pinzon et al 2012[441]		
Random sequence generation	Low risk	The volunteers were randomly allocated to one of two groups, according to admission order, following a computer-generated randomisation list.
Allocation concealment	Low risk	To guarantee concealment for randomisation, each sequential number corresponded to a sealed opaque envelope containing the questionnaires and information regarding the randomization group.
Blinding	High risk	Due to the nature of the study, it was not possible to blind the women participating.
Detection bias	Low risk	Research assistants were blinded to the group assignment of the subjects and were in charge of the prenatal care of the women.
Incomplete outcome data	High risk	14 women withdrew early (22%; 9 in study and 5 in control arm) therefore 50/64 women assessed for fitness outcomes. Weight and pregnancy outcome data were only available for 35/64 women (55%; 18 in study and 17 in control group)
Selective reporting	Unclear risk	Unable to comment as study protocol not seen.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Price et al 2012[442]		
Random sequence generation	Unclear risk	Randomly assigned
Allocation concealment	Low risk	Subjects were randomised using numbered, opaque envelopes containing an equal number of group assignments prepared by the study statistician
Blinding	High risk	Participants and personnel not blinded. Author kept a log of attendance and seemed to perform the fitness assessments
Detection bias	High risk	
Incomplete outcome data	High risk	12/43 (28%) and 17/48 (35%) dropped out in the intervention and control groups, respectively.
Selective reporting	Unclear risk	Mean weight gain (12.4 kg vs 10.5 kg in intervention and control groups, respectively) was NR with standard deviations or denominators so these data were not usable in this meta-analysis
Other limitations	High risk	Baseline BMI was significantly lower in the intervention group and loss to follow-up was high. Also, ”control subjects were told not to exercise because it would blur the distinction between the groups“. This contributed to high drop out rates in the control group and may make results less generalisable by enforcing no exercise.
Renault et al 2014[451]		
Random sequence generation	Unclear risk	The randomization was stratified according to parity to ensure equal distribution of primiparous in the 3 groups
Allocation concealment	Low risk	Web allocation by an independent organisation properly concealed the procedure
Blinding	High risk	Blinding not possible due to the nature of the study.
Detection bias	Unclear risk	Assessor blinding not described.
Incomplete outcome data	Low risk	Low attrition rates for most outcomes.
Selective reporting	Unclear risk	Could not determine.
Other limitations	Low risk	Baseline characteristics were comparable. Good compliance.

Study limitation	Judgement	Support for judgement
Ruiz et al 2013[443]		
Random sequence generation	Low risk	Computer generated.
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Unclear risk	14% attrition overall. 68 women in the control arm and 70 in the intervention arm were lost to follow-up. No protocol deviations
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Seneviratne et al 2016[273]		
Random sequence generation	Low risk	Randomisation sequences were generated by a biostatistician with no clinical involvement in the trial, and were used sequentially according to enrolment order.
Allocation concealment	Low risk	Randomisation sequences were stored securely with password protection, and group allocation revealed to participants only after completion of baseline assessments. The recruitment coordinator (responsible for order of enrolment) did not have access to the randomisation tables at any time, maintaining allocation concealment.
Blinding	Unclear risk	Due to the nature of the intervention, participants were un-blinded to group allocation after completion of baseline assessments.
Detection bias	Unclear risk	Assessor blinding not described.
Incomplete outcome data	Low risk	ITT analysis conducted.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Simmons et al 2017[402]		
Random sequence generation	Low risk	Randomization to either HE+PA, HE, PA, or UC (Fig. 1) was performed using a computerized electronic random number generator, prestratified for site.
Allocation concealment	Low risk	The trial coordinator (D.S.) prepared and distributed sealed opaque envelopes, containing group allocations to each site. The allocation outcome was communicated to the participants by the coach.
Blinding	High risk	The staff involved with measurements, but not the participants, were kept unaware of the intervention. Statistical analyses were performed blinded for allocation.
Detection bias	Low risk	
Incomplete outcome data	Low risk	Data were analysed according to intention to treat and according to an a priori statistical analysis plan. Differences between subjects withdrawing from the study and those who stayed in the study were assessed.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
SongØYgard et al 2012[444]		
Random sequence generation	Low risk	The women were randomly allocated in blocks of 30 to intervention and control groups following a computerized randomization procedure.
Allocation concealment	Unclear risk	Not described
Blinding	High risk	Due to the nature of the intervention, participants were not blinded to allocation.
Detection bias	Low risk	Authors who analysed the data were not involved in the intervention and were blinded to allocation.
Incomplete outcome data	High risk	Unbalanced high attrition; 11.7% in the intervention group and 20.2% in the control group. Only 57% of women followed the recommended exercise protocol.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Stafne et al 2012[445]		
Random sequence generation	Low risk	Concealed randomization in blocks of 30 was performed at the Unit for Applied Clinical Research, Norwegian University of Technology and Science, by a Web-based computerized procedure.
Allocation concealment	Low risk	The staff involved with training or outcome assessments had no influence on the randomization procedure.
Blinding	High risk	Because of the nature of the study it was not blinded.
Detection bias	Unclear risk	Analyses of glucose and insulin levels were performed blinded for group allocation; no information on whether outcome assessors for other outcomes were blinded for group allocation
Incomplete outcome data	High risk	18% dropout overall with more dropouts in the control group (24% vs the intervention group 13%)
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	High risk	At baseline, women in the intervention group had lower insulin resistance. Women lost to follow-up reported performing less regular exercise before pregnancy than women completing the study
Taniguchi & Sato 2016[299]		
Random sequence generation	Unclear risk	"Random sampling"
Allocation concealment	Low risk	The researcher handed out sealed, sequentially numbered opaque envelopes in turn. The doctor and clinic staff members were unaware of which groups the participants had been assigned to until the end of the study.
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Unclear risk	Six women in the walking group dropped out during the study period as did five women in the control group. Only five (of 54) women completed 100% of the intervention, although 32 completed 80% or more.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Vargas-Terrones et al 2018[446]		
Random sequence generation	Low risk	"A simple randomisation was performed with the Epidat V.3.1 program to allocate the participants into two groups in order of entry: intervention group (IG) and control group (CG). For this, a computer-generated list of random numbers (n=200) was created through the Epidat option of balanced groups (similar but not of equal size)."
Allocation concealment	Unclear risk	Not described
Blinding	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	High risk	"Significant differences were found in the percentage of participants who dropped out of the study (χ_2=6.72; p=0.01), being 13% (n=7) in the CG compared with 1.4% (n=1) in the IG, based on the data available at 6 weeks postpartum."
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups
Wang et al 2017[452]		
Random sequence generation	Low risk	Women were randomly allocated using an automatic computer-generated random number table.
Allocation concealment	High risk	Due to the nature of the intervention, all participants and research staff were aware of the allocations.
Blinding	High risk	
Detection bias	High risk	
Incomplete outcome data	Unclear	High overall attrition (25%). Loss to follow-up was similar in the intervention (25%) and control (24%) groups.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Lifestyle counselling intervention studies

Study limitation	Judgement	Support for judgement
Altazan et al 2019[507]		
Random sequence generation	High risk	"Random assignment was stratified by enrollment body mass index (BMI) class and was prepared prior to study initiation by the biostatistician who numbered and sealed envelopes until an unblinded staff member could retrieve the appropriate envelope."
Allocation concealment	Unclear risk	Not described
Performance bias	Unclear risk	Not described
Detection bias	High risk	Research assistants were not blinded to treatment allocation.
Incomplete outcome data	High risk	Four women dropped due to miscarriage and 7 women did not complete psychological assessments after baseline so 11 women were not included. Of the 11 women, 5 were dropped from the SmartMoms® intervention, and 6 were dropped from the Usual Care group. This meant that 86.5% of women randomised to the intervention group and 65% of women randomised to the control group were included in the analysis.
Selective reporting	Unclear risk	All expected outcomes reported.
Other limitations	Low risk	"The demographic characteristics of the SmartMoms® Intervention and Usual Care groups were similar with no statistical differences observed between groups at enrolment."
Althuizen et al 2013[485]		
Random sequence generation	Low risk	"A computerised random number generator drew up an allocation schedule prestratified for midwifery practices."
Allocation concealment	Unclear risk	Not described
Performance bias	High risk	"Participant blinding not possible for the intervention."
Detection bias	Low risk	"Research assistants blinded to treatment allocation."
Incomplete outcome data	Low risk	11% of participants (17 in intervention and 10 in control group) dropped out during the course of the study. Reasons for loss to follow-up given.
Selective reporting	Unclear risk	All expected outcomes reported.
Other limitations	Low risk	None noted. Baseline characteristics comparable.

Study limitation	Judgement	Support for judgement
Asbee et al 2009[488]		
Random sequence generation	Low risk	"Randomisation was performed using computer-generated random allocation."
Allocation concealment	Low risk	"Study randomization was numbered and sealed in an opaque envelope. Randomisation occurred in consecutive order at the time of the new obstetrical visit."
Performance bias	High risk	Blinding of women and trial personnel not considered feasible in view of the intervention and control
Detection bias	Unclear risk	Not described.
Incomplete outcome data	High risk	Of 144 women randomised, 44 (31%) were excluded after randomisation; therefore 100 (69%) were included in the analyses. It was unclear which groups the excluded women had been randomised to. No other losses to follow-up were reported.
Selective reporting	High risk	Outcomes were not clearly pre-specified in the methods (only total GWG and BMI change from pre-pregnancy to before delivery were discussed in the methods). While the results section details secondary outcomes including operative vaginal birth, neonatal weight, pre-eclampsia, GDM, vaginal/perinatal lacerations and shoulder dystocia, no numeric outcome data were reported; quote: "no statistically significant differences were noted between the groups".
Other limitations	Low risk	No obvious sources of other bias identified.
Asci & Rathfisch 2016[489]		
Random sequence generation	Low risk	"The women were divided into randomized groups by a staff [member] who was not involved in this study, by drawing lots."
Allocation concealment	Unclear risk	Not described.
Performance bias	Unclear risk	"Participants were blind about which group they were involved in and the evaluated study outcomes." Not clear how participants could be unaware of the group to which they were allocated.
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Low risk	Balanced attrition between groups.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No obvious sources of other bias identified

Study limitation	Judgement	Support for judgement
Bogaerts et al 2013[510]		
Random sequence generation	Unclear risk	Not described.
Allocation concealment	Low risk	"Randomisation took place by choosing one opaque envelope containing a ticket indicating one of the three groups."
Performance bias	Unclear risk	Not described.
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Low risk	Low attrition and reasons given.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	High risk	"Obese women with GDM or preterm delivery, as well as those with missing psychological measurements throughout pregnancy, were not excluded but this was controlled for in the statistical models."
Bruno et al 2017[499]		
Random sequence generation	Low risk	"The randomisation list was obtained by computer-generated random allocation with a 1:1 ratio."
Allocation concealment	Low risk	"The allocations were sealed in numbered white envelopes, which were kept in the midwifery facility. After eligibility was assessed, a midwife opened the next random envelope."
Performance bias	High risk	The trial was described as open: "Because of the study design, the gynaecologist and the dietitian knew the group allocation of the patient".
Detection bias	Low risk	"The obstetrician in charge of the enrolled women was blind to the allocation group. The data regarding the delivery and the newborns were collected from the clinical records by two residents who were blind to the allocation group." Not clear whether some outcomes (such as GDM and GWG) were able to be assessed blind.
Incomplete outcome data	High risk	Of 191 women randomised, 131 (69%) women were included in the analyses. Women lost to follow-up were significantly younger, had a lower educational level and were more frequently overweight
Selective reporting	High risk	The protocol, published with ClinicalTrials.gov, was modified before the preliminary analyses; the primary outcome was changed, and additional secondary outcomes were included. The reporting of outcomes is incomplete for outcomes such as NICU admission ("were very few and did not differ between the groups").
Other limitations	Low risk	No obvious sources of other bias identified.

Study limitation	Judgement	Support for judgement
Buckingham-Schutt et al 2019[483]		
Random sequence generation	Unclear risk	Not described
Allocation concealment	Unclear risk	Not described
Performance bias	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Unclear risk	Some data appear to be missing from the CONSORT diagram.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No obvious sources of other bias identified.
Chan et al 2018[518]		
Random sequence generation	Low risk	"Randomisation was performed through the use of a computer-generated list of random numbers in blocks of 6 by a study coordinator."
Allocation concealment	Low risk	"Treatment assignments were concealed in consecutively-numbered sealed envelopes, which were opened sequentially upon subject enrollment."
Performance bias	High risk	"The interventionists (the dietitian and the exercise instructor), the participants and the study coordinator were not blinded to the treatment assignment. However, the interventionists did not take any outcome measurements."
Detection bias	Low risk	"All investigators, outcome assessors, clinicians and nurses of routine antenatal and postnatal care were blinded to the treatment assignment."
Incomplete outcome data	Low risk	Loss to follow-up described and reasons given.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No obvious sources of other bias identified.

Study limitation	Judgement	Support for judgement
Dodd et al 2014[501,521,543,544]		
Random sequence generation	Low risk	"The computer-generated randomisation schedule used balanced variable blocks in the ratio 1:1 and was prepared by an investigator not involved with recruitment or clinical care."
Allocation concealment	Low risk	"A research assistant counselled eligible women and then randomised them to receive lifestyle advice or standard care by telephoning the central randomisation service."
Performance bias	High risk	Blinding of women and trial personnel not considered feasible in view of the intervention and control
Detection bias	Low risk	"Outcome assessors were blinded to the treatment group allocated. After birth, a research assistant not involved in providing the intervention and blinded to treatment allocation obtained information relating to antenatal, birth, and infant outcomes from the case notes."
Incomplete outcome data	Low risk	Low attrition (97% women included in the analyses) with reasons given.
Selective reporting	Low risk	Data for pre-specified outcomes (according to published trial protocol) were reported.
Other limitations	Low risk	No obvious sources of other bias identified
Dodd et al 2019[484]		
Random sequence generation	Low risk	"We used a computer-based randomisation service in the Discipline of Obstetrics and Gynaecology, The University of Adelaide. The randomisation schedule used balanced variable blocks with stratification for parity (0 versus 1 or more) and was prepared by an investigator who was not involved with recruitment or clinical care."
Allocation concealment	Unclear risk	Not described.
Performance bias	High risk	"Blinding of participants was not possible given the nature of the intervention."
Detection bias	Low risk	"Where possible, antenatal care-providers, outcome assessors and data analysts were blinded to treatment allocation."
Incomplete outcome data	Low risk	Loss to follow-up described and reasons given.
Selective reporting	Low risk	Data for pre-specified outcomes were reported.
Other limitations	Low risk	No obvious sources of other bias identified

Study limitation	Judgement	Support for judgement
Gallagher et al 2018[502]		
Random sequence generation	Low risk	The random allocation sequence was computer generated by the data manager.
Allocation concealment	Unclear risk	Not described.
Performance bias	High risk	A printed copy was placed in the participant's chart and the staff completing the randomisation informed the participant immediately in person of group assignment.
Detection bias	Low risk	Staff involved in collection of measurements were blind to group assignment.
Incomplete outcome data	High risk	Reasons for attrition between allocation and study visits not given.
Selective reporting	Low risk	All pre-specified outcomes reported
Other limitations	High risk	Attendance at exercise classes was extremely poor at 9.7%.
Guelinckx et al 2010[511]		
Random sequence generation	Unclear risk	Not described.
Allocation concealment	Low risk	"Patients were randomly assigned by using block randomisation."
Performance bias	Unclear risk	Not described.
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Low risk	Loss to follow-up 9.7%. Reasons for excluding the participants from each group were similar
Selective reporting	Unclear risk	Could not determine.
Other limitations	Low risk	Baseline characteristics of participants were similar between intervention and control groups.

Study limitation	Judgement	Support for judgement
Harrison et al 2013[520,545]		
Random sequence generation	Low risk	"Participating women were randomly assigned to intervention or control through computer-generated randomised sequencing."
Allocation concealment	Low risk	"Allocation concealment was achieved by using sealed opaque envelopes."
Performance bias	High risk	Due to the nature of the intervention and control, it was not possible to blind women, though "pedometers were sealed to blind participants to their step count".
Detection bias	Low risk	"Care providers, investigators, and outcome data analysers were blinded to group allocation; Anthropometric assessment included weight... and height measured by a registered nurse unaware of participant allocation."
Incomplete outcome data	Low risk	Low attrition, (86% of intervention group and 92% of the control group analysed) with reasons for loss to follow-up given.
Selective reporting	Unclear risk	With no access to a trial protocol, it was not possible to confidently assess selective reporting.
Other limitations	Low risk	No obvious sources of other bias identified.
Hawkins et al 2014[503]		
Random sequence generation	Unclear risk	"Eligible patients were randomised... by the health educators to either a lifestyle intervention or a standard care group. Randomization was stratified by age (< 30 years, ≥ 30 years) and pre-pregnancy BMI (25-30 kg/m^2, ≥ 30 kg/m^{2}with a block size of four."
Allocation concealment	Unclear risk	As above; no further information provided.
Performance bias	High risk	Blinding of women and trial personnel not considered feasible in view of the intervention and control
Detection bias	Low risk	"Assessments were conducted by telephone, at baseline, mid-pregnancy, and at 6 weeks postpartum by bilingual and bicultural interviewers blinded to the assigned intervention group."
Incomplete outcome data	Low risk	Of the 33 women randomised to the intervention group, 30 (94%), 32 (97%) and 24 (75%) were available for the mid-pregnancy, clinical outcome and postpartum assessments, respectively. Of the 35 women randomised to the control group, 29 (85%), 34 (97%) and 29 (85%) were available for the mid-pregnancy, clinical outcome and postpartum assessments respectively. The losses at mid-pregnancy and postpartum were associated with women being unable to be contacted via telephone; losses for clinical outcomes were associated with women being delivered off-site
Selective reporting	High risk	Reporting of GDM is incomplete (only the number of cases across both groups in text) and a very limited number of clinical outcomes are reported
Other limitations	Low risk	No obvious sources of other bias identified

Study limitation	Judgement	Support for judgement
Hui et al 2012[490]		
Random sequence generation	Low risk	"Randomisation was performed using a computer-generated randomisation allocation table by a staff member without involvement in the study design."
Allocation concealment	Low risk	"After randomisation, participants received a sealed envelope labelled with the assigned randomisation number, which contained instructions for participants."
Performance bias	High risk	The nature of the study meant that participants and study staff were not blinded to the types of interventions
Detection bias	Unclear risk	Not described
Incomplete outcome data	Unclear risk	Suggestion of differential attrition; 91% of intervention group and 79% of control group included in analysis. Reasons given.
Selective reporting	Unclear risk	With no access to a trial protocol, it was not possible to confidently assess selective reporting
Other limitations	Low risk	No obvious sources of other bias identified
Hui et al 2014[491]		
Random sequence generation	Low risk	"Randomisation was performed using a computer-generated randomization allocation table by a staff member without involvement in the study design."
Allocation concealment	Low risk	"After randomisation participants received a sealed envelope labelled with the assigned randomisation number, which contained instructions for participants."
Performance bias	High risk	Authors reported that "the nature of the study meant that participants and study staff were not blinded to the types of interventions".
Detection bias	Low risk	"Data on delivery route, maternal weight at delivery room, birth weight and birth weight-related obstetric procedures (induction, forceps or caesarean section) were collected from hospital medical charts by student assistants without knowledge in study design."
Incomplete outcome data	Low risk	"None of the participants discontinued during the participation". No losses or exclusions.
Selective reporting	Unclear risk	With no access to a trial protocol, it was not possible to confidently assess selective reporting.
Other limitations	Low risk	No obvious sources of other bias identified.

Study limitation	Judgement	Support for judgement
Jing et al 2015[492]		
Random sequence generation	Low risk	"The participants were divided according to the sequence of time and randomised numbers produced by SAS version 11.0 (SAS Institute Inc, Raleigh, NC, USA)."
Allocation concealment	Unclear risk	Not described.
Performance bias	High risk	"Participants and data analysts were masked to group assignment. The investigators were not masked to the assignment so that they could implement the personalised intervention for women in the intervention group." While authors report women were blinded, blinding of women was not considered feasible in view of the intervention and control
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Unclear risk	"Only women who finished the whole study were included in the analysis." Suggestion of differential attrition; 88% of intervention group and 81% of control group included in analysis.
Selective reporting	Unclear risk	With no access to a trial protocol, it was not possible to confidently assess selective reporting
Other limitations	Low risk	No obvious sources of other bias identified
Kennelly et al 2018[506]		
Random sequence generation	Low risk	Randomisation was performed using a computer- generated sequence in a ratio of one to one.
Allocation concealment	Low risk	The biostatistician prepared sequentially numbered, sealed opaque envelopes, which were opened at the first study visit.
Performance bias	High risk	As a result of the nature of the intervention, neither participants nor researchers were blinded to the intervention or outcomes.
Detection bias	High risk	
Incomplete outcome data	Low risk	Low attrition; primary outcome data were available for 87% of intervention group and 90% of control group. Reasons given.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No obvious sources of other bias identified

Study limitation	Judgement	Support for judgement
Kiani-Asiabar et al 2018[498]		
Random sequence generation	High risk	Randomisations were performed using the method of the roll of a die. Those participants with numbers 1 and 2 framed group A; 3 and 4, group B and 5 and 6, group C
Allocation concealment	Unclear risk	Not described
Performance bias	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Unclear risk	Low attrition; primary outcome data were available for 82% of intervention group A, 84% of intervention Group B and 80% of control group. Reasons given. There is a discrepancy between the flow diagram, text and reporting of outcomes in Group A, with one women apparently lost to follow-up without explanation.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	Data analysis showed no differences between the intervention groups (A and B) and the control group
Koivusalo et al 2016[519]		
Random sequence generation	Unclear risk	"In the randomisation process, we used randomly permuted blocks stratified by risk factors (BMI ≥30 kg/m^2, history of GDM)." Not stated how randomly permuted blocks were generated."
Allocation concealment	Low risk	"The randomisation was performed by a study nurse and by dispensing the next sequentially numbered subject code and opening the corresponding code envelope, which included the intervention arm to be assigned to the subject."
Performance bias	High risk	Blinding of women and trial personnel not considered feasible in view of the intervention and control.
Detection bias	Low risk	"Blinded-study physicians reviewed participants' obstetric records and confirmed maternal and neonatal diagnosis."
Incomplete outcome data	Low risk	Low attrition; 93% of intervention group and 91% of control group included in analysis. Reasons given.
Selective reporting	Unclear risk	The trial has reported on perinatal outcomes; the trial protocol indicates that 12-month follow-up is also complete (this was not reported on), and that there will be ongoing follow-up to 10 years for mothers, fathers and children. The protocol indicates additional outcomes which have not yet been reported (including maternal quality of life, cost-effectiveness, prevention of maternal type 2 diabetes 1 year after birth, small-for-gestational age and neonatal hypoglycaemia).
Other limitations	Low risk	No obvious sources of other bias identified

Study limitation	Judgement	Support for judgement
Korpi-Hyovalti et al 2011[516,546]		
Random sequence generation	Low risk	"These high-risk women were randomly assigned to the lifestyle intervention group... or to the close follow- up group... by the study physician in the Central Hospital with the use of a computed randomisation list."
Allocation concealment	Unclear risk	"The health care nurses who scheduled the study visits did not have access to the randomisation list."
Performance bias	High risk	No blinding, trial described as "open".
Detection bias	Unclear risk	Trial described as "open". No further information provided.
Incomplete outcome data	Unclear risk	60 women were randomised; 54 women (90%) were analysed. 3 women dropped out from each group (4 due to early miscarriage, 1 with a twin pregnancy, and 1 woman moved away). No detail of whether the characteristics of the women lost to follow-up differed from those analysed
Selective reporting	High risk	For the baseline characteristics, and a number of other outcomes, data were reported by groups, with the P values reported as "NS" (indicating non-significance). For a number of outcomes, the data were not presented ("There was no statistically significant difference between the randomised groups in terms of pre-eclampsia, induction of labour, lacerations, Caesarean deliveries (data not shown)")
Other limitations	Unclear risk	Pre-pregnancy weight in the intervention group tended to be higher (P=0.061) with "all women weighing over 100 kg" being in the intervention group. Women in the control group tended to have a higher educational status (P=0.080).
Kunath et al 2019[497]		
Random sequence generation	Low risk	Cluster randomised — Within these five regions, paired cluster randomisation was conducted by matching two areas per region according to birth figures and socioeconomic status. In each of the five pairs, both urban and rural districts were included. One area of each pair was randomly assigned to the intervention and the other to the control group.
Allocation concealment	Unclear risk	Not described.
Performance bias	Unclear risk	Not described.
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Low risk	Reasons for missing outcome data were miscarriage (n=73), termination (n=9) or severe pregnancy complications (n=4). A further 158 (7.0%) women dropped out from both groups due to (multiple answers were possible) change of practice or residence (n=65), decline of further study visits (n=59) or no longer reachable (n=31).
Selective reporting	Unclear risk	Some secondary outcomes described in the study design have not yet been reported.
Other limitations	Unclear risk	The proportion of nulliparous women was higher in the intervention (62%) than in the control group (53%).

Study limitation	Judgement	Support for judgement
Luoto et al 2011[522,548-550]		
Random sequence generation	Low risk	"In the randomisation process, participating municipalities were first pairwise matched with regard to annual number of births, size and socioeconomic level of the population, estimated incidence of GDM, and urbanity level. Municipalities were then randomised by computer."
Allocation concealment	Unclear risk	Not described.
Performance bias	High risk	"An inevitable limitation is also that the women and the nurses in the usual care group could not be blinded for the purpose of the study, which may have resulted in changes in their health behaviour or counselling practices."
Detection bias	Unclear risk	Not described.
Incomplete outcome data	High risk	14 clusters were randomised and all included in the analyses. Of the women who received the allocated intervention, 89% were followed up in the intervention group and 92% in the control group. For some outcomes "n Missing" is reported in the tables - it is unclear however from which groups the data are missing (for example, GWG "n Missing"=31, and it is unclear if these women are from the intervention or control groups)
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Unclear risk	There were more women in the intervention group with high education than in the usual care group. The trial's statistical methods appear to take clustering into account, and a number of individual level characteristics such as education (unadjusted and adjusted analyses were performed)
Pawalia et al 2017[493]		
Random sequence generation	Unclear risk	Not described
Allocation concealment	Unclear risk	Not described
Performance bias	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	High risk	"Some subjects were lost to follow up; they are not included in this paper." "Some women wanted to learn exercises during pregnancy after they were allocated to control group. Such subjects were taught exercises for home, as not doing so would have been ethically wrong but they were excluded from the study in final analysis to prevent contamination."
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	High risk	Women in the control group had a higher mean BMI at baseline.

