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Scientific Advisory Committee on Nutrition

Nutrition and maternal weight outcomes

Contents

1. Background

1.1 UK dietary recommendations for pregnant and lactating women are based on advice from the Scientific Advisory Committee on Nutrition (SACN) and its predecessor, the Committee on Medical Aspects of Food and Nutrition Policy (COMA).

1.2 Dietary reference values (DRVs) for energy and nutrient requirements for the UK population and its subgroups, including pregnant and lactating women, were established by COMA in 'Dietary Reference Values for Food Energy and Nutrients for the United Kingdom' (Department of Health, 1991).

1.3 Subsequent reports by SACN have included consideration of requirements for pregnant and lactating women and updated dietary recommendations as appropriate. These include the following SACN reports:

- 'Dietary reference values for energy' (SACN, 2011a)
- 'Folate and disease prevention' (SACN, 2006)
- 'Update on folic acid' (SACN, 2017)
- 'The influence of maternal, fetal and child nutrition on the development of chronic disease in later life' (SACN, 2011b)
- 'Vitamin D and health' (SACN, 2016)

1.4 In 2016, SACN identified the 'health of women of reproductive age' as a focus area for SACN's future work programme. Accordingly, in 2019, it was agreed that a working group should be established to conduct a risk assessment on nutrition and maternal health focusing on maternal outcomes during pregnancy, childbirth and the postpartum period. Women of reproductive (or 'childbearing') age were subsequently defined as girls and women aged 14 to 49 years.

1.5 The draft scope for this risk assessment was considered by SACN in March 2019 and was then issued for comments from interested parties in July 2019. Details of the nutrition and maternal health working group are available on the SACN webpage. Responses were received from 11 interested parties and the scope was subsequently updated.

1.6 To complement this work, the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) was asked to conduct a review of the risks of toxicity from chemicals in the diet of girls and women and to consider whether current government advice should be revised.

Terms of reference

1.7 The terms of reference for SACN's consideration of nutrition and maternal health are:

- to review the scientific basis of UK dietary recommendations for women during preconception, pregnancy and up to 24 months after delivery, in relation to maternal health and pregnancy-related outcomes (that is, maternal outcomes during pregnancy, childbirth and up to 24 months after delivery)
- to make recommendations based on the review of the evidence

1.8 Preconception was considered from a biological perspective, as the critical period spanning from days to weeks before embryo development (Stephenson and others, 2018).

1.9 This report covers girls and women aged 14 to 49 years, hereafter referred to as 'women of childbearing age', unless a specific age group is being considered. Evidence from systematic reviews was sought for girls and women aged 16 years and over while national survey data was analysed from 14 years to allow consideration of nutritional status in the preconception period across the full age range.

1.10 The terms 'breastfeeding' and 'lactating' are both used in this report reflecting the terms used in the underlying sources.

1.11 This is the first of 2 publications on SACN's assessment of nutrition and maternal health. This report considers SACN's assessment of nutrition and maternal weight outcomes. A further position statement will consider wider UK dietary recommendations for women of childbearing age. This will include details of the COT statements describing COT's assessments, findings and associated advice.

1.12 SACN considers evidence for the general population. Clinical assessment and management are outside SACN's remit and are under the remit of the National Institute for Health and Care Excellence (NICE). This SACN report should be read alongside the NICE guidelines:

- Maternal and child nutrition: nutrition and weight management in pregnancy, and nutrition in children up to 5 years (NG247) (NICE, 2025a)

- Overweight and obesity management (NG246) (NICE, 2025b)

1.13 SACN acknowledges that people who do not identify as women can become pregnant. These people may have additional clinical needs that are beyond the remit of this report.

1.14 The evidence available for consideration in this report was from studies that collected data among pregnant women. No evidence was identified which referred to people who do not identify as women. Therefore, the terminology 'pregnant women' is used throughout to reflect the evidence included.

1.15 As stated in the SACN Code of Practice (available on the SACN webpage), SACN does not have a remit for risk management (that is, how the recommendations made are translated into policy and advice), which is the responsibility of government.

1.16 This report was developed using SACN process and was signed off by SACN (SACN, 2023).

Preconception body mass index

1.17 NICE guidance 'Overweight and obesity management' (NG246) highlighted the health benefits of being a healthy weight, and if necessary, losing weight, before pregnancy.

1.18 NICE (NG246) classifies weight status in adults using the following body mass index (BMI) ranges: underweight (below 18.5kg/m^2), healthy weight (18.5kg/m^2 to 24.9kg/m^2), overweight (25.0kg/m^2 to 29.9kg/m^2) and obesity (over 30kg/m^2). NICE advises using lower BMI thresholds as a practical measure of overweight and obesity among people with a South Asian, Chinese, other Asian, Middle Eastern, Black African or African-Caribbean family background due to a higher risk of central adiposity and increased cardiometabolic risk at a lower BMI. For these groups, overweight is classified as BMI 23kg/m^2 to 27.4kg/m^2 and obesity as a BMI 27.5kg/m^2 or above.

1.19 BMI categories for girls aged 14 to 18 years are not comparable to those for women aged 19 years and over. This is because the BMI measurement in children and young people needs to be adjusted for age. NICE recommends that BMI is plotted against growth and BMI charts to classify BMI centile in children and young people. In clinical settings, overweight is classified as a BMI over the 91st centile, obesity over the 98th centile and severe obesity over 99.6th centile (NICE, 2023). For population monitoring purposes, a child's BMI is classed as overweight or obese where it is on or above the 85th centile or 95th centile, respectively, based on the British 1990 (UK90) growth reference data (Cole and others, 1995).

1.20 Women living with preconception overweight and obesity, are at an increased risk of pregnancy-related complications, with women living with severe obesity (BMI of 40kg/m^2 or above) at a greatest risk (NMPA, 2021; SACN, 2011b; Santos and others, 2019). Risks for the mother include pre-eclampsia, high blood pressure, gestational diabetes mellitus (GDM), induction of labour, caesarean birth, wound infections, anaesthetic complications, thromboembolism, pre-term birth, maternal death and retaining weight after birth (Denison and others, 2019; SACN, 2011b; Vats and others, 2021; WHO, 2012). Risks for the fetus and baby include being born large for gestational age (LGA) (usually defined as birth weight above the 90th percentile), miscarriage, stillbirth, neonatal death, congenital anomalies, and a greater risk of becoming obese and developing type 2 diabetes (T2D) as children and adolescents (Godfrey and others, 2017; Poston and others, 2016; SACN, 2011b; Vats and others, 2021; WHO, 2012).

1.21 Maternal preconception BMI lower than the healthy range is also an important risk factor for maternal complications in pregnancy and for sub-optimal fetal growth (Institute of Medicine (IOM) and National Research Council (NRC), 2009). Women who are underweight at the beginning of pregnancy are at risk of pre-term birth (less than 37 weeks' gestation) and delivery of a small for gestational age (SGA) infant (birth weight less than the 10th percentile) (Vats and others, 2021).

Weight gain in pregnancy

1.22 There is considerable variation in weight gained during pregnancy (gestational weight gain (GWG)), with only a proportion due to increases in maternal body fat. GWG is made up of fetal components (amniotic fluid and fetal fat mass and fat-free mass), placental weight and maternal components (total body water, maternal blood volume, mammary gland and maternal fat-free and fat mass) (Champion and others, 2020; IOM and NRC, 2009). The increment in maternal fat mass is the most variable, accounting for approximately 70% of the variability in GWG. While average fat gain is approximately 2kg to 5kg, values can range from a loss of several kilograms to a gain of approximately 12kg (Allen, 2013).

1.23 Excess GWG (for example, as defined by the National Academy of Medicine (NAM), formerly IOM) has been associated with adverse fetal and childhood outcomes, including LGA macrosomia (usually defined as birth weight over 4kg), and offspring living with obesity. It has also been associated with adverse maternal outcomes including caesarean delivery, GDM, pre-eclampsia and postpartum weight retention (Goldstein and others, 2017; Voerman and others, 2019). However, some researchers have also questioned the validity of excess GWG as an indicator of adverse maternal and fetal outcomes (Dodd and others, 2024).

1.24 Inadequate GWG (for example, as defined by NAM, formerly IOM) has been associated with a greater risk of SGA infants and an increased risk of premature birth (Goldstein and others, 2017).

Preconception BMI and weight gain in pregnancy

1.25 Women with a high preconception BMI (those living with overweight or obesity) are at risk of complications, such as gestational hypertension, pre-eclampsia, GDM and LGA infant, regardless of how much weight they gain during pregnancy (Santos and others, 2019). A direct indication of increased maternal fat mass being a key mediator in these associations is derived from studies in which maternal adiposity was assessed in early pregnancy by anthropometric measures; these studies have shown relationships between increased adiposity and GDM, hypertensive disorders and delivery related outcomes (Heslehurst and others, 2022).

1.26 Evidence suggests a linear relationship between maternal preconception BMI and GWG, whereby GWG decreases with increasing preconception BMI (Dodd and others, 2024). This means that women living with overweight or obesity before pregnancy would typically have a lower GWG than women with a preconception BMI within a healthy range. Whilst GWG decreased linearly as maternal BMI increased, it was also observed that the risk of ‘excess’ GWG (based on NAM guidelines) increased markedly at BMI category thresholds (that is, between the normal and overweight BMI category threshold and between the overweight and obese BMI category threshold) (Dodd and others, 2024). Increasing maternal preconception BMI was associated with increased risk of adverse pregnancy outcomes, however, there was no evidence that this effect was mediated via effects on GWG (Dodd and others, 2024).

Guidance on weight gain in pregnancy

1.27 In 2025, NICE published its guidelines:

- ‘Maternal and child nutrition: nutrition and weight management in pregnancy, and nutrition in children up to 5 years’ (NG247)
- ‘Overweight and obesity management’ (NG246)

These guidelines update and replace:

- ’Maternal and child nutrition’ (PH11) published in 2008

- ’Weight management before, during and after pregnancy’ (PH27) published in 2010

1.28 The 2025 NICE guideline NG247 on maternal and child nutrition provides guidance for healthcare professionals on weight management in pregnancy. It notes that recommendations on sensitive communication and avoiding stigma during discussions about weight should be followed when discussing weight during pregnancy.

1.29 Recommendations made in the 2025 NICE guideline NG247 on maternal and child nutrition include that:

- the focus should be on starting or maintaining a healthy diet and physical activity during pregnancy
- people do not need to ‘eat for two’ and, other than avoiding specific foods and drinks, they do not need a special diet during pregnancy
- it is important to eat a variety of different foods every day to get the right balance of nutrients
- intentional weight loss during pregnancy is not recommended because of potential adverse effects on the baby

1.30 The 2025 NICE guideline NG247 on maternal and child nutrition highlights that there are currently no evidence-based UK guidelines on recommended weight-gain ranges during pregnancy due to uncertainties around optimal weight change in pregnancy (NICE, 2025a). NICE advise that if people are interested in monitoring their weight change during pregnancy, the NAM (formerly IOM) gestational weight recommendations can be referred to.

1.31 In the USA, the NAM (formerly IOM) published revised GWG guidelines based on preconception BMI. These were developed primarily from the findings of observational studies from high income countries (HICs) and did not include common complications of pregnancy, including gestational hypertension, pre-eclampsia and GDM (IOM and NRC, 2009; WHO, 2023a).

1.32 The NAM (formerly IOM) guidelines for total weight gain and rate of weight gain during pregnancy by preconception BMI are shown in Table 1.1.

Table 1.1: recommendations by the NAM (formerly IOM) for total and rate of weight gain during pregnancy, by preconception BMI (notes 1, 2)

Preconception body weight classification	BMI (kg/m^2) (WHO)	Total weight gain range (kg)	Mean (range) rates of weight gain 2nd and 3rd trimester (kg per week) (note 3)
Underweight	<18.5	12.5 to 18.0	0.51 (range 0.44 to 0.58)
Normal weight	18.5 to 24.9	11.5 to 16.0	0.42 (range 0.35 to 0.50)
Overweight	25.0 to 29.9	7.0 to 11.5	0.28 (range 0.23 to 0.33)
Obese (includes all classes)	≥30.0	5.0 to 9.0	0.22 (range 0.17 to 0.27)

Note 1: table depicted from the IOM report (IOM and NRC, 2009).

Note 2: symbols and abbreviations used in table: < less than; ≥ more than or equal to; BMI, body mass index; WHO, World Health Organization.

Note 3: calculations assume a 0.5 to 2kg (1.1 to 4.4lbs) weight gain in the first trimester (Abrams and others, 1995; Carmichael and others, 1997; Siega-Riz and others, 1994).

1.33 The joint Food and Agriculture Organization of the United Nations (FAO), WHO and United Nations University (UNU) expert consultation report Human energy requirements endorsed the WHO recommendation (WHO, 1995) that healthy, well-nourished women should gain 10 to 14kg during pregnancy, with an average of 12kg, in order to increase the probability of delivering full-term infants with an average birth weight of 3.3kg, and to reduce the risk of fetal and maternal complications.

1.34 The WHO report 'Good Maternal Nutrition' (WHO, 2016) reported that 36 countries had national recommendations for appropriate GWG during pregnancy. Of these, two-thirds (24 countries) reported that the recommendations were based on preconception BMI and 21 countries included guidance for BMI categories indicating underweight, normal weight, overweight and obesity. However, there is currently no WHO guidance at global or European level on the amount of weight that women living with obesity should gain during pregnancy.

1.35 In 2023, the WHO initiated a process to develop GWG standards and optimal GWG ranges to reduce the risk of maternal and infant adverse outcomes

(WHO, 2023a; WHO, 2023b). Further information is available on the WHO nutrition and food safety department webpage.

Postpartum weight

1.36 Postpartum weight retention is the weight retained following delivery compared with pre-pregnancy weight. Most women have sustained weight retention one year following childbirth (Dellapiana and others, 2024). Excessive GWG, caesarean section, and lifestyle factors, including a decline in healthy dietary behaviours, may contribute to the weight gained (Dellapiana and others, 2024; Makama and others, 2021; Meyer and others, 2024). Women are recommended to lose weight gained after pregnancy because of adverse influences on their health and that of their child. Sustained postpartum weight retention after childbirth increases a woman's risk of obesity (Gore and others, 2003), and related health outcomes. In subsequent pregnancies, there is also heightened risk to the mother of pre-eclampsia, GDM and caesarean section. Postpartum weight retention also increases the likelihood of congenital abnormalities, stillbirth and the infant being born LGA in subsequent pregnancies (Timmermans and others, 2020; Villamor and others, 2006).

1.37 Exclusive breastfeeding may support weight loss after pregnancy. SACN's report 'Feeding in the first year of life' (SACN, 2018) noted that:

- exclusive breastfeeding (for the first 6 months of an infant's life) is associated with greater postpartum weight loss
- the duration of any breastfeeding is associated with lower maternal BMI in the longer term
- once solid foods have been introduced at around 6 months, continued breastfeeding alongside solid foods for at least the first year of life is also associated with improved maternal health

1.38 Glucagon-like peptide-1 (GLP-1) receptor agonist weight loss medications should not be taken during pregnancy or just before trying to get pregnant, or by people who are breastfeeding. This is because there is not enough safety data to know whether taking the medicine can cause harm to the baby (Medicines and Healthcare products Regulatory Agency, 2025).