Study limitation	Judgement	Support for judgement
Petrella et al 2013[504]		
Random sequence generation	Low risk	"Randomisation list was obtained by using a computer-generated random allocation in blocks of three."
Allocation concealment	Low risk	"The numbers were sealed in numbered white envelopes. After eligibility assessment, the midwife open the next envelope."
Performance bias	High risk	Blinding of women and trial personnel not considered feasible in view of the intervention and control
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	"Two women randomised to Controls later withdrew their consent for the study. Therefore, the remnant participants were 33 in the Therapeutic Lifestyle Changes group and 28 in the Controls."
Selective reporting	High risk	A number of outcomes are reported incompletely as "similar" between groups, or "no statistically significant differences".
Other limitations	Low risk	No obvious sources of other bias identified.
Phelan et al 2011[494,551]		
Random sequence generation	Low risk	"Randomisation was computer-generated in randomly varying block sizes and stratified by clinic and BMI category."
Allocation concealment	Low risk	"Allocation was concealed in opaque envelopes prepared by the study statistician."
Performance bias	High risk	"Clinic staff and physicians were blinded to subject randomisation to prevent contamination." However, blinding of women and trial personnel not considered feasible in view of the intervention and control
Detection bias	Low risk	"The clinic staff and physicians at these offices were blind to subject randomisation to prevent contamination of the data."
Incomplete outcome data	Low risk	Balanced attrition with reasons given. ITT analysis was performed assuming that those lost to follow-up were treatment failures. It was reported that this revealed almost identical results as for those completing the study (data not shown).
Selective reporting	Unclear risk	Assessment from published study report.
Other limitations	Low risk	The two study groups did not significantly differ on key baseline measures (sample stratified).

Study limitation	Judgement	Support for judgement
Phelan et al 2018[508]		
Random sequence generation	Low risk	"Randomisation was computer-generated by the study statistician, and women were randomly assigned within site and by ethnicity (Hispanic or non-Hispanic)."
Allocation concealment	Unclear risk	Not described
Performance bias	High risk	"Participants were not blinded to treatment assignment, which could have biased responses to meal replacement intake and other self-reported measures."
Detection bias	Unclear risk	Study is described as blinded but process not described.
Incomplete outcome data	Low risk	After randomisation, 4 usual-care and 3 intervention participants withdrew participation and 1 participant was lost to follow-up, leaving an analytic sample of 256.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	The two study groups did not significantly differ on key baseline measures.
Polley et al 2002[495]		
Random sequence generation	Unclear risk	"Women were randomly assigned to the standard care control group or to the intervention."
Allocation concealment	Unclear risk	Not described.
Performance bias	High risk	Blinding of women and trial personnel not considered feasible in view of the intervention and control
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Low risk	Minimal losses to follow-up during the pregnancy period: of 61 women randomised to the intervention group, 2 women moved out of the area, 1 had a miscarriage, and 1 withdrew; thus 57 (93%) were followed to delivery; in the control group, of 59 women randomised, 4 women moved out of the area and 2 had miscarriages; thus 53 (90%) were followed to delivery. Follow-up: an additional 23 intervention group women were lost to postpartum follow-up, thus 34 (56%) were followed postpartum; an additional 13 control group women were lost postpartum, thus 40 (68%) were followed postpartum
Selective reporting	Unclear risk	While outcomes were described in the methods, with no access to a trial protocol, it is not possible to confidently assess selective reporting.
Other limitations	Low risk	No obvious sources of other bias identified (16/90 refused), and higher in overweight black women than in any of the other 3 weight-by-race categories

Study limitation	Judgement	Support for judgement
Poston et al 2013[512]		
Random sequence generation	Low risk	"The randomised treatment was allocated automatically, balanced by minimisation for maternal age, centre, ethnicity, parity and BMI."
Allocation concealment	Low risk	"Randomisation was performed online."
Performance bias	High risk	Blinding of women and trial personnel not considered feasible in view of the intervention and control
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Low risk	Study retention was 99.6% (256 of 257).
Selective reporting	Unclear risk	With no access to a trial protocol, it was not possible to confidently assess selective reporting. The methods specify a number of clinical outcomes for which data were "recorded but not reported".
Other limitations	Low risk	No obvious sources of other bias identified.
Poston et al 2015[513,552]		
Random sequence generation	Low risk	"We used a computer-generated randomisation procedure via a password-protected website."
Allocation concealment	Low risk	"Allocation to study groups was done by centre's UPBEAT trial midwife."
Performance bias	High risk	"In view of the nature of the intervention, participants and staff were aware of allocations."
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Unclear risk	Primary outcome data were available for 80% of women and 97% of infants in the intervention group and 84% of mothers and 97% of infants in the control group. Authors reported that "the main reason for missing outcome data was that participants declined to attend further study visits." More women in the intervention group (16%) compared with the control group (12%) failed to complete the OGTT required for the primary outcome.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No obvious sources of other bias identified.

Study limitation	Judgement	Support for judgement
Rauh et al 2013[496,554]		
Random sequence generation	Low risk	Women "were randomly assigned to either an 'intervention' or 'control group' using a computer-generated randomisation allocation table."
Allocation concealment	Low risk	"Randomisation was performed by a researcher not involved in the study design thereby preventing allocation bias."
Performance bias	High risk	The trial was open-label. "The nature of the study meant that participants and study staff were not blinded to the types of interventions."
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Low risk	Balanced attrition; 91% of intervention group and 89% of control group included in analysis with reasons given. Follow-up: 91% of women in the intervention group and 87% of women in the control group could be contacted at the 4-month follow-up and 89% of women in the intervention group and 78% of women in the control group were included in the 1-year follow-up.
Selective reporting	Unclear risk	With no access to a trial protocol, it was not possible to confidently assess selective reporting.
Other limitations	High risk	"During recruitment, however it turned out that it was easier to recruit women for the intervention group than for the control group, yielding a 2:1 ratio". The authors speculated that this may have been due to unmotivated gynaecologists/practice staff recruiting women, or low numbers of pregnant women among the control practices; they acknowledge that as practice staff and women were not blinded, knowledge of the 'control group' status of these practices may have influence recruitment and participation rates, raising the possibility of post-randomisation selection. Pre-pregnancy weight and BMI were "although slightly" significantly higher in the control group, compared to the intervention group (with more overweight and obese women in the control group); median weight at the first antenatal visit was also higher among women in the control group. The sample size calculations did not take into account clustering.
Renault et al 2014[451]		
Random sequence generation	Unclear risk	"The randomisation was stratified according to parity to ensure equal distribution of primiparous in the 3 groups."
Allocation concealment	Low risk	"Web allocation by an independent organisation properly concealed the procedure."
Performance bias	High risk	Blinding not possible due to the nature of the study.
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Low risk	Low attrition rates for most outcomes.
Selective reporting	Unclear risk	Could not determine.
Other limitations	Low risk	Baseline characteristics were comparable. Good compliance.

Study limitation	Judgement	Support for judgement
Ronnberg et al 2015[486,555,556]		
Random sequence generation	Unclear risk	Consecutive randomisation after written informed consent was applied.
Allocation concealment	Unclear risk	The person responsible for producing the random sequence of group allocation had no other involvement in the study.
Performance bias	High risk	The study participants were not blinded to treatment. However, achieving blinding of treatment allocation for educational and exercise interventions is not feasible.
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	There was a low loss to follow up (8%) in the group receiving intervention versus an intermediate loss (11%) in the group receiving standard care. The participants who were lost to follow up did not differ in age, parity or BMI category between groups. All data analysis was carried out according to intention to treat and according to the pre-established analysis plan
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Unclear risk	The consecutive randomisation used led to the same midwife receiving patients from both study groups in her practice. The caregiver's awareness of IOM recommendations could have affected performance of standard maternity care.
Ruchat et al 2012[482]		
Random sequence generation	Unclear risk	"Each woman was randomised using a randomised/block procedure with four subjects per block into either the LI (30% HRR) or MI (70% HRR) group."
Allocation concealment	Unclear risk	Not described
Performance bias	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Low risk	Forty-nine of the 73 participants completed the intervention. Before randomization, seven women decided to withdraw after the peak exercise test, eight women (MI group, n=4; LI group, n=4) dropped out because of reasons unrelated to exercise, nine women (MI group, n=3; LI group, n=6) dropped out because of time commitment concerns, leaving 26 women in the MI group and 23 women in the LI group.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Unclear risk	Historical control

Study limitation	Judgement	Support for judgement
Sagedal et al 2017[300,487,557]		
Random sequence generation	Low risk	Women were randomised "using a computer-generated list with 1:1 allocation ratio in blocks of 20".
Allocation concealment	Low risk	"A research nurse assigned participants...The research nurse never met the participants, had no role in recruitment or measurements, and had no knowledge of questionnaire responses".
Performance bias	High risk	"It was not feasible to blind participants to their group allocation, but they were instructed to refrain from revealing this to assessors".
Detection bias	Low risk	"All examinations, blood test evaluations, record reviews, and scoring of questionnaire responses were performed by assessors blinded to group allocation".
Incomplete outcome data	Low risk	Balanced attrition; 98% of intervention group and 97% of control group were included in the main analyses (14 and 15 women respectively withdrew from participation but consented to data collection) and 66% of the intervention group and 62% of the control group were included in the 12-month analyses.
Selective reporting	Low risk	Outcomes reported as per the published trial protocol, except for the pre-specified outcomes 'maternal glucose levels, and 'hormones related to glucose metabolism'.
Other limitations	Low risk	No obvious sources of other bias identified.
Simmons et al 2017[402]		
Random sequence generation	Low risk	"Randomisation … was performed using a computerised electronic random number generator, prestratified for site."
Allocation concealment	Low risk	The trial coordinator (D.S.) prepared and distributed sealed opaque envelopes, containing group allocations to each site. The allocation outcome was communicated to the participants by the coach.
Performance bias	High risk	The staff involved with measurements, but not the participants, were kept unaware of the intervention.
Detection bias	Low risk	Statistical analyses were performed blinded for allocation.
Incomplete outcome data	Low risk	Data were analysed according to intention to treat and according to an a priori statistical analysis plan. Differences between women withdrawing from the study and those who stayed in the study were assessed.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Low risk	No significant differences between baseline characteristics of groups

Study limitation	Judgement	Support for judgement
Trak-Fellermeier et al 2019[509]		
Random sequence generation	Low risk	"An independent RCU statistician generated an urn randomisation scheme."
Allocation concealment	Unclear risk	Not described
Performance bias	Unclear risk	Not described
Detection bias	Low risk	"Study staff other than a designated statistician and intervention staff remained blinded until the trial concluded."
Incomplete outcome data	High risk	Primary outcome imputed for 7/15 women in the intervention group and 4/16 in the control group.
Selective reporting	Low risk	All pre-specified outcomes reported.
Other limitations	High risk	A higher proportion of women in the control group were African American (46.7 vs 6.3%) and a higher proportion of women in the intervention group were obese (87.5 vs 53.3%).
Van Horn et al 2018[505]		
Random sequence generation	Low risk	"Eligible pregnant women were randomized at a 1:1 allocation in random blocks of four and six"
Allocation concealment	Unclear risk	Not described
Performance bias	Unclear risk	Not described
Detection bias	Low risk	"Blinded study personnel collected all data."
Incomplete outcome data	Low risk	After randomisation, five participants experienced pregnancy losses; hence for secondary outcomes, the sample sizes vary.
Selective reporting	Low risk	All expected outcomes reported.
Other limitations	Low risk	None noted. Baseline characteristics comparable.

Study limitation	Judgement	Support for judgement
Vesco et al 2012[514,558,559]		
Random sequence generation	Low risk	”Randomisation ...using a computerised algorithm to generate the random assignments in blocks of four.“
Allocation concealment	Unclear risk	Not described
Performance bias	Unclear risk	Not described
Detection bias	Unclear risk	Not described
Incomplete outcome data	Unclear risk	Good follow-up achieved.
Selective reporting	Low risk	Prespecified outcomes were reported. ITT analysis.
Other limitations	Unclear risk	Follow-up weight gain data were collected at 34 weeks (i.e. earlier than most other included studies)
Vinter et al 2011[515,560,561]		
Random sequence generation	Low risk	“Participants were randomized 1:1 by computer-generated numbers.”
Allocation concealment	Low risk	Women received allocation “in closed, opaque envelopes”.
Performance bias	High risk	Trial described as “non-blinded”; “blinding was not possible for pragmatic reasons”; “there was no blinding to patients or healthcare professionals”.
Detection bias	Unclear risk	See above For 2.8-year follow-up: “All children were measured by a medical doctor (M.T.) and a research bioanalyst, both blinded to the LiP intervention”.
Incomplete outcome data	Unclear risk	Balanced attrition; 83% of women in the intervention group and 86% of women in the control group were included in analyses, with reasons given. Follow-up at 6-month postpartum follow-up included 68% of women in the intervention group and 64% of women in the control group. The 66 women who did not attend, and were excluded had ”higher mean pre gestational BMI, higher GWG and more obstetric or neonatal complications, but the differences were not significant compared with those who did attend“. For 2.8-year follow-up included 55% of infants in the intervention group and 49% of infants in the control group.
Selective reporting	Unclear risk	With no access to a trial protocol, it was not possible to confidently assess selective reporting. A protocol for the infant follow-up was supplied as supporting information. The trial registration lists “Metabolic Markers” as secondary outcome measures, however data were not reported for these outcomes. Some data are reported incompletely, e.g. breastfeeding at 5 months, ”no differences between the intervention groups“, and weight development from 0-5 months and 0-12 months “no difference... between the intervention groups...(data not known)”.
Other limitations	Low risk	The groups did not differ significantly on any maternal baseline characteristics, although there were more smokers in the control group despite stratified randomisation (11.7% versus 7.3%). The dropout group was older and had a higher percentage with a BMI ≥ 40 kg/m^2, and a higher percentage of smokers, compared with the completing group (though not statistically significant). For the follow-up trial: “At baseline, there were no differences between those who attended and who were lost to follow-up except for 20-h OGTT plasma glucose values performed at 28 weeks gestation“.

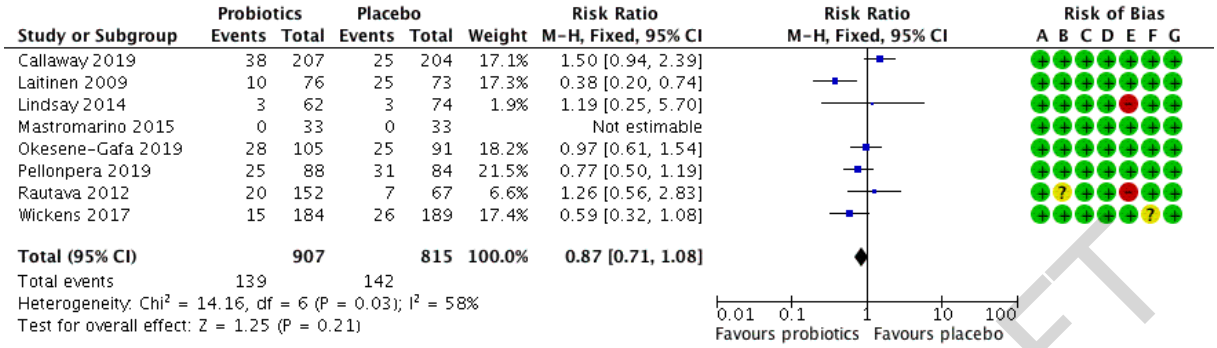
Study limitation	Judgement	Support for judgement
Wang et al 2015[517]		
Random sequence generation	Unclear risk	Authors reported that the trial was cluster randomised. However, it is not clear how clustering was used. The sequence generation is simply described as: "exponential random numbers produced the intervention group and the control group".
Allocation concealment	Unclear risk	Not described.
Performance bias	High risk	Blinding of women and trial personnel not considered feasible in view of the intervention and control.
Detection bias	Unclear risk	Not described.
Incomplete outcome data	Low risk	Balanced attrition; 91% of intervention group and 92% of control group were followed up and included in the analyses, with reasons for attrition given.
Selective reporting	Unclear risk	With no access to a trial protocol, it was not possible to confidently assess selective reporting.
Other limitations	Unclear risk	Limited methodological detail provided; insufficient information to determine risk of other bias.
Willcox et al 2017[500]		
Random sequence generation	Low risk	"Randomisation utilised computer-generated random numbers."
Allocation concealment	Low risk	"Numbered cards allocating women to either the intervention or control groups were placed in opaque, sequentially numbered envelopes."
Performance bias	High risk	Given the nature of the intervention, participants could not be blinded to group assignment.
Detection bias	Low risk	"The participant group allocation was re-coded by an independent researcher to ensure that the data analyst was blinded to allocation."
Incomplete outcome data	High risk	Four women from each arm withdrew early in the intervention due to miscarriage or pregnancy complications, and one woman withdrew from the intervention arm citing dislike of the intervention.
Selective reporting	Low risk	Pre-specified outcomes reported.
Other limitations	Unclear risk	A higher proportion of the intervention group had lower household incomes than in the control group.

C Analyses

Comparison 1: Probiotics versus placebo

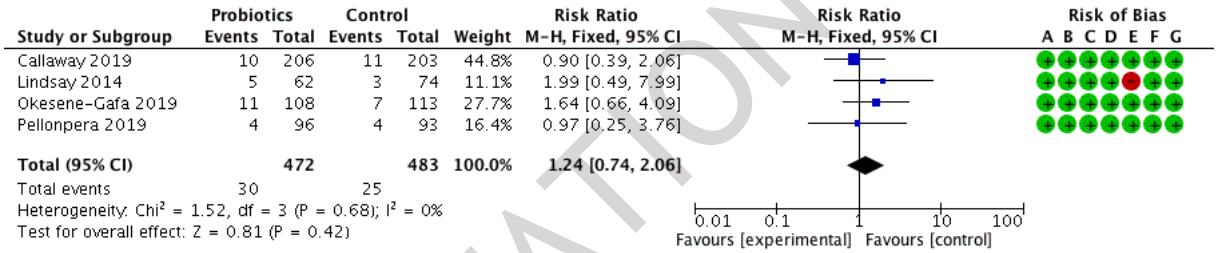
Maternal outcomes

1.1 Gestational diabetes



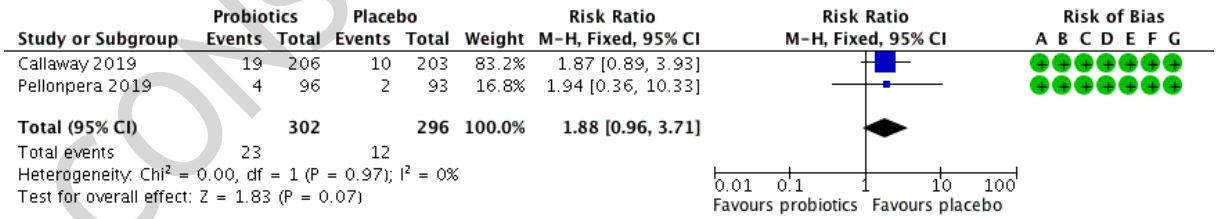
Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

1.2 Gestational hypertension



Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

1.3 Pre-eclampsia

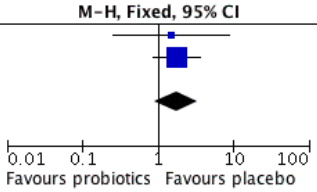


Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

1.4 Bacterial vaginosis

Study or Subgroup	Probiotics Events	Total	Placebo Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Gille 2016	3	135	2	136	16.2%	1.51 [0.26, 8.90]
Husain 2019	19	123	10	115	83.8%	1.78 [0.86, 3.66]
Total (95% CI)		**258**		**251**	**100.0%**	**1.73 [0.89, 3.38]**
Total events	22		12			

Heterogeneity: Chi² = 0.03, df = 1 (P = 0.87); I² = 0%
Test for overall effect: Z = 1.61 (P = 0.11)

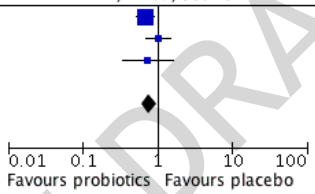


Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

1.5 Group B streptococcus

Study or Subgroup	Probiotics Events	Total	Placebo Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Ho et al 2016 (1)	28	49	41	50	62.9%	0.70 [0.53, 0.92]
Olsen 2008	15	19	10	13	18.4%	1.03 [0.70, 1.50]
Sharpe et al 2019 (2)	9	57	12	56	18.7%	0.74 [0.34, 1.61]
Total (95% CI)		**125**		**119**	**100.0%**	**0.76 [0.61, 0.97]**
Total events	52		63			

Heterogeneity: Chi² = 2.78, df = 2 (P = 0.25); I² = 28%
Test for overall effect: Z = 2.25 (P = 0.02)



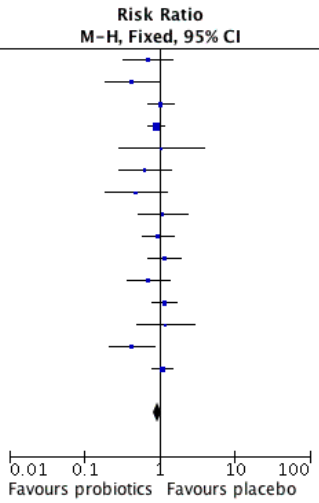
Footnotes
(1) GBS positive at birth among women colonised at 35-37 weeks
(2) Colonisation at 35-37 weeks

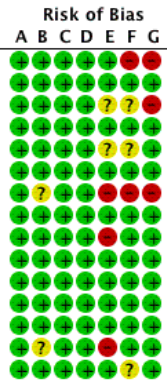
Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

1.6 Caesarean section

Study or Subgroup	Probiotics Events	Total	Placebo Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Abrahamsson 2007	10	95	14	93	4.1%	0.70 [0.33, 1.49]
Badehnoosh 2018	6	30	14	30	4.0%	0.43 [0.19, 0.96]
Boyle 2005	34	125	33	125	9.4%	1.03 [0.68, 1.55]
Callaway 2019	73	206	80	204	23.0%	0.90 [0.70, 1.16]
Kalliomaki	4	30	4	32	1.1%	1.07 [0.29, 3.89]
Karamali 2016	7	30	11	30	3.1%	0.64 [0.29, 1.42]
Kim 2010	5	33	11	35	3.1%	0.48 [0.19, 1.24]
Laitinen 2009	12	75	11	76	3.1%	1.11 [0.52, 2.35]
Lindsay 2014	20	62	25	74	6.5%	0.95 [0.59, 1.55]
Lindsay 2015	24	73	21	74	6.0%	1.16 [0.71, 1.89]
Mastromarino 2015	10	33	14	33	4.0%	0.71 [0.37, 1.37]
Okesene-Gafa 2019	40	112	35	114	9.9%	1.16 [0.80, 1.69]
Pellonpera 2019	10	96	8	92	2.3%	1.20 [0.49, 2.90]
Rautava 2012	13	158	14	73	5.5%	0.43 [0.21, 0.87]
Wickens 2017	57	206	51	201	14.8%	1.09 [0.79, 1.51]
Total (95% CI)		**1364**		**1286**	**100.0%**	**0.92 [0.81, 1.05]**
Total events	325		346			

Heterogeneity: Chi² = 16.04, df = 14 (P = 0.31); I² = 13%
Test for overall effect: Z = 1.28 (P = 0.20)





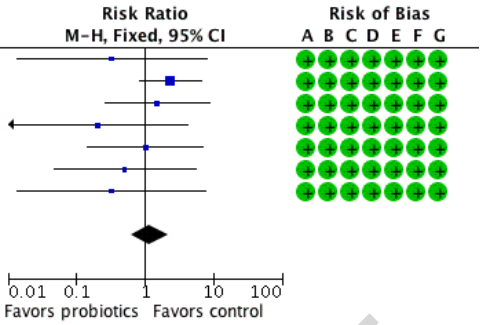
Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

Infant outcomes

1.7 Perinatal death

Study or Subgroup	Probiotics Events	Total	Control Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Callaway 2019 (1)	0	207	1	204	9.1%	0.33 [0.01, 8.02]
Gille 2016 (2)	12	154	5	151	30.5%	2.35 [0.85, 6.52]
Laitinen 2009 (3)	3	85	2	86	12.0%	1.52 [0.26, 8.86]
Lindsay 2015 (4)	0	74	2	75	15.0%	0.20 [0.01, 4.15]
Okesene-Gafa 2019 (5)	2	112	2	114	12.0%	1.02 [0.15, 7.10]
Pellonpera 2019 (6)	1	109	2	110	12.0%	0.50 [0.05, 5.48]
Pellonpera 2019 (7)	0	96	1	93	9.2%	0.32 [0.01, 7.83]
Total (95% CI)		**837**		**833**	**100.0%**	**1.17 [0.62, 2.24]**
Total events	18		15			

Heterogeneity: Chi² = 4.91, df = 6 (P = 0.56); I² = 0%
Test for overall effect: Z = 0.49 (P = 0.63)



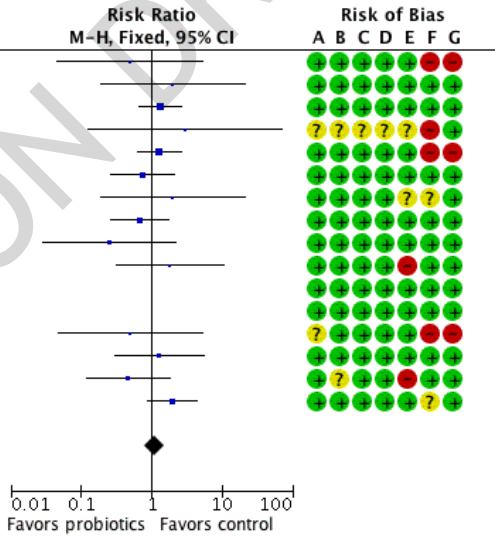
Footnotes
(1) Stillbirth
(2) Miscarriage at <22 weeks
(3) Miscarriage
(4) Neonatal mortality
(5) Stillbirth
(6) Miscarriage <22 weeks
(7) Stillbirth

Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

1.8 Preterm birth <37 weeks

Study or Subgroup	Probiotics Events	Total	Control Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Abrahamsson 2007	1	114	2	113	2.8%	0.50 [0.05, 5.39]
Badehnoosh 2018	2	30	1	30	1.4%	2.00 [0.19, 20.90]
Callaway 2019	17	193	12	180	17.3%	1.32 [0.65, 2.69]
Dolatkhah 2015	1	32	0	32	0.7%	3.00 [0.13, 71.00]
Dotterud 2010	16	211	12	204	17.0%	1.29 [0.63, 2.66]
Gille 2016	6	154	8	151	11.3%	0.74 [0.26, 2.07]
Jafarnejad 2016	2	41	1	41	1.4%	2.00 [0.19, 21.21]
Krauss-Silva 2011	7	323	10	317	14.1%	0.69 [0.26, 1.78]
Laitinen 2009	1	85	4	86	5.5%	0.25 [0.03, 2.22]
Lindsay 2014	3	63	2	75	2.5%	1.79 [0.31, 10.35]
Lindsay 2015	0	74	0	75		Not estimable
Mastromarino 2015	0	33	0	33		Not estimable
Niers 2009	1	78	2	78	2.8%	0.50 [0.05, 5.40]
Pellonpera 2019	4	96	3	92	4.3%	1.28 [0.29, 5.55]
Rautava 2012	4	158	4	73	7.6%	0.46 [0.12, 1.80]
Wickens 2017	16	205	8	201	11.3%	1.96 [0.86, 4.48]
Total (95% CI)		**1890**		**1781**	**100.0%**	**1.10 [0.81, 1.50]**
Total events	81		69			

Heterogeneity: Chi² = 9.23, df = 13 (P = 0.76); I² = 0%
Test for overall effect: Z = 0.62 (P = 0.54)

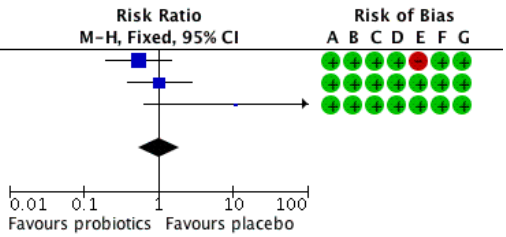


Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

1.9 Small for gestational age

Study or Subgroup	Probiotics Events	Total	Placebo Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Lindsay 2014	5	63	11	75	57.7%	0.54 [0.20, 1.47]
Lindsay 2015	7	56	7	58	39.5%	1.04 [0.39, 2.76]
Mastromarino 2015	5	33	0	33	2.9%	11.00 [0.63, 191.27]
Total (95% CI)		**152**		**166**	**100.0%**	**1.04 [0.55, 1.94]**
Total events	17		18			

Heterogeneity: Chi² = 4.24, df = 2 (P = 0.12); I² = 53%
Test for overall effect: Z = 0.11 (P = 0.91)

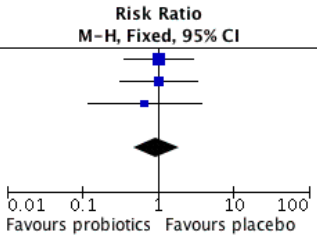


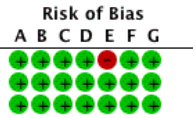
Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

1.10 Large for gestational age

Study or Subgroup	Probiotics Events	Total	Placebo Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Lindsay 2014	6	62	7	74	44.6%	1.02 [0.36, 2.89]
Lindsay 2015	5	56	5	58	34.4%	1.04 [0.32, 3.38]
Mastromarino 2015	2	33	3	33	21.0%	0.67 [0.12, 3.73]
Total (95% CI)		**151**		**165**	**100.0%**	**0.95 [0.47, 1.93]**
Total events	13		15			

Heterogeneity: Chi² = 0.20, df = 2 (P = 0.90); I² = 0%
Test for overall effect: Z = 0.13 (P = 0.89)



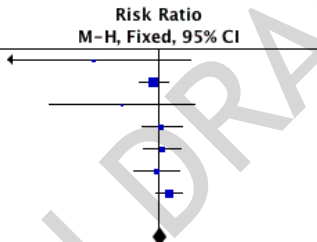


Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

1.11 Macrosomia >4,000 g

Study or Subgroup	Probiotics Events	Total	Placebo Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Badehnoosh 2018	0	30	3	30	2.9%	0.14 [0.01, 2.65]
Callaway 2019	31	206	35	203	29.7%	0.87 [0.56, 1.36]
Karamali 2016	1	30	3	30	2.5%	0.33 [0.04, 3.03]
Lindsay 2014	15	62	16	74	12.3%	1.12 [0.60, 2.08]
Lindsay 2015	19	73	17	74	14.2%	1.13 [0.64, 2.00]
Pellonpera 2019	13	96	13	92	11.2%	0.96 [0.47, 1.96]
Wickens 2017	46	205	32	202	27.1%	1.42 [0.94, 2.13]
Total (95% CI)		**702**		**705**	**100.0%**	**1.06 [0.85, 1.33]**
Total events	125		119			

Heterogeneity: Chi² = 5.70, df = 6 (P = 0.46); I² = 0%
Test for overall effect: Z = 0.52 (P = 0.60)



Risk of bias legend
(A) Random sequence generation
(B) Allocation concealment
(C) Blinding of participants and personnel
(D) Blinding of outcome assessment
(E) Incomplete outcome data
(F) Selective reporting
(G) Other bias

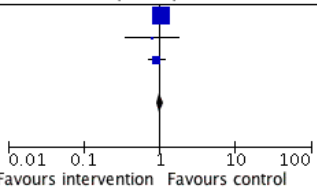
Comparison 2: Regular weighing and advice on weight gain versus usual care

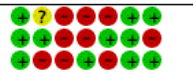
Maternal outcomes

2.1 Weight gain exceeding IOM guidelines

Study or Subgroup	Intervention Events	Total	Control Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Brownfoot 2016	267	355	204	288	69.4%	1.06 [0.97, 1.17]
Daley 2015	8	34	10	34	3.1%	0.80 [0.36, 1.78]
Daley 2019	81	305	90	311	27.5%	0.92 [0.71, 1.18]
Total (95% CI)		**694**		**633**	**100.0%**	**1.01 [0.92, 1.12]**
Total events	356		304			

Heterogeneity: Chi² = 1.82, df = 2 (P = 0.40); I² = 0%
Test for overall effect: Z = 0.28 (P = 0.78)



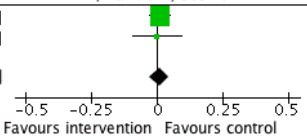


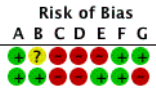
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

2.2 Mean weight gain (kg per week)

Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Brownfoot 2016	0.54	0.28	355	0.53	0.24	288	84.8%	0.01 [-0.03, 0.05]
Daley 2015	0.4	0.2	34	0.4	0.2	34	15.2%	0.00 [-0.10, 0.10]
Total (95% CI)			**389**			**322**	**100.0%**	**0.01 [-0.03, 0.05]**

Heterogeneity: Tau² = 0.00; Chi² = 0.04, df = 1 (P = 0.85); I² = 0%
Test for overall effect: Z = 0.45 (P = 0.65)



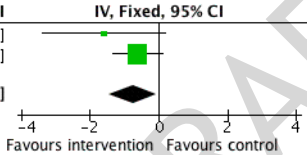


Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

2.3 Depression

Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
Daley 2015	3.8	2.7	20	5.4	3.4	24	14.0%	-1.60 [-3.40, 0.20]
Daley 2019	3.93	3.04	136	4.56	3.04	133	86.0%	-0.63 [-1.36, 0.10]
Total (95% CI)			**156**			**157**	**100.0%**	**-0.77 [-1.44, -0.09]**

Heterogeneity: Chi² = 0.96, df = 1 (P = 0.33); I² = 0%
Test for overall effect: Z = 2.23 (P = 0.03)

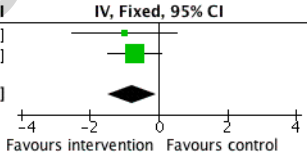


Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

2.4 Anxiety

Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
Daley 2015	4.7	2.7	31	5.7	3	24	21.4%	-1.00 [-2.53, 0.53]
Daley 2019	5.18	3.09	136	5.89	3.58	133	78.6%	-0.71 [-1.51, 0.09]
Total (95% CI)			**167**			**157**	**100.0%**	**-0.77 [-1.48, -0.06]**

Heterogeneity: Chi² = 0.11, df = 1 (P = 0.74); I² = 0%
Test for overall effect: Z = 2.13 (P = 0.03)



Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

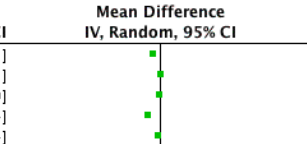
Comparison 3: Diet versus usual care

Maternal outcomes

3.1 Mean gestational weight gain

Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Di Carlo 2014	8.2	4	61	13.4	4.2	59	17.4%	-5.20 [-6.67, -3.73]
Laitinen 2009	14.8	5.1	86	14.8	5.1	85	17.3%	0.00 [-1.53, 1.53]
Simmons 2017 (1)	8	4.7	74	8.8	4.7	26	16.5%	-0.80 [-2.90, 1.30]
Thornton 2009	4.99	6.79	116	14.06	7.4	116	16.9%	-9.07 [-10.90, -7.24]
Walsh 2012	12.2	4.4	372	13.7	4.9	387	18.2%	-1.50 [-2.16, -0.84]
Wolff 2008	6.6	5.5	23	13.3	7.5	27	13.7%	-6.70 [-10.31, -3.09]
Total (95% CI)			**732**			**700**	**100.0%**	**-3.76 [-6.38, -1.13]**

Heterogeneity: Tau² = 9.74; Chi² = 89.34, df = 5 (P < 0.00001); I² = 94%
Test for overall effect: Z = 2.81 (P = 0.005)



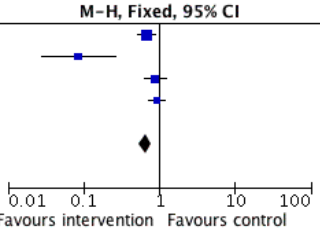
Footnotes
(1) 4-armed study; control group divided by three

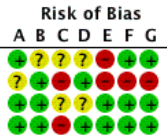
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

3.2 Weight gain exceeding IOM guidelines

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Abdel-Aziz 2018	38	75	54	72	34.8%	0.68 [0.52, 0.88]
Di Carlo 2014	3	61	34	59	21.8%	0.09 [0.03, 0.26]
Laitinen 2009	35	86	39	85	24.8%	0.89 [0.63, 1.25]
Simmons 2017	53	74	20	26	18.7%	0.93 [0.72, 1.20]
Total (95% CI)		**296**		**242**	**100.0%**	**0.65 [0.54, 0.77]**
Total events	129		147			

Heterogeneity: $Chi^2 = 23.65$, df = 3 (P < 0.0001); $I^2 = 87\%$
Test for overall effect: Z = 4.96 (P < 0.00001)



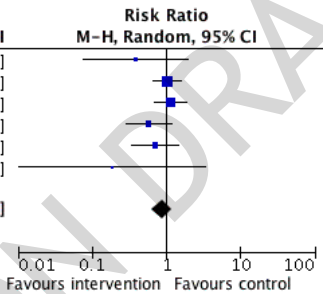


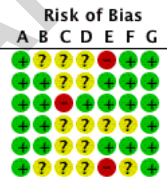
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

3.3 Gestational diabetes

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdel-Aziz 2018	2	75	5	72	3.4%	0.38 [0.08, 1.92]
Laitinen 2009	27	76	25	73	34.9%	1.04 [0.67, 1.61]
Simmons 2017 (1)	40	91	12	31	28.6%	1.14 [0.69, 1.87]
Thornton 2009	11	116	19	116	16.4%	0.58 [0.29, 1.16]
Walsh 2012	12	350	18	371	15.6%	0.71 [0.35, 1.45]
Wolff 2008	0	23	3	30	1.1%	0.18 [0.01, 3.40]
Total (95% CI)		**731**		**693**	**100.0%**	**0.86 [0.64, 1.17]**
Total events	92		82			

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 5.67$, df = 5 (P = 0.34); $I^2 = 12\%$
Test for overall effect: Z = 0.95 (P = 0.34)





Footnotes
(1) 4-armed study; control group divided by three

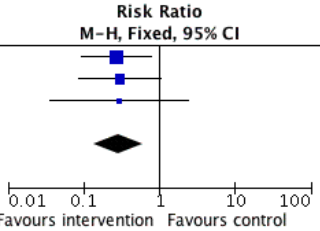
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

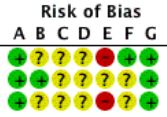
Note: Studies differed in diagnostic criteria for gestational diabetes.

3.4 Gestational hypertension

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Abdel-Aziz 2018	4	75	14	72	51.1%	0.27 [0.09, 0.79]
Thornton 2009	3	116	10	116	35.8%	0.30 [0.08, 1.06]
Wolff 2008	1	23	4	27	13.2%	0.29 [0.04, 2.44]
Total (95% CI)		**214**		**215**	**100.0%**	**0.29 [0.13, 0.61]**
Total events	8		28			

Heterogeneity: $Chi^2 = 0.01$, df = 2 (P = 0.99); $I^2 = 0\%$
Test for overall effect: Z = 3.23 (P = 0.001)



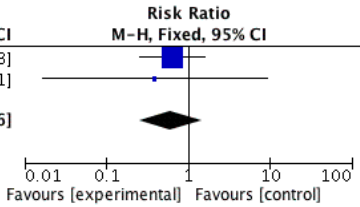


Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

3.5 Pre-eclampsia

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Thornton 2009	7	116	11	116	88.8%	0.64 [0.26, 1.58]
Wolff 2008	0	23	1	27	11.2%	0.39 [0.02, 9.11]
Total (95% CI)		**139**		**143**	**100.0%**	**0.61 [0.25, 1.46]**
Total events	7		12			

Heterogeneity: $Chi^2 = 0.09$, df = 1 (P = 0.77); $I^2 = 0\%$
Test for overall effect: Z = 1.11 (P = 0.27)

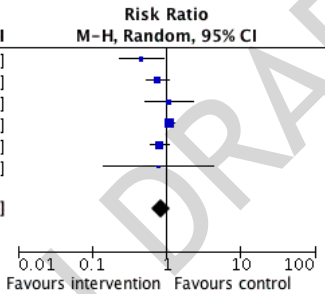


Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

3.6 Caesarean section

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdel-Aziz 2018	10	75	21	72	11.0%	0.46 [0.23, 0.90]
Di Carlo 2014	26	61	33	59	21.1%	0.76 [0.53, 1.10]
Laitinen 2009	12	77	11	76	9.5%	1.08 [0.51, 2.29]
Thornton 2009	91	116	83	116	31.1%	1.10 [0.94, 1.27]
Walsh 2012	66	372	85	387	24.8%	0.81 [0.61, 1.08]
Wolff 2008	2	23	3	27	2.4%	0.78 [0.14, 4.29]
Total (95% CI)		**724**		**737**	**100.0%**	**0.85 [0.64, 1.11]**
Total events	207		236			

Heterogeneity: $Tau^2 = 0.06$; $Chi^2 = 12.92$, df = 5 (P = 0.02); $I^2 = 61\%$
Test for overall effect: Z = 1.19 (P = 0.23)

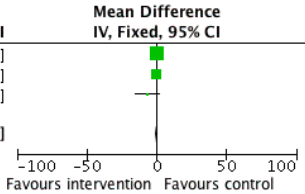


Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

3.7 Postnatal weight retention

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
Walsh 2012 (1)	-0.09	6.18	185	-0.1	5.94	181	58.3%	0.01 [-1.23, 1.25]
Walsh 2012 (2)	-14.25	5.52	88	-13.9	4.23	77	40.4%	-0.35 [-1.84, 1.14]
Wolff 2008 (3)	-4.5	12.6	16	2.4	12.6	19	1.3%	-6.90 [-15.28, 1.48]
Total (95% CI)			**289**			**277**	**100.0%**	**-0.22 [-1.17, 0.72]**

Heterogeneity: $Chi^2 = 2.60$, df = 2 (P = 0.27); $I^2 = 23\%$
Test for overall effect: Z = 0.46 (P = 0.64)



Footnotes
(1) 5 years postpartum
(2) 3 months postpartum
(3) 4 weeks, obese women

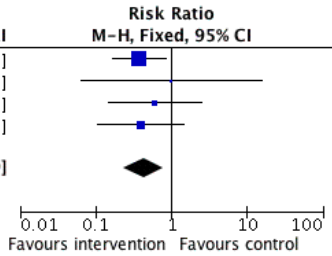
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

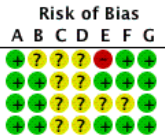
Infant outcomes

3.8 Preterm birth

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Abdel-Aziz 2018	7	75	18	72	57.0%	0.37 [0.17, 0.84]
Laitinen 2009	1	79	1	79	3.1%	1.00 [0.06, 15.71]
Thornton 2009	3	116	5	116	15.5%	0.60 [0.15, 2.45]
Walsh 2012	3	372	8	387	24.3%	0.39 [0.10, 1.46]
Total (95% CI)		**642**		**654**	**100.0%**	**0.43 [0.24, 0.79]**
Total events	14		32			

Heterogeneity: Chi² = 0.71, df = 3 (P = 0.87); I² = 0%
Test for overall effect: Z = 2.74 (P = 0.006)



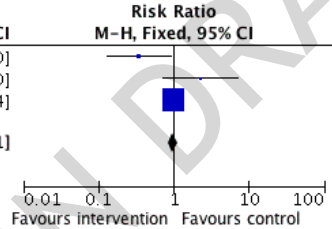


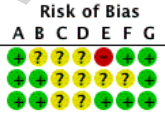
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

3.9 Macrosomia

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Abdel-Aziz 2018 (1)	5	75	14	72	6.7%	0.34 [0.13, 0.90]
Thornton 2009 (2)	9	116	4	116	1.9%	2.25 [0.71, 7.10]
Walsh 2012 (3)	189	372	199	387	91.4%	0.99 [0.86, 1.14]
Total (95% CI)		**563**		**575**	**100.0%**	**0.97 [0.84, 1.11]**
Total events	203		217			

Heterogeneity: Chi² = 6.56, df = 2 (P = 0.04); I² = 70%
Test for overall effect: Z = 0.45 (P = 0.65)





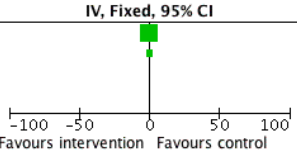
Footnotes
(1) Not defined
(2) >4,500 g
(3) >4,000g

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

3.10 Early childhood weight

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
Laitinen 2009 (1)	8.23	0.986	73	8.26	0.965	70	78.0%	-0.03 [-0.35, 0.29]
Walsh 2012 (2)	6.99	4.36	211	6.76	0.98	211	22.0%	0.23 [-0.37, 0.83]
Total (95% CI)			**284**			**281**	**100.0%**	**0.03 [-0.26, 0.31]**

Heterogeneity: Chi² = 0.56, df = 1 (P = 0.46); I² = 0%
Test for overall effect: Z = 0.19 (P = 0.85)



Footnotes
(1) 6 months
(2) 3 months

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

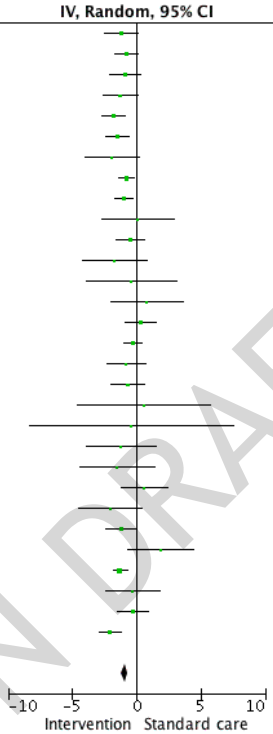
Comparison 4: Exercise versus usual care

Maternal outcomes

4.1 Mean gestational weight gain

Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Bacchi 2018	12.7	2.6	49	13.9	4.3	62	3.2%	-1.20 [-2.49, 0.09]
Baciuk 2008	14.3	2.1	34	15.1	1.6	37	5.9%	-0.80 [-1.67, 0.07]
Barakat 2009	11.5	3.7	72	12.4	3.4	70	3.8%	-0.90 [-2.07, 0.27]
Barakat 2012a	12.5	3.2	40	13.8	3.1	43	3.0%	-1.30 [-2.66, 0.06]
Barakat 2012b	11.9	3.7	138	13.7	4.1	152	5.7%	-1.80 [-2.70, -0.90]
Barakat 2013	11.8	3.6	169	13.3	4.3	157	6.0%	-1.50 [-2.36, -0.64]
Barakat 2014	11.72	4.06	107	13.66	9.62	93	1.4%	-1.94 [-4.04, 0.16]
Barakat 2016	12.1	3.7	382	12.9	4.5	383	9.7%	-0.80 [-1.38, -0.22]
Barakat 2018	12.26	3.6	227	13.27	4.1	202	7.4%	-1.01 [-1.74, -0.28]
Bisson 2015	12.3	4	24	12.2	5.9	24	0.8%	0.10 [-2.75, 2.95]
da Silva 2017	12.4	5.7	176	12.9	6.5	351	4.3%	-0.50 [-1.58, 0.58]
Daly 2017	6.2	6	34	7.9	4.8	42	1.0%	-1.70 [-4.18, 0.78]
Dekker Nitert 2015	7.9	4	19	8.3	6.1	16	0.5%	-0.40 [-3.89, 3.09]
Garnaes 2016	10.5	4.87	38	9.7	7.35	36	0.8%	0.80 [-2.06, 3.66]
Garshasbi 2005	14.1	3.8	107	13.8	5.2	105	3.5%	0.30 [-0.93, 1.53]
Guelfi 2016	6.4	2.1	81	6.7	2.6	76	7.3%	-0.30 [-1.04, 0.44]
Haakstad 2011	13	4	52	13.8	4	53	2.4%	-0.80 [-2.33, 0.73]
Hopkins 2010	8.2	2.7	47	8.9	3.3	37	3.1%	-0.70 [-2.01, 0.61]
Kong 2014 (1)	10.53	5.37	9	9.94	6.14	10	0.2%	0.59 [-4.59, 5.77]
Kong 2014 (2)	12.07	9.01	9	12.48	8.51	10	0.1%	-0.41 [-8.31, 7.49]
Nascimento 2011	10.3	5	39	11.5	7.4	41	0.8%	-1.20 [-3.96, 1.56]
Ong 2009	3.7	3.4	6	5.2	1.3	6	0.7%	-1.50 [-4.41, 1.41]
Oostdam 2012 (3)	6.2	5	43	5.6	3.5	41	1.7%	0.60 [-1.24, 2.44]
Perales 2015b	11.85	4.19	90	13.89	10.23	77	1.0%	-2.04 [-4.48, 0.40]
Perales 2016a	11.6	3.6	83	12.8	4.4	83	3.5%	-1.20 [-2.42, 0.02]
Price 2012	12.4	5.13	31	10.5	5.13	31	0.9%	1.90 [-0.65, 4.45]
Ruiz 2013	11.9	3.8	481	13.2	4.3	381	10.3%	-1.30 [-1.85, -0.75]
Simmons 2017 (4)	8.5	5	76	8.8	4.7	26	1.3%	-0.30 [-2.43, 1.83]
Taniguchi 2016	10.1	3.7	54	10.4	2.6	53	3.6%	-0.30 [-1.51, 0.91]
Wang 2017	8.38	3.65	132	10.47	3.33	133	6.2%	-2.09 [-2.93, -1.25]
Total (95% CI)			**2849**			**2831**	**100.0%**	**-0.95 [-1.20, -0.69]**

Heterogeneity: Tau² = 0.08; Chi² = 35.81, df = 29 (P = 0.18); I² = 19%
Test for overall effect: Z = 7.34 (P < 0.00001)



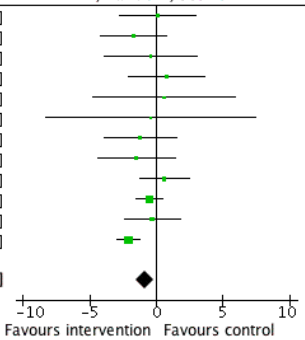
Footnotes
(1) Overweight
(2) Obese
(3) 31% data missing
(4) 4-armed; control group divided by three

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel...
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Mean gestational weight gain among women who were overweight or obese

Study or Subgroup	Intervention Mean	SD	Total	Standard care Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Bisson 2015	12.3	4	24	12.2	5.9	24	4.9%	0.10 [-2.75, 2.95]
Daly 2017	6.2	6	34	7.9	4.8	42	6.3%	-1.70 [-4.18, 0.78]
Dekker Nitert 2015	7.9	4	19	8.3	6.1	16	3.4%	-0.40 [-3.89, 3.09]
Garnaes 2016	10.5	4.87	38	9.7	7.35	36	4.9%	0.80 [-2.06, 3.66]
Kong 2014 (1)	10.53	5.37	9	9.94	6.14	9	1.5%	0.59 [-4.74, 5.92]
Kong 2014 (2)	12.07	9.01	9	12.48	8.51	10	0.7%	-0.41 [-8.31, 7.49]
Nascimento 2011	10.3	5	39	11.5	7.4	41	5.2%	-1.20 [-3.96, 1.56]
Ong 2009	3.7	3.4	6	5.2	1.3	6	4.7%	-1.50 [-4.41, 1.41]
Oostdam 2012	6.2	5	43	5.6	3.5	41	10.3%	0.60 [-1.24, 2.44]
Ruiz 2013	11.1	4.3	146	11.6	4.2	129	22.8%	-0.50 [-1.51, 0.51]
Simmons 2017 (3)	8.5	5	76	8.8	4.7	26	8.2%	-0.30 [-2.43, 1.83]
Wang 2017	8.38	3.65	132	10.47	3.33	133	27.0%	-2.09 [-2.93, -1.25]
Total (95% CI)			**575**			**513**	**100.0%**	**-0.84 [-1.51, -0.17]**