Determinants of dietary behaviours and weight status

1.39 There are many biological, cultural, environmental and social factors that shape food preferences, behaviours and dietary intakes. In particular, the food and drink choices that girls and women make may be shaped by their socioeconomic circumstances (and whether they are experiencing food insecurity). Choices are also influenced by the wider food environment, including what foods and drinks are available and how these are marketed and advertised.

Pre-pregnancy influences

1.40 Some risk factors for negative maternal weight outcomes may be apparent as early as adolescence. During adolescence, exposure to certain risk factors could predict both pre-pregnancy obesity and high GWG later in life, both of which may have important influences on maternal and infant health (IOM and NRC, 2009; Vats and others, 2021).

1.41 Adolescent overweight or obesity, binge eating, body dissatisfaction, weight teasing, unhealthy weight control behaviours and adverse childhood experiences are just some of the risk factors that have been shown to be associated with pre-pregnancy obesity risk and/or high GWG (Mason and others, 2025; Ranchod and others, 2016). Food insecurity and deprivation have also been associated with pre-pregnancy obesity and/or high GWG (Laraia and others, 2010; Walker and others, 2019). Eating disorders can also contribute to undernutrition and a lower BMI in women pre-pregnancy (Arnold and others, 2019; Storto and others, 2025), with associated risk of adverse outcomes when pregnant.

Perinatal influences

1.42 During pregnancy, numerous physiological adaptations occur to provide an adequate environment for growth. Whilst essential for a healthy pregnancy, these responses may directly influence eating patterns, commonly causing notable taste perception alterations, food aversions and cravings. Food cravings are an uncontrollable urge to consume a particular type of food and integrate cognitive (thinking about a specific food), emotional (desire to eat that item), behavioural (seeking and consuming the food) and physiological aspects (Haddad-Tóvolli and others, 2023). Recurrent food cravings for, and compulsive eating of, highly palatable food has been proposed to contribute to the development and maintenance of gestational overweight and obesity (Haddad-Tóvolli and others, 2023).

1.43 In contrast, many women also experience symptoms of nausea and vomiting in pregnancy (NVP), with reported rates ranging from 35% to 91% of pregnancies

(Einarson and others, 2013). Fewer (around 1% according to a UK population-based pregnancy cohort study (Fiaschi and others, 2019)) experience hyperemesis gravidarum (HG), an extreme form of NVP (Meinich and others, 2020). Women with HG are at risk of significant early pregnancy weight loss and often struggle to achieve sufficient total pregnancy weight gain (Fejzo and others, 2009). Inadequate total maternal weight gain during pregnancy, not regaining pre-pregnancy weight by week 13 to 18 of gestation and a low pre-pregnancy BMI are all independent risk factors for delivering an SGA baby in women affected by HG (Meinich and others, 2020). Data from the Southampton Women's Study (SWS), a large (n = 2,270) UK-based prospective cohort, showed significant differences in changes in consumption of some foods in response to NVP and, while this only resulted in differences in energy intake in the severe NVP group, there were notable graded differences in the changes in diet quality in early pregnancy among women across all NVP groups (mild, moderate or severe). An increasing severity of nausea was associated with decreasing prudent diet score from before to early pregnancy, such that women with severe nausea had prudent diet scores 0.29 standard deviations (SDs) lower than those with no nausea ($p < 0.001$). However, this was transient as NVP was not related to a change in diet quality when assessed from before to late pregnancy (Crozier and others, 2017).

1.44 Eating disorders may profoundly affect the health of women during pregnancy (Feng and others, 2023, Hambleton and others, 2022, Myszko and others, 2023). A narrative review identified that both active eating disorders or a history of eating disorders during pregnancy appeared to be associated with numerous negative maternal and birth outcomes (Storto and others, 2025), which in part may relate to atypical GWG.

1.45 The entire perinatal period (throughout pregnancy and up to one year postpartum), represents a period of physical, physiological, psychological and social changes (Clark and others, 2009). During this period, women are at an increased risk of experiencing mental health problems (Schmied and others, 2013). Maternal mental health status during pregnancy may play a role in the determination of GWG, specifically excessive and inadequate GWG (Badon and others, 2019; Farias and others, 2021).

1.46 External influences, such as household food insecurity and poorer prenatal diet quality, have also been shown to have implications for adverse perinatal outcomes and the potential for long-lasting impacts on maternal and child health (Whiteoak and others, 2024). A higher prenatal maternal diet quality has been found to be protective against both inadequate and excessive GWG throughout pregnancy (Ancira-Moreno and others, 2019). In addition to the positive implications for GWG, beneficial changes in diet sustained during the entire pregnancy may also lead to long-term benefits for the mother and offspring (Ancira-Moreno and others, 2019).

1.47 Data from the SWS showed that there were reductions in alcohol consumption from before pregnancy to during early pregnancy. Before pregnancy, 54% of women drank more than 4 units of alcohol per week, compared to 10% in early pregnancy (Crozier and others, 2009a). There was a further smaller reduction between early and late pregnancy, when 5% of the women were drinking more than the maximum recommended amount of alcohol (Crozier and others, 2009a).

1.48 Despite the perinatal influences that may impact eating patterns as described above, evidence from an analysis of dietary patterns during pregnancy in the SWS showed that throughout pregnancy, women make little overall change to their usual dietary patterns (Crozier and others, 2009b).

Genotype and GWG

1.49 To date, SACN has not made nutritional or other recommendations on the basis of genotype. SACN does consider genetic effects where data is available and these have the potential to affect the interpretation of the evidence (SACN, 2023).

1.50 Genetic variants have the potential to influence both BMI at the start of pregnancy and GWG. Obesity is partly determined by genotype (Loos and others, 2022; Masood and others, 2023), and there is some evidence that GWG is also affected by genotype. The heritability of GWG has been estimated at 43% in the first pregnancy and 26% in the second pregnancy (Andersson and others, 2015). Common genetic variants within the maternal genome have been suggested to explain around 20% of GWG, with only a small contribution from the fetal genome (Warrington and others, 2018).

1.51 Maternal genotype may also influence the links between GWG and adverse pregnancy outcomes. These include the risks of pregnancy conditions, such as gestational diabetes, (Beysel and others, 2019; Liu and others, 2023; van Poppel and others, 2022) and birth outcomes, including low birth weight, macrosomia, SGA, LGA, and lower ponderal index (Mărginean and others, 2019; Wu and others, 2022).

1.52 The outcomes of observational studies are more likely to be influenced by genetic traits than those of randomised controlled trials (RCTs) where genotype should be approximately equivalent in the control and intervention arms. However, genotype also has the potential to influence the response to dietary and lifestyle interventions, therefore the generalisability of both RCTs and prospective cohort study results may depend on how representative the study population is, including in terms of ethnicity.

2. Current dietary recommendations

Overview of UK dietary recommendations

2.1 UK dietary recommendations are based on SACN's risk assessments of the scientific evidence. Longstanding dietary advice recommends that, as for the general UK population, pregnant and lactating women should consume a healthy, balanced diet as depicted in the UK's national food model, the Eatwell Guide. As part of this, and as with the rest of the population, women of childbearing age, including those who are pregnant or lactating, are advised to:

- consume at least 5 portions of a variety of vegetables and fruit a day
- base meals on potatoes, bread, rice, pasta and other higher fibre starchy carbohydrates
- consume some beans, pulses, fish, eggs, meat and other protein foods
- consume some dairy or alternatives
- eat at least 2 portions (each 140g) of fish every week, one of which should be oily, such as salmon, sardines or mackerel (there is additional food safety advice for pregnant women who eat fish)
- reduce consumption of red and processed meat to no more than 70g per day if they usually eat more than 90g per day
- consume food and drinks that are high in (saturated) fat, salt and sugar less often and in small amounts

2.2 UK dietary reference values (DRVs) describe the distribution of energy and nutrient requirements of different groups of people within the UK population. These values vary according to age, sex and physiological state, based on evidence available at that time, and include:

- estimated average requirement (EAR): the nutrient intake value that is estimated to meet the requirement of 50% of individuals in a life stage and sex group (about half of a defined population will usually need more than the EAR, and half less)
- reference nutrient intake (RNI): the average daily intake of a nutrient sufficient to meet the needs of almost all members (97.5%) of a healthy population

2.3 While no specific dietary pattern is recommended during pregnancy and lactation, some increments to the UK DRVs have been set to meet the increased energy and nutrient requirements associated with pregnancy and lactation.

2.4 Table 2.1 summarises current UK DRVs for energy and macronutrients for women aged 14 to 49 years (and the increments for pregnancy and lactation).

2.5 For the majority of women, most nutrient requirements during pregnancy and lactation can be met through consuming a healthy, balanced diet, with 2 exceptions. Current UK dietary guidance states that:

- all women who could become pregnant should take a daily 400 micrograms (µg) folic acid supplement prior to conception (ideally for 3 months before) and until the twelfth week of pregnancy; some women who are at higher risk of a neural tube defect affected pregnancy should take a higher daily dose of 5 milligrams (mg) (NICE, 2025a; NICE, 2025b)

- for adults and children over 4 years old, everyone (including pregnant and lactating women) should consider taking a daily supplement containing 10µg (400 international units) of vitamin D during the autumn and winter - population groups with limited sun exposure are recommended to take the 10µg daily vitamin D supplement all year round

2.6 The dietary recommendations for vitamins and minerals ('micronutrients') are detailed in the second part of SACN's assessment of nutrition and maternal health (SACN Nutrition and Maternal health outcomes position statement).

2.7 Women with a twin or triplet pregnancy are generally given the same advice about diet, lifestyle and nutritional supplements as women with a singleton pregnancy (see NICE guideline Twin and triplet pregnancy (NG137)). This includes advice that pregnant women do not need to "eat for two" (NICE, 2025a).

2.8 Existing UK dietary recommendations for pregnant and lactating women are communicated through the NHS website. This includes the following pages:

- Have a healthy diet in pregnancy

- Vitamins, minerals and supplements in pregnancy

- The vegetarian diet

- The vegan diet

- Foods to avoid in pregnancy

- Drinking alcohol while pregnant
- Breastfeeding and diet
- Get help to buy food and milk (the Healthy Start scheme)

Table 2.1: UK dietary recommendations for energy and macronutrients for women of childbearing age

Dietary component	Dietary recommendation for women of childbearing age	Increment for pregnancy	Increment for lactation
Energy (based on SACN DRVs) (note 1)	8.4 MJ per day (2,000 kcal per day)	0.8 MJ per day (191 kcal per day) in the last trimester only	1.38 MJ per day (330 kcal per day) (note 2)
Carbohydrates (note 3)	Should average at least 50% of energy (population average) (note 4)	No change to %	No change to %
Free sugars (note 3)	Should average no more than 5% of energy (population average) (note 4)	No change to %	No change to %
Dietary fibre (note 3)	25 grams per day for girls aged 14 and 15 years and 30 grams per day for girls and women aged 16 to 49 years (population averages)	No change	No change
Total fats (note 5)	Should average no more than 35% of energy (population average) (note 4)	No change to %	No change to %
Saturated fats (note 6)	Should average no more than 10% of energy (population average) (note 4)	No change to %	No change to %
Monounsaturated fatty acids (MUFA) (note 5)	12% of energy (population average) (note 7)	No change to %	No change to %

Dietary component	Dietary recommendation for women of childbearing age	Increment for pregnancy	Increment for lactation
n-6 polyunsaturated fatty acids (n-6 PUFA) (note 5)	6% of energy (population average) (note 7)	No change to %	No change to %
Linoleic acid (note 8)	At least 1% of energy (note 7)	No change to %	No change to %
Long chain n-3 PUFA (note 9)	0.45 grams per day (population average) (note 10)	No change	No change
Alpha linolenic acid (ALA) (note 8)	At least 0.2% of energy (note 7)	No change to %	No change to %
Trans fats (note 8)	No more than about 2% of energy (population average) (note 7)	No change to %	No change to %
Protein (note 8)	41.2 grams per day for girls aged 14 years and 45 grams per day for girls and women aged 15 to 49 years (note 11)	6 grams per day in 1st, 2nd and 3rd trimester (note 12)	11 grams per day up to 6 months of lactation and 8 grams per day past 6 months of lactation (note 12)

Note 1: dietary reference values for energy are set at the estimated average requirement (EAR) for the population. In its 2011 report ‘Dietary Reference Values for Energy’, SACN calculated revised EAR values for dietary energy for all age groups, including women of childbearing age (SACN, 2011a). In light of the high levels of overweight and obesity in the UK population (as detailed in chapter 4), UK governments continue to recommend that, as a guide, healthy girls and women aged 11 years and over who have average levels of physical activity consume around 8.4MJ (2,000kcal) per day, as reported in ‘Government dietary recommendations’ (PHE, 2016).

Note 2: values assume exclusive breastfeeding during the first 6 months (including an allowance for appropriate postpartum weight loss).

Note 3: ‘SACN Carbohydrates and Health Report’ (SACN, 2015).

Note 4: for total fats, saturated fats, carbohydrates and free sugars the ‘percentage of energy’ is stated in relation to the intake of energy excluding ethanol (alcohol). That is, “energy intakes from all energy sources excluding the ethanol component of any ethanol containing foods and drinks” (SACN, 2025). Full details are available in the SACN statement on expressing energy, fat and carbohydrate intakes and recommendations.

Note 5: the Committee on Medical Aspects of Food and Nutrition Policy (COMA) report ‘Nutritional Aspects of Cardiovascular Disease’ (Department of Health, 1994).

Note 6: SACN ‘Saturated fats and health’ (SACN, 2019).

Note 7: for MUFA, n-6 PUFA, linoleic acid, ALA, and trans fats, the ‘percentage of energy’ is stated in relation to the intake of energy excluding ethanol. Full details are available in the SACN statement on expressing energy, fat and carbohydrate intakes and recommendations.

Note 8: values are from ‘Dietary Reference Values for Food Energy and Nutrients for the United Kingdom’ (Department of Health, 1991).

Note 9: from SACN and COT report ‘Advice on fish consumption: benefits and risks’ (SACN and COT, 2004). SACN endorsed the population recommendation (including pregnant women) to eat at least 2 portions of fish per week, of which one should be oily. Two portions of fish per week, one white and one oily, contain approximately 0.45g per day long chain n-3 PUFA.

Note 10: from SACN and COT report ‘Advice on fish consumption: benefits and risks’ (SACN and COT, 2004). To note that COMA report ‘Nutritional Aspects of Cardiovascular Disease’ (Department of Health, 1994) recommended “an increase in the population average consumption of long chain n-3 PUFA from about 0.1g per day to about 0.2g per day (1.5g per week)”.

Note 11: values are based on the reference nutrient intake (RNI) of 0.75g of protein per kilogram (kg) of bodyweight (based on bodyweights of 43.8kg for girls aged 14 years, 55.5kg for girls and young women aged 15 to 18 years and 60kg for women aged 19 to 50 years). Figures are based on egg and milk protein and assume complete digestibility.

Note 12: recommendations for protein are given as absolute amounts and therefore include specific increments during pregnancy and lactation. Fat and carbohydrate recommendations are relative to total energy intakes and therefore increase proportionally based on the increments for energy intake during pregnancy and lactation.