Heterogeneity: Tau² = 0.25; Chi² = 13.71, df = 11 (P = 0.25); I² = 20%
Test for overall effect: Z = 2.47 (P = 0.01)



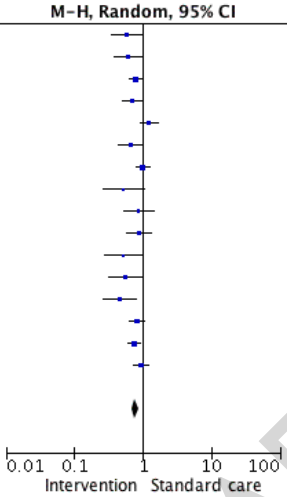
Footnotes
(1) Overweight
(2) Obese
(3) 4-armed; control group divided by three

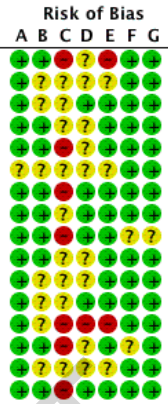
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

4.2 Weight gain exceeding IOM guidelines

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Bacchi 2018	13	49	28	62	3.8%	0.59 [0.34, 1.01]
Barakat 2014	22	107	31	93	4.6%	0.62 [0.39, 0.99]
Barakat 2016	101	382	131	383	10.3%	0.77 [0.62, 0.96]
Barakat 2018	47	227	61	202	7.2%	0.69 [0.49, 0.95]
Bisson 2015	21	24	17	24	8.0%	1.24 [0.92, 1.66]
Cordero 2015	23	101	54	156	5.4%	0.66 [0.43, 1.00]
da Silva 2017	67	176	136	351	9.9%	0.98 [0.78, 1.24]
Daly 2017	8	36	19	44	2.5%	0.51 [0.26, 1.04]
Haakstad 2011	17	52	20	53	4.0%	0.87 [0.51, 1.46]
Nascimento 2011	19	39	23	41	5.4%	0.87 [0.57, 1.32]
Perales 2015b	12	90	20	77	2.8%	0.51 [0.27, 0.98]
Perales 2016a	14	83	25	83	3.4%	0.56 [0.31, 1.00]
Perales 2016b	15	83	23	59	3.6%	0.46 [0.27, 0.81]
Renault 2014 (1)	64	125	42	67	9.2%	0.82 [0.63, 1.05]
Ruiz 2013	115	481	154	481	10.6%	0.75 [0.61, 0.92]
Simmons 2017 (2)	55	76	20	26	9.2%	0.94 [0.73, 1.21]
Total (95% CI)		**2131**		**2202**	**100.0%**	**0.77 [0.69, 0.87]**
Total events	613		804			

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 27.86$, df = 15 (P = 0.02); $I^2 = 46\%$
Test for overall effect: Z = 4.13 (P < 0.0001)





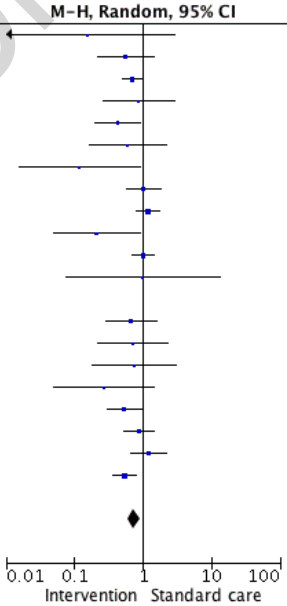
Footnotes
(1) 3-armed; control group halved
(2) 4-armed; control group divided by three

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel...
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

4.3 Gestational diabetes

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Barakat 2012a	0	40	3	43	0.4%	0.15 [0.01, 2.88]
Barakat 2012b	6	138	12	152	3.5%	0.55 [0.21, 1.43]
Barakat 2013	41	210	61	218	11.9%	0.70 [0.49, 0.99]
Barakat 2014	5	107	5	93	2.3%	0.87 [0.26, 2.91]
Barakat 2016	9	382	21	382	4.9%	0.43 [0.20, 0.92]
Bisson 2015	3	24	5	24	2.0%	0.60 [0.16, 2.23]
Cordero 2015	1	101	13	156	0.9%	0.12 [0.02, 0.89]
da Silva 2017	16	205	31	407	7.2%	1.02 [0.57, 1.83]
Daly 2017	25	43	21	43	10.7%	1.19 [0.80, 1.77]
Garnaes 2016	2	38	9	36	1.7%	0.21 [0.05, 0.91]
Guelfi 2016	34	84	34	85	11.4%	1.01 [0.70, 1.46]
Kong 2014 (1)	1	9	1	9	0.6%	1.00 [0.07, 13.64]
Kong 2014 (2)	0	9	0	10		Not estimable
Oostdam 2012	7	48	11	51	4.1%	0.68 [0.29, 1.60]
Perales 2016b	5	83	5	59	2.4%	0.71 [0.22, 2.35]
Price 2012	3	31	4	31	1.8%	0.75 [0.18, 3.08]
Renault 2014 (3)	2	125	4	67	1.3%	0.27 [0.05, 1.43]
Ruiz 2013	16	481	30	481	7.0%	0.53 [0.29, 0.97]
Simmons 2017 (4)	30	89	12	31	8.0%	0.87 [0.51, 1.48]
Stafne 2012	25	375	18	327	7.1%	1.21 [0.67, 2.18]
Wang 2017	29	132	54	133	11.0%	0.54 [0.37, 0.79]
Total (95% CI)		**2754**		**2838**	**100.0%**	**0.74 [0.60, 0.90]**
Total events	260		354			

Heterogeneity: $Tau^2 = 0.05$; $Chi^2 = 28.18$, df = 19 (P = 0.08); $I^2 = 33\%$
Test for overall effect: Z = 3.03 (P = 0.002)



Footnotes
(1) Overweight
(2) Obese
(3) 3-armed; control group halved
(4) 4-armed; control group divided by three

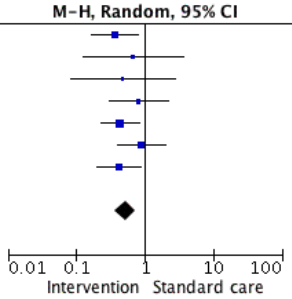
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel...
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Note: Studies differed in diagnostic criteria for gestational diabetes.

4.4 Gestational hypertension

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Barakat 2016	8	382	22	383	17.4%	0.36 [0.16, 0.81]
Bisson 2015	2	24	3	24	3.8%	0.67 [0.12, 3.64]
Perales 2016b	2	83	3	59	3.6%	0.47 [0.08, 2.75]
Renault 2014 (1)	9	125	6	67	11.3%	0.80 [0.30, 2.16]
Ruiz 2013	13	481	30	481	27.0%	0.43 [0.23, 0.82]
Stafne 2012	11	385	11	340	16.3%	0.88 [0.39, 2.01]
Wang 2017	9	112	22	114	20.7%	0.42 [0.20, 0.86]
Total (95% CI)		**1592**		**1468**	**100.0%**	**0.51 [0.37, 0.71]**
Total events	54		97			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 3.86$, df = 6 (P = 0.70); $I^2 = 0\%$
Test for overall effect: Z = 3.95 (P < 0.0001)



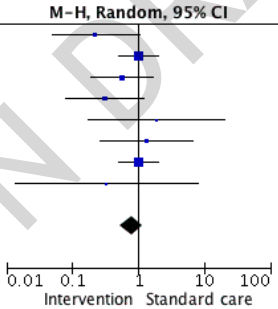
Footnotes
(1) 3-armed; control group halved

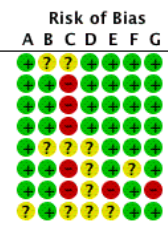
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel...
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

4.5 Pre-eclampsia

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Barakat 2016	2	382	9	383	6.5%	0.22 [0.05, 1.02]
da Silva 2017	11	205	22	407	30.4%	0.99 [0.49, 2.01]
De Oliveria Melo 2012 (1)	6	60	5	28	12.5%	0.56 [0.19, 1.68]
De Oliveria Melo 2012 (2)	3	54	5	28	8.2%	0.31 [0.08, 1.21]
Guelfi 2016	2	81	1	76	2.7%	1.88 [0.17, 20.28]
Renault 2014 (3)	5	125	2	67	5.8%	1.34 [0.27, 6.72]
Stafne 2012	16	426	16	426	32.6%	1.00 [0.51, 1.97]
Taniguchi 2016	0	54	1	53	1.5%	0.33 [0.01, 7.86]
Total (95% CI)		**1387**		**1468**	**100.0%**	**0.78 [0.53, 1.15]**
Total events	45		61			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 6.92$, df = 7 (P = 0.44); $I^2 = 0\%$
Test for overall effect: Z = 1.26 (P = 0.21)





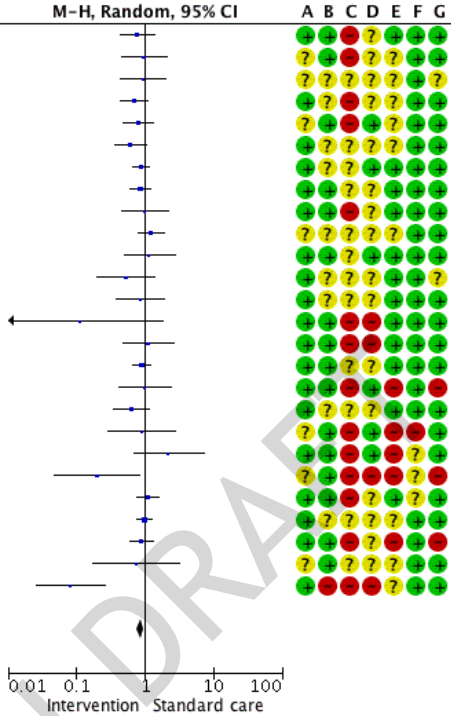
Footnotes
(1) From 20 weeks; 3-armed, control group halved
(2) From 13 weeks; 3-armed, control group halved
(3) 3-armed; control group halved

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel...
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

4.6 Caesarean section

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Baciuk 2008	12	34	17	37	4.0%	0.77 [0.43, 1.36]
Barakat 2009	11	72	11	70	2.6%	0.97 [0.45, 2.10]
Barakat 2012a	12	30	6	14	2.7%	0.93 [0.44, 1.97]
Barakat 2012b	22	138	35	152	5.1%	0.69 [0.43, 1.12]
Barakat 2013	24	169	28	157	4.9%	0.80 [0.48, 1.31]
Barakat 2014	18	107	26	93	4.5%	0.60 [0.35, 1.03]
Barakat 2016	73	382	83	383	9.0%	0.88 [0.67, 1.17]
Barakat 2018	51	227	53	202	7.7%	0.86 [0.61, 1.20]
Bisson 2015	8	24	8	24	2.4%	1.00 [0.45, 2.23]
Cordero 2015	26	101	33	156	5.6%	1.22 [0.78, 1.91]
Daly 2017	9	43	8	44	2.1%	1.15 [0.49, 2.71]
Dekker Nitert 2015	4	16	9	19	1.7%	0.53 [0.20, 1.40]
Guelfi 2016	10	81	11	76	2.4%	0.85 [0.38, 1.89]
Kong 2014 (1)	0	9	4	9	0.2%	0.11 [0.01, 1.80]
Kong 2014 (2)	5	9	5	10	2.2%	1.11 [0.47, 2.60]
Nascimento 2011	25	38	29	40	8.5%	0.91 [0.67, 1.22]
Oostdam 2012	7	30	8	34	2.0%	0.99 [0.41, 2.41]
Perales 2015b	14	90	19	77	3.6%	0.63 [0.34, 1.17]
Petrov Fieril 2015	5	38	5	34	1.3%	0.89 [0.28, 2.83]
Pinzon 2012 (3)	7	18	3	17	1.2%	2.20 [0.68, 7.16]
Price 2012	2	31	10	31	0.8%	0.20 [0.05, 0.84]
Renault 2014 (4)	51	125	25	67	6.9%	1.09 [0.75, 1.59]
Ruiz 2013	93	481	94	481	9.6%	0.99 [0.76, 1.28]
Stafne 2012	45	426	50	425	6.8%	0.90 [0.61, 1.31]
Taniguchi 2016	3	54	4	53	0.8%	0.74 [0.17, 3.13]
Wang 2017	3	112	37	114	1.3%	0.08 [0.03, 0.26]
Total (95% CI)		**2885**		**2819**	**100.0%**	**0.85 [0.74, 0.98]**
Total events	540		621			

Heterogeneity: Tau² = 0.03; Chi² = 36.51, df = 25 (P = 0.06); I² = 32%
Test for overall effect: Z = 2.31 (P = 0.02)



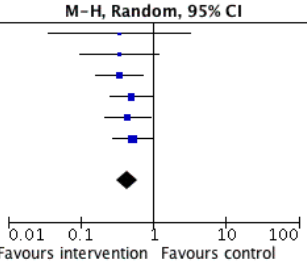
Footnotes
(1) Overweight
(2) Obese
(3) 45% missing data
(4) 3-armed; control group halved

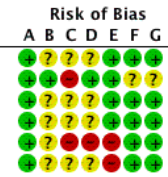
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel...
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

4.7 Antenatal depression

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Guelfi 2016	1	85	3	87	2.1%	0.34 [0.04, 3.22]
Haakstad 2011	3	52	9	53	6.9%	0.34 [0.10, 1.19]
Perales 2015a	7	44	25	53	19.7%	0.34 [0.16, 0.70]
Perales 2015b	11	90	19	77	23.3%	0.50 [0.25, 0.98]
Perales 2016b	10	83	16	59	20.9%	0.44 [0.22, 0.91]
Vargas-Terrones 2018	13	70	16	45	27.1%	0.52 [0.28, 0.98]
Total (95% CI)		**424**		**374**	**100.0%**	**0.44 [0.32, 0.61]**
Total events	45		88			

Heterogeneity: Tau² = 0.00; Chi² = 1.13, df = 5 (P = 0.95); I² = 0%
Test for overall effect: Z = 4.91 (P < 0.00001)



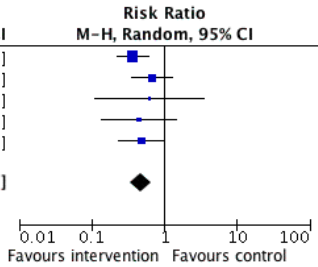


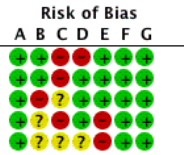
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

4.8 Postnatal depression

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Aguilar-Cordero 2019	14	65	38	64	41.6%	0.36 [0.22, 0.60]
da Silva 2017	12	192	36	387	26.9%	0.67 [0.36, 1.26]
Garnaes 2016	2	36	3	34	3.6%	0.63 [0.11, 3.54]
Songoyard 2012	4	379	8	340	7.5%	0.45 [0.14, 1.48]
Vargas-Terrones 2018	10	69	14	47	20.5%	0.49 [0.24, 1.00]
Total (95% CI)		**741**		**872**	**100.0%**	**0.47 [0.34, 0.65]**
Total events	42		99			

Heterogeneity: Tau² = 0.00; Chi² = 2.39, df = 4 (P = 0.66); I² = 0%
Test for overall effect: Z = 4.52 (P < 0.00001)



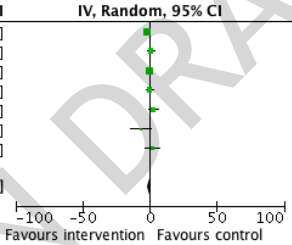


Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

4.9 Postnatal weight retention

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Daly 2017 (1)	-1.6	1.2	36	0.2	5.4	36	25.2%	-1.80 [-3.61, 0.01]
Garnaes 2016 (2)	-0.8	5.6	36	-1.6	5.4	34	16.7%	0.80 [-1.78, 3.38]
Haakstad 2011 (3)	3.3	3.9	33	3.3	4.1	37	24.3%	0.00 [-1.88, 1.88]
Haakstad 2011 (4)	1.3	4.3	40	1.5	6.9	40	17.2%	-0.20 [-2.72, 2.32]
Kong 2014 (5)	1.64	2.09	8	-0.94	5.6	10	9.5%	2.58 [-1.18, 6.34]
Kong 2014 (6)	-0.1	8.11	7	6.35	7.47	9	2.6%	-6.45 [-14.19, 1.29]
Price 2012 (7)	2.5	11.4978	31	0.7	11.4978	31	4.6%	1.80 [-3.92, 7.52]
Total (95% CI)			**191**			**197**	**100.0%**	**-0.20 [-1.48, 1.09]**

Heterogeneity: Tau² = 0.87; Chi² = 8.64, df = 6 (P = 0.19); I² = 31%
Test for overall effect: Z = 0.30 (P = 0.77)



Footnotes
(1) 6 weeks
(2) 3 months postpartum
(3) 6 weeks
(4) 6 years
(5) Overweight; 6 months
(6) Obese; 6 months
(7) 6-8 weeks

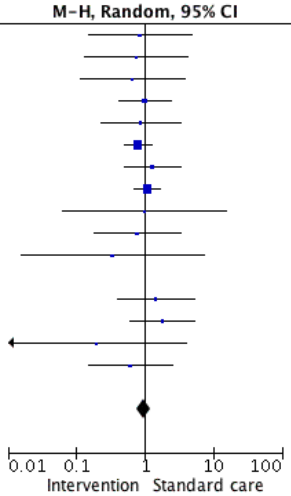
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Infant outcomes

4.10 Preterm birth

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Bacchi 2018	2	49	3	62	2.0%	0.84 [0.15, 4.85]
Baciuk 2008	2	33	3	37	2.0%	0.75 [0.13, 4.20]
Barakat 2009	2	72	3	70	2.0%	0.65 [0.11, 3.76]
Barakat 2012b	9	138	10	152	8.1%	0.99 [0.42, 2.37]
Barakat 2014	4	107	4	93	3.3%	0.87 [0.22, 3.38]
Barakat 2016	29	382	37	383	28.2%	0.79 [0.49, 1.25]
Barakat 2018	10	227	7	202	6.8%	1.27 [0.49, 3.28]
da Silva 2017	26	198	48	396	30.7%	1.08 [0.69, 1.69]
Garnaes 2016 (1)	1	46	1	45	0.8%	0.98 [0.06, 15.17]
Guelfi 2016	3	85	4	87	2.8%	0.77 [0.18, 3.33]
Kong 2014 (2)	0	9	1	9	0.6%	0.33 [0.02, 7.24]
Kong 2014 (3)	0	9	0	10		Not estimable
Renault 2014 (4)	8	125	3	67	3.6%	1.43 [0.39, 5.21]
Ruiz 2013 (5)	9	481	5	481	5.2%	1.80 [0.61, 5.33]
Taniguchi 2016	0	54	2	53	0.7%	0.20 [0.01, 4.00]
Wang 2017	3	112	5	114	3.1%	0.61 [0.15, 2.49]
Total (95% CI)		**2127**		**2261**	**100.0%**	**0.95 [0.74, 1.22]**
Total events	108		136			

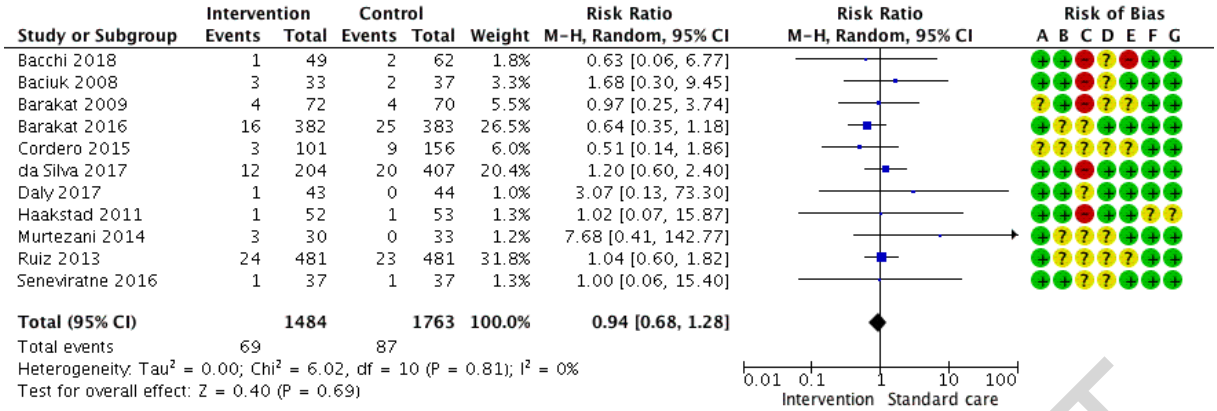
Heterogeneity: Tau² = 0.00; Chi² = 5.31, df = 14 (P = 0.98); I² = 0%
Test for overall effect: Z = 0.38 (P = 0.70)



Footnotes
(1) Reported as 2 and 0 in follow-up study
(2) Overweight
(3) Obese
(4) 3-armed; control group halved
(5) <36 weeks

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel...
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

4.11 Low birth weight

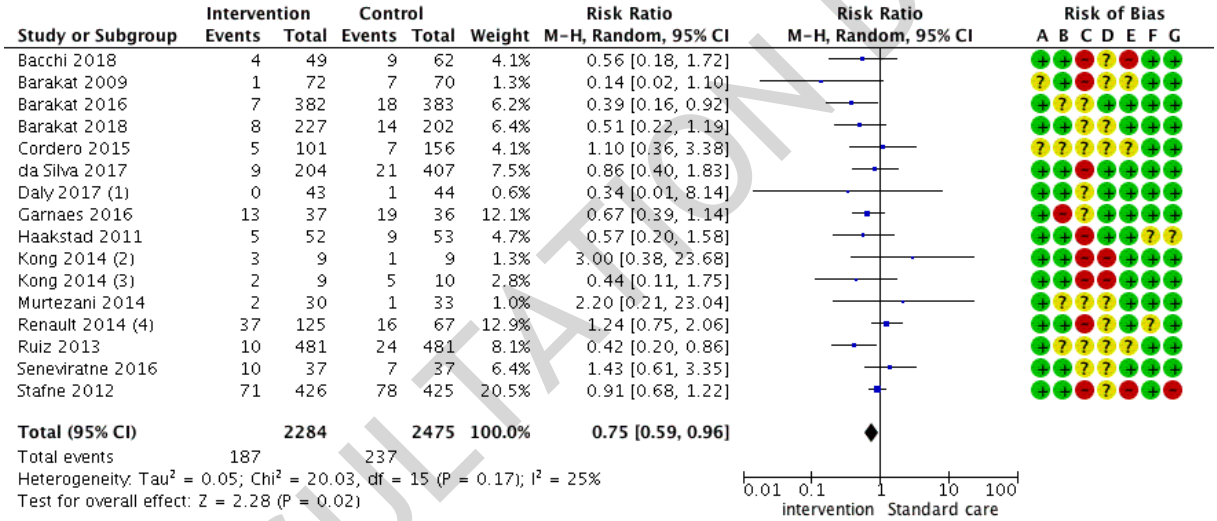


Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Bacchi 2018	1	49	2	62	1.8%	0.63 [0.06, 6.77]
Baciuk 2008	3	33	2	37	3.3%	1.68 [0.30, 9.45]
Barakat 2009	4	72	4	70	5.5%	0.97 [0.25, 3.74]
Barakat 2016	16	382	25	383	26.5%	0.64 [0.35, 1.18]
Cordero 2015	3	101	9	156	6.0%	0.51 [0.14, 1.86]
da Silva 2017	12	204	20	407	20.4%	1.20 [0.60, 2.40]
Daly 2017	1	43	0	44	1.0%	3.07 [0.13, 73.30]
Haakstad 2011	1	52	1	53	1.3%	1.02 [0.07, 15.87]
Murtezani 2014	3	30	0	33	1.2%	7.68 [0.41, 142.77]
Ruiz 2013	24	481	23	481	31.8%	1.04 [0.60, 1.82]
Seneviratne 2016	1	37	1	37	1.3%	1.00 [0.06, 15.40]
Total (95% CI)		**1484**		**1763**	**100.0%**	**0.94 [0.68, 1.28]**
Total events	69		87			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 6.02$, df = 10 (P = 0.81); $I^2 = 0\%$
Test for overall effect: Z = 0.40 (P = 0.69)

Risk of bias legend
(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective reporting (reporting bias)
(**G**) Other bias

4.12 Macrosomia



Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Bacchi 2018	4	49	9	62	4.1%	0.56 [0.18, 1.72]
Barakat 2009	1	72	7	70	1.3%	0.14 [0.02, 1.10]
Barakat 2016	7	382	18	383	6.2%	0.39 [0.16, 0.92]
Barakat 2018	8	227	14	202	6.4%	0.51 [0.22, 1.19]
Cordero 2015	5	101	7	156	4.1%	1.10 [0.36, 3.38]
da Silva 2017	9	204	21	407	7.5%	0.86 [0.40, 1.83]
Daly 2017 (1)	0	43	1	44	0.6%	0.34 [0.01, 8.14]
Garnaes 2016	13	37	19	36	12.1%	0.67 [0.39, 1.14]
Haakstad 2011	5	52	9	53	4.7%	0.57 [0.20, 1.58]
Kong 2014 (2)	3	9	1	9	1.3%	3.00 [0.38, 23.68]
Kong 2014 (3)	2	9	5	10	2.8%	0.44 [0.11, 1.75]
Murtezani 2014	2	30	1	33	1.0%	2.20 [0.21, 23.04]
Renault 2014 (4)	37	125	16	67	12.9%	1.24 [0.75, 2.06]
Ruiz 2013	10	481	24	481	8.1%	0.42 [0.20, 0.86]
Seneviratne 2016	10	37	7	37	6.4%	1.43 [0.61, 3.35]
Stafne 2012	71	426	78	425	20.5%	0.91 [0.68, 1.22]
Total (95% CI)		**2284**		**2475**	**100.0%**	**0.75 [0.59, 0.96]**
Total events	187		237			

Heterogeneity: $Tau^2 = 0.05$; $Chi^2 = 20.03$, df = 15 (P = 0.17); $I^2 = 25\%$
Test for overall effect: Z = 2.28 (P = 0.02)

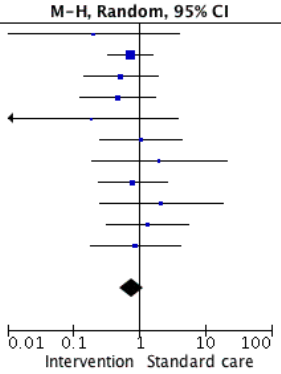
Footnotes
(1) Macrosomia defined as >4500 g
(2) Overweight
(3) Obese
(4) 3-armed; control group halved

Risk of bias legend
(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel...
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective reporting (reporting bias)
(**G**) Other bias

4.13 Small for gestational age

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Bisson 2015	0	24	2	24	2.1%	0.20 [0.01, 3.96]
da Silva 2017	8	204	22	407	29.4%	0.73 [0.33, 1.60]
De Oliveria Melo 2012 (1)	4	54	4	28	10.8%	0.52 [0.14, 1.92]
De Oliveria Melo 2012 (2)	4	60	4	28	10.7%	0.47 [0.13, 1.73]
Guelfi 2016	0	81	2	76	2.0%	0.19 [0.01, 3.85]
Hopkins 2010	4	47	3	37	9.0%	1.05 [0.25, 4.40]
Nascimento 2011	2	33	1	33	3.3%	2.00 [0.19, 21.00]
Price 2012	4	31	5	31	12.4%	0.80 [0.24, 2.70]
Renault 2014 (3)	4	125	1	67	3.9%	2.14 [0.24, 18.80]
Seneviratne 2016	4	37	3	37	9.1%	1.33 [0.32, 5.55]
Simmons 2017 (4)	5	87	2	30	7.3%	0.86 [0.18, 4.21]
Total (95% CI)		**783**		**798**	**100.0%**	**0.76 [0.50, 1.17]**
Total events	39		49			

Heterogeneity: Tau² = 0.00; Chi² = 4.81, df = 10 (P = 0.90); I² = 0%
Test for overall effect: Z = 1.23 (P = 0.22)



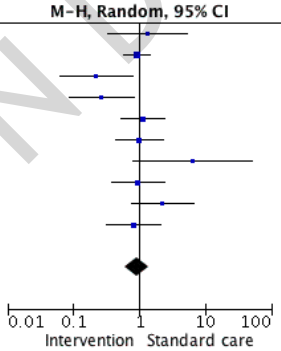
Footnotes
(1) From 13 weeks; 3-armed, control group halved
(2) From 20 weeks; 3-armed, control group halved
(3) 3-armed; control group halved
(4) 4-armed; control group divided by three

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel...
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

4.14 Large for gestational age

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Bisson 2015	4	24	3	24	6.4%	1.33 [0.33, 5.33]
da Silva 2017	24	204	53	407	19.3%	0.90 [0.57, 1.42]
De Oliveria Melo 2012 (1)	3	54	7	28	7.2%	0.22 [0.06, 0.79]
De Oliveria Melo 2012 (2)	4	60	7	28	8.4%	0.27 [0.08, 0.84]
Guelfi 2016	12	81	10	76	13.1%	1.13 [0.52, 2.45]
Nascimento 2011	8	33	8	33	11.9%	1.00 [0.43, 2.35]
Oostdam 2012	6	47	1	50	3.3%	6.38 [0.80, 51.05]
Renault 2014 (3)	8	125	9	134	11.0%	0.95 [0.38, 2.39]
Seneviratne 2016	9	37	4	37	9.0%	2.25 [0.76, 6.67]
Simmons 2017 (4)	12	88	5	30	10.5%	0.82 [0.31, 2.13]
Total (95% CI)		**753**		**847**	**100.0%**	**0.91 [0.61, 1.36]**
Total events	90		107			

Heterogeneity: Tau² = 0.17; Chi² = 15.88, df = 9 (P = 0.07); I² = 43%
Test for overall effect: Z = 0.47 (P = 0.64)



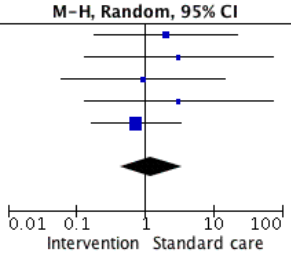
Footnotes
(1) From 13 weeks; 3-armed, control group halvedv
(2) From 20 weeks; 3-armed, control group halved
(3) 3-armed; control group halved
(4) 4-armed; control group divided by three

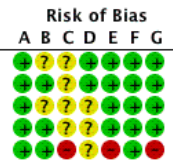
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel...
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

4.15 Apgar score <7 at 5 minutes

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Barakat 2016	2	382	1	383	18.2%	2.01 [0.18, 22.02]
Daly 2017	1	43	0	44	10.4%	3.07 [0.13, 73.30]
Guelfi 2016	1	81	1	76	13.8%	0.94 [0.06, 14.74]
Nascimento 2011	1	36	0	37	10.4%	3.08 [0.13, 73.24]
Stafne 2012	3	422	4	414	47.1%	0.74 [0.17, 3.27]
Total (95% CI)		**964**		**954**	**100.0%**	**1.23 [0.44, 3.42]**
Total events	8		6			

Heterogeneity: Tau² = 0.00; Chi² = 1.30, df = 4 (P = 0.86); I² = 0%
Test for overall effect: Z = 0.40 (P = 0.69)





Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

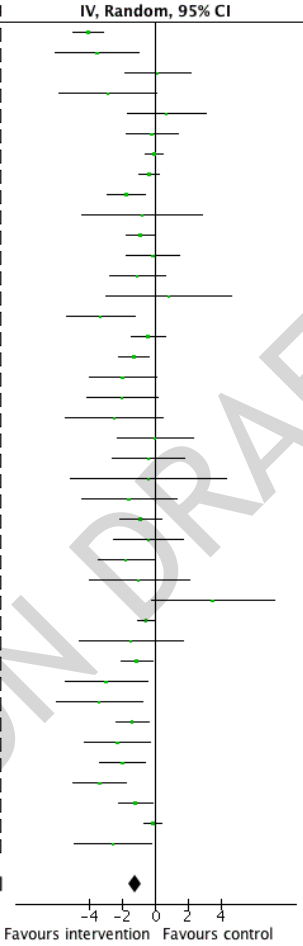
Comparison 5: Lifestyle counselling as part of pregnancy care versus usual care alone

Maternal outcomes

5.1 Mean gestational weight gain

Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Altazan 2019 (1)	8.7	0.9	32	12.8	1.5	11	3.8%	-4.10 [-5.04, -3.16]
Asbee 2009	13.02	5.67	57	16.56	7.03	43	1.6%	-3.54 [-6.11, -0.97]
Asci 2016	12.45	5.04	45	12.29	4.8	45	2.1%	0.16 [-1.87, 2.19]
Bogaerts 2013 (2)	10.6	7	76	13.5	7.3	32	1.3%	-2.90 [-5.88, 0.08]
Bruno 2016	10.1	7.4	69	9.4	6.8	62	1.7%	0.70 [-1.73, 3.13]
Chan 2018	11.6	4	76	11.8	5.9	81	2.7%	-0.20 [-1.77, 1.37]
Dodd 2014	9.39	5.74	897	9.44	5.77	871	4.5%	-0.05 [-0.59, 0.49]
Dodd 2019	11.32	3.96	316	11.7	3.78	313	4.4%	-0.38 [-0.98, 0.22]
Gallagher 2018	7.89	4.07	94	9.67	4.17	93	3.4%	-1.78 [-2.96, -0.60]
Guelinckx 2010 (3)	9.8	7.6	42	10.6	6.9	22	0.9%	-0.80 [-4.49, 2.89]
Harrison 2013 (4)	6	2.8	106	6.9	3.3	97	4.0%	-0.90 [-1.75, -0.05]
Hawkins 2014	17.73	4.06	32	17.87	2.39	34	2.6%	-0.14 [-1.76, 1.48]
Hui 2012	14.1	6	102	15.2	5.9	88	2.5%	-1.10 [-2.80, 0.60]
Hui 2014 (5)	15.21	7.5	27	14.39	7.05	29	0.9%	0.82 [-3.00, 4.64]
Hui 2014 (6)	12.9	3.72	30	16.23	4.38	27	2.0%	-3.33 [-5.45, -1.21]
Jing 2015	9.24	3.99	115	9.69	3.85	106	3.6%	-0.45 [-1.48, 0.58]
Kennelly 2018	11.3	5.6	278	12.6	5.6	287	3.8%	-1.30 [-2.22, -0.38]
Kiani-Asiabar 2018	13.55	3.2	42	15.53	4.2	20	2.0%	-1.98 [-4.06, 0.10]
Kiani-Asiabar 2018	13.5	3.85	41	15.53	4.2	20	1.9%	-2.03 [-4.22, 0.16]
Korpi-Hyövälti 2011	11.4	6	27	13.9	5.1	27	1.3%	-2.50 [-5.47, 0.47]
Kunath 2019	14.1	5.3	40	14.1	5.2	40	1.8%	0.00 [-2.30, 2.30]
Luoto 2011 (7)	13.8	5.8	51	14.2	5.1	42	1.9%	-0.40 [-2.62, 1.82]
Pawalia 2017 (8)	12.91	3.65	12	13.33	5.33	6	0.6%	-0.42 [-5.16, 4.32]
Petrella 2013	8.8	6.5	33	10.4	5	28	1.3%	-1.60 [-4.49, 1.29]
Phelan 2011 (9)	15.3	4.4	92	16.2	4.6	94	3.2%	-0.90 [-2.19, 0.39]
Phelan 2011 (10)	14.7	6.9	87	15.1	7.5	90	2.0%	-0.40 [-2.52, 1.72]
Phelan 2018	9.4	6.9	129	11.2	7	127	2.5%	-1.80 [-3.50, -0.10]
Polley 2002 (11)	15.4	7.1	30	16.4	4.8	31	1.2%	-1.00 [-4.05, 2.05]
Polley 2002 (12)	13.6	7.2	27	10.1	6.2	22	0.9%	3.50 [-0.25, 7.25]
Poston 2015	7.19	4.6	526	7.76	4.6	567	4.5%	-0.57 [-1.12, -0.02]
Rauh 2013	14.1	4.1	33	15.6	5.8	16	1.1%	-1.50 [-4.67, 1.67]
Ronnberg 2015	14.19	4.45	192	15.31	5.38	182	3.7%	-1.12 [-2.12, -0.12]
Ruchat 2012 (13)	15.3	2.9	23	18.3	5.3	22	1.6%	-3.00 [-5.51, -0.49]
Ruchat 2012 (14)	14.9	3.8	26	18.3	5.3	22	1.5%	-3.40 [-6.05, -0.75]
Sagedal 2017	14.4	6.2	267	15.8	5.7	266	3.7%	-1.40 [-2.41, -0.39]
Simmons 2017 (15)	6.5	3.8	75	8.8	4.7	26	2.1%	-2.30 [-4.30, -0.30]
Van Horn 2018	10	6	140	12	6	141	3.0%	-2.00 [-3.40, -0.60]
Vesco 2012 (16)	5	4.1	54	8.4	4.7	57	2.6%	-3.40 [-5.04, -1.76]
Vinter 2011	7.4	4.6	144	8.6	4.4	148	3.6%	-1.20 [-2.23, -0.17]
Wang 2015 (17)	5.51	2.18	134	5.66	2.25	138	4.5%	-0.15 [-0.68, 0.38]
Willcox 2017	11	5.92	45	13.6	5.6	46	1.7%	-2.60 [-4.97, -0.23]
Total (95% CI)			**4664**			**4419**	**100.0%**	**-1.25 [-1.64, -0.86]**

Heterogeneity: Tau² = 0.80; Chi² = 119.42, df = 40 (P < 0.00001); I² = 67%
Test for overall effect: Z = 6.31 (P < 0.00001)



Footnotes
(1) In person and smart phone groups combined
(2) 3-armed; control group halved
(3) 3-armed study; control group halved
(4) 26-28 weeks
(5) BMI≥25
(6) BMI≤24.9
(7) Data are from a follow-up study that did not exclude 4 outliers from the analysis
(8) 3-armed; control group halved
(9) Normal weight
(10) Overweight or obese
(11) Normal weight
(12) Overweight or obese
(13) Low intensity exercise; 3-armed, control group halved
(14) Moderate intensity exercise; 3-armed, control group halved
(15) 4-armed; control group divided by three
(16) 34 weeks
(17) 24-28 weeks

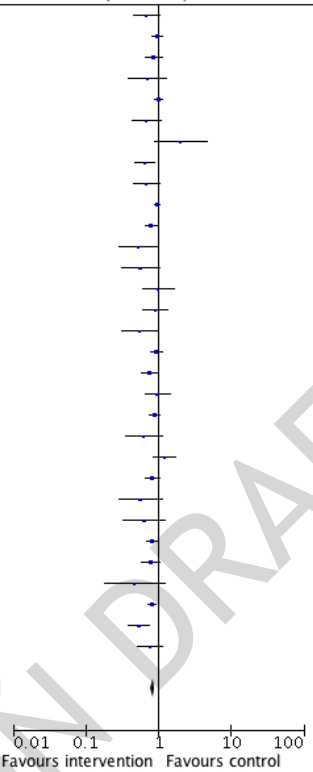
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

5.2 Weight gain exceeding IOM guidelines

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Altazan 2019 (1)	18	32	9	11	2.1%	0.69 [0.45, 1.04]
Althuizen 2013	75	106	82	113	6.1%	0.98 [0.83, 1.15]
Bogaerts 2013 (2)	47	76	23	32	3.7%	0.86 [0.65, 1.14]
Chan 2018	14	76	21	81	1.1%	0.71 [0.39, 1.29]
Dodd 2014	380	897	368	871	7.7%	1.00 [0.90, 1.12]
Dodd 2019	28	316	41	313	1.8%	0.68 [0.43, 1.07]
Guelinckx 2010 (3)	17	37	5	22	0.6%	2.02 [0.87, 4.71]
Hui 2012	36	102	48	88	3.0%	0.65 [0.47, 0.90]
Hui 2014	21	57	30	56	2.1%	0.69 [0.45, 1.04]
Jing 2015	102	115	97	106	8.3%	0.97 [0.89, 1.06]
Kennelly 2018	87	171	120	188	5.7%	0.80 [0.66, 0.96]
Kiani-Asiabar 2018 (4)	12	41	11	20	1.1%	0.53 [0.29, 0.99]
Kiani-Asiabar 2018 (5)	13	42	11	20	1.1%	0.56 [0.31, 1.03]
Kunath 2019	18	40	18	40	1.6%	1.00 [0.62, 1.62]
Luoto 2011	24	51	22	42	2.1%	0.90 [0.60, 1.35]
Petrella 2013	11	33	17	28	1.3%	0.55 [0.31, 0.97]
Phelan 2011	95	179	104	184	5.6%	0.94 [0.78, 1.13]
Phelan 2018	53	129	69	127	4.0%	0.76 [0.58, 0.98]
Polley 2002	26	57	25	53	2.2%	0.97 [0.65, 1.45]
Poston 2015	174	526	212	566	6.2%	0.88 [0.75, 1.04]
Rauh 2013	13	33	10	16	1.3%	0.63 [0.36, 1.11]
Renault 2014 (6)	59	130	25	67	2.6%	1.22 [0.85, 1.75]
Ronnberg 2015 (7)	79	192	91	182	4.7%	0.82 [0.66, 1.03]
Ruchat 2012 (8)	8	26	12	22	0.9%	0.56 [0.28, 1.13]
Ruchat 2012 (9)	8	23	12	22	0.9%	0.64 [0.32, 1.26]
Sagedal 2017	111	267	133	266	5.6%	0.83 [0.69, 1.00]
Simmons 2017 (10)	45	75	20	26	3.7%	0.78 [0.59, 1.03]
Trak-Fellermeie 2019	4	15	9	16	0.5%	0.47 [0.18, 1.22]
Van Horn 2018	96	140	119	141	7.0%	0.81 [0.71, 0.93]
Vesco 2012	24	54	47	57	3.1%	0.54 [0.39, 0.74]
Willcox 2017	21	45	28	46	2.3%	0.77 [0.52, 1.13]
Total (95% CI)		**4083**		**3822**	**100.0%**	**0.83 [0.78, 0.89]**
Total events	1719		1839			

Heterogeneity: $Tau^2 = 0.01$; $Chi^2 = 55.36$, df = 30 (P = 0.003); $I^2 = 46\%$

Test for overall effect: Z = 5.35 (P < 0.00001)



Footnotes

(1) In person and smart phone groups combined
(2) 3-armed; control group halved
(3) 3-armed; control group halved
(4) Spouse included in education; 3-armed, control group halved
(5) Spouse not included in education; 3-armed, control group halved
(6) 3-armed; control group halved
(7) 1990 IOM guidelines
(8) Moderate intensity exercise; 3-armed, control group halved
(9) Low intensity exercise; 3-armed, control group halved
(10) 4-armed; control group divided by three

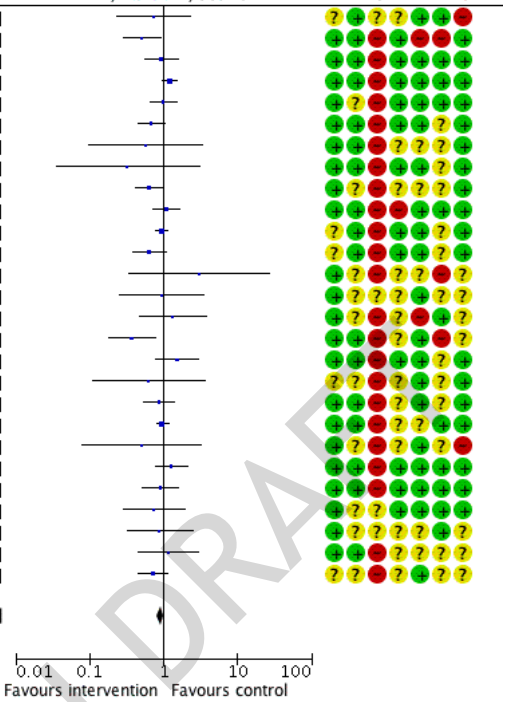
Risk of bias legend

(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective reporting (reporting bias)
(**G**) Other bias

5.3 Gestational diabetes

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Bogaerts 2013 (1)	7	76	4	32	0.9%	0.74 [0.23, 2.34]
Bruno 2016	13	69	23	62	3.1%	0.51 [0.28, 0.91]
Chan 2018	20	80	23	86	3.8%	0.93 [0.56, 1.57]
Dodd 2014	148	1080	120	1073	11.9%	1.23 [0.98, 1.54]
Dodd 2019	39	316	39	313	5.4%	0.99 [0.65, 1.50]
Harrison 2013	27	121	35	107	5.2%	0.68 [0.44, 1.05]
Hui 2012	2	102	3	88	0.4%	0.58 [0.10, 3.36]
Hui 2014	1	57	3	56	0.2%	0.33 [0.04, 3.05]
Jing 2015	26	115	37	106	5.2%	0.65 [0.42, 0.99]
Kennelly 2018	37	241	36	257	5.3%	1.10 [0.72, 1.67]
Koivusalo 2016 (2)	107	235	111	229	13.8%	0.94 [0.77, 1.14]
Koivusalo 2016 (3)	20	144	27	125	3.7%	0.64 [0.38, 1.09]
Korpi-Hyövälti 2011	3	27	1	27	0.2%	3.00 [0.33, 27.06]
Kunath 2019	4	41	4	39	0.7%	0.95 [0.26, 3.54]
Luoto 2011	8	51	5	42	1.1%	1.32 [0.47, 3.73]
Petrella 2013	7	33	16	28	2.1%	0.37 [0.18, 0.77]
Phelan 2011	19	171	13	178	2.4%	1.52 [0.78, 2.98]
Polley 2002	2	57	3	53	0.4%	0.62 [0.11, 3.57]
Poston 2013	22	79	24	75	4.2%	0.87 [0.54, 1.41]
Poston 2015	160	629	172	651	14.3%	0.96 [0.80, 1.16]
Rauh 2013	2	32	2	16	0.3%	0.50 [0.08, 3.23]
Sagedal 2017	32	275	25	272	4.1%	1.27 [0.77, 2.08]
Simmons 2017 (4)	27	84	11	31	3.3%	0.91 [0.51, 1.60]
Van Horn 2018	7	133	9	127	1.3%	0.74 [0.29, 1.93]
Vesco 2012	6	56	7	58	1.1%	0.89 [0.32, 2.48]
Vinter 2011	9	150	8	154	1.3%	1.16 [0.46, 2.91]
Wang 2015	23	134	33	138	4.4%	0.72 [0.45, 1.16]
Total (95% CI)		**4588**		**4423**	**100.0%**	**0.90 [0.81, 1.01]**
Total events	778		794			

Heterogeneity: $Tau^2 = 0.01$; $Chi^2 = 32.00$, df = 26 (P = 0.19); $I^2 = 19\%$
Test for overall effect: Z = 1.80 (P = 0.07)



Footnotes
(1) 3-armed; control group halved
(2) All women
(3) Normoglycaemic women
(4) 4-armed; control group divided by three

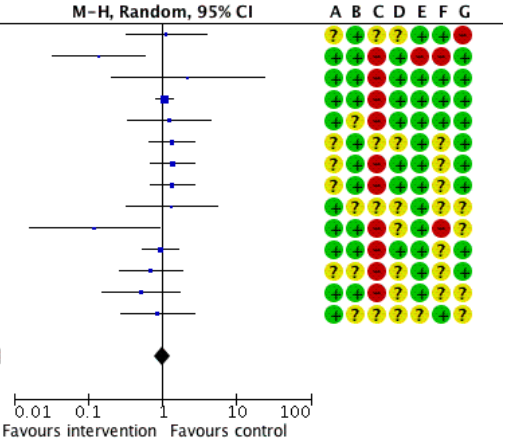
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Note: Studies differed in diagnostic criteria for gestational diabetes.