UK energy recommendations

2.9 In 2011, SACN published revised DRVs for energy (SACN, 2011a) which replaced the DRVs for energy set by the Committee on Medical Aspects of Food and Nutrition Policy (COMA) in 1991 (Department of Health, 1991). Full details on DRVs for energy are provided in SACN's report on DRVs for energy.

2.10 DRVs for energy are set at the EAR for the population. In 2011, SACN calculated revised EAR values for dietary energy for all age groups, including women of childbearing age (SACN, 2011a). These were calculated using a physical activity level (PAL) value of 1.63 and set at amounts consistent with maintaining a body mass index (BMI) of 22.5kg/m^2.

2.11 The energy requirements for pregnancy and lactation are calculated as increments to be added to the mother's EAR and are based on singleton pregnancies reaching term. For pregnancy and lactation, the EAR should be set using pre-pregnancy BMI, rather than the ideal BMI of 22.5kg/m^2.

2.12 The EAR values for energy for women aged 14 to 49 years derived by SACN (2011a) are presented in Table 2.2.

Table 2.2: estimated average requirement for energy for women of childbearing age (notes 1, 2)

Age (years)	Estimated average requirement	Increment for pregnancy	Increment for lactation
14	9.8 MJ/day (2,342 kcal/day)	0.8 MJ/day (191 kcal/day)	1.38 MJ/day (330 kcal/day)
15 to 18	10.0 to 10.3 MJ/day (2,390 to 2,462 kcal/day)	0.8 MJ/day (191 kcal/day)	1.38 MJ/day (330 kcal/day)
19 to 34	9.1 MJ/day (2,175 kcal/day)	0.8 MJ/day (191 kcal/day)	1.38 MJ/day (330 kcal/day)
35 to 49	8.8 MJ/day (2,103 kcal/day)	0.8 MJ/day (191 kcal/day)	1.38 MJ/day (330 kcal/day)

Note 1: data from SACN's 2011 report 'Dietary Reference Values for Energy' (SACN, 2011a).

Note 2: abbreviations: MJ, megajoule; kcal, kilocalorie.

2.13 In light of the high levels of overweight and obesity in the UK population (as detailed in chapter 4), UK governments continue to recommend that, as a guide, healthy girls and women aged 11 years and over who have average levels of physical activity consume around 8.4 MJ (2,000kcal) per day (DHSC, 2011). The values were set at levels of energy intake required to maintain a healthy body weight for otherwise healthy people at what were current levels of physical activity at the time the EARs were set. The advice recognises that individual requirements will vary depending on body size and usual activity levels (PHE, 2018).

SACN considerations for pregnancy

2.14 In its 2011 report (SACN, 2011a), SACN noted that:

"Ideally, women should begin pregnancy at a healthy weight (BMI 18.5-24.9 kg/m^2)". The EARs for non-pregnant women identified by SACN were "set at amounts consistent with maintaining a BMI of 22.5kg/m^2."

"It is important to note that a weight equivalent to a BMI of 22.5kg/m^2 does not represent a precise target body weight to which everyone should aspire, rather that a single figure was required for the purpose of calculating prescriptive EARs based on healthy body weights. A body weight equating to a BMI within the range of 18.5kg/m^2 - 24.9kg/m^2 is generally considered 'normal' or 'healthy'."

"Women who are [living with] underweight or overweight at the beginning of pregnancy are at risk of poor maternal and fetal outcomes. Women who are [living with] underweight benefit from greater weight gain during pregnancy. For women who are [living with] overweight [or obesity], although excess weight gain is associated with adverse outcomes, the consequences of weight change during pregnancy are not completely understood. Given this uncertainty, a precautionary approach has been adopted and weight loss during pregnancy is not advised. The EARs for pregnancy and lactation defined in this report are therefore estimates of the incremental energy intakes likely to be associated with healthy outcomes for mother and child, for women consuming energy intakes which match energy expenditure at the commencement of pregnancy. That is, for women who are overweight the incremental energy intakes should be added to EAR values calculated at preconceptional body weights, rather than at healthy body weights for non-pregnant women". This is a precautionary approach as the setting of energy requirements based on a BMI of 22.5kg/m^2 rather than actual body weight could result in weight loss which is not currently advised in pregnancy."

2.15 In 2011, SACN also highlighted that: "The energy requirements for pregnancy need to take into account the protection of vulnerable groups. Adolescents who become pregnant must meet the dietary requirements imposed by growth, in addition to the demands of pregnancy and lactation. This is a complex issue. For example, consuming the extra energy needed to cover the costs of pregnancy does not in itself guarantee a better outcome (Kramer and others, 2003).

Also, those under 18 years of age are at greater risk than older women of giving birth to infants who are of low birth weight as a result of pre-term delivery or being of small size for gestational age (FAO and others, 2004). Thus, pregnancies up to 18 years are qualitatively different and must be considered differently". The energy requirements for adolescents during pregnancy and lactation were not specifically addressed by SACN in its 2011 report.

2.16 The SACN 2011 report also considered the energy requirements of women in the UK over the course of a pregnancy. The report noted that in general, it is unlikely that extra energy is required in the first trimester of pregnancy while compensatory reductions in physical activity during the second and third trimesters are likely to reduce the demand for extra energy at this time (SACN, 2011a). The report also states that: "the extent to which women are able to modify habitual physical activity patterns during pregnancy will be determined by socioeconomic and cultural factors specific to the population; women who are sedentary prior to pregnancy will have little flexibility to reduce their level of physical activity further. The SACN 2011 report went on to highlight evidence that: "inadequate gestational weight gain (GWG) is associated with decreased birth weight and fetal growth (small for gestational age, SGA) (Siega-Riz and others, 2009). Recommendations for constraining weight gain may also be inappropriate for pregnancies in vulnerable groups such as teenagers."

2.17 SACN (2011a) concluded that: "Taken together and in the absence of sufficient evidence to revise the recommendation made by the COMA (Department of Health, 1991) … it was considered prudent to retain the EAR for pregnancy set by COMA, that is, an additional intake of 0.8 MJ/day (191 kcal/day) during the last trimester." SACN noted, however, that women entering pregnancy who are [living with] overweight [or obesity] may not require this increment but that data at the time was insufficient to make a recommendation regarding this group. It was also noted that women who were [living with] underweight at the beginning of pregnancy, and women who did not reduce activity, may have a higher EAR (SACN, 2011a).

SACN considerations for lactation

2.18 The average total energy requirements associated with lactation can be estimated by the factorial approach, whereby the cost of milk production (estimated from the amount of milk produced, energy density of milk and the energetic efficiency of milk synthesis) is added to the energy requirements of non-pregnant women, with an allowance made for energy mobilisation from tissue stores, if replete.

2.19 In its 2011 report, SACN considered a number of approaches to calculating the energy requirements for lactation. Having reviewed the available evidence, it was agreed that the approach adopted by the US Energy Dietary Reference Intakes

(DRI) report (IOM, 2005) should be adopted for the UK. The US DRI report used a doubly labelled water (DLW) database of individual energy expenditure measures of lactating women with a pre-pregnancy BMI of 18.5kg/m^2 up to 25kg/m^2. The measured total energy expenditure (TEE), milk energy output and estimated energy mobilisation from tissue stores were used to estimate energy requirements. Based on a milk energy output rounded to 2.1MJ per day (500kcal per day) for women who exclusively breastfeed their infants throughout the first 6 months and assuming an average weight loss of 0.8kg per month, which is equivalent to 0.7MJ per day (170kcal per day), the recommendation is for an increment of 1.38MJ per day (330kcal per day) for the first 6 months to support exclusive breastfeeding. After the first 6 months, the energy cost of lactation will depend on the amount of breast milk produced, which is likely to be diminishing once solid foods are introduced and provide increasing amounts of energy.

2.20 SACN therefore recommended that the energy reference values for lactation should be an increment of 1.38 MJ per day (330kcal per day) for the first 6 months of lactation (assuming exclusive breastfeeding). It was noted that “thereafter, the energy intake required to support breastfeeding will be modified by maternal body composition and the breast milk intake of the infant.” (SACN, 2011a).

International energy recommendations

Pregnancy

2.21 The 2004 joint Food and Agricultural Organization (FAO), World Health Organization (WHO) and United Nations University (UNU) expert consultation report on human energy requirements (FAO and others, 2004) reported that, assuming a mean GWG of 12kg, the extra energy cost of pregnancy is 321 megajoule (MJ) (77,000kcal). This is divided into approximately 0.35MJ per day, 1.2MJ per day and 2.0 MJ per day (85kcal per day, 285kcal per day and 475kcal per day) during the first, second and third trimesters of pregnancy, respectively.

2.22 The joint report (FAO and others, 2004) also noted that “there are many societies with a high proportion of non-obese women who do not seek prenatal advice before the second or third month of pregnancy. In the absence of early pregnancy weight measurement, the consultation recommended that in such societies, pregnant women increase their food intake by 1.5 MJ per day (360 kcal per day) in the second trimester, and by 2.0 MJ per day (475 kcal per day) in the third”.

2.23 In the USA, the National Academy of Medicine (NAM) (formerly the Institute of Medicine (IOM)) calculated the estimated energy requirements (EER) during the second and third trimester of pregnancy to be about 340kcal per day and 452kcal per day, respectively, above pre-pregnancy requirements for women with a healthy pre-pregnancy weight. The IOM report notes that: “since total energy expenditure (TEE) changes little and weight gain is minor during the first trimester, no increase in energy intake during the first trimester is recommended” (IOM, 2005). These estimated changes in energy needs during pregnancy are reported in the Dietary Guidelines for Americans, 2020 to 2025.

2.24 A range of European expert bodies have also considered energy requirements during pregnancy, including the:

- European Food Safety Authority (EFSA) (EFSA, 2013)
- Nordic Council of Ministers in its report Nordic nutrition recommendations 2023
- Health Council of the Netherlands in its report Dietary recommendations for pregnant women

Lactation

2.25 The joint FAO, WHO and UNU expert consultation report on human energy requirements (FAO and others, 2004) reported that “well-nourished women with adequate gestational weight gain (GWG) should increase their food intake by 2.1 MJ per day (505 kcal per day) for the first six months of lactation, while undernourished women and those with insufficient GWG should add to their personal energy demands 2.8 MJ per day (675 kcal per day) during the first trimester of lactation. Energy requirements for milk production in the second six months are dependent on rates of milk production, which are highly variable among women and populations”.

2.26 In the USA, NAM (formerly IOM) calculated EERs during the first and second 6 months of lactation to be approximately 330kcal per day and 400kcal per day, respectively, above pre-pregnancy requirements for women with a healthy pre-pregnancy weight (IOM, 2005). These estimated changes in energy needs during lactation are reported in the ‘Dietary Guidelines for Americans, 2020 to 2025’ (USDA and HHS, 2020). The guidelines state that: “The EER for the first 6 months of lactation is calculated by adding 500kcal per day to pre-pregnancy needs to account for the energy needed for milk production during this time period, then subtracting 170kcal/day to account for weight loss in the first 6 months postpartum. The EER for the second 6 months of lactation is calculated by adding 400kcal per day to pre-pregnancy needs to account for the energy needed for milk production during this time period. Weight stability is assumed after 6 months postpartum.”

2.27 A range of European expert bodies have also considered energy requirements for lactation, including the:

- EFSA (EFSA, 2013)
- Nordic Council of Ministers in its report ‘Nordic nutrition recommendations 2023’
- Health Council of the Netherlands in its report ‘Dietary recommendations for pregnant women’

3. Methods

Background

3.1 Assessment of the evidence for this report is consistent with the Scientific Advisory Committee on Nutrition's (SACN's) framework for the evaluation of evidence (SACN, 2023). The assessment was informed by:

- previous assessments undertaken by SACN, in particular the SACN report on dietary reference values for energy (as detailed in chapter 2)
- survey data on the prevalence of overweight and obesity in both pregnant and non-pregnant women of childbearing age in the UK
- evidence on dietary intakes of women of childbearing age from the UK National Diet and Nutrition Survey (NDNS) and associated modelling of estimated energy intakes based on body height and weight data from the Health Survey for England (HSE)
- evidence obtained through literature searches for systematic reviews (SRs) and meta-analyses (MAs) examining the relationship between nutrition and maternal weight outcomes
- a review of dietary patterns and GWG undertaken by the United States Department of Agriculture (USDA)

UK National Diet and Nutrition Survey

3.2 The NDNS informed the chapter describing current food consumption and nutrient intakes of women of 'childbearing' age (aged 14 to 49 years) in the UK (chapter 5). Data on energy intakes and macronutrient intakes have been included as these have relevance to the outcomes of interest in this report. Data on micronutrient intake and status will be provided as part of SACN's position statement which will consider wider UK dietary recommendations for women of childbearing age. NDNS data on weight status of women of childbearing age was also used - this is presented in chapter 4.

3.3 The NDNS is a continuous cross-sectional survey of food consumption, nutrient intake and nutritional status in adults and children aged 18 months upwards living in private households in the UK. Data collection started in 2008. The NDNS sample is drawn from all 4 UK countries and is designed to be nationally representative.

3.4 The dietary data collection method used in the NDNS 2014 to 2019 was a 4-day diary. Participants (or a parent or carer for children) were asked to keep a detailed diary of all foods and drinks consumed for 4 consecutive days. Quantities consumed were estimated using a combination of household measures and photographs with portion sizes. The survey was designed to represent all days of the week equally.

3.5 Girls and women who were pregnant or breastfeeding were excluded from the NDNS until 2024. Therefore, non-pregnant and non-lactating girls and women (aged 14 to 49 years) have been used to describe the nutritional intakes of women of childbearing age. To note that the definition of women of childbearing age in NDNS is 16 to 49 years. It was agreed that the lower age boundary should be extended to include girls aged 14 and 15 years to allow consideration of nutritional status in the preconception period across the full age range.

3.6 Energy and nutrient intakes are based on data from 5 years of the NDNS (2014 to 2019) (PHE, 2020a). In line with SACN's position statement on expressing energy, fat and carbohydrate intakes and recommendations (SACN, 2025):

- energy intakes are expressed as 'total energy' to describe energy intakes from all energy sources including from ethanol (alcohol)
- intakes from fats and carbohydrates are expressed as a percentage of energy excluding ethanol (hereafter shortened to 'percentage (%) of energy') for comparison with the DRVs

3.7 From 2014 to 2019 each NDNS fieldwork year collected data on approximately 275 girls and women aged 14 to 49 years part of a wider annual sample of 500 adults and 500 children aged 1.5 years and above. The survey is designed to be representative of the UK population. Full details of the methodology and findings from the NDNS can be found elsewhere (PHE, 2020b).

3.8 For this report, NDNS results were stratified by index of multiple deprivation (IMD) quintile. IMD is calculated in a slightly different way in each UK nation, and it is not possible to combine to present data for the UK as a whole. IMD is the official measure of relative deprivation for small areas in England - it ranks every small area from most deprived to least deprived. IMD combines information from 7 domains (using different weights) to produce an overall relative measure of deprivation, including: income deprivation (22.5%), employment deprivation (22.5%), education, skills and training deprivation (13.5%), health deprivation and disability (13.5%), crime (9.3%), barriers to housing and services (9.3%), and living environment deprivation (9.3%) (Ministry of Housing, Communities and Local Government, 2019).