5.4 Gestational hypertension

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Bogaerts 2013 (1)	8	76	3	32	3.7%	1.12 [0.32, 3.96]
Bruno 2016	2	69	13	62	2.8%	0.14 [0.03, 0.59]
Chan 2018	2	77	1	84	1.1%	2.18 [0.20, 23.59]
Dodd 2014	101	1080	94	1073	27.3%	1.07 [0.82, 1.40]
Dodd 2019	5	316	4	313	3.4%	1.24 [0.34, 4.57]
Guelinckx 2010 (2)	18	42	7	22	9.7%	1.35 [0.67, 2.72]
Koivusalo 2016 (3)	19	144	12	125	10.2%	1.37 [0.70, 2.72]
Koivusalo 2016 (4)	18	235	13	229	10.0%	1.35 [0.68, 2.69]
Kunath 2019	4	40	3	40	2.9%	1.33 [0.32, 5.58]
Petrella 2013	1	33	7	28	1.5%	0.12 [0.02, 0.93]
Phelan 2011	20	171	22	178	13.2%	0.95 [0.54, 1.67]
Polley 2002	6	57	8	53	5.6%	0.70 [0.26, 1.88]
Renault 2014 (5)	5	130	5	67	4.0%	0.52 [0.15, 1.72]
Vesco 2012 (6)	5	56	6	58	4.5%	0.86 [0.28, 2.67]
Total (95% CI)		**2526**		**2364**	**100.0%**	**0.99 [0.77, 1.28]**
Total events	214		198			

Heterogeneity: $Tau^2 = 0.04$; $Chi^2 = 16.39$, df = 13 (P = 0.23); $I^2 = 21\%$
Test for overall effect: Z = 0.08 (P = 0.94)



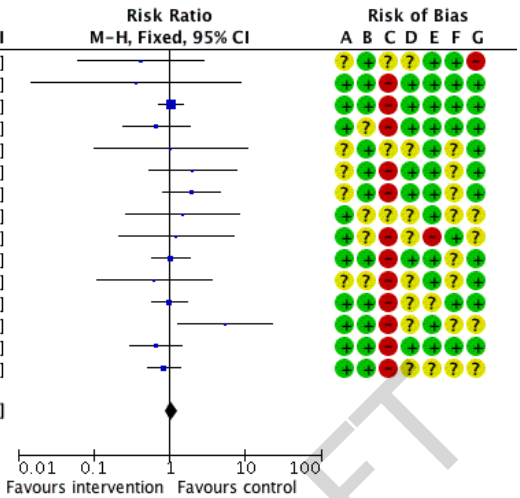
Footnotes
(1) 3-armed; control group halved
(2) 3-armed; control group halved
(3) Normoglycaemic women
(4) All women
(5) 3-armed; control group halved
(6) Includes pre-eclampsia

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

5.5 Pre-eclampsia

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Bogaerts 2013 (1)	2	76	2	32	1.6%	0.42 [0.06, 2.86]
Chan 2018	0	77	1	84	0.8%	0.36 [0.02, 8.79]
Dodd 2014	56	1080	53	1073	30.0%	1.05 [0.73, 1.51]
Dodd 2019	6	316	9	313	5.1%	0.66 [0.24, 1.83]
Guelinckx 2010 (2)	2	42	1	22	0.7%	1.05 [0.10, 10.92]
Koivusalo 2016 (3)	7	144	3	125	1.8%	2.03 [0.54, 7.67]
Koivusalo 2016 (4)	14	235	7	229	4.0%	1.95 [0.80, 4.74]
Kunath 2019	3	40	2	40	1.1%	1.50 [0.26, 8.50]
Luoto 2011	3	51	2	42	1.2%	1.24 [0.22, 7.05]
Phelan 2011	20	171	20	178	11.1%	1.04 [0.58, 1.87]
Polley 2002	2	57	3	53	1.8%	0.62 [0.11, 3.57]
Poston 2015	27	753	27	752	15.2%	1.00 [0.59, 1.69]
Renault 2014 (5)	21	130	2	67	1.5%	5.41 [1.31, 22.39]
Sagedal 2017 (6)	10	293	15	290	8.5%	0.66 [0.30, 1.44]
Vinter 2011 (7)	23	150	28	154	15.6%	0.84 [0.51, 1.40]
Total (95% CI)		**3615**		**3454**	**100.0%**	**1.06 [0.87, 1.29]**
Total events	196		175			

Heterogeneity: Chi² = 12.72, df = 14 (P = 0.55); I² = 0%
Test for overall effect: Z = 0.56 (P = 0.57)



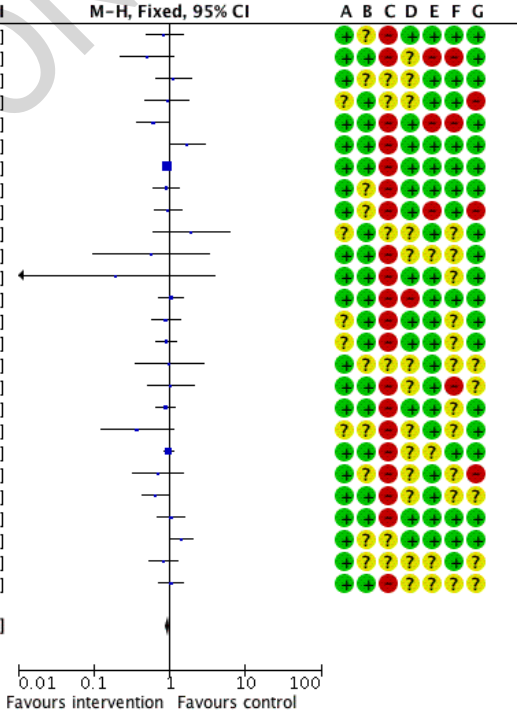
Footnotes
(1) 3-armed; control group halved
(2) 3-armed; control group halved
(3) Normoglycaemic women
(4) All women
(5) 3-armed; control group halved
(6) Includes combined pre-eclampsia, severe pre-eclampsia/HELLP/eclampsia
(7) Includes pregnancy-induced hypertension

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

5.6 Caesarean section

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Althuizen 2013	18	103	22	107	1.7%	0.85 [0.48, 1.49]
Asbee 2009	8	57	12	43	1.1%	0.50 [0.23, 1.12]
Asci 2016	17	45	15	45	1.2%	1.13 [0.65, 1.98]
Bogaerts 2013 (1)	20	76	9	32	1.0%	0.94 [0.48, 1.83]
Bruno 2016	17	69	25	62	2.1%	0.61 [0.37, 1.02]
Chan 2018	24	69	16	78	1.2%	1.70 [0.98, 2.92]
Dodd 2014	370	1075	389	1067	30.8%	0.94 [0.84, 1.06]
Dodd 2019	41	316	45	313	3.6%	0.90 [0.61, 1.34]
Gallagher 2018	29	97	31	99	2.4%	0.95 [0.63, 1.46]
Guelinckx 2010 (2)	11	42	3	22	0.3%	1.92 [0.60, 6.17]
Hui 2012	2	102	3	88	0.3%	0.58 [0.10, 3.36]
Hui 2014	0	57	2	56	0.2%	0.20 [0.01, 4.00]
Kennelly 2018	50	270	48	270	3.8%	1.04 [0.73, 1.49]
Koivusalo 2016 (3)	31	144	30	125	2.5%	0.90 [0.58, 1.39]
Koivusalo 2016 (4)	55	235	59	229	4.7%	0.91 [0.66, 1.25]
Kunath 2019	6	40	6	40	0.5%	1.00 [0.35, 2.84]
Petrella 2013	11	33	9	28	0.8%	1.04 [0.50, 2.14]
Phelan 2011	57	171	67	178	5.2%	0.89 [0.67, 1.18]
Polley 2002	4	57	10	53	0.8%	0.37 [0.12, 1.11]
Poston 2015	271	765	274	757	21.7%	0.98 [0.86, 1.12]
Rauh 2013	10	34	7	17	0.7%	0.71 [0.33, 1.54]
Renault 2014 (5)	32	130	25	67	2.6%	0.66 [0.43, 1.02]
Sagedal 2017 (6)	38	296	36	295	2.8%	1.05 [0.69, 1.61]
Van Horn 2018	55	140	37	137	3.0%	1.45 [1.03, 2.05]
Vesco 2012	21	56	26	58	2.0%	0.84 [0.54, 1.30]
Vinter 2011	40	150	39	154	3.0%	1.05 [0.72, 1.54]
Total (95% CI)		**4629**		**4420**	**100.0%**	**0.95 [0.89, 1.02]**
Total events	1238		1245			

Heterogeneity: Chi² = 26.66, df = 25 (P = 0.37); I² = 6%
Test for overall effect: Z = 1.44 (P = 0.15)



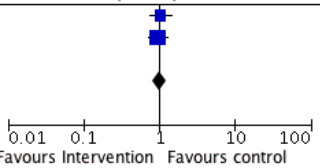
Footnotes
(1) 3-armed; control group halved
(2) 3-armed; control group halved
(3) Normoglycaemic women
(4) All women
(5) 3-armed; control group halved
(6) A follow-up study reported sample sizes as 295 and 294

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

5.7 Antenatal depression

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Dodd 2014 (1)	65	695	62	687	41.3%	1.04 [0.74, 1.44]
Poston 2015 (2)	85	769	88	757	58.7%	0.95 [0.72, 1.26]
Total (95% CI)		**1464**		**1444**	**100.0%**	**0.99 [0.80, 1.22]**
Total events	150		150			

Heterogeneity: Chi² = 0.15, df = 1 (P = 0.70); I² = 0%
Test for overall effect: Z = 0.13 (P = 0.90)



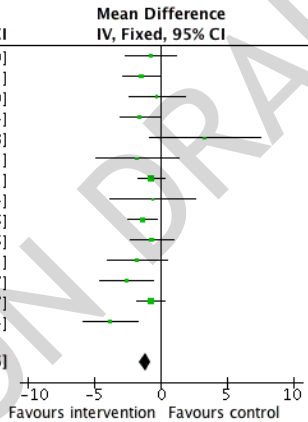
Footnotes
(1) EPDS score >12 at 36 weeks
(2) EPDS score ≥13 at 27-28 weeks

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

5.8 Postnatal weight retention

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
Asci 2016 (1)	5.19	4.71	45	5.95	4.79	45	4.8%	-0.76 [-2.72, 1.20]
Harrison 2013 (2)	0.51	4.48	104	1.96	5.74	98	9.1%	-1.45 [-2.88, -0.02]
Kunath 2019	4	4.8	41	4.3	4.8	39	4.2%	-0.30 [-2.40, 1.80]
Phelan 2011 (3)	1.4	6.3	128	3	5.7	133	8.7%	-1.60 [-3.06, -0.14]
Polley 2002 (4)	3.6	5.6	16	0.3	7	19	1.1%	3.30 [-0.88, 7.48]
Polley 2002 (5)	4.4	5.4	18	6.2	4.5	21	1.9%	-1.80 [-4.95, 1.35]
Poston 2015 (6)	-0.37	7.41	344	0.36	6.71	355	16.9%	-0.73 [-1.78, 0.32]
Rauh 2013 (7)	0.2	3.6	32	0.8	5.7	14	1.8%	-0.60 [-3.84, 2.64]
Ronnberg 2015 (8)	1.81	4.52	137	3.19	4.77	130	14.9%	-1.38 [-2.50, -0.26]
Ronnberg 2015 (9)	0.3	5.52	87	1	5.46	81	6.7%	-0.70 [-2.36, 0.96]
Ruchat 2012 (10)	5.4	3.9	23	7.2	3.8	22	3.7%	-1.80 [-4.05, 0.45]
Ruchat 2012 (11)	4.6	3.3	26	7.2	3.8	22	4.5%	-2.60 [-4.63, -0.57]
Sagedal 2017 (12)	0.66	5.48	203	1.42	4.96	188	17.3%	-0.76 [-1.79, 0.27]
Vesco 2012 (13)	-2.6	5.5	54	1.2	5.6	58	4.4%	-3.80 [-5.86, -1.74]
Total (95% CI)			**1258**			**1225**	**100.0%**	**-1.19 [-1.62, -0.76]**

Heterogeneity: Chi² = 16.18, df = 13 (P = 0.24); I² = 20%
Test for overall effect: Z = 5.40 (P < 0.00001)



Footnotes
(1) 6 weeks postpartum
(2) 6 weeks postpartum
(3) 12 months postpartum
(4) Overweight and obese 8 weeks postpartum
(5) Normal weight 8 weeks postpartum
(6) 6 months postpartum
(7) 12 months postpartum
(8) ≤16 weeks postpartum
(9) 12 months postpartum
(10) 2 months postpartum; low intensity exercise; 3-armed, control group halved
(11) 2 months postpartum; moderate intensity exercise; 3-armed, control group halved
(12) 12 months postpartum
(13) 2 weeks

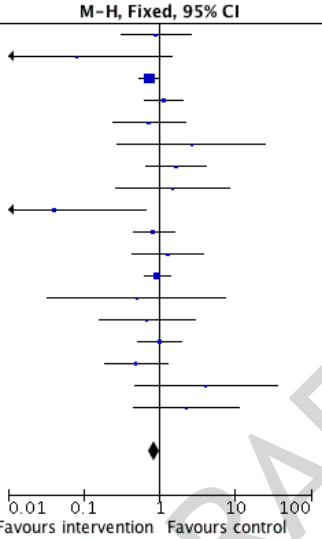
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Infant outcomes

5.9 Preterm birth

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Althuizen 2013	6	103	7	107	2.7%	0.89 [0.31, 2.56]
Bruno 2016	0	69	5	62	2.3%	0.08 [0.00, 1.45]
Dodd 2014	62	1075	83	1067	32.7%	0.74 [0.54, 1.02]
Dodd 2019	23	316	20	313	7.9%	1.14 [0.64, 2.03]
Gallagher 2018	5	97	7	99	2.7%	0.73 [0.24, 2.22]
Harrison 2013	3	121	1	107	0.4%	2.65 [0.28, 25.12]
Koivusalo 2016	12	235	7	229	2.8%	1.67 [0.67, 4.17]
Kunath 2019	3	40	2	40	0.8%	1.50 [0.26, 8.50]
Petrella 2013	0	33	10	28	4.4%	0.04 [0.00, 0.66]
Phelan 2011 (1)	16	171	20	178	7.7%	0.83 [0.45, 1.55]
Polley 2002 (2)	7	57	5	53	2.0%	1.30 [0.44, 3.85]
Poston 2015	45	761	48	751	18.9%	0.93 [0.62, 1.37]
Rauh 2013	1	34	1	17	0.5%	0.50 [0.03, 7.51]
Renault 2014 (3)	4	130	3	67	1.6%	0.69 [0.16, 2.98]
Sagedal 2017	17	296	17	295	6.7%	1.00 [0.52, 1.91]
Van Horn 2018	6	139	12	136	4.8%	0.49 [0.19, 1.27]
Vesco 2012	4	56	1	58	0.4%	4.14 [0.48, 35.93]
Vinter 2011	5	82	2	75	0.8%	2.29 [0.46, 11.44]
Total (95% CI)		**3815**		**3682**	**100.0%**	**0.85 [0.72, 1.01]**
Total events	219		251			

Heterogeneity: Chi² = 18.39, df = 17 (P = 0.36); I² = 8%
Test for overall effect: Z = 1.80 (P = 0.07)



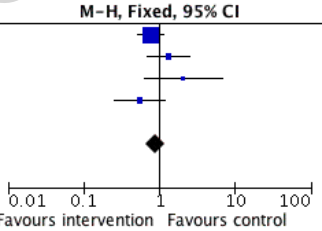
Footnotes
(1) <36 weeks
(2) <36 weeks
(3) 3-armed; control group halved

Risk of bias legend
(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective reporting (reporting bias)
(**G**) Other bias

5.10 Low birth weight

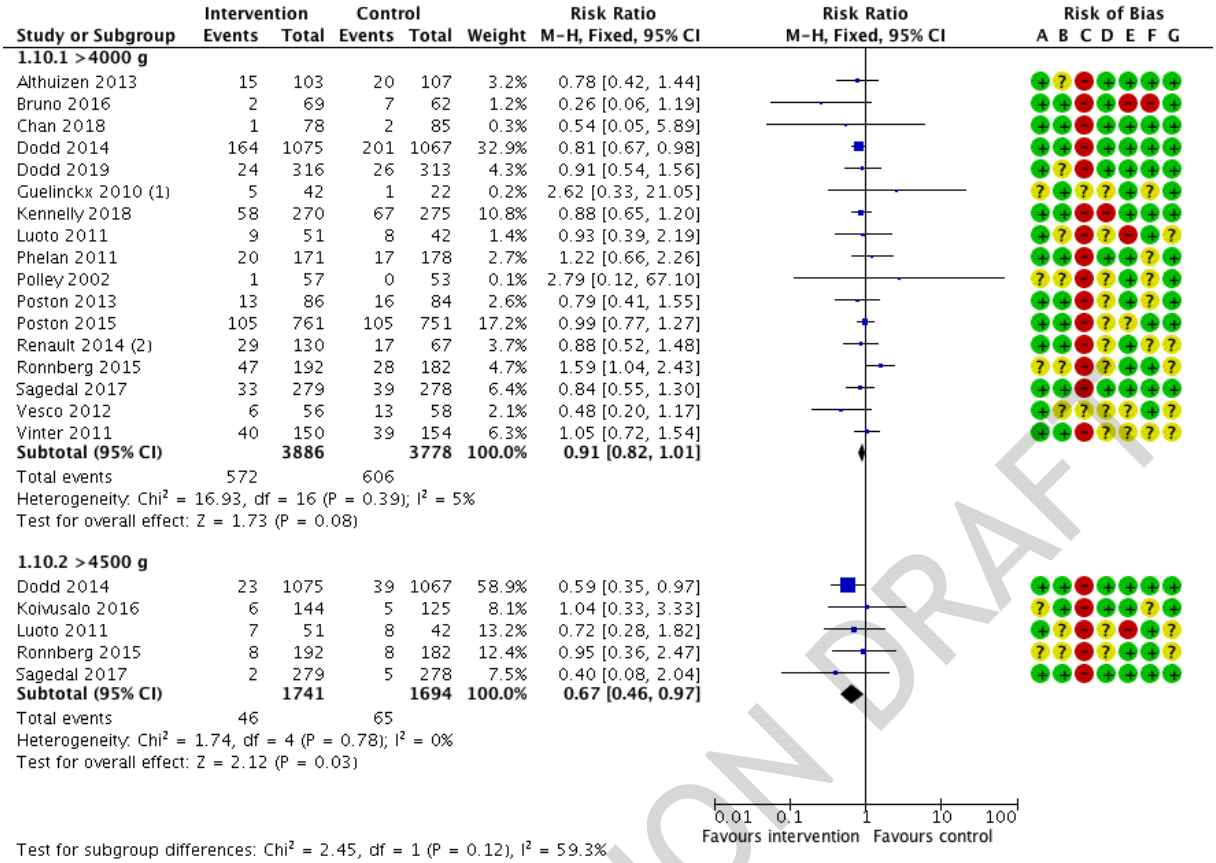
Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Dodd 2014	43	1075	56	1067	61.2%	0.76 [0.52, 1.12]
Dodd 2019	20	316	15	313	16.4%	1.32 [0.69, 2.53]
Kennelly 2018	8	270	4	275	4.3%	2.04 [0.62, 6.69]
Phelan 2011	9	171	17	178	18.1%	0.55 [0.25, 1.20]
Total (95% CI)		**1832**		**1833**	**100.0%**	**0.87 [0.65, 1.17]**
Total events	80		92			

Heterogeneity: Chi² = 5.31, df = 3 (P = 0.15); I² = 44%
Test for overall effect: Z = 0.93 (P = 0.35)



Risk of bias legend
(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective reporting (reporting bias)
(**G**) Other bias

5.11 Macrosomia >4,000 g



Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
1.10.1 >4000 g						
Althuizen 2013	15	103	20	107	3.2%	0.78 [0.42, 1.44]
Bruno 2016	2	69	7	62	1.2%	0.26 [0.06, 1.19]
Chan 2018	1	78	2	85	0.3%	0.54 [0.05, 5.89]
Dodd 2014	164	1075	201	1067	32.9%	0.81 [0.67, 0.98]
Dodd 2019	24	316	26	313	4.3%	0.91 [0.54, 1.56]
Guelinckx 2010 (1)	5	42	1	22	0.2%	2.62 [0.33, 21.05]
Kennelly 2018	58	270	67	275	10.8%	0.88 [0.65, 1.20]
Luoto 2011	9	51	8	42	1.4%	0.93 [0.39, 2.19]
Phelan 2011	20	171	17	178	2.7%	1.22 [0.66, 2.26]
Polley 2002	1	57	0	53	0.1%	2.79 [0.12, 67.10]
Poston 2013	13	86	16	84	2.6%	0.79 [0.41, 1.55]
Poston 2015	105	761	105	751	17.2%	0.99 [0.77, 1.27]
Renault 2014 (2)	29	130	17	67	3.7%	0.88 [0.52, 1.48]
Ronnberg 2015	47	192	28	182	4.7%	1.59 [1.04, 2.43]
Sagedal 2017	33	279	39	278	6.4%	0.84 [0.55, 1.30]
Vesco 2012	6	56	13	58	2.1%	0.48 [0.20, 1.17]
Vinter 2011	40	150	39	154	6.3%	1.05 [0.72, 1.54]
Subtotal (95% CI)		**3886**		**3778**	**100.0%**	**0.91 [0.82, 1.01]**
Total events	572		606			
Heterogeneity: Chi² = 16.93, df = 16 (P = 0.39); I² = 5%						
Test for overall effect: Z = 1.73 (P = 0.08)						
1.10.2 >4500 g						
Dodd 2014	23	1075	39	1067	58.9%	0.59 [0.35, 0.97]
Koivusalo 2016	6	144	5	125	8.1%	1.04 [0.33, 3.33]
Luoto 2011	7	51	8	42	13.2%	0.72 [0.28, 1.82]
Ronnberg 2015	8	192	8	182	12.4%	0.95 [0.36, 2.47]
Sagedal 2017	2	279	5	278	7.5%	0.40 [0.08, 2.04]
Subtotal (95% CI)		**1741**		**1694**	**100.0%**	**0.67 [0.46, 0.97]**
Total events	46		65			
Heterogeneity: Chi² = 1.74, df = 4 (P = 0.78); I² = 0%						
Test for overall effect: Z = 2.12 (P = 0.03)						

Risk Ratio M-H, Fixed, 95% CI

0.01 0.1 1 10 100

Favours intervention Favours control

Risk of Bias A B C D E F G

Test for subgroup differences: Chi² = 2.45, df = 1 (P = 0.12), I² = 59.3%

Footnotes

(1) 3-armed; control group halved

(2) 3-armed; control group halved

Risk of bias legend

(A) Random sequence generation (selection bias)

(B) Allocation concealment (selection bias)

(C) Blinding of participants and personnel (performance bias)

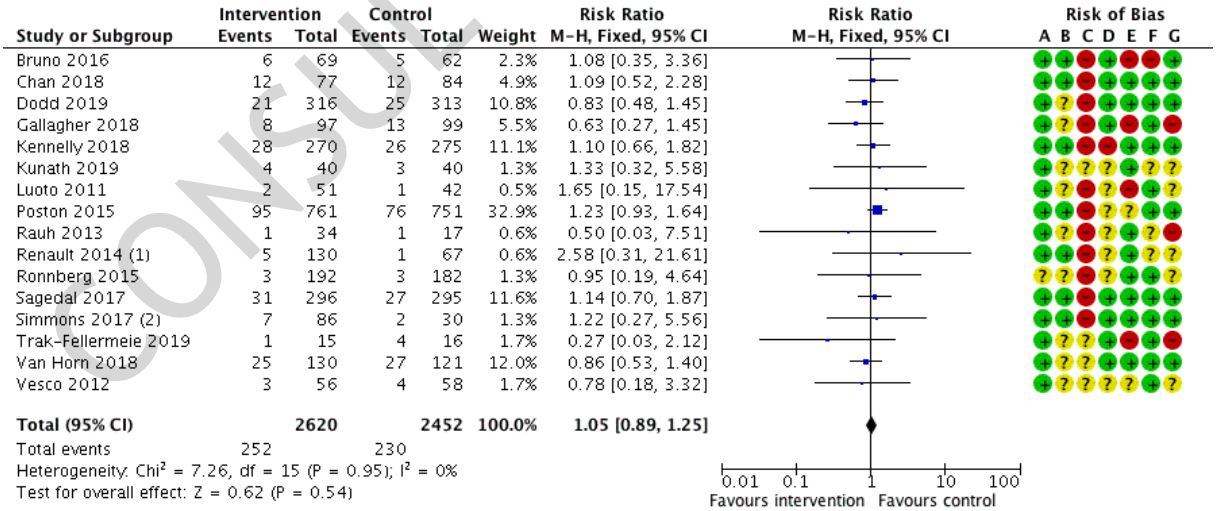
(D) Blinding of outcome assessment (detection bias)

(E) Incomplete outcome data (attrition bias)

(F) Selective reporting (reporting bias)

(G) Other bias

5.12 Small for gestational age



Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Bruno 2016	6	69	5	62	2.3%	1.08 [0.35, 3.36]
Chan 2018	12	77	12	84	4.9%	1.09 [0.52, 2.28]
Dodd 2019	21	316	25	313	10.8%	0.83 [0.48, 1.45]
Gallagher 2018	8	97	13	99	5.5%	0.63 [0.27, 1.45]
Kennelly 2018	28	270	26	275	11.1%	1.10 [0.66, 1.82]
Kunath 2019	4	40	3	40	1.3%	1.33 [0.32, 5.58]
Luoto 2011	2	51	1	42	0.5%	1.65 [0.15, 17.54]
Poston 2015	95	761	76	751	32.9%	1.23 [0.93, 1.64]
Rauh 2013	1	34	1	17	0.6%	0.50 [0.03, 7.51]
Renault 2014 (1)	5	130	1	67	0.6%	2.58 [0.31, 21.61]
Ronnberg 2015	3	192	3	182	1.3%	0.95 [0.19, 4.64]
Sagedal 2017	31	296	27	295	11.6%	1.14 [0.70, 1.87]
Simmons 2017 (2)	7	86	2	30	1.3%	1.22 [0.27, 5.56]
Trak-Fellermeie 2019	1	15	4	16	1.7%	0.27 [0.03, 2.12]
Van Horn 2018	25	130	27	121	12.0%	0.86 [0.53, 1.40]
Vesco 2012	3	56	4	58	1.7%	0.78 [0.18, 3.32]
Total (95% CI)		**2620**		**2452**	**100.0%**	**1.05 [0.89, 1.25]**
Total events	252		230			
Heterogeneity: Chi² = 7.26, df = 15 (P = 0.95); I² = 0%						
Test for overall effect: Z = 0.62 (P = 0.54)						

Risk Ratio M-H, Fixed, 95% CI

0.01 0.1 1 10 100

Favours intervention Favours control

Risk of Bias A B C D E F G

Footnotes

(1) 3-armed; control group halved

(2) 4-armed; control group divided by three

Risk of bias legend

(A) Random sequence generation (selection bias)

(B) Allocation concealment (selection bias)

(C) Blinding of participants and personnel (performance bias)

(D) Blinding of outcome assessment (detection bias)

(E) Incomplete outcome data (attrition bias)

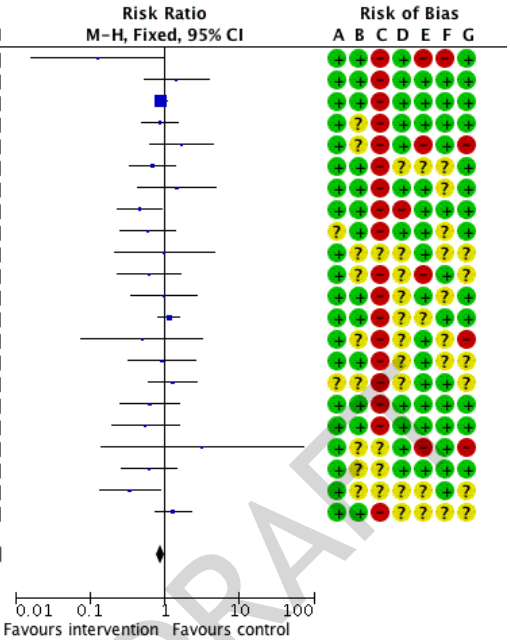
(F) Selective reporting (reporting bias)

(G) Other bias

5.13 Large for gestational age

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Bruno 2016	1	69	7	62	1.5%	0.13 [0.02, 1.01]
Chan 2018	8	77	6	84	1.2%	1.45 [0.53, 4.00]
Dodd 2014	203	1075	224	1067	45.8%	0.90 [0.76, 1.07]
Dodd 2019	22	316	25	313	5.1%	0.87 [0.50, 1.51]
Gallagher 2018	10	97	6	99	1.2%	1.70 [0.64, 4.50]
Hui 2012	12	102	15	88	3.3%	0.69 [0.34, 1.39]
Hui 2014	6	57	4	56	0.8%	1.47 [0.44, 4.94]
Kennelly 2018	11	270	24	275	4.8%	0.47 [0.23, 0.93]
Koivusalo 2016	8	235	13	229	2.7%	0.60 [0.25, 1.42]
Kunath 2019	3	40	3	40	0.6%	1.00 [0.21, 4.66]
Luoto 2011	6	51	8	42	1.8%	0.62 [0.23, 1.64]
Poston 2013	7	86	7	84	1.4%	0.98 [0.36, 2.66]
Poston 2015	71	761	61	751	12.5%	1.15 [0.83, 1.59]
Rauh 2013	2	34	2	17	0.5%	0.50 [0.08, 3.25]
Renault 2014 (1)	9	130	5	67	1.3%	0.93 [0.32, 2.66]
Ronnberg 2015	15	192	11	182	2.3%	1.29 [0.61, 2.74]
Sagedal 2017	7	296	11	295	2.2%	0.63 [0.25, 1.61]
Simmons 2017	8	86	5	30	1.5%	0.56 [0.20, 1.57]
Trak-Fellermeie 2019	1	15	0	16	0.1%	3.19 [0.14, 72.69]
Van Horn 2018	8	130	12	121	2.5%	0.62 [0.26, 1.47]
Vesco 2012	5	56	15	58	3.0%	0.35 [0.13, 0.89]
Vinter 2011	23	150	18	154	3.6%	1.31 [0.74, 2.33]
Total (95% CI)		**4325**		**4130**	**100.0%**	**0.89 [0.79, 1.00]**
Total events	446		482			

Heterogeneity: Chi² = 23.78, df = 21 (P = 0.30); I² = 12%
Test for overall effect: Z = 1.93 (P = 0.05)



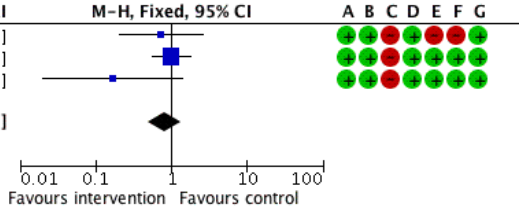
Footnotes
(1) 3-armed; control group halved

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

5.14 Apgar score <7 at 5 minutes

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Bruno 2016	4	69	5	62	15.8%	0.72 [0.20, 2.56]
Dodd 2014	22	1075	22	1067	66.2%	0.99 [0.55, 1.78]
Sagedal 2017	1	296	6	295	18.0%	0.17 [0.02, 1.37]
Total (95% CI)		**1440**		**1424**	**100.0%**	**0.80 [0.48, 1.32]**
Total events	27		33			

Heterogeneity: Chi² = 2.68, df = 2 (P = 0.26); I² = 25%
Test for overall effect: Z = 0.87 (P = 0.38)

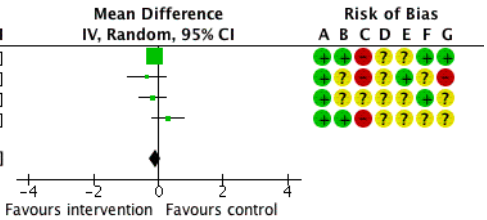


Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

5.15 Weight in early childhood

Study or Subgroup	Intervention Mean	Intervention SD	Intervention Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Poston 2015 (1)	7.93	1.07	332	8.03	1.08	345	65.8%	-0.10 [-0.26, 0.06]
Rauh 2013 (2)	9.38	0.93	33	9.74	1	15	7.9%	-0.36 [-0.96, 0.24]
Vesco 2012 (3)	9.83	0.93	51	10.01	1.24	52	15.0%	-0.18 [-0.60, 0.24]
Vinter 2011 (4)	14.7	1.82	82	14.4	1.3	75	11.4%	0.30 [-0.19, 0.79]
Total (95% CI)			**498**			**487**	**100.0%**	**-0.09 [-0.26, 0.08]**

Heterogeneity: Tau² = 0.00; Chi² = 3.39, df = 3 (P = 0.34); I² = 12%
Test for overall effect: Z = 0.99 (P = 0.32)



Footnotes
(1) 6 months
(2) 10-12 months
(3) 12 months
(4) 2.8 years

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

D Excluded studies

Diet (questions 1, 2 and 9)

Duplicate

Allen R, Rogozinska E, Sivarajasingam P et al (2014) Effect of diet- and lifestyle-based metabolic risk-modifying interventions on preeclampsia: a meta-analysis. *Acta Obstet Gynecol Scand* 93(10): 973-85.

Anleu E, Reyes M, Araya BM et al (2019) Effectiveness of an intervention of dietary counseling for overweight and obese pregnant women in the consumption of sugars and energy. *Nutrients* 11(2).

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Baroni L, Goggi S, Battaglino R et al (2018) Vegan nutrition for mothers and children: practical tools for healthcare providers. *Nutrients* 11(1).

Bennett CJ, Walker RE, Blumfield ML et al (2018) Interventions designed to reduce excessive gestational weight gain can reduce the incidence of gestational diabetes mellitus: A systematic review and meta-analysis of randomised controlled trials. *Diabetes Res Clin Pract* 141: 69-79.

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Lee YQ, Collins CE, Schumacher TL et al (2018) Disparities exist between the dietary intake of Indigenous Australian women during pregnancy and the Australian dietary guidelines: the Gomeroi gaaynggal study. *J Hum Nutr Diet* 31(4): 473-85.

Raghavan R, Dreibelbis C, Kingshipp BL et al (2019) Dietary patterns before and during pregnancy and maternal outcomes: a systematic review. *Am J Clin Nutr* 109(Suppl_7): 705S-28S.

Renault KM, Carlsen EM, Norgaard K et al (2015) Intake of sweets, snacks and soft drinks predicts weight gain in obese pregnant women: detailed analysis of the results of a randomised controlled trial. *PLoS One* 10(7): e0133041.

Schumacher TL, Weatherall L, Keogh L et al (2018) Characterizing gestational weight gain in a cohort of Indigenous Australian women. *Midwifery* 60: 13-19.

Tieu J, Shepherd E, Middleton P et al (2017) Dietary advice interventions in pregnancy for preventing gestational diabetes mellitus. *Cochrane Database Syst Rev* 1: CD006674.

Narrative review

Abiri B, Kelishadi R, Sadeghi H et al (2016) Effects of maternal diet during pregnancy on the risk of childhood acute lymphoblastic leukemia: a systematic review. *Nutrition and Cancer* 68(7): 1065-72.

Baroni L, Goggi S, Battaglino R et al (2018) Vegan nutrition for mothers and children: practical tools for healthcare providers. *Nutrients* 11(1).

Baskin R, Hill B, Jacka FN et al (2015) The association between diet quality and mental health during the perinatal period. A systematic review. *Appetite* 91: 41-7.

Biagi C, Nunzio MD, Bordoni A et al (2019) Effect of adherence to Mediterranean diet during pregnancy on children's health: a systematic review. *Nutrients* 11(5).

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Flynn AC, Dalrymple K, Barr S et al (2016) Dietary interventions in overweight and obese pregnant women: a systematic review of the content, delivery, and outcomes of randomized controlled trials. *Nutr Rev* 74(5): 312-28.

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O'Neil A, Itsiopoulos C, Skouteris H et al (2014) Preventing mental health problems in offspring by targeting dietary intake of pregnant women. *BMC Med* 12: 208.

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Rees WD (2019) Interactions between nutrients in the maternal diet and the implications for the long-term health of the offspring. *Proc Nutr Soc* 78(1): 88-96.

Sparling TM, Henschke N, Nesbitt RC et al (2017) The role of diet and nutritional supplementation in perinatal depression: a systematic review. *Matern Child Nutr* 13(1).

Tielemans MJ, Garcia AH, Peralta Santos A et al (2016) Macronutrient composition and gestational weight gain: a systematic review. *Am J Clin Nutr* 103(1): 83-99.

Wrong study design

Mijatovic-Vukas J, Capling L, Cheng S et al (2018) Associations of diet and physical activity with risk for gestational diabetes mellitus: a systematic review and meta-analysis. *Nutrients* 10(6).

Opie RS, Neff M, Tierney AC (2016) A behavioural nutrition intervention for obese pregnant women: Effects on diet quality, weight gain and the incidence of gestational diabetes. *Aust N Z J Obstet Gynaecol* 56(4): 364-73.

Wrong setting

Anleu E, Reyes M, Araya BM et al (2019) Effectiveness of an intervention of dietary counseling for overweight and obese pregnant women in the consumption of sugars and energy. *Nutrients* 11(2).

Lau Y, Klainin-Yobas P, Htun TP et al (2017) Electronic-based lifestyle interventions in overweight or obese perinatal women: a systematic review and meta-analysis. *Obes Rev* 18(9): 1071-87.

O'Brien OA, McCarthy M, Gibney ER et al (2014) Technology-supported dietary and lifestyle interventions in healthy pregnant women: a systematic review. *Eur J Clin Nutr* 68(7): 760-6.

Okesene-Gafa KAM, Li M, McKinlay CJD et al (2019) Effect of antenatal dietary interventions in maternal obesity on pregnancy weight-gain and birthweight: Healthy Mums and Babies (HUMBA) randomized trial. *Am J Obstet Gynecol* 221(2): 152 e1-52 e13.

Sherifali D, Nerenberg KA, Wilson S et al (2017) The effectiveness of ehealth technologies on weight management in pregnant and postpartum women: systematic review and meta-analysis. *J Med Internet Res* 19(10): e337.

Wrong population

Bao W, Bowers K, Tobias DK et al (2014) Prepregnancy low-carbohydrate dietary pattern and risk of gestational diabetes mellitus: a prospective cohort study. *Am J Clin Nutr* 99(6): 1378-84.

Bricker L, Reed K, Wood L et al (2015) Nutritional advice for improving outcomes in multiple pregnancies. *Cochrane Database Syst Rev*(11): CD008867.

Callaghan-Gillespie M, Schaffner AA, Garcia P et al (2017) Trial of ready-to-use supplemental food and corn-soy blend in pregnant Malawian women with moderate malnutrition: a randomized controlled clinical trial. *Am J Clin Nutr* 106(4): 1062-69.

Carmichael SL, Yang W, Gilboa S et al (2016) Elevated body mass index and decreased diet quality among women and risk of birth defects in their offspring. *Birth Defects Res A Clin Mol Teratol* 106(3): 164-71.

Deveer R, Deever M, Akbaba E et al (2013) The effect of diet on pregnancy outcomes among pregnants with abnormal glucose challenge test. *Eur Rev Med Pharmacol* 17: 1258-61.

Donazar-Ezcurra M, Lopez-Del Burgo C, Martinez-Gonzalez MA et al (2017) Pre-pregnancy adherences to empirically derived dietary patterns and gestational diabetes risk in a Mediterranean cohort: the Seguimiento Universidad de Navarra (SUN) project. *Br J Nutr* 118(9): 715-21.

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Koutelidakis AE, Alexatou O, Kousaiti S et al (2018) Higher adherence to Mediterranean diet prior to pregnancy is associated with decreased risk for deviation from the maternal recommended gestational weight gain. *Int J Food Sci Nutr* 69(1): 84-92.

Lamyian M, Hosseinpour-Niazi S, Mirmiran P et al (2017) Pre-pregnancy fast food consumption is associated with gestational diabetes mellitus among Tehranian women. *Nutrients* 9(3).

Looman M, Schoenaker D, Soedamah-Muthu SS et al (2018) Pre-pregnancy dietary carbohydrate quantity and quality, and risk of developing gestational diabetes: the Australian Longitudinal Study on Women's Health. *Br J Nutr* 120(4): 435-44.

Mijatovic-Vukas J, Capling L, Cheng S et al (2018) Associations of Diet and Physical Activity with Risk for Gestational Diabetes Mellitus: A Systematic Review and Meta-Analysis. *Nutrients* 10(6).

Ormesher L, Myers JE, Chmiel C et al (2018) Effects of dietary nitrate supplementation, from beetroot juice, on blood pressure in hypertensive pregnant women: A randomised, double-blind, placebo-controlled feasibility trial. *Nitric Oxide* 80: 37-44.

Osorio-Yanez C, Gelaye B, Qiu C et al (2017) Maternal intake of fried foods and risk of gestational diabetes mellitus. *Ann Epidemiol* 27(6): 384-90 e1.

Parisi F, Rousian M, Koning IV et al (2018) Periconceptional maternal dairy-rich dietary pattern is associated with prenatal cerebellar growth. *PLoS One* 13(5): e0197901.

Wrong outcomes

Donnelly JM, Walsh JM, Byrne J et al (2015) Impact of maternal diet on neonatal anthropometry: a randomized controlled trial. *Pediatr Obes* 10(1): 52-6.

Gresham E, Bisquera A, Byles JE et al (2016) Effects of dietary interventions on pregnancy outcomes: a systematic review and meta-analysis. *Matern Child Nutr* 12(1): 5-23.

Horan MK, McGowan CA, Gibney ER et al (2016) Maternal nutrition and glycaemic index during pregnancy impacts on offspring adiposity at 6 months of age--analysis from the ROLO randomised controlled trial. *Nutrients* 8(1).

Kinnunen TI, Puhkala J, Raitanen J et al (2014) Effects of dietary counselling on food habits and dietary intake of Finnish pregnant women at increased risk for gestational diabetes - a secondary analysis of a cluster-randomized controlled trial. *Matern Child Nutr* 10(2): 184-97.

Ota E, Hori H, Mori R et al (2015) Antenatal dietary education and supplementation to increase energy and protein intake. *Cochrane Database Syst Rev*(6): CD000032.

Taylor RM, Fealy SM, Bisquera A et al (2017) Effects of nutritional interventions during pregnancy on infant and child cognitive outcomes: a systematic review and meta-analysis. *Nutrients* 9(11).

Wrong comparator

Hill B, Skouteris H, Fuller-Tyszkiewicz M et al (2016) Can a health coaching intervention delivered during pregnancy help prevent excessive gestational weight gain? *Journal of Behavioral Medicine* 39(5): 793-803.

Kizirian NV, Kong Y, Muirhead R et al (2016) Effects of a low-glycemic index diet during pregnancy on offspring growth, body composition, and vascular health: a pilot randomized controlled trial. *Am J Clin Nutr* 103(4): 1073-82.

Moses RG, Casey SA, Quinn EG et al (2014) Pregnancy and Glycemic Index Outcomes study: effects of low glycemic index compared with conventional dietary advice on selected pregnancy outcomes. *Am J Clin Nutr* 99(3): 517-23.

Skouteris H, McPhie S, Hill B et al (2016) Health coaching to prevent excessive gestational weight gain: A randomized-controlled trial. *Br J Health Psychol* 21(1): 31-51.

Study included in a systematic review

Karamanos B, Thanopoulou A, Anastasiou E et al (2013) Relation of the Mediterranean diet with the incidence of gestational diabetes. *European Journal of Clinical Nutrition* 68(1): 8-13.

Markovic TP, Muirhead R, Overs S et al (2016) Randomized Controlled trial investigating the effects of a low-glycemic index diet on pregnancy outcomes in women at high risk of gestational diabetes mellitus: The GI Baby 3 Study. *Diabetes Care* 39(1): 31-8.

Petherick ES, Tuffnell D, Wright J (2014) Experiences and outcomes of maternal Ramadan fasting during pregnancy: results from a sub-cohort of the Born in Bradford birth cohort study. *BMC Pregnancy Childbirth* 14: 335.

Seckin KD, Yeral MI, Karsli MF et al (2014) Effect of maternal fasting for religious beliefs on fetal sonographic findings and neonatal outcomes. *Int J Gynaecol Obstet* 126(2): 123-5.

Systematic review with all studies included in another systematic review

Gresham E, Byles JE, Bisquera A et al (2014) Effects of dietary interventions on neonatal and infant outcomes: a systematic review and meta-analysis. *American J Clin Nutrition* 100(5): 1298-321.

Overview of studies included individually

Peaceman AM, Clifton RG, Phelan S et al (2018) Lifestyle interventions limit gestational weight gain in women with overweight or obesity: LIFE-Moms Prospective meta-analysis. *Obesity (Silver Spring)* 26(9): 1396-404.

Pregnancy not reported separately

Garcia-Larsen V, Ierodiakonou D, Jarrold K et al (2018) Diet during pregnancy and infancy and risk of allergic or autoimmune disease: A systematic review and meta-analysis. *PLoS Med* 15(2): e1002507.

Netting MJ, Middleton PF, Makrides M (2014) Does maternal diet during pregnancy and lactation affect outcomes in offspring? A systematic review of food-based approaches. *Nutrition* 30(11-12): 1225-41.

Not generalisable to the Australian context

Mani I, Dwarkanath P, Thomas T et al (2016) Maternal fat and fatty acid intake and birth outcomes in a South Indian population. *Int J Epidemiol* 45(2): 523-31.

Pathirathna ML, Sekijima K, Sadakata M et al (2017) Impact of second trimester maternal dietary intake on gestational weight gain and neonatal birth weight. *Nutrients* 9(6).

Supplements (question 3)

Vitamin B_9 (folic acid)

Wrong study design

Alfonso VH, Bandoli G, von Ehrenstein O et al (2018) Early folic acid supplement initiation and risk of adverse early childhood respiratory health: a population-based study. *Matern Child Health J* 22(1): 111-19.

Fortes C, Mastroeni S, Mannooranparampil TJ et al (2019) Pre-natal folic acid and iron supplementation and atopic dermatitis in the first 6 years of life. *Arch Dermatol Res* 311(5): 361-67.

Taylor CM, Atkinson C, Penfold C et al (2015) Folic acid in pregnancy and mortality from cancer and cardiovascular disease: further follow-up of the Aberdeen folic acid supplementation trial. *J Epidemiol Community Health* 69(8): 789-94.

Veeranki SP, Gebretsadik T, Dorris SL et al (2014) Association of folic acid supplementation during pregnancy and infant bronchiolitis. *Am J Epidemiol* 179(8): 938-46.

Veeranki SP, Gebretsadik T, Mitchel EF et al (2015) Maternal folic acid supplementation during pregnancy and early childhood asthma. *Epidemiology* 26(6): 934-41.

Yan J, Liu Y, Cao L et al (2017) Association between duration of folic acid supplementation during pregnancy and risk of postpartum depression. *Nutrients* 9(11).

Yu Y, Gu G, Yang J et al (2017) Correlation between folic acid supplement in different stage of pregnancy and wheezing in infants: a case-control study. *Int J Clin Exp Med* 10(9): 13950-53.

Zetstra-van der Woude PA, De Walle HE, Hoek A et al (2014) Maternal high-dose folic acid during pregnancy and asthma medication in the offspring. *Pharmacoepidemiol Drug Saf* 23(10): 1059-65.

Duplicate

Bixenstine PJ, Cheng TL, Cheng D et al (2015) Association between preconception counseling and folic acid supplementation before pregnancy and reasons for non-use. *Matern Child Health J* 19(9): 1974-84.

Hodgetts VA, Morris RK, Francis A et al. Effectiveness of folic acid supplementation in pregnancy on reducing the risk of small-for-gestational age neonates: a population study, systematic review and meta-analysis. *BJOG*. 2015; 122(4): 478-90.

USPST (2017) Folic acid supplementation for the prevention of neural tube defects: us preventive services task force recommendation statement. *JAMA* 317(2): 183-89.

Narrative review

Gao Y, Sheng C, Xie RH et al (2016) New perspective on impact of folic acid supplementation during pregnancy on neurodevelopment/autism in the offspring children - a systematic review. *PLoS One* 11(11): e0165626.

Gomes S, Lopes C, Pinto E (2016) Folate and folic acid in the periconceptional period: recommendations from official health organizations in thirty-six countries worldwide and WHO. *Public Health Nutr* 19(1): 176-89.

Murray LK, Smith MJ, Jadavji NM (2018) Maternal oversupplementation with folic acid and its impact on neurodevelopment of offspring. *Nutr Rev* 76(9): 708-21.

USPST (2017) Folic acid supplementation for the prevention of neural tube defects: us preventive services task force recommendation statement. *JAMA* 317(2): 183-89.

van Gool JD, Hirche H, Lax H et al (2018) Folic acid and primary prevention of neural tube defects: A review. *Reprod Toxicol* 80: 73-84.

Xie RH, Liu YJ, Retnakaran R et al (2016) Maternal folate status and obesity/insulin resistance in the offspring: a systematic review. *Int J Obes (Lond)* 40(1): 1-9.

Wrong population

Brown SB, Reeves KW, Bertone-Johnson ER (2014) Maternal folate exposure in pregnancy and childhood asthma and allergy: a systematic review. *Nutr Rev* 72(1): 55-64.

de Smit DJ, Weinreich SS, Cornel MC (2015) Effects of a simple educational intervention in well-baby clinics on women's knowledge about and intake of folic acid supplements in the periconceptional period: a controlled trial. *Public Health Nutr* 18(6): 1119-26.

Nguyen PH, Gonzalez-Casanova I, Young MF et al (2017) Preconception micronutrient supplementation with iron and folic acid compared with folic acid alone affects linear growth and fine motor development at 2 years of age: a randomized controlled trial in vietnam. *J Nutr* 147(8): 1593-601.

Suren P, Roth C, Bresnahan M et al (2013) Association between maternal use of folic acid supplements and risk of autism spectrum disorders in children. *JAMA* 309(6): 570-7.

Toivonen KI, Lacroix E, Flynn M et al (2018) Folic acid supplementation during the preconception period: A systematic review and meta-analysis. *Prev Med* 114: 1-17.

Not relevant to the Australian context

Cawley S, Mullaney L, McKeating A et al (2016a) Knowledge about folic acid supplementation in women presenting for antenatal care. *Eur J Clin Nutr* 70(11): 1285-90.

Systematic review with all studies included in another systematic review

Crider KS, Cordero AM, Qi YP et al (2013) Prenatal folic acid and risk of asthma in children: a systematic review and meta-analysis. *Am J Clin Nutr* 98(5): 1272-81.

Observational study included in a systematic review

Czeizel AE, Vereczkey A, Szabo I (2015) Folic acid in pregnant women associated with reduced prevalence of severe congenital heart defects in their children: a national population-based case-control study. *Eur J Obstet Gynecol Reprod Biol* 193: 34-9.

Does not answer research question

Cawley S, Mullaney L, McKeating A et al (2016b) A review of European guidelines on periconceptional folic acid supplementation. *Eur J Clin Nutr* 70(2): 143-54.

Chilukuri N, Cheng TL, Psoter KJ et al (2018) Effectiveness of a pediatric primary care intervention to increase maternal folate use: results from a cluster randomized controlled trial. *J Pediatr* 192: 247-52 e1.

Gildestad T, Bjorge T, Vollset SE et al (2015) Folic acid supplements and risk for oral clefts in the newborn: a population-based study. *Br J Nutr* 114(9): 1456-63.

Roy A, Kocak M, Hartman TJ et al (2018) Association of prenatal folate status with early childhood wheeze and atopic dermatitis. *Pediatr Allergy Immunol* 29(2): 144-50.

Shere M, Nguyen P, Tam C et al (2015) Pregnancy-induced changes in the long-term pharmacokinetics of 1.1 mg vs. 5 mg folic acid: a randomized clinical trial. *J Clin Pharmacol* 55(2): 159-67.

Yang L, Jiang L, Bi M et al (2015) High dose of maternal folic acid supplementation is associated to infant asthma. *Food Chem Toxicol* 75: 88-93. [Pregnancy not reported separately]

Yang X, Chen H, Du Y et al (2016) Periconceptional folic acid fortification for the risk of gestational hypertension and pre-eclampsia: a meta-analysis of prospective studies. *Matern Child Nutr* 12(4): 669-79.

Other B vitamins

Wrong study design

Falsaperla R, Saporito MAN, Di Stefano V et al (2017) Pyridoxine supplementation during pregnancy, lactation and the first months of life: A review of the literature. *Curr Pediatr Res* 21(4): 613-19.

Jeruszka-Bielak M, Isman C, Schroder TH et al (2017) South Asian ethnicity is related to the highest risk of vitamin B12 deficiency in pregnant Canadian women. *Nutrients* 9(4).

O'Malley EG, Reynolds CME, Cawley S et al (2018) Folate and vitamin B12 levels in early pregnancy and maternal obesity. *Eur J Obstet Gynecol Reprod Biol* 231: 80-84.

Pawlak R, Lester SE, Babatunde T (2014) The prevalence of cobalamin deficiency among vegetarians assessed by serum vitamin B12: a review of literature. *Eur J Clin Nutr* 68(5): 541-8.

Schroder TH, Sinclair G, Mattman A et al (2017) Pregnant women of South Asian ethnicity in Canada have substantially lower vitamin B12 status compared with pregnant women of European ethnicity. *Br J Nutr* 118(6): 454-62.

Sukumar N, Venkataraman H, Wilson S et al (2016) Vitamin B12 Status among pregnant women in the UK and Its association with obesity and gestational diabetes. *Nutrients* 8(12).

Does not answer research question

Devi S, Mukhopadhyay A, Dwarkanath P et al (2017) Combined vitamin B-12 and balanced protein-energy supplementation affect homocysteine remethylation in the methionine cycle in pregnant south indian women of low vitamin B-12 status. *J Nutrit* 147(6): 1094-103.

Raghavan R, Riley AW, Volk H et al (2018) Maternal multivitamin intake, plasma folate and vitamin B12 levels and autism spectrum disorder risk in offspring. *Paediatr Perinat Epidemiol* 32(1): 100-11.

Whitfield KC, Karakochuk CD, Kroeun H et al (2016) Perinatal consumption of thiamine-fortified fish sauce in rural cambodia: a randomized clinical trial. *JAMA Pediatr* 170(10): e162065.

Vitamin C

Wrong population

Azami M, Azadi T, Farhang S et al (2017) The effects of multi mineral-vitamin D and vitamins (C+E) supplementation in the prevention of preeclampsia: An RCT. *Int J Reprod Biomed (Yazd)* 15(5): 273-78. [High-risk pregnancies]

Zhou K, West HM, Zhang J et al (2015) Interventions for leg cramps in pregnancy. *Cochrane Database Syst Rev*(8): CD010655.

Yieh L, McEvoy CT, Hoffman SW et al (2018) Cost effectiveness of vitamin c supplementation for pregnant smokers to improve offspring lung function at birth and reduce childhood wheeze/asthma. *J Perinatol* 38(7): 820-27.

Narrative review

FIGO Working Group on Good Clinical Practice in Maternal-Fetal Medicine (2019) Good clinical practice advice: Micronutrients in the periconceptional period and pregnancy. *Int J Gynaecol Obstet* 144(3): 317-21.