3.9 NDNS results have not been stratified by ethnicity because the numbers of girls and women with non-white ethnicity were too small to allow this. The distribution of ethnicity in girls and women aged 14 to 49 years with dietary data from NDNS years 7 to 11 (2014 to 2019) is shown in Table 3.1.

Table 3.1: distribution of ethnicity in women of childbearing age in the UK (note 1)

Age (years)	White (%)	Mixed (%)	Black or Black British (%)	Asian or Asian British (%)	Any other ethnic group (%)	Number of participants
14 to 18	84.7	2.8	3.8	7.8	1.0	398
19 to 29	88.5	1.4	2.1	5.6	2.4	287
19 to 24	90.2	0.8	3.3	5.7	0 (note 2)	123
25 to 29	87.2	1.8	1.2	5.5	4.3	164
30 to 39	84.0	1.6	3.1	9.1	2.2	319
40 to 49	86.7	1.4	5.7	5.4	0.8	369
All ages (14 to 49)	85.9	1.8	3.8	7.0	1.5	1,373

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: there were no cases for this group.

Evidence from SRs and MAs

3.10 SACN's Framework for the Evaluation of Evidence (SACN, 2023) informed the approach for the risk assessment. The framework sets out the approach from initial scoping to formal grading of the evidence. The SACN framework is based on an evidence hierarchy which ranks the certainty of the evidence according to study design. More weight is given to evidence from randomised controlled trials (RCTs) since well-conducted RCTs minimise the potential for selection bias and confounding. Less weight is given to observational studies because these studies are potentially subject to residual confounding and reverse causality. However, in the absence of RCTs, observational evidence from non-randomised studies of interventions (NRSI) and prospective cohort studies is still considered stronger than observational evidence from other study designs (case-control, cross-sectional and case reports).

3.11 This report is based on evidence from SRs or MAs of prospective cohort studies, NRSI and RCTs examining the relationship between diet and maternal weight outcomes.

3.12 Well-conducted, comprehensive, high-quality SRs and MAs reduce the potential for biased study selection or overlooking relevant studies since they are systematic and provide a comprehensive and quantitative analysis of the research in a particular field.

3.13 SACN's preferred approach is to use evidence provided by published SRs and MAs to inform its evaluations rather than conducting its own SRs of primary evidence. This is because undertaking a SR is time and resource intensive and may duplicate efforts from others. SACN's approach makes use of existing published evidence and draws upon broader scientific expertise. However, there are also limitations since the value of SRs in informing recommendations is dependent on their quality, the quality of the included studies and the analyses conducted. In addition, the relevance and generalisability of the results of SRs are dependent on how closely the SR question matches SACN's research question, the specific inclusion or exclusion criteria and comparators.

3.14 The protocol for SACN's SR of SRs was prospectively registered in the international prospective register of SRs (PROSPERO) under the registration number: CRD42021278723.

Inclusion criteria

3.15 The following types of studies were included: SRs and MAs of RCTs, NRSI and prospective cohort studies.

3.16 Eligibility criteria for the SRs and MAs included:

- English language publications of self-proclaimed SRs (with or without MAs) including one or more RCT or prospective cohort study which provide information on the effect of nutritional interventions and/or associations between nutritional intake and maternal gestational weight

- SRs published from 1st January 2000 which include studies based in any setting and in countries where data is deemed relevant to UK policy

- studies of women of any weight status and aged 16 years or over, conducted in the pre- (up to 3 months), peri-, and/or postpartum (up to 24 months) periods

Exclusion criteria

3.17 The following types of studies were excluded: non-systematic reviews, SR protocols, or primary research.

3.18 Additional exclusion criteria were:

- SRs solely of women with gestational diabetes
- SRs with mixed populations (for example, those with and without gestational diabetes) where the data is not presented separately

Literature search

3.19 A SR of SRs examining the relationship between diet and maternal weight outcomes was commissioned to inform this report.

3.20 The Cochrane Library and Embase, as well as MEDLINE, PsycINFO and CINAHL via EBSCOhost were searched, using the search terms outlined in Annex 1, for relevant publications meeting the inclusion criteria (see paragraphs 3.15 and 3.16).

3.21 All databases were searched from 2000, and no language restrictions were applied during the searches. English language was an inclusion criterion; however, searches were not limited by language to overcome any indexing errors.

3.22 The agreed cut-off date for consideration of newly published eligible evidence was 29 September 2021. It was agreed that publications identified after 29 September 2021 would be considered as part of the draft report peer review, and that the draft report would be amended if any evidence identified after 29 September 2021 or through the peer-review process was judged to have an important bearing on the conclusions or recommendations.

Exposures and outcomes considered

3.23 The exposures or interventions considered in this report are:

- individual-level interventions which consider the effect of dietary interventions on maternal gestational weight outcomes
- prospective cohort studies within included reviews which assess the association between nutritional intake and maternal gestational weight outcomes

3.24 The main outcomes considered in this report are:

- maternal preconception body mass index (BMI, kg/m^2) (maximum 3 months before conception)
- gestational weight gain (GWG)
- postnatal weight retention or weight change up to 24 months postpartum
- other anthropometric indicators such as BMI, skin fold thickness, body composition and waist circumference 3 months before pregnancy and up to 24 months postpartum

3.25 Moderating factors that may influence the efficacy of interventions or any observed associations have also been considered where appropriate. Where possible, the baseline BMI of the women has been considered when interpreting the results. GWG as a mediator of maternal and fetal health outcomes has also been considered throughout.

3.26 The terminology used to describe the exposures and outcomes in the evidence sections of this report reflect the terms used by the SR authors.

Selection of studies

3.27 After removing duplicates, titles and abstracts of the identified publications were screened for eligibility.

3.28 The screening steps for eligibility (screening on title and abstract and screening on full text) were performed using Covidence. Title and abstract screening were conducted independently by 2 researchers. Disagreements about the eligibility of studies were resolved by a third reviewer.

3.29 The PRISMA (preferred reporting items for systematic reviews and meta-analyses) diagram in Figure 3.1 shows how studies were selected for the review. In total, 6,178 records were identified from 5 online databases (see paragraph 3.20). After removal of 1,653 duplicates, 4,525 records identified through the online database search were screened for eligibility on title and abstract. At this stage, a further 4,433 records were excluded.

3.30 The full texts of 92 records were retrieved and screened against the inclusion and exclusion criteria by at least 2 independent reviewers. A third reviewer was consulted if disagreements occurred.

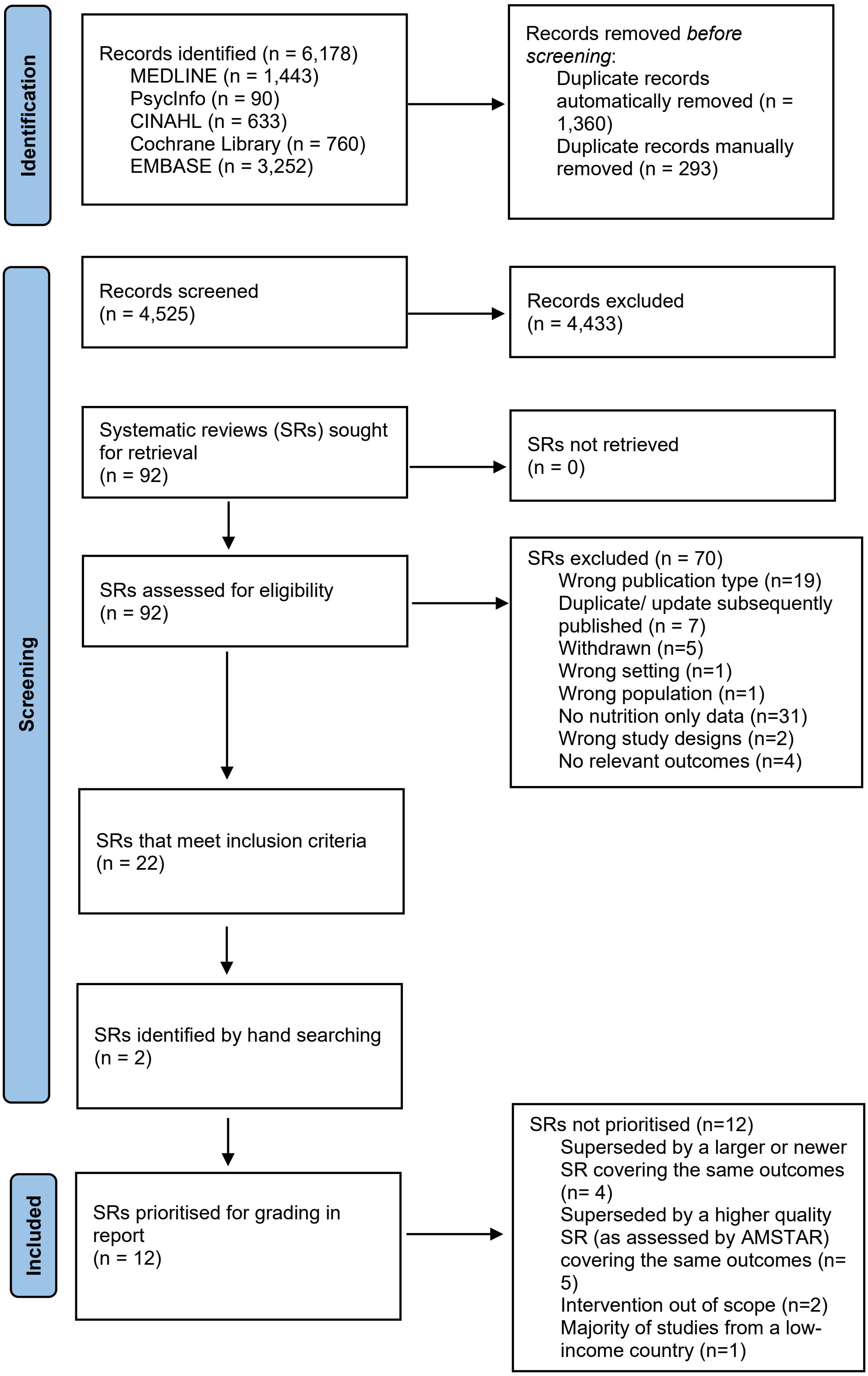
3.31 Of the 92 full-text articles that were screened, 22 SRs met the inclusion criteria, while 70 publications were excluded. The reasons for exclusion were:

- no nutrition-only data (31 studies)
- wrong publication type (19 studies)
- duplicate or an update published subsequently (7 studies)
- withdrawn publication (5 studies)
- no relevant outcomes (4 studies)
- wrong study designs (2 studies)
- wrong setting (1 study)
- wrong population (1 study)

3.32 In addition to the SRs identified through the literature search, 2 key international SRs from United States Department of Agriculture (USDA) were identified by hand searching. USDA published SRs on diet and nutrition during pregnancy and lactation and specific health outcomes in preparation for the Dietary Guidelines for Americans, 2020 to 2025. More detail on this evidence is provided in paragraphs 3.61 to 3.69.

3.33 Details of the excluded references and reasons for their exclusion are presented in Annex 2.

Figure 3.1 PRISMA flow chart of study selection



Data extraction

3.34 The following data from the 24 included SRs was extracted (this is presented in detail in Annex 3):

- first author, year of publication, study design, funding and declaration of interest
- review aim or objectives or research questions
- search time frame, inclusion criteria (study design, population, intervention or exposure, comparators, and outcomes) and statistical analysis details
- details of the included studies (for example, number of studies and participants, participant demographics, intervention or exposure details), study findings (results on maternal weight outcomes or other relevant outcome measures) and confounders
- the methods and results of any assessment of study quality or risk of bias (RoB), and the limitations identified by the SR authors

3.35 For SRs with MAs, summary estimates from the MAs were extracted (rather than the individual findings of primary studies).

3.36 A standardised, piloted electronic form (Microsoft Excel) was used to extract data from the included SRs for assessment of quality and evidence synthesis. The form was used by at least one reviewer, with a subset checked by a different second reviewer. Any discrepancies were resolved by a third researcher.

3.37 In circumstances where additional information on, for example, populations, BMI status, intervention, follow-up, adherence were required, information from the primary studies identified in the SRs was accessed and reviewed (see Annex 5).

Prioritisation of studies

3.38 All 24 SRs were reviewed and in cases where SRs identified the same exposure to outcome relationship, a mapping activity was conducted to identify the primary studies included in each of the SRs to allow any overlap of primary studies to be considered.

3.39 The methodological quality of these 24 eligible SRs was assessed using the AMSTAR 2 tool (see paragraphs 3.47 to 3.51 and Annex 4, Table A4.1). The 24 eligible SRs were further reviewed to take into consideration whether any of the lower quality SRs covered exposures or interventions not covered by better quality

SRs. After assessment of the 24 eligible SRs, 12 were considered to be of better quality or covered exposures or interventions not covered by other SRs.

3.40 The process for SR prioritisation is shown in Figure 3.1. Of the 12 non-prioritised SRs, 5 were superseded by a higher quality SR covering the same outcomes, 4 were superseded by a larger or newer SR covering the same outcomes, 2 covered out-of-scope interventions, and 1 contained mostly studies from a low-income country. Details of these non-prioritised SRs are presented in Annex 3.

Quality and certainty of identified evidence

3.41 For this report, SACN's Framework for the Evaluation of Evidence (SACN, 2023) was used as the basis for assessing SR evidence.

3.42 As noted above, the methodological quality of SRs was also assessed using the AMSTAR 2 tool.

3.43 The following criteria were considered for SRs (with or without MAs) and pooled analyses:

- scope and aims
- search dates (publication dates of studies included in the reviews or MAs)
- inclusion and exclusion criteria
- number of primary studies and total number of participants
- conduct of review and reporting of pre-specified outcomes consistent with registered protocol

3.44 The following criteria were considered for primary studies considered within SRs or MAs:

- whether the primary studies were RCTs, NRSI or prospective cohort studies
- populations considered and relevant characteristics (for example, the number of studies which included pregnant women)
- sample size or power (including interpretation of the width of the confidence interval, with wide confidence intervals indicating low power to estimate effect or association size)
- exposure or intervention duration and follow-up

- detail of the dietary intervention
- quality of the dietary assessment methods and outcome assessment methods

3.45 The following criteria were considered for interpretation of results and their analysis:

- appropriateness of statistical methods used
- whether and which confounding factors were accounted for in the study design and subsequent analysis
- consistency of the effect or association (taking account of overlap in the primary studies considered)
- heterogeneity - I^2 statistic and other measures of heterogeneity
- direction and size of effect and statistical significance
- results of subgroup and sensitivity analyses

3.46 The word 'effect' was used to describe the evidence from RCTs and NRSIs and the word 'association' was used when referring to evidence from prospective cohort studies.

AMSTAR 2 assessment

3.47 For each eligible publication, the methodological quality was assessed using AMSTAR 2. The methodological quality of each eligible publication was assessed by one person, with a selection checked by a second, and disputes solved by a third. AMSTAR 2 comprises 16 items for evaluation (Shea and others, 2017) which are listed in the SACN Framework (SACN, 2023).