Grzeskowiak L (2018) Vitamin and mineral supplementation during pregnancy: Is more necessarily better? *J Pharm Prac Res* 48: 106-07. [Editorial]

RCT included in another systematic review

Casanueva E, Ripoll C, Tolentino M et al (2005) Vitamin C supplementation to prevent premature rupture of the chorioamniotic membranes: a randomized trial. *Am J Clin Nutr* 81(4): 859-63.

Wrong intervention

Chavatte-Palmer P, Cohen JM, Beddaoui M et al (2015) Maternal antioxidant levels in pregnancy and risk of preeclampsia and small for gestational age birth: A systematic review and meta-analysis. *Plos One* 10(8).

Does not answer research question

Tita AT, Doherty L, Roberts JM et al (2018) Adverse maternal and neonatal outcomes in indicated compared with spontaneous preterm birth in healthy nulliparas: A secondary analysis of a randomized trial. *Am J Perinatol* 35(7): 624-31.

Vitamin E

Duplicate

Azami M, Azadi T, Farhang S et al (2017) The effects of multi mineral-vitamin D and vitamins (C+E) supplementation in the prevention of preeclampsia: An RCT. *Int J Reprod Biomed (Yazd)* 15(5): 273-78. [High-risk pregnancies]

RCT included in systematic review

Abramovici A, Gandley RE, Clifton RG et al (2015) Prenatal vitamin C and E supplementation in smokers is associated with reduced placental abruption and preterm birth: a secondary analysis. *BJOG* 122(13): 1740-7.

Vitamin A

Wrong outcomes

Ahmad SM, Alam MJ, Khanam A et al (2018) Vitamin A supplementation during pregnancy enhances pandemic H1N1 Vaccine response in mothers, but enhancement of transplacental antibody transfer may depend on when mothers are vaccinated during pregnancy. *The Journal of Nutrition* 148(12): 1968-75.

Narrative review

Cruz S, da Cruz SP, Ramalho A (2018) Impact of Vitamin A supplementation on pregnant women and on women who have just given birth: A systematic review. *J Am Coll Nutr* 37(3): 243-50.

No intervention

Cohen JM, Beddaoui M, Kramer MS et al (2015) Maternal antioxidant levels in pregnancy and risk of preeclampsia and small for gestational age birth: A systematic review and meta-analysis. *PLoS One* 10(8): e0135192.

Hanson C, Schumacher MV, Lyden E et al (2018) Fat-soluble vitamins A and E and health disparities in a cohort of pregnant women at delivery. *J Nutr Sci* 7: e14.

Multiple micronutrients

Wrong population

Akison LK, Kuo J, Reid N et al (2018) Effect of choline supplementation on neurological, cognitive, and behavioral outcomes in offspring arising from alcohol exposure during development: a quantitative systematic review of clinical and preclinical studies. *Alcoholism: Clinical and Experimental Research* 42(9): 1591-611.

Looman M, Schoenaker D, Soedamah-Muthu SS et al (2019) Pre-pregnancy dietary micronutrient adequacy is associated with lower risk of developing gestational diabetes in Australian women. *Nutr Res* 62: 32-40.

Does not answer research question

Barenys M, Masjosthusmann S, Fritsche E (2017) Is intake of flavonoid-based food supplements during pregnancy safe for the developing child? a literature review. *Curr Drug Targets* 18(2): 196-231.

Caudill MA, Strupp BJ, Muscalu L et al (2018) Maternal choline supplementation during the third trimester of pregnancy improves infant information processing speed: a randomized, double-blind, controlled feeding study. *FASEB J* 32(4): 2172-80.

Larson LM & Yousafzai AK (2017) A meta-analysis of nutrition interventions on mental development of children under-two in low- and middle-income countries. *Matern Child Nutr* 13(1).

Leermakers ET, Moreira EM, Kiefte-de Jong JC et al (2015) Effects of choline on health across the life course: a systematic review. *Nutr Rev* 73(8): 500-22.

Masih SP, Plumptre L, Ly A et al (2015) Pregnant Canadian women achieve recommended intakes of one-carbon nutrients through prenatal supplementation but the supplement composition, including choline, requires reconsideration. *J Nutr* 145(8): 1824-34.

Wilkinson D, Shepherd E, Wallace EM (2016) Melatonin for women in pregnancy for neuroprotection of the fetus. *Cochrane Database Syst Rev* 3: CD010527.

Duplicate

Perkins AV & Vanderlelie JJ (2016) Multiple micronutrient supplementation and birth outcomes: The potential importance of selenium. *Placenta* 48 Suppl 1: S61-S65.

Narrative review

Biesalski HK & Tinz J (2017) Multivitamin/mineral supplements: Rationale and safety - A systematic review. *Nutrition* 33: 76-82.

FIGO Working Group on Good Clinical Practice in Maternal-Fetal Medicine (2019) Good clinical practice advice: Micronutrients in the periconceptional period and pregnancy. *Int J Gynaecol Obstet* 144(3): 317-21.

Gernand AD (2019) The upper level: examining the risk of excess micronutrient intake in pregnancy from antenatal supplements. *Ann N Y Acad Sci* 1444(1): 22-34.

Parisi F, di Bartolo I, Savasi VM et al (2019) Micronutrient supplementation in pregnancy: Who, what and how much? *Obstet Med* 12(1): 5-13.

Perkins AV & Vanderlelie JJ (2016) Multiple micronutrient supplementation and birth outcomes: The potential importance of selenium. *Placenta* 48 Suppl 1: S61-S65.

Sparling TM, Henschke N, Nesbitt RC et al (2017) The role of diet and nutritional supplementation in perinatal depression: a systematic review. *Matern Child Nutr* 13(1).

Systematic review with all studies included in another systematic review

Devakumar D, Fall CH, Sachdev HS et al (2016) Maternal antenatal multiple micronutrient supplementation for long-term health benefits in children: a systematic review and meta-analysis. *BMC Med* 14: 90.

Taylor RM, Fealy SM, Bisquera A et al (2017) Effects of nutritional interventions during pregnancy on infant and child cognitive outcomes: a systematic review and meta-analysis. *Nutrients* 9(11).

Does not report on pregnancy separately

Garcia-Larsen V, Ierodiakonou D, Jarrold K et al (2018) Diet during pregnancy and infancy and risk of allergic or autoimmune disease: A systematic review and meta-analysis. *PLoS Med* 15(2): e1002507.

Not relevant to the Australian contetx

Quinn MK, Smith ER, Williams PL et al (2020) The effect of maternal multiple micronutrient supplementation on female early infant mortality is fully mediated by increased gestation duration and intrauterine growth. *J Nutr* 150(2): 356-63.

Suchdev PS, Pena-Rosas JP, De-Regil LM (2015) Multiple micronutrient powders for home (point-of-use) fortification of foods in pregnant women. *Cochrane Database Syst Rev*(6): CD011158.

Iron

Wrong population

Ali MK, Abbas AM, Abdelmagied AM et al (2017) A randomized clinical trial of the efficacy of single versus double-daily dose of oral iron for prevention of iron deficiency anemia in women with twin gestations. *J Matern Fetal Neonatal Med* 30(23): 2884-89.

Angulo-Barroso RM, Li M, Santos DC et al (2016) Iron Supplementation in Pregnancy or Infancy and Motor Development: A Randomized Controlled Trial. *Pediatrics* 137(4).

Nguyen PH, Young M, Gonzalez-Casanova I et al (2016) Impact of Preconception Micronutrient Supplementation on Anemia and Iron Status during Pregnancy and Postpartum: A Randomized Controlled Trial in Rural Vietnam. *PLoS One* 11(12): e0167416.

Systematic literature review with all studies included in another systematic review

Cantor AG, Bougatsos C, Dana T et al (2015) Routine iron supplementation and screening for iron deficiency anemia in pregnancy: a systematic review for the U.S. Preventive Services Task Force. *Ann Intern Med* 162(8): 566-76.

Narrative review

Iqbal S & Ekmekcioglu C (2019) Maternal and neonatal outcomes related to iron supplementation or iron status: a summary of meta-analyses. *J Matern Fetal Neonatal Med* 32(9): 1528-40.

Wrong comparator

Matias SL, Mridha MK, Young RT et al (2018) Daily Maternal Lipid-Based Nutrient Supplementation with 20 mg Iron, Compared with Iron and Folic Acid with 60 mg Iron, Resulted in Lower Iron Status in Late Pregnancy but Not at 6 Months Postpartum in Either the Mothers or Their Infants in Bangladesh. *J Nutr* 148(10): 1615-24.

Serdula MK, Zhou Y, Li H et al (2019) Prenatal iron containing supplements provided to Chinese women with no or mild anemia had no effect on hemoglobin concentration in post-partum women or their infants at 6 and 12 months of age. *Eur J Clin Nutr* 73(11): 1473-79.

Wang L, Mei Z, Li H et al (2016) Modifying effects of maternal Hb concentration on infant birth weight in women receiving prenatal iron-containing supplements: a randomised controlled trial. *Br J Nutr* 115(4): 644-9.

Does not answer research question

Yadav K, Ahamed F, Kant S et al (2018) Effect of directly observed oral iron supplementation during pregnancy on iron status in a rural population in Haryana: A randomized controlled trial. *Indian Journal of Public Health* 62(4).

Calcium

Wrong population

Hofmeyr GJ & Manyame S (2017) Calcium supplementation commencing before or early in pregnancy, or food fortification with calcium, for preventing hypertensive disorders of pregnancy. *Cochrane Database Syst Rev* 9: CD011192.

Hofmeyr GJ, Betrán AP, Singata-Madliki M et al (2019) Prepregnancy and early pregnancy calcium supplementation among women at high risk of pre-eclampsia: a multicentre, double-blind, randomised, placebo-controlled trial. *The Lancet* 393(10169): 330-39.

Systematic review with all studies included in another systematic review

An L-b, Li W-t, Xie T-n et al (2015) Calcium supplementation reducing the risk of hypertensive disorders of pregnancy and related problems: A meta-analysis of multicentre randomized controlled trials. *International Journal of Nursing Practice* 21: 19-31.

Wrong interevention

Asemi Z, Samimi M, Siavashani MA et al (2016) Calcium-Vitamin D Co-supplementation Affects Metabolic Profiles, but not Pregnancy Outcomes, in Healthy Pregnant Women. *Int J Prev Med* 7: 49.

Mansouri A, Mirghafourvand M, Charandabi SMA et al (2017) The effect of Vitamin D and calcium plus Vitamin D on leg cramps in pregnant women: A randomized controlled trial. *J Res Med Sci* 22: 24.

Does not answer research question

Cormick AP, Betran IB, Romero CF et al (2019) Global inequities in dietary calcium intake during pregnancy: a systematic review and meta-analysis. *BJOG* 126(4):444-456.

Jung ME, Stork MJ, Stapleton J et al (2016) A systematic review of behavioural interventions to increase maternal calcium intake. *Matern Child Nutr* 12(2): 193-204.

Ward KA, Jarjou L, Prentice A (2017) Long-term effects of maternal calcium supplementation on childhood growth differ between males and females in a population accustomed to a low calcium intake. *Bone* 103: 31-38.

Iodine

Duplicate

Abel MH, Brandlistuen RE, Caspersen IH et al (2019) Language delay and poorer school performance in children of mothers with inadequate iodine intake in pregnancy: results from follow-up at 8 years in the Norwegian Mother and Child Cohort Study. *Eur J Nutr* 58(8): 3047-58.

Farebrother J, Naude CE, Nicol L et al (2018) Effects of iodized salt and iodine supplements on prenatal and postnatal growth: a systematic review. *Adv Nutr* 9(3): 219-37.

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Wrong study design

Abel MH, Brandlistuen RE, Caspersen IH et al (2019) Language delay and poorer school performance in children of mothers with inadequate iodine intake in pregnancy: results from follow-up at 8 years in the Norwegian Mother and Child Cohort Study. *Eur J Nutr* 58(8): 3047-58.

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Narrative review

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Does not answer research question

Amiri P, Hamzavi Zarghani N, Nazeri P et al (2017) Can an educational intervention improve iodine nutrition status in pregnant women? a randomized controlled trial. *Thyroid* 27(3): 418-25.

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Nazarpour S, Ramezani Tehrani F, Behboudi-Gandevani S et al (2019) Maternal urinary iodine concentration and pregnancy outcomes in euthyroid pregnant women: a systematic review and meta-analysis. *Biol Trace Elem Res*.

Wrong population

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Zinc

Wrong outcomes

Ahmad SM, Hossain MB, Monirujjaman M et al (2016) Maternal zinc supplementation improves hepatitis B antibody responses in infants but decreases plasma zinc level. *Eur J Nutr* 55(5): 1823-9.

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Wrong population

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Shah D, Sachdev HS, Gera T et al (2016) Fortification of staple foods with zinc for improving zinc status and other health outcomes in the general population. *Cochrane Database Syst Rev*(6): CD010697.

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Narrative review

Terrin G, Berni Canani R, Di Chiara M et al (2015) Zinc in early life: a key element in the fetus and preterm neonate. *Nutrients* 7(12): 10427-46.

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Does not answer research question

Naem NE, El-Sayed NM, Nossier SA et al (2014) Zinc status and dietary intake of pregnant women, Alexandria, Egypt. *J Egypt Public Health Assoc* 89(1): 35-41.

Magnesium

Duplicate

Veronese N, Demurtas J, Pesolillo G et al (2020) Magnesium and health outcomes: an umbrella review of systematic reviews and meta-analyses of observational and intervention studies. *Eur J Nutr* 59(1): 263-72.

Wrong study design

Alves JG, de Araujo CA, Pontes IE et al (2014) The BRAzil MAGnesium (BRAMAG) trial: a randomized clinical trial of oral magnesium supplementation in pregnancy for the prevention of preterm birth and perinatal and maternal morbidity. *BMC Pregnancy Childbirth* 14: 222. [Protocol]

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Not supplementation

Lai JS, Cai S, Feng L et al (2019) Associations of maternal zinc and magnesium with offspring learning abilities and cognitive development at 4 years in GUSTO. *Nutr Neurosci*: 1-10.

Wrong population

Asemi Z, Karamali M, Jamilian M et al (2015) Magnesium supplementation affects metabolic status and pregnancy outcomes in gestational diabetes: a randomized, double-blind, placebo-controlled trial. *The American Journal of Clinical Nutrition* 102(1): 222-29.

Fard FE, Mirghafourvand M, Mohammad-Alizadeh Charandabi S et al (2017) Effects of zinc and magnesium supplements on postpartum depression and anxiety: A randomized controlled clinical trial. *Women Health* 57(9): 1115-28.

Systematic review with all studies included in another systematic review

Veronese N, Demurtas J, Pesolillo G et al (2020) Magnesium and health outcomes: an umbrella review of systematic reviews and meta-analyses of observational and intervention studies. *Eur J Nutr* 59(1): 263-72.

Selenium

Wrong study design

Barman M, Brantsaeter AL, Nilsson S et al. Maternal dietary selenium intake is associated with increased gestational length and decreased risk of preterm delivery. *Br J Nutr*. 2020; 123(2): 209-19.

Pieczynska J, Placzkowska S, Sozanski R et al. Is maternal dietary selenium intake related to antioxidant status and the occurrence of pregnancy complications? *J Trace Elem Med Biol*. 2019; 54: 110-7.

Wrong intervention

Guo Y, Yu P, Zhu J et al. High maternal selenium levels are associated with increased risk of congenital heart defects in the offspring. *Prenat Diagn*. 2019; 39(12): 1107-14.

Lewandowska M, Sajdak S, Lubinski J. The role of early pregnancy maternal selenium levels on the risk for small-for-gestational age newborns. *Nutrients*. 2019; 11(10).

Lewandowska M, Sajdak S, Lubiński J. Serum selenium level in early healthy pregnancy as a risk marker of pregnancy induced hypertension. *Nutrients*. 2019; 11(5).

Wrong population

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Narrative review

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Nutritionally based complementary medicines (question 4)

Herbal preparations

Non-ingested modalities

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Garcia-Mochon L, Martin JJ, Aranda-Regules JM et al (2015) Cost effectiveness of using moxibustion to correct non-vertex presentation. *Acupunct Med* 33(2): 136-41.

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Narrative review

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Bowman D, Steel A, Adams J et al (2014) The characteristics of women using different forms of botanical medicines to manage pregnancy-related health conditions: A preliminary cross-sectional analysis. *Advances in Integrative Medicine* 1(3): 138-43.

Dante G, Bellei G, Neri I et al (2014) Herbal therapies in pregnancy: what works? *Curr Opin Obstet Gynecol* 26(2): 83-91.

Frawley J, Adams J, Broom A et al (2014) Majority of women are influenced by nonprofessional information sources when deciding to consult a complementary and alternative medicine practitioner during pregnancy. *J Altern Complement Med* 20(7): 571-7.

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Frawley J, Sundberg T, Steel A et al (2016b) Prevalence and characteristics of women who consult with osteopathic practitioners during pregnancy; a report from the Australian Longitudinal Study on Women's Health (ALSWH). *J Bodyw Mov Ther* 20(1): 168-72.

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Mollart L, Stulz V, Foureur M (2019) Midwives' personal views and beliefs about complementary and alternative medicine (CAM): A national survey. *Complement Ther Clin Pract* 34: 235-39.

Munoz Balbontin Y, Stewart D, Shetty A et al (2019) Herbal medicinal product use during pregnancy and the postnatal period: a systematic review. *Obstet Gynecol* 133(5): 920-32.

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Ozgoli G & Saei Ghare Naz M (2018) Effects of complementary medicine on nausea and vomiting in pregnancy: a systematic review. *Int J Prev Med* 9: 75.

Peng W, Lauche R, Frawley J et al (2018) Utilization of complementary and alternative medicine and conventional medicine for headache or migraine during pregnancy: A cross-sectional survey of 1,835 pregnant women. *Complement Ther Med* 41: 192-95.

Sibbritt DW, Catling CJ, Adams J et al (2014) The self-prescribed use of aromatherapy oils by pregnant women. *Women Birth* 27(1): 41-5.

Steel A (2016) Important considerations of the use of complementary and alternative medicine through pregnancy, labour and birth: an update based on recent Australian research. *Aust J Herb Med* 28(2): 36-40.

Steel A, Adams J, Sibbritt D et al (2014) Determinants of women consulting with a complementary and alternative medicine practitioner for pregnancy-related health conditions. *Women Health* 54(2): 127-44.

Steel A, Hall H, Diezel H et al (2019) Filling the gaps in contemporary maternity care: The perceptions of complementary medicine practitioners providing care to women during pregnancy. *Complement Ther Clin Pract* 34: 174-78.

Does not answer research question

Boelig RC, Barton SJ, Saccone G et al (2018) Interventions for treating hyperemesis gravidarum: a Cochrane systematic review and meta-analysis. *J Matern Fetal Neonatal Med* 31(18): 2492-505.

Jo J, Lee SH, Lee JM et al (2016) Use and safety of Korean herbal medicine during pregnancy: A Korean medicine literature review. *European Journal of Integrative Medicine* 8(1): 4-11.

Raikkonen K, Martikainen S, Pesonen AK et al (2017) Maternal licorice consumption during pregnancy and pubertal, cognitive, and psychiatric outcomes in children. *Am J Epidemiol* 185(5): 317-28.

Shawahna R & Taha A (2017) Which potential harms and benefits of using ginger in the management of nausea and vomiting of pregnancy should be addressed? A consensual study among pregnant women and gynecologists. *BMC Complement Altern Med* 17(1): 204.

Wrong comparator

Boltman-Binkowski H (2016) A systematic review: Are herbal and homeopathic remedies used during pregnancy safe? *Curationis* 39(1): 1514.

Jafari-Dehkordi E, Hashem-Dabaghian F, Aliasl F et al (2017) Comparison of quince with vitamin B6 for treatment of nausea and vomiting in pregnancy: a randomised clinical trial. *J Obstet Gynaecol* 37(8): 1048-52.

Shakeri A, Hashempur MH, Mojibian M et al (2018) A comparative study of ranitidine and quince (Cydonia oblonga mill) sauce on gastroesophageal reflux disease (GERD) in pregnancy: a randomised, open-label, active-controlled clinical trial. *J Obstet Gynaecol* 38(7): 899-905.

Wrong outcomes

Cao H, Wu R, Han M et al (2017) Oral administration of Chinese herbal medicine during gestation period for preventing hemolytic disease of the newborn due to ABO incompatibility: A systematic review of randomized controlled trials. *PLoS One* 12(7): e0180746.

Wrong intervention

Dennis CL & Dowswell T (2013) Interventions (other than pharmacological, psychosocial or psychological) for treating antenatal depression. *Cochrane Database Syst Rev*(7): CD006795.

Evans K, Morrell CJ, Spiby H (2018) Systematic review and meta-analysis of non-pharmacological interventions to reduce the symptoms of mild to moderate anxiety in pregnant women. *J Adv Nurs* 74(2): 289-309.

Duplicate

Frawley J, Adams J, Steel A et al (2015) Women's use and self-prescription of herbal medicine during pregnancy: an examination of 1,835 pregnant women. *Womens Health Issues* 25(4): 396-402.

RCT included in a systematic review

Sharifzadeh F, Kashanian M, Koohpayehzadeh J et al (2018) A comparison between the effects of ginger, pyridoxine (vitamin B6) and placebo for the treatment of the first trimester nausea and vomiting of pregnancy (NVP). *J Matern Fetal Neonatal Med* 31(19): 2509-14.

Systematic review with all studies included in another systematic review

Matthews A, Haas DM, O'Mathuna DP et al (2015) Interventions for nausea and vomiting in early pregnancy. *Cochrane Database Syst Rev*(9): CD007575.

McParlin C, O'Donnell A, Robson SC et al (2016) Treatments for hyperemesis gravidarum and nausea and vomiting in pregnancy: a systematic review. *JAMA* 316(13): 1392-401.

Probiotics

Supplementation beyond pregnancy

Allen SJ, Jordan S, Storey M et al (2014) Probiotics in the prevention of eczema: a randomised controlled trial. *Arch Dis Child* 99(11): 1014-9.

Baldassarre ME, Di Mauro A, Mastromarino P et al (2016) Administration of a multi-strain probiotic product to women in the perinatal period differentially affects the breast milk cytokine profile and may have beneficial effects on neonatal gastrointestinal functional symptoms. a randomized clinical trial. *Nutrients* 8(11).

Garcia-Larsen V, Ierodiakonou D, Jarrold K et al (2018) Diet during pregnancy and infancy and risk of allergic or autoimmune disease: A systematic review and meta-analysis. *PLoS Med* 15(2): e1002507.

Kallio S, Kukkonen AK, Savilahti E et al (2019) Perinatal probiotic intervention prevented allergic disease in a Caesarean-delivered subgroup at 13-year follow-up. *Clin Exp Allergy* 49(4): 506-15.

Mansfield JA, Bergin SW, Cooper JR et al (2014) Comparative probiotic strain efficacy in the prevention of eczema in infants and children: a systematic review and meta-analysis. *Mil Med* 179(6): 580-92.

Simpson MR, Dotterud CK, Storro O et al (2015) Perinatal probiotic supplementation in the prevention of allergy related disease: 6 year follow up of a randomised controlled trial. *BMC Dermatol* 15: 13.

Slykerman RF, Hood F, Wickens K et al (2017) Effect of Lactobacillus rhamnosus HN001 in pregnancy on postpartum symptoms of depression and anxiety: a randomised double-blind placebo-controlled trial. *EBioMedicine* 24: 159-65.

Slykerman RF, Kang J, Van Zyl N et al (2018) Effect of early probiotic supplementation on childhood cognition, behaviour and mood a randomised, placebo-controlled trial. *Acta Paediatr* 107(12): 2172-78.

Wickens K, Barthow C, Mitchell EA et al (2018a) Effects of Lactobacillus rhamnosus HN001 in early life on the cumulative prevalence of allergic disease to 11 years. *Pediatr Allergy Immunol* 29(8): 808-14.

Wickens K, Barthow C, Mitchell EA et al (2018b) Maternal supplementation alone with Lactobacillus rhamnosus HN001 during pregnancy and breastfeeding does not reduce infant eczema. *Pediatr Allergy Immunol* 29(3): 296-302.

Zuccotti G, Meneghin F, Aceti A et al (2015) Probiotics for prevention of atopic diseases in infants: systematic review and meta-analysis. *Allergy* 70(11): 1356-71.

Wrong study design

Bertelsen RJ, Brantsaeter AL, Magnus MC et al (2014) Probiotic milk consumption in pregnancy and infancy and subsequent childhood allergic diseases. *J Allergy Clin Immunol* 133(1): 165-71 e1-8.

Nordqvist M, Jacobsson B, Brantsaeter AL et al (2018) Timing of probiotic milk consumption during pregnancy and effects on the incidence of preeclampsia and preterm delivery: a prospective observational cohort study in Norway. *BMJ Open* 8(1): e018021.

Wrong comparator

Asgharian H, Homayouni-Rad A, Mirghafourvand M et al (2020) Effect of probiotic yoghurt on plasma glucose in overweight and obese pregnant women: a randomized controlled clinical trial. *Eur J Nutr* 59(1): 205-15.

Fernandez L, Cardenas N, Arroyo R et al (2016) Prevention of infectious mastitis by oral administration of Lactobacillus salivarius PS2 during late pregnancy. *Clin Infect Dis* 62(5): 568-73.

Mantaring J, Benyacoub J, Destura R et al (2018) Effect of maternal supplement beverage with and without probiotics during pregnancy and lactation on maternal and infant health: a randomized controlled trial in the Philippines. *BMC Pregnancy Childbirth* 18(1): 193.

Wrong outcomes

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Weight gain and monitoring (question 7)

Gestational weight change

Duplicate

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Wrong study design

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Wrong intervention

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Wrong outcomes

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Wrong comparator

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Wrong setting

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Narrative review

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Does not answer research question

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Weight monitoring

Duplicate

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Opinion piece

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Wrong setting

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Risk assessments (question 8)

Wrong study design

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Duplicate

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Does not answer research question

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Lifestyle counselling (question 9)

Duplicate

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Wrong study design

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Wrong setting

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Wrong population

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Wrong intervention

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Wrong comparator

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Wrong outcomes

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