3.48 The following items were identified as critical by AMSTAR 2 (see Annex 4 for the full list of the AMSTAR 2 items):

- item 2 - this assessed whether the report of the review contained an explicit statement that the review methods had been established prior to the conduct of the review, and whether the report justified any significant deviations from the protocol
- item 4 - this assessed whether the review authors used a comprehensive literature search strategy

- item 7 - this assessed whether the review authors provided a list of excluded studies and justified the exclusions

- item 9 - this assessed whether the review authors used a satisfactory technique for assessing the RoB in individual studies that were included in the review

- item 11 - this assessed whether the review authors used appropriate methods for statistical combination of results, in cases where MA was performed

- item 13 - this assessed whether the review authors accounted for RoB in individual studies when interpreting or discussing the results of the review

- item 15 - this assessed whether the review authors carried out an adequate investigation of publication bias (small study bias) and discussed its likely impact on the results of the review, in cases where quantitative synthesis was performed

3.49 For each item, a review received one of the following outcomes: yes (Y), no (N), partial yes (PY), or no MA (NM). In grading confidence, a PY outcome was considered as adequate adherence to the standard.

3.50 In the context of this risk assessment, SACN agreed that item 7 (relating to the list of excluded studies) was not considered as a critical domain as few of the included SRs met these best practices. Therefore, the critical domains for this risk assessment were items 2, 4, 9, 11, 13 and 15.

3.51 The full AMSTAR 2 scoring for the SR evidence included in this report is available in Annex 4.

Statistical methods

3.52 Interpretation of statistical methods and data was undertaken in line with the SACN Framework (SACN, 2023).

Grading evidence

3.53 The certainty of evidence from SRs was assessed using the ‘Grading of recommendations, assessment, development and evaluation’ (GRADE) approach in line with the SACN Framework (SACN, 2023).

3.54 The certainty was assessed separately for each exposure to outcome relationship.

3.55 GRADE specifies 4 levels of certainty for a body of evidence: ‘high’, ‘moderate’, ‘low’ and ‘very low’. The interpretation of these GRADE certainty ratings is as follows:

- 'high' certainty - very confident that the true effect lies close to that of the estimate of the effect

- 'moderate' certainty - 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 - confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect

- 'very low' certainty - very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect

3.56 A body of evidence from randomised trials starts with a high-certainty rating. The level of certainty can then be decreased by one or 2 levels after considering the following 5 criteria: risk of bias, imprecision, inconsistency, indirectness, and publication bias.

3.57 A body of evidence from observational studies usually starts with a low-certainty rating because of potential bias due to lack of randomisation (confounding and selection bias) and recognition that confounding is always a concern in even the most rigorously conducted observational studies. The level of certainty can be further downgraded considering the 5 criteria listed above.

3.58 The level of certainty from non-randomised evidence can be upgraded if any of the following 3 criteria are met: large magnitude of effect, clear dose-response gradient, residual confounding (this is likely to decrease rather than increase the magnitude of effect, where an effect is observed).

3.59 Decisions to downgrade or upgrade were based on expert judgements of working group and SACN members. Thresholds for downgrading or upgrading depended on a number of factors, including the outcome and exposure of interest.

3.60 Draft grading was initially conducted by SACN for consideration and agreement by working group members. Final grading was agreed by SACN.

USDA method for grading evidence

3.61 In 2020, the USDA 2020 Dietary guidelines advisory pregnancy and lactation subcommittee assessed evidence on the association between maternal dietary patterns and GWG (USDA, 2020a).

3.62 The USDA Nutrition Evidence Systematic Review (NESR) methodology had predefined criteria, based on 5 grading elements, that their expert group uses to evaluate and grade the strength of the evidence supporting each conclusion statement. The 5 grading elements are: consistency, precision, risk of bias, directness, and generalisability.

3.63 Even though publication bias is not a formal element in its grading process, USDA recognises the importance of this issue and evaluates and documents the potential for its presence during evidence synthesis.

3.64 A USDA conclusion statement can receive a grade of ‘strong’, ‘moderate’, or ‘limited’. If insufficient or no evidence is available to answer a systematic review question, then no grade is assigned (that is, ‘grade not assignable’).

3.65 The overall USDA grade is not based on a predefined formula for scoring or tallying ratings of the 5 grading elements. Rather, each overall grade reflects the NESR expert group’s thorough consideration of all of the grading elements, as they each relate to the specific nuances of the body of evidence under review.

3.66 USDA states that their grading process aligns with those used by other organisations, such as the GRADE approach, noting the grading processes all rely on consideration of specific elements and share 4 of 5 grading elements in common: consistency, precision, risk of bias, and directness. The USDA authors also note that all approaches take study design into consideration, and all assign an overall grade that communicates the strength or certainty of the evidence to decision makers and stakeholders. USDA state that their grading process differs in its consideration of publication bias and generalisability, given its role in informing public health nutrition decisions within the U.S. government (USDA, 2023).

3.67 SACN reviewed the USDA subcommittee’s evaluation of the evidence base, including their assessment on the certainty of the evidence and agreed to adopt their assessment. This evidence is presented in chapter 6.

3.68 Full details of the USDA grading process are available in the USDA methodology manual.

3.69 Full assessment of the evidence and the grade assigned for maternal dietary patterns and GWG is available on pages 37 to 40 and in Tables 5 and 6 (pages 93 and 94) of the SR Dietary patterns during pregnancy and gestational weight gain.

Report development

3.70 SACN considered SRs (with and without MAs) that met the inclusion criteria. Chapters were initially drafted by members of the SACN secretariat with support from the committee. These chapters provided the basis for ‘Nutrition and maternal health’ working group discussions, with the final text, conclusions and recommendations discussed and agreed by the SACN main committee.

3.71 The draft report was made available for public peer review from 23 July to 19 September 2024. Comments received from interested parties were taken into consideration before the report was finalised. Peer-review comments and the SACN responses to these are published alongside the draft report on the SACN webpage.

4. Weight status

4.1 This chapter provides information on the weight status of:

- women of childbearing age who are not pregnant
- pregnant women

Women of childbearing age

4.2 Given that preconception body mass index (BMI) has an important influence on maternal and fetal health, the following section provides information from national surveys on the weight status of women who may become pregnant. To note that the age bands used differ across surveys.

NDNS

4.3 The National Diet and Nutrition Survey (NDNS) sample is drawn from all 4 UK countries and is designed to be nationally representative. NDNS height and weight measurements for 2014 to 2019 were made by a fieldworker. NDNS 2014 to 2019 did not collect data from women who were pregnant or lactating.

4.4 The height and weight of girls and women aged 14 to 49 years from NDNS 2014 to 2019 is shown in Table 4.1.

Table 4.1: height and weight of women of childbearing age (notes 1, 2)

Age (years)	Height (cm) mean (SD)	Weight (kg) mean (SD)	Number of participants
14 to 18	162.9 (6.8)	62.4 (14.9)	375
19 to 29	163.9 (5.9)	68.2 (17.1)	269
19 to 24	163.9 (5.8)	68.2 (19.3)	112
25 to 29	164.0 (6.0)	68.3 (15.1)	157
164.0 (6.0)	164.1 (6.2)	70.8 (15.5)	302
30 to 39	163.1(6.2)	74.2 (16.8)	336
40 to 49	163.6 (6.2)	69.9 (16.7)	1,282

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD; standard deviation, kg; kilogram, cm; centimetre.

4.5 The weight status of girls and women in the UK aged 14 to 49 years from NDNS 2014 to 2019 is shown in Table 4.2, Table 4.3 and Table 4.4.

4.6 The NDNS shows a lower proportion of those living with overweight and obesity than other national data sets.

4.7 Table 4.2 and Table 4.3 show the weight status of UK girls aged 14 to 18 from NDNS years 7 to 11 (2014 to 2019) (PHE, 2020a). Results for this age group have not been combined with data from other age groups because BMI categories for girls aged 14 to 18 years are not comparable to those for women aged 19 years and over. Girls aged 18 and younger are classified by the British 1990 growth reference (UK90) according to age (Cole and others, 1995). In clinical settings, overweight is classified as a BMI over the 91st centile, obesity over the 98th centile of the UK90 (NICE, 2023). For population monitoring, overweight is classified as a BMI on or above the 85th centile, but less than the 95th centile of the UK90. Obesity is classified as a BMI on or above the 95th centile of the UK90. Underweight is classified as BMI below 2nd centile. To note that the healthy weight category includes a small number of girls living with underweight due to insufficient sample size to analyse the data separately.

Table 4.2: weight status of girls aged 14 to 18 years (note 1) using clinical cut-offs

Age (years)	Healthy weight (below 91st centile)	Overweight (between 91st and 98th centile)	Obesity (above 98th centile)	Number of participants
14 to 18	70.1%	13.5%	16.4%	375

Note 1: from NDNS years 2014 to 2019.

Table 4.3: weight status of girls aged 14 to 18 years (note 1) using population monitoring cut-offs

Age (years)	Healthy weight (below 85th centile)	Overweight (between 85th and 95th centile)	Obesity (above 95th centile)	Number of participants
14 to 18	63.3%	14.5%	22.1%	375

Note 1: from NDNS years 2014 to 2019.

4.8 Table 4.4 shows the weight status of UK women aged 19 to 49 from NDNS years 7 to 11 (2014 to 2019).

Table 4.4 body mass index (BMI) distribution for women of childbearing age (note 1)

Age (years)	Under-weight (below 18.5kg/m^2) %	Healthy weight (18.5 to 24.9kg/ m^2) %	Overweight (25 to 29.9kg/m^2) %	Obesity (above 30kg/m^2) %	Number of participants
19 to 29	3.1	55.8	24.3	16.8	269
19 to 24	4.2	51.6	25.4	18.8	112
25 to 29	2.1	59.5	23.4	15.0	157
30 to 39	1.5	45.3	35.1	18.2	302
40 to 49	0.4	35.9	34.8	29.0	336
19 to 49	1.7	46.1	31.1	21.1	907

Note 1: from NDNS years 2014 to 2019 (women aged 19 to 49 years).

England

4.9 In England, trends in overweight and obesity in the general population are captured through the Health Survey for England (HSE). Data from the HSE is published in different age bands from those published by NDNS; HSE provides information about children aged 15 years and under, and adults aged 16 years and over, living in private households. The 2022 HSE used interviewer administered height and weight measurements (further information is available in the HSE 2022 methods publication).

4.10 The height and weight of women aged 16 to 54 years from the 2022 HSE are shown in Table 4.5.

Table 4.5: height and weight of women aged 16 to 54 years in England (notes 1, 2)

Age (years)	Height (cm) mean (SE)	Weight (kg) mean (SE)	Number of participants (note 3)
16 to 24	163.9 (0.62)	67.3 (1.72)	166
25 to 34	163.5 (0.40)	72.8 (1.08)	320
35 to 44	164.3 (0.43)	75.6 (1.05)	399
45 to 54	163.1 (0.42)	75.7 (1.10)	378

Note 1: from HSE 2022. The HSE includes data on women aged 16 years and over which are presented by pre-defined age groups; for the purposes of this report, only the age groups that include women of childbearing age are presented.

Note 2: abbreviations: SE; standard error of the mean, kg; kilogram, cm; centimetre.

Note 3: number of participants presented is based on the height data. The number of participants for the weight data is as follows: 153 for 16 to 24 year olds, 294 for 25 to 34 year olds, 383 for 35 to 44 year olds and 372 for 45 to 54 year olds.

4.11 Findings from the 2022 HSE indicated that the prevalence of women aged 16 years and older living with overweight or obesity was 61%.

4.12 In England, the overall prevalence of women living with overweight or obesity has increased between 1993 and 2022 (Table 4.6). The proportion of women living with severe obesity (that is, BMI 40 kg/m2 or above) has increased 3-fold between 1993 and 2022 (from 1.5% to 4.5%).

Table 4.6: body mass index (BMI) of women aged 16 to 54 years in England in 2022 compared with 1993 (note 1)

Age (years)	Underweight (below 18.5kg/m^2) in 2022 (1993) %	Healthy weight (18.5 to 24.9kg/m^2) in 2022 (1993) %	Overweight (25 to 29.9kg/m^2) in 2022 (1993) %	Obesity (30kg/m^2 or above) in 2022 (1993) %	Number of participants in 2022 (1993)
16 to 24	9 (5)	52 (68)	21 (20)	17 (8)	151 (1,020)
25 to 34	3 (2)	40 (62)	31 (25)	26 (11)	286 (1,544)
35 to 44	2 (2)	37 (52)	28 (29)	33 (17)	372 (1,459)
45 to 54	1 (1)	35 (43)	31 (37)	34 (19)	359 (1,306)

Note 1: from HSE 2022. The HSE includes data on women aged 16 years and over which are presented by pre-defined age groups; for the purposes of this report, only the age groups that include women of childbearing age are presented.

Scotland

4.13 In Scotland, weight status of the population is recorded as part of the Scottish Health Survey, published by the Scottish Government. The Scottish Health Survey in 2023 used a combination of self-reported and interviewer-administered height and weight measurements.

4.14 The height and weight data from the Scottish Health Survey in 2023 was not available in the reported findings.

4.15 Findings for the year 2023 indicated that 65% of women were living with overweight or obesity, of whom 34% were living with obesity (Scottish Government, 2024). The survey also indicated that the prevalence of women (aged 16 years and over) living with:

- overweight, including obesity, was 40% for 16 to 24 year olds, 61% for 25 to 34 year olds, 61% for 35 to 44 year olds and 69% for 45 to 54 year olds
- underweight (that is, BMI less than 18.5kg/m^2) was 6% for 16 to 24 year olds, 1% for 25 to 34 year olds, 2% for 35 to 44 year olds and 1% for 45 to 54 year olds

Wales

4.16 In Wales, weight status of the population is recorded as part of the National Survey for Wales, published by the Welsh Government. The National Survey for Wales (2022 to 2023) used self-reported height and weight measurements.

4.17 The mean height and weight of women aged 16 years and over from the National Survey for Wales (2022 to 2023) were 162.8cm and 72.5kg, respectively. Height and weight data for women by age group was not available in the reported findings.

4.18 Findings for the years 2022 to 2023 (Welsh Government, 2023) indicated that the prevalence of non-pregnant women (aged 16 years and over) living with:

- overweight was 30%
- obesity was 27%
- underweight was 2%

Northern Ireland

4.19 In Northern Ireland, weight status is recorded through the Health Survey Northern Ireland. The Health Survey Northern Ireland (2023 to 2024) used interviewer-administered height and weight measurements. The survey for years 2023 to 2024 noted that the sample size was too small to undertake additional analysis on the percentage of individuals living with overweight and/or obesity by age group or by sex and age group (Department of Health Northern Ireland, 2024).

4.20 The height and weight data from the Health Survey Northern Ireland (2023 to 2024) was not available in the reported findings.

4.21 Findings for the years 2023 to 2024 indicated that the prevalence of women (aged 16 years and over) living with:

- overweight was 34%
- obesity was 26%
- underweight was 1%

Pregnant women

4.22 The Maternity Services Data Set (MSDS) is a patient-level data set that captures information on the weight status of pregnant women in England (NHS England, 2024b). The BMI data is based on interviewer measured heights and weights at a first booking appointment, around 10 weeks gestation.

4.23 MSDS data from 2018 to 2019 (Schoenaker and others, 2023) found that:

- 3.1% of pregnant women were living with underweight, 28.0% were living with overweight and 22.3% were living with obesity
- for pregnant adolescent girls (under 20 years of age), 9.2% were living with underweight, 22.7% were living with overweight and 16.8% living with obesity

4.24 MSDS data from 2023 to 2024 (DHSC, 2024) found that:

- the proportion of women living with obesity in early pregnancy had increased from 25.4% in 2022 to 26.2% in 2023
- the proportion of women living with obesity in early pregnancy varied between ethnic groups:
    - Black or African or Caribbean or Black British women (36.3%),
    - women of white ethnicities (27.5%)
    - women in mixed or multiple ethnic groups (26.9%)
    - women whose ethnic group was not known or not stated (22.4%)
    - women in other ethnic groups (20.4%)
    - women in Asian or Asian British, including Chinese, ethnic groups (19.4%)
- the proportion of women who were living with obesity in early pregnancy varied with age, with the highest proportion among those aged 45 years or over (30.9%)

4.25 In Scotland, figures from Public Health Scotland for the years 2022 to 2023 indicated that 56.5% of women (n = 24,673) were living with overweight or obesity at their antenatal booking visit (Public Health Scotland, 2023). Of these, 28.6% were living with overweight and 27.9% with obesity.

4.26 In Wales, the most recently available data from the 'Maternity and Birth Statistics' for the year 2021 indicated that 30% of pregnant women were living with obesity (BMI of 30kg/m^2 or above) at their initial antenatal assessment (Welsh Government, 2022).

4.27 In Northern Ireland, figures from the 'Children's Health in Northern Ireland' report by the Public Health Agency for the years 2023 to 2024 indicated that 60% of pregnant women were living with overweight or obesity at the time of their antenatal booking appointment (Public Health Agency, 2025). Of these, 31.4% were living with overweight and 28.6% were living with obesity.

Weight status and deprivation

4.28 In England, the greatest rates of adults living with obesity are seen in the most deprived areas of the country (OHID, 2022). The HSE 2022 indicated that 68% of non-pregnant women (aged 16 years and over) in the most deprived areas were living with overweight, including obesity, compared with 54% of women in the least deprived areas (NHS England, 2024a). Similarly, MSDS data from 2023 to 2024 (DHSC, 2024) found that the proportion of women living with obesity in early pregnancy increased with the level of area deprivation: 32.4% of women were living with obesity in early pregnancy in the most deprived decile compared with 19.8% in the least deprived decile.

4.29 In Scotland, the Scottish Health Survey 2022 indicated that 71% of women (aged 16 years and over) in the most deprived area were living with overweight or obesity, compared with 51% in the least deprived area (Scottish Government, 2023).

4.30 In Wales, the National Survey for Wales report BMI data by index of multiple deprivation (IMD) for adults (aged 16 years and older) but do not stratify the data by sex.

4.31 In Northern Ireland, the Health Survey Northern Ireland (years 2023 to 2024) noted that the sample size was too small to undertake additional analysis on the percentage of individuals living with overweight and/or obesity by deprivation quintile. Earlier editions of the Health Survey Northern Ireland do report BMI data by deprivation quintile for adults (aged 16 years and older) but do not stratify the data by sex.

5. Dietary intakes

Background

5.1 Data from the National Diet and Nutrition Survey (NDNS) informed this chapter (PHE, 2020a). The NDNS provides the only source of nationally representative UK data on food consumption, nutrient intakes, and nutritional status (derived from analysis of blood and urine biomarkers).

5.2 An overview of the NDNS is provided in chapter 3. As previously stated in chapter 3, the NDNS 2014 to 2019 did not collect data from women who were pregnant or lactating. Therefore, NDNS data on women aged 14 to 49 years who are not pregnant or lactating are used to describe dietary intakes in women of childbearing age.

Data included in this chapter

5.3 This chapter covers NDNS data on energy and macronutrient intakes as these have a bearing on the outcomes of interest in this report. NDNS data on the intake of vegetables and fruit, oily fish and red and processed meat compared with recommendations is also included.

5.4 Energy and macronutrient intakes are based on a UK representative sample of 1,376 women of childbearing age, collected between 2014 and 2019.

5.5 Intakes stratified by index of multiple deprivation (IMD) quintile are presented for 928 women of childbearing age in England for 2014 to 2019.

5.6 Data are interpreted against the UK dietary reference values (DRVs) for women of childbearing age who are not pregnant or lactating (see chapter 2).

5.7 Due to rounding, row or column percentages in the data tables may not add exactly to 100%.

5.8 In line with SACN's position statement on expressing energy, fat and carbohydrate intakes and recommendations (SACN, 2025):

- energy intakes are expressed as 'total energy' to describe energy intakes from all energy sources including from ethanol (alcohol)

- intakes from fats and carbohydrates are expressed as a percentage of energy excluding ethanol (hereafter shortened to 'percentage (%) of energy') for comparison with the DRVs

Energy

Current recommendations

5.9 In 2011, SACN derived estimated average requirement (EAR) values for energy for women of childbearing age, including increments for pregnancy and lactation (SACN (2011a) - see chapter 2 for more detail.

5.10 Current UK recommendations for energy intake at a population level include that healthy girls and women aged 11 years and over who have average levels of physical activity consume around 8.4 MJ (2,000kcal) per day (DHSC, 2011). NDNS data on energy intakes in women of childbearing age have been compared against this population recommendation.

Total energy intake

5.11 The total energy intakes in women of childbearing age in the UK from the NDNS (years 2014 to 2019) are presented in Table 5.1.

Table 5.1: total energy intakes of women of childbearing age (notes 1, 2)

Age (years)	Total energy intake (MJ per day) mean (SD)	Total energy intake (kcal per day) mean (SD)	Mean intake as % of recommended intake (note 3)	Number of participants
14 to 18	6.49 (1.84)	1,541 (437)	77	399
19 to 29	6.97 (2.30)	1,657 (546)	83	287
19 to 24	6.78 (1.92)	1,612 (458)	81	123
25 to 29	7.14 (2.58)	1,697 (612)	85	164
30 to 39	7.10 (1.93)	1,689 (459)	85	321
40 to 49	6.71 (2.01)	1,595 (479)	80	369
All ages (14 to 49)	6.87 (2.07)	1,634 (492)	82	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: EAR, estimated average requirement; MJ, megajoule; kcals, kilocalories; SD, standard deviation.

Note 3: 8.4 MJ (2,000kcal) per day (DHSC, 2011).

5.12 The NDNS (2014 to 2019) indicated that in all age groups (14 to 49 years) average energy intakes were below the EAR. However, underreporting of energy intake is known to be an issue for all dietary surveys and studies where the assessment of usual diet relies on self-reporting. The doubly labelled water (DLW) method provides a direct measure of energy expenditure and indicates the extent to which reported energy intake is likely to reflect habitual energy intake and/or the degree of underreporting. A DLW sub-study of the NDNS (OHID, 2023) included a small sample of 44 women aged 16 to 49 years. The study findings indicated that mean total energy expenditure (TEE) was 10.6 MJ per day (2,535kcal per day) compared with a mean reported energy intake of 7.2 MJ per day (1,710kcal per day). Therefore, participant reported energy intake was around 67% of likely habitual energy intake based on DLW measurements.

5.13 Modelling of estimated energy intakes indicates that, on average, women in England aged between 20 and 59 years old who are living with overweight or obesity consume approximately 1.2 and 1.4 MJ per day (275 and 324 kcal per day) above the EAR (OHID, 2024). The modelling used standardised equations that calculate TEE and height and weight data from the Health Survey for England (HSE) for 2017 to 2019 to provide an estimate of expected energy requirements, which in turn were assumed to be equivalent to energy intakes for women in energy balance. These were compared with relevant EARs which are consistent with maintaining a body mass index (BMI) of 22.5kg/m^2 to calculate excess energy intakes.

Energy intakes and deprivation

5.14 Total energy intakes (MJ per day) broken down by IMD quintiles in women of childbearing age in England from the NDNS (years 2014 to 2019) are presented in Table 5.2.

Table 5.2: total energy intake by IMD quintile in women of childbearing age (notes 1, 2)

Intake	IMD quintile 1 (most deprived)	IMD quintile 2	IMD quintile 3	IMD quintile 4	IMD quintile 5 (least deprived)
Energy (MJ/day); mean (95% CI)	6.67 (6.42 to 6.91)	7.01 (6.70 to 7.33)	7.10 (6.76 to 7.45)	6.73 (6.46 to 6.99)	6.91 (6.60 to 7.22)
Energy (kcal/day) mean (95% CI)	1585 (1526 to 1644)	1667 (1593 to 1742)	1688 (1606 to 1771)	1600 (1535 to 1664)	1644 (1570 to 1718)
Number of participants	218	209	152	167	182

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: CI, confidence interval; IMD, index of multiple deprivation; MJ, megajoule.

5.15 This data indicated that there was no evidence of a strong linear trend (indicated by overlapping confidence intervals) between total daily energy intake (TDEI) and IMD quintile.

Carbohydrates

Current recommendations

5.16 UK recommendations for carbohydrates are included within the SACN report on ‘Carbohydrates and Health’ (SACN, 2015). Definitions for different types of carbohydrates can be found in the glossary.

5.17 SACN did not recommend an increment for pregnant and lactating women. The DRVs for total carbohydrates, free sugars and dietary fibre for women aged 14 to 49 years are presented in Table 5.3. SACN also recommended that sugar-sweetened beverages should be minimised.

Table 5.3: DRVs for total carbohydrates, free sugars and dietary fibre for women of childbearing age (notes 1, 2)

Type of carbohydrate	DRV
Total carbohydrates (note 3)	Should average at least 50% of energy (population average)
Free sugars (note 3)	Should average no more than 5% of energy (population average)
Dietary fibre (14 and 15 years)	25 grams per day
Dietary fibre (16 to 49 years)	30 grams per day

Note 1: abbreviations: DRV, dietary reference value.

Note 2: values from SACN report on 'Carbohydrates and Health' (SACN, 2015).

Note 3: the 'percentage of energy' is stated in relation to the intake of energy excluding ethanol (alcohol) as detailed in SACN statement on expressing energy, fat and carbohydrate intakes and recommendations.

Carbohydrate intakes

Total carbohydrate

5.18 Total carbohydrate intake in women of childbearing age in the UK from the NDNS (years 2014 to 2019) is presented in Table 5.4.

Table 5.4: total carbohydrate intake in women of childbearing age (notes 1, 2)

Age (years)	Grams per day; mean (SD)	% energy intake; mean (SD)	Number of participants
14 to 18	205 (62)	50.2 (6.0)	399
19 to 29	206 (79)	48.0 (7.5)	287
19 to 24	206 (62)	49.4 (5.7)	123
25 to 29	207 (92)	46.7 (8.6)	164
30 to 39	206 (64)	47.4 (7.5)	321
40 to 49	190 (58)	47.0 (7.3)	369
All ages (14 to 49)	201 (68)	47.8 (7.3)	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation.

5.19 Mean intakes for total carbohydrates were below the DRV of 50% except in the youngest age group (14 to 18 years).

Free sugars

5.20 Free sugars intake in women of childbearing age in the UK from NDNS (years 2014 to 2019) is presented in Table 5.5.

Table 5.5: free sugars intake in women of childbearing age (notes 1, 2)

Age (years)	Grams per day; mean (SD)	% energy intake; mean (SD)	% participants meeting DRV (note 3)	Number of participants
14 to 18	58.0 (34.4)	13.7 (6.5)	7	399
19 to 29	57.1 (40.1)	12.8 (6.4)	10	287
19 to 24	59.8 (35.9)	13.9 (6.1)	5	123
25 to 29	54.8 (43.4)	11.9 (6.5)	13	164
30 to 39	50.8 (39.7)	11.2 (6.9)	12	321
40 to 49	43.1 (30.7)	10.3 (6.2)	18	369
All ages (14 to 49)	51.4 (37.2)	11.7 (6.6)	12	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: DRV, dietary reference value; SD, standard deviation.

Note 3: DRV: should provide an average for the population of no more than 5% of energy excluding ethanol.

5.21 All age groups had intakes above the maximum recommendation of 5% energy. The percentage of women meeting the 5% recommendation ranged from 5% in 19 to 24 year old women to 18% in 40 to 49 year old women.

Dietary fibre

5.22 Dietary fibre intake in women of childbearing age from the NDNS (years 2014 to 2019) is presented in Table 5.6.

Table 5.6: dietary fibre intake in women of childbearing age (notes 1, 2)

Age (years)	Fibre grams per day; mean (SD)	% participants meeting DRV (note 3)	Number of participants
14 to 18	14.7 (5.3)	2	399
19 to 29	16.6 (6.6)	4	287
19 to 24	16.3 (6.2)	1	123
25 to 29	17.0 (6.9)	5	164
30 to 39	18.0 (6.4)	4	321
40 to 49	18.1 (7.2)	6	369
All ages (14 to 49)	17.2 (6.7)	4	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation; DRV, dietary reference value.

Note 3: DRV: fibre intake in girls aged 14 and 15 years should be 25g per day and for girls and women aged 16 years and over it should be 30g per day (SACN, 2015).

5.23 The percentage of women of childbearing age meeting the DRV of 30g per day ranged from 1% in 19 to 24 year old women to 6% in 40 to 49 year old women.

Carbohydrate intakes and deprivation

5.24 Intake of carbohydrates (by type) broken down by IMD quintiles in women of childbearing age in England from the NDNS (years 2014 to 2019) are presented in Table 5.7.

Table 5.7: carbohydrate intakes by IMD quintile in women of childbearing age (notes 1, 2)

Intakes	IMD quintile 1 (most deprived)	IMD quintile 2	IMD quintile 3	IMD quintile 4	IMD quintile 5 (least deprived)
Total carbohydrate as % energy; mean (95% CI)	48.5 (47.5 to 49.5)	48.5 (47.5 to 49.5)	47.1 (45.8 to 48.4)	46.8 (45.7 to 47.9)	47.2 (46.3 to 48.0)

Intakes	IMD quintile 1 (most deprived)	IMD quintile 2	IMD quintile 3	IMD quintile 4	IMD quintile 5 (least deprived)
Free sugars as % energy; mean (95% CI)	11.8 (10.9 to 12.6)	11.8 (10.9 to 12.8)	12.0 (10.9 to 13.1)	11.5 (10.5 to 12.4)	11.2 (10.4 to 12.1)
Dietary fibre as grams per day; mean (95% CI)	16.4 (15.6 to 17.3)	17.3 (16.4 to 18.2)	17.6 (16.5 to 18.7)	17.8 (16.8 to 18.8)	17.6 (16.7 to 18.6)
Number of participants	218	209	152	167	182

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: IMD, index of multiple deprivation; CI, confidence interval.

5.25 Data from NDNS (years 2014 to 2019) indicated that there was no evidence of a strong linear trend (indicated by overlapping confidence intervals) between total carbohydrate, free sugars or dietary fibre intakes and IMD quintile.

Dietary fat

Current recommendations

5.26 UK recommendations for dietary fats are included within the SACN ‘Saturated fats and Health’ report (SACN, 2019) and the COMA ‘Nutritional Aspects of Cardiovascular Disease’ (Department of Health, 1994). SACN and COMA did not recommend an increment for pregnant and lactating women.

5.27 The DRVs for dietary fat for the population which also apply to women aged 14 to 49 years are presented in Table 5.8.

Table 5.8: UK government dietary recommendations for dietary fat for women of childbearing age (note 1)

Dietary fat	DRV
Total fats (note 2)	Should average no more than 35% of energy (population average)
Saturated fatty acids (saturated fats) (note 2)	Should average no more than 10% of energy (population average)
Monounsaturated fatty acids (MUFA) (note 2)	12% of energy (population average)
n-6 polyunsaturated fatty acids (n-6 PUFA) (note 2)	6% of energy (population average)
Linoleic acid (note 2)	At least 1% of energy
Long chain n-3 PUFA	0.45 grams per day (population average)
Alpha linolenic acid (ALA) (note 2)	At least 0.2% of energy
Trans fats (note 2)	No more than about 2% of energy (population average)

Note 1: DRVs for dietary fats are based on previous SACN and COMA reports as detailed in chapter 2, Table 2.1.

Note 2: the 'percentage of energy' is stated in relation to the intake of energy excluding ethanol (alcohol) as detailed in SACN statement on expressing energy, fat and carbohydrate intakes and recommendations.

Dietary fat intakes

Total fat

5.28 Total fat intake in women of childbearing age in the UK from the NDNS (years 2014 to 2019) is presented in Table 5.9.

Table 5.9: total fat intake in women of childbearing age (notes 1, 2)

Age (years)	Grams per day; mean (SD)	% energy; mean (SD)	% participants meeting DRV (note 3)	Number of participants
14 to 18	59.2 (20.2)	34.5 (5.2)	52	399
19 to 29	62.8 (23.5)	34.8 (5.7)	51	287
19 to 24	60.1 (21.3)	33.9 (5.3)	55	123
25 to 29	65.1 (25.2)	35.6 (5.9)	48	164
30 to 39	65.9 (24.5)	35.6 (6.7)	43	321
40 to 49	61.1 (25.2)	35.1 (7.3)	50	369
All ages (14 to 49)	62.7 (24.0)	35.1 (6.4)	49	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: DRV; dietary reference value.

Note 3: DRV: no more than 35% energy.

5.29 The percentage of women of childbearing age meeting the DRV (no more than 35% energy) ranged from 43% (in 30 to 39 year old women) to 55% (in 19 to 24 year old women).

Saturated fatty acids (saturated fats)

5.30 Saturated fatty acid (saturated fats) intake in women of childbearing age in the UK from the NDNS (years 2014 to 2019) is presented in Table 5.10.

Table 5.10: saturated fat intake in women of childbearing age (notes 1, 2)

Age (years)	Grams per day; mean (SD)	% energy; mean (SD)	% participants meeting DRV (note 3)	Number of participants
14 to 18	21.3 (8.4)	12.3 (2.8)	19	399
19 to 29	22.8 (9.8)	12.6 (3.2)	20	287
19 to 24	21.9 (9.0)	12.3 (3.1)	20	123
25 to 29	23.6 (10.4)	12.8 (3.3)	20	164
30 to 39	24.1 (10.6)	12.9 (3.5)	19	321
40 to 49	21.7 (10.4)	12.4 (3.8)	27	369
All ages (14 to 49)	22.7 (10.1)	12.6 (3.4)	22	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation; DRV, dietary reference value.

Note 3: DRV: no more than 10% energy.

5.31 The percentage of women meeting the DRV (no more than 10% energy) ranged from 19% in the 14 to 18 year old age group and women, to 27% in 40 to 49 year old women.

Monounsaturated fatty acids

5.32 Cis monounsaturated fatty acid (cis MUFA) intake in women of childbearing age in the UK from the NDNS (years 2014 to 2019) is presented in Table 5.11. SACN ‘Saturated fats and Health’ report (SACN, 2019) recommended that saturated fats are substituted with unsaturated fats, such as cis MUFA.

Table 5.11: cis monounsaturated fatty acids (cis MUFA) intakes in women of childbearing age (notes 1, 2, 3)

Age (years)	Grams per day; mean (SD)	% energy; mean (SD)	Number of participants
14 to 18	22.7 (8.2)	13.2 (2.6)	399
19 to 29	23.4 (9.3)	13.0 (2.8)	287
19 to 24	22.7 (8.9)	12.7 (2.8)	123
25 to 29	24.1 (9.6)	13.2 (2.8)	164
30 to 39	24.4 (9.8)	13.2 (3.1)	321
40 to 49	22.7 (10.1)	13.0 (3.3)	369
All ages (14 to 49)	23.4 (9.6)	13.1 (3.0)	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation.

Note 3: DRV: should continue to provide an average for the population of about 12% of energy.

Polyunsaturated fatty acids

5.33 Cis n-3 and cis n-6 polyunsaturated fatty acid (cis n-3 and n-6 PUFA) intake in women of childbearing age in the UK from NDNS (years 2014 to 2019) is presented in Table 5.12 and Table 5.13. SACN ‘Saturated fats and Health’ report (SACN, 2019) recommended that saturated fats are substituted with unsaturated fats, such as cis n-3 and cis n-6 PUFA.

Table 5.12: cis n-3 polyunsaturated fatty acids intakes in women of childbearing age (notes 1, 2)

Age (years)	Grams per day; mean (SD)	% energy; mean (SD)	Number of participants
14 to 18	1.6 (0.7)	0.9 (0.3)	399
19 to 29	1.8 (0.9)	1.0 (0.5)	287
19 to 24	1.7 (0.9)	1.0 (0.7)	123
25 to 29	1.9 (1.0)	1.0 (0.4)	164
30 to 39	1.8 (0.9)	1.0 (0.4)	321
40 to 49	1.9 (1.1)	1.1 (0.5)	369
All ages (14 to 49)	1.8 (0.9)	1.0 (0.5)	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation.

Table 5.13: n-6 polyunsaturated fatty acids intakes in women of childbearing age (notes 1, 2)

Age (years)	Grams per day; mean (SD)	% energy; mean (SD)	Number of participants
14 to 18	8.7 (3.6)	5.1 (1.6)	399
19 to 29	9.1 (4.2)	5.1 (1.6)	287
19 to 24	8.5 (3.5)	4.8 (1.4)	123
25 to 29	9.7 (4.7)	5.3 (1.7)	164
30 to 39	9.7 (4.2)	5.3 (1.7)	321
40 to 49	9.3 (4.9)	5.4 (2.1)	369
All ages (14 to 49)	9.3 (4.4)	5.2 (1.8)	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation.

Trans fatty acids

5.34 Trans fatty acid intake in women of childbearing age in the UK from the NDNS (years 2014 to 2019) is presented in Table 5.14.

Table 5.14: trans fatty acid intakes in women of childbearing age (notes 1, 2, 3)

Age (years)	Grams per day; mean (SD)	% energy; mean (SD)	% meeting DRV	Number of participants
14 to 18	0.8 (0.4)	0.4 (0.2)	100	399
19 to 29	0.9 (0.5)	0.5 (0.2)	100	287
19 to 24	0.9 (0.5)	0.5 (0.2)	100	123
25 to 29	0.9 (0.5)	0.5 (0.2)	100	164
30 to 39	0.9 (0.5)	0.5 (0.2)	100	321
40 to 49	0.8 (0.5)	0.5 (0.2)	100	369
All ages (14 to 49)	0.9 (0.5)	0.5 (0.2)	100	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation; DRV, dietary reference value.

Note 3: trans fatty acid intakes should be no more than about 2% of energy (Department of Health, 1994).

5.35 No girls or women in any age group exceeded the recommendation of no more than 2% energy from trans fatty acids.

Dietary fat intakes and deprivation

5.36 Dietary fat intakes (by type) broken down by IMD quintiles in women of childbearing age in England from the NDNS (years 2014 to 2019) are presented in Table 5.15.

Table 5.15: dietary fat intakes by IMD quintile in women of childbearing age (notes 1, 2)

Intakes	IMD quintile 1 (most deprived)	IMD quintile 2	IMD quintile 3	IMD quintile 4	IMD quintile 5 (least deprived)
Total fat as % energy; mean (95% CI)	34.7 (33.9 to 35.6)	35.1 (34.2 to 36.1)	35.0 (34.0 to 36.0)	35.8 (34.8 to 36.8)	35.2 (34.4 to 36.1)
Saturated fat as % energy; mean (95% CI)	12.2 (11.8 to 12.7)	12.6 (12.1 to 13.1)	12.7 (12.2 to 13.3)	13.0 (12.4 to 13.5)	12.5 (12.0 to 12.9)
Cis MUFA as % energy; mean (95% CI)	13.2 (12.8 to 13.6)	13.0 (12.6 to 13.4)	13.0 (12.5 to 13.4)	13.2 (12.8 to 13.6)	13.2 (12.8 to 13.7)
Cis n-3 PUFA as % energy; mean (95% CI)	1.0 (0.9 to 1.0)	1.0 (0.9 to 1.0)	1.0 (1.0 to 1.1)	1.1 (1.0 to 1.2)	1.1 (1.0 to 1.1)
Cis n-6 PUFA as % energy; mean (95% CI)	5.3 (5.0 to 5.5)	5.5 (5.2 to 5.7)	5.0 (4.7 to 5.3)	5.3 (5.0 to 5.6)	5.3 (5.1 to 5.6)
Number of participants	218	209	152	167	182

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: CI, confidence interval; IMD, index of multiple deprivation.

5.37 Data from NDNS (years 2014 to 2019) indicated that there was no evidence of a strong linear trend (indicated by overlapping confidence intervals) between total fat, saturated fat, cis MUFA, cis n-6 PUFA or cis n-3 PUFA intakes and IMD quintile.

Protein

Current recommendations

5.38 The current DRVs for protein in the UK were set by COMA in 1991 (Department of Health, 1991) (see Table 5.16). The reference nutrient intake (RNI) for protein is based on 0.75g protein per kg bodyweight (this is based on egg and milk protein and assumes complete digestibility). The RNIs for women of childbearing age are based on the following mean body weights: 43.8kg for those aged up to 14 years, 55.5kg for those aged 15 to 18 years, and 60kg for those aged

19 to 50 years. The increment for pregnancy applies throughout all stages of pregnancy.

Table 5.16: DRVs for protein for women of childbearing age (note 1)

Age (years)	RNI (grams per day)
14	41.2
15 to 18	45.4
19 to 50	45.0
Increment for pregnancy	+6
Increment for lactation (0 to 6 months)	+11
Increment for lactation (after 6 months)	+8

Note 1: data from Department of Health (1991). It is recommended that intake in adults should not exceed twice the RNI.

Protein intakes

5.39 Protein intake in women of childbearing age in the UK from the NDNS (years 2014 to 2019) is presented in Table 5.17.

Table 5.17: protein intakes in women of childbearing age (notes 1, 2)

Age (years)	Grams per day; mean (SD)	% energy; mean (SD)	Mean intake as % of RNI	Number of participants
14 to 18	57.3 (16.6)	15.3 (3.2)	130	399
19 to 29	67.0 (25.0)	17.2 (5.5)	149	287
19 to 24	64.1 (19.3)	16.7 (4.1)	142	123
25 to 29	69.6 (28.9)	17.6 (6.5)	155	164
30 to 39	68.2 (20.4)	17.0 (4.2)	151	321
40 to 49	66.5 (18.7)	17.9 (4.9)	148	369
All ages (14 to 49)	66.1 (21.3)	17.1 (4.8)	147	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation; RNI, reference nutrient intake.

5.40 Mean protein intake (g per day) exceeded the RNI in all age categories.

Protein intakes and deprivation

5.41 Protein intakes broken down by IMD quintiles in women of childbearing age in England from the NDNS (years 2014 to 2019) are presented in Table 5.18.

Table 5.18: protein intakes by IMD quintile in women of childbearing age (notes 1, 2)

Intakes	IMD quintile 1 (most deprived)	IMD quintile 2	IMD quintile 3	IMD quintile 4	IMD quintile 5 (least deprived)
Protein as % of energy; mean (95% CI)	16.8 (16.2 to 17.3)	16.4 (15.8 to 16.9)	17.9 (16.9 to 18.9)	17.4 (16.7 to 18.1)	17.6 (16.9 to 18.3)
Number of participants	218	209	152	167	182

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: CI, confidence interval; IMD, index of multiple deprivation.

5.42 Data from NDNS (years 2014 to 2019) indicated that there was no evidence of a strong linear trend (indicated by overlapping confidence intervals) between protein intake and IMD quintile.

Vegetables and fruit

Current recommendations

5.43 All UK population groups are advised to consume at least 5 portions of a variety of vegetables and fruit a day. This applies to pregnant and lactating women.

Vegetable and fruit intakes

5.44 Vegetable and fruit consumption for women of childbearing age expressed in grams per day and as number of portions based on the ‘5 A Day’ criteria are presented in Table 5.19 to Table 5.22 (NDNS 2014 to 2019).

Table 5.19: vegetable and fruit consumption in women of childbearing age (excludes fruit juice) (notes 1, 2)

Age (years)	Vegetable and fruit grams per day; mean (SD) including non-consumers	% consumers over 4 days	Number of participants
14 to 18	185 (130.5)	99.8	399
19 to 29	257 (173.1)	100	287
19 to 24	254 (176.7)	100	123
25 to 29	259 (170.8)	100	164
30 to 39	292 (176.9)	100	321
40 to 49	307 (188.7)	100	369
All ages (14 to 49)	273 (178.3)	99.8	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation.

Table 5.20: vegetable and fruit portions consumed by women of childbearing age (notes 1, 2, 3)

Age (years)	Portions per day; mean (SD)	% meeting 5 A Day	Number of participants
14 to 18	2.9 (1.8)	10	399
19 to 29	3.7 (2.2)	27	287
19 to 24	3.7 (2.3)	25	123
25 to 29	3.7 (2.2)	28	164
30 to 39	4.1 (2.3)	29	321
40 to 49	4.2 (2.4)	31	369
All ages (14 to 49)	3.8 (2.3)	27	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation.

Note 3: the number of portions of vegetables and fruit has been calculated based on the '5 A Day' criteria. The current recommendation is to consume at least 5 portions of a variety of fruit and vegetables per day, as outlined on the NHS page 5 A Day: what counts?.

5.45 The percentage of women of childbearing age meeting the '5 A Day' recommendation ranged from 10% in the 14 to 18 year old age group and women, to 31% of 40 to 49 year old women.

Table 5.21: vegetable consumption in women of childbearing age (notes 1, 2)

Age (years)	Vegetable grams per day; mean (SD) including non-consumers	% consumers over 4 days	Number of participants
14 to 18	118 (77.9)	99.8	399
19 to 29	182 (133.5)	100	287
19 to 24	179 (140.8)	100	123
25 to 29	185 (127.5)	100	164
30 to 39	197 (122.8)	100	321
40 to 49	200 (124.2)	100	369
All ages (14 to 49)	184 (124.7)	100	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation.

Table 5.22 fruit consumption in women of childbearing age (excludes fruit juice) (notes 1, 2)

Age (years)	Fruit grams per day; mean (SD) including non-consumers	Fruit grams per day; mean (SD) consumers only	% consumers over 4 days	Number of participants
14 to 18	67 (83.6)	82 (85.7)	80.9	399
19 to 29	75 (74.4)	84 (73.8)	89.2	287
19 to 24	75 (75.2)	82 (74.9)	91.6	123
25 to 29	74 (74.0)	85 (73.1)	87.0	164
30 to 39	95 (90.3)	106 (89.2)	90.1	321
40 to 49	106 (108.9)	116 (108.7)	91.7	369
All ages (14 to 49)	89 (92.1)	99 (91.9)	89.2	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation.

Vegetable and fruit intakes and deprivation

5.46 Vegetable and fruit consumption broken down by IMD quintiles in women of childbearing age in England from the NDNS (years 2014 to 2019) is presented in Table 5.23.

Table 5.23: vegetable and fruit consumption by IMD quintile in women of childbearing age (notes 1, 2)

Intakes	IMD quintile 1 (most deprived)	IMD quintile 2	IMD quintile 3	IMD quintile 4	IMD quintile 5 (least deprived)
5 A Day portions; mean (95% CI)	3.6 (3.3 to 3.9)	3.7 (3.4 to 4.0)	4.2 (3.8 to 4.6)	4.4 (4.0 to 4.7)	3.9 (3.6 to 4.2)
% meeting 5 A Day (95% CI)	24 (20 to 29)	22 (18 to 27)	35 (29 to 41)	32 (26 to 38)	27 (22 to 33)
Total vegetables and fruit as grams per day; mean (95% CI)	257 (233 to 280)	261 (237 to 284)	302 (269 to 334)	309 (282 to 336)	275 (252 to 298)
Total fruit as grams per day; mean (95% CI)	86 (73 to 99)	83 (70 to 96)	95 (80 to 109)	100 (86 to 113)	89 (79 to 100)
Total vegetables as grams per day; mean (95% CI)	170 (155 to 186)	178 (162 to 194)	207 (185 to 230)	209 (190 to 229)	186 (169 to 203)
Number of participants	218	209	152	167	182

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation; IMD, index of multiple deprivation; CI, confidence intervals.

5.47 Data from NDNS (years 2014 to 2019) indicated that there was no evidence of a strong linear trend (indicated by overlapping confidence intervals) between vegetable or fruit consumption and IMD quintile.

Oily fish

Current recommendations

5.48 All UK population groups are advised to eat at least 2 portions (each 140g) of fish every week, one of which should be oily, such as salmon, sardines or mackerel. However, there is additional food safety advice for pregnant women who eat fish.

Oily fish intakes

5.49 Oily fish consumption expressed in grams per day for women of childbearing age in the UK from the NDNS (years 2014 to 2019) is presented in Table 5.24.

Table 5.24: oily fish consumption in women of childbearing age (notes 1, 2)

Age (years)	Oily fish grams per day; mean (SD) including non-consumers	Oily fish grams per day; mean (SD) consumers only	% consumers over 4 days	Number of participants
14 to 18	3 (10.0)	19 (18.5)	15.2	399
19 to 29	5 (13.8)	24 (21.2)	21.6	287
19 to 24	4 (9.5)	19 (14.4)	18.2	123
25 to 29	7 (16.6)	27 (24.5)	24.6	164
30 to 39	6 (13.9)	25 (19.0)	22.9	321
40 to 49	8 (17.9)	29 (22.8	28.1	369
All ages (14 to 49)	6 (14.8)	26 (21.1)	23.1	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation.

5.50 Mean consumption of oily fish at population level was equivalent to 42g per week on average across the age range, well below the recommended one portion per week (140 g). 77% of women of childbearing age consumed no oily fish over the 4 survey days.

Red and processed meat

Current recommendations

5.51 All UK population groups are advised to reduce consumption of red and processed meat to no more than 70g per day if they usually eat more than 90g per day. There are no specific recommendations for pregnancy or lactation.

Red and processed meat intakes

5.52 Red and processed meat consumption expressed in grams per day for women of childbearing age in the UK from the NDNS (years 2014 to 2019) is presented in Table 5.25.

Table 5.25: red and processed meat consumption in women of childbearing age (notes 1, 2)

Age (years)	Red and processed meat grams per day; mean (SD) including non-consumers	Red and processed meat grams per day; mean (SD) consumers only	% consumers over 4 days	Number of participants
14 to 18	47 (38.0)	54 (35.5)	85.6	399
19 to 29	45 (40.9)	54 (38.9)	83.0	287
19 to 24	42 (40.3)	50 (39.3)	85.5	123
25 to 29	48 (41.5)	59 (38.2)	80.8	164
30 to 39	48 (40.5)	58 (37.4)	83.1	321
40 to 49	47 (40.6)	57 (37.6)	81.6	369
All ages (14 to 49)	47 (40.3)	56 (37.7)	82.9	1,376

Note 1: NDNS years 2014 to 2019 (women aged 14 to 49 years).

Note 2: abbreviations: SD, standard deviation.

5.53 Mean consumption of red and processed meat in women of childbearing age met the recommendation of no more than 70g per day in all age groups

6. Energy and macronutrient intake and GWG

Background

6.1 The energy and nutrient density of the diet, including the balance of macronutrients (and micronutrients), need to be considered in women of childbearing age as well as throughout pregnancy.

6.2 Macronutrients (carbohydrate, dietary fat and protein) contribute to an individual's dietary energy intake. The major factors that are associated with differences in energy requirements and thus intakes among individuals are differences in body size and physical activity (SACN, 2011a) (see chapter 2).

6.3 In non-pregnant adult populations, weight gain is the result of a positive energy balance, largely irrespective of the source of energy (Romieu and others, 2017). Weight gain during pregnancy includes fetal weight gain, placental weight development, maternal fat accumulation, and major changes in extracellular volume (IOM and NRC, 2009).

Evidence in this chapter

6.4 This chapter considers evidence from one systematic review (SR) without meta-analysis (MA). Results were reported narratively in the SR. Details of this SR can be found in Annex 3. Quality assessment of the SR using the AMSTAR 2 tool can be found in Annex 4 (Table A4.1).

6.5 The criteria used to grade the evidence are provided in chapter 3 (see paragraphs 3.53 to 3.60). As no MA was conducted for this SR, expert judgment was used to interpret the findings of the primary studies in line with the SACN Framework (SACN, 2023).

6.6 The source of evidence in this chapter is an SR (Tielemans and others, 2016) that examined the association between multiple exposures, including energy and macronutrient intake during pregnancy, and the primary outcomes of absolute gestational weight gain (GWG) (measured or self-reported) and adequacy of GWG. 'Adequacy of GWG' is based on categories of GWG (for example, 'low' or 'inadequate', 'adequate', or 'excess'). Varying definitions and cut-offs are used by primary study authors. Studies also differ in whether they report that GWG was 'adequate' or 'excess'. In this chapter, the terms 'adequate' and 'excess' are used as they were reported by Tielemans and others (2016). Tielemans sometimes grouped findings for studies reporting outcomes in relation to 'excess' and' adequate' GWG together. Where this was the case, a judgement has been taken, based on the reporting information for the primary studies, on whether the most appropriate terminology is in relation to 'excess' or 'adequate'.

6.7 Tielemans and others (2016) (AMSTAR 2 confidence rating: moderate) included 56 studies in total across the review. Not all studies were included for each exposure. Ten of the 56 studies included in the SR were interventional (including 2 randomised controlled trials (RCTs)) and 46 were observational (predominantly prospective cohort studies). Overall, most studies included women of mixed weight status; where available, the mean pre-pregnancy body mass index (BMI) was in the healthy weight range (18.5kg/m^2 to 24.9kg/m^2). Seven studies applied weight-status-based inclusion criteria, which included women living with obesity pre-pregnancy or during pregnancy (in 3 studies), women with a pre-pregnancy BMI in the healthy weight range (in one study), women of average weight-for-height pre-pregnancy (in one study), women within 90% to 120% of ideal body weight in pregnancy (in one study), and women with BMI in the underweight range (18.5kg/m^2 or below) in pregnancy to compare with women with BMI above 18.5kg/m^2 (in one study).

6.8 In most cases, GWG was calculated using measured weight in the third trimester compared with self-reported pre-pregnancy weight. Intake assessments varied by study and included food-frequency questionnaires, food records and 24-hour dietary recall.

Energy intake

GWG

6.9 Tielemans and others (2016) included 42 studies that reported on the association between maternal energy intake and GWG. Twenty-one (50%) of the reported studies were conducted in high income countries (HICs), of which all were prospective cohort studies (n = 15,713). Most of these studies included women of mixed pre-pregnancy weight status; where available, mean pre-pregnancy BMI of the recruited sample was in the healthy weight range (18.5kg/m^2 to 24.9kg/m^2).

6.10 Out of the 21 prospective cohort studies, 5 (n = 12,497, of which 4 were high quality) reported that habitual higher energy intake was associated with higher GWG. Thirteen prospective cohort studies (n = 2,599, one high quality) reported no association. Three of the prospective cohort studies reported the results in subgroups: one study (n = 194) reported that energy intake was associated with higher GWG in women with BMI of 25kg/m^2 or above, with no association in women with BMI less than 25kg/m^2. One study (n = 60) reported no association between energy intake and GWG in the total population, but that energy intake was associated with higher GWG in non-smokers. One study (n = 156) reported a positive correlation between energy intake and the change in intake with GWG during the first trimester, and a negative correlation between the change in energy intake and GWG later in pregnancy. The 21 prospective cohort studies differed in their adjustment for confounders.

Adequacy of GWG

6.11 Tielemans and others (2016) included 17 prospective cohort studies that reported on the association between maternal energy intake and adequacy of GWG. Ten (48%) of the reported studies were conducted in HICs (n = 10,985). Most of these studies included women of mixed pre-pregnancy weight status; where available, mean pre-pregnancy BMI of the recruited sample was in the healthy weight range (18.5kg/m^2 to 24.9kg/m^2).

6.12 Categories for adequacy of GWG were defined differently across the prospective cohort studies: 8 categorised adequate GWG based on the National Academy of Medicine (NAM) (formerly the Institute of Medicine (IOM)) guidelines from 1990 and 2009, one determined adequacy according to Icelandic guidelines (optimal GWG for 'normal' weight, between 12.1kg and 18.0kg and for overweight, between 7.1kg and 12.0kg), and one categorised inadequate GWG as 6.8kg or less and adequate GWG as more than 6.8kg.

6.13 Out of the 10 prospective cohort studies, 5 (n = 9,391, of which 3 were high quality) reported that higher energy intake was associated with excess GWG. Five prospective cohort studies (n = 1,594, 0 high quality) reported no association.

Summary: energy intake

6.14 The available evidence from SRs examining the effect of energy intake during pregnancy and GWG is from one SR without MAs (given a moderate confidence rating using the AMSTAR 2 tool).

6.15 The GRADE assessment on the certainty of the evidence on energy intake during pregnancy and GWG and adequacy of GWG is presented in Table 6.1 and Table 6.2. The summary of the evidence is presented in Table 6.3.

Table 6.1: GRADE assessment on energy intake during pregnancy and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	21
Number of participants	15,713
Study design	Prospective cohort studies
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	No
Inconsistency	No
Indirectness	No
Imprecision	Rating not assignable (note 1)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Increase
Certainty	Low

Note 1: rating was not assignable as this was a narrative systematic review.

6.16 There was low certainty evidence from prospective cohort studies that higher maternal total energy intake may be associated with higher GWG in women with a range of BMIs (21 prospective cohort studies, 15,713 participants, low certainty (observational data)).

Table 6.2: GRADE assessment on energy intake during pregnancy and excess GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	10
Number of participants	10,985
Study design	Prospective cohort studies
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	No
Inconsistency	No
Indirectness	No
Imprecision	Rating not assignable (note 1)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Increase
Certainty	Low

Note 1: rating was not assignable as this was a narrative systematic review.

6.17 There was low certainty evidence from prospective cohort studies that higher total energy intake may be associated with excess GWG in women with a range of BMIs (10 prospective cohort studies, 10,985 participants, low certainty (observational data)).

Table 6.3: summary of the evidence on energy intake during pregnancy and GWG

Intervention or exposure	Outcome	Direction of effect	Certainty of evidence
Energy intake	GWG	Increase	Low
Energy intake	Excess GWG	Increase	Low

Carbohydrate intake

GWG

6.18 Tielemans and others (2016) included 18 studies that reported the association between maternal carbohydrate intake and GWG. Ten studies (56%) were conducted in HICs, all of which were prospective cohort studies (n = 8,315). Most of these studies included women of mixed pre-pregnancy weight status; where available, mean pre-pregnancy BMI of the recruited sample was in the healthy weight range (18.5kg/m^2 to 24.9kg/m^2).

6.19 Out of the 10 prospective cohort studies, one prospective cohort study (n = 6,959, high quality) reported that higher carbohydrate intake was associated with higher GWG. Six prospective cohort studies (n = 799) reported no consistent association between higher carbohydrate intake and GWG, one prospective cohort study (n = 207) reported higher carbohydrate intake was associated with lower GWG. Three of the prospective cohort studies reported the results in subgroups: one prospective cohort study (n = 194) reported higher carbohydrate intake was associated with higher GWG in women with BMI 25kg/m^2 or above, but no consistent association was shown in women with BMI below 25kg/m^2. One prospective cohort study (n = 156) reported a positive correlation between carbohydrate intake during the first trimester and the change of intake during the first trimester with GWG, and a negative correlation between the change in carbohydrate intake later in pregnancy (from 3rd to 8th month of pregnancy) with GWG.

6.20 The 10 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

Adequacy of GWG

6.21 Tielemans and others (2016) included 9 studies that reported on the association between maternal carbohydrate intake and adequacy of GWG. Six studies (67%) were conducted in HICs, all of which were prospective cohort studies (n = 7,864). Most of these studies included women of mixed pre-pregnancy weight status; where available, mean pre-pregnancy BMI of the recruited sample was in the healthy weight range (18.5kg/m^2 to 24.9kg/m^2).

6.22 Adequacy of GWG was determined or categorised differently across the prospective cohort studies. Two prospective cohort studies categorised adequate GWG based on the NAM (formerly IOM) guidelines from 1990 and 2009. One prospective cohort study categorised it as less than 8kg. One prospective cohort study categorised it as 6kg or more. One prospective cohort study categorised it as GWG more than 1kg per month. One prospective cohort study categorised it based on Icelandic guidelines and classed adequate GWG as more than 6.8kg.

6.23 Out of the 6 prospective cohort studies, 4 (n = 711, 0 high quality) reported maternal carbohydrate intake was not associated with the prevalence of inadequate or excess GWG. One prospective cohort study (n = 6,959, high quality) reported a higher prevalence of excess GWG with increased maternal carbohydrate intake. One prospective cohort study (n = 194) reported a lower prevalence of excess GWG with higher intake of carbohydrate in women living with overweight.

6.24 The 6 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

Summary: carbohydrate intake

6.25 The available evidence from SRs examining the effect of carbohydrate intake during pregnancy and GWG is from one SR without MAs (given a moderate confidence rating using the AMSTAR 2 tool).

6.26 The GRADE assessment on the certainty of the evidence on carbohydrate intake during pregnancy and GWG and GWG adequacy is presented in Table 6.4 and Table 6.5. The summary of the evidence is presented in Table 6.6.

Table 6.4: GRADE assessment on carbohydrate intake during pregnancy and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	10
Number of participants	8,315
Study design	Prospective cohort studies
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	Serious (note 1)
Inconsistency	Serious (note 2)
Indirectness	No
Imprecision	Rating not assignable (note 3)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Inconsistent
Certainty	Very low

Note 1: one of 6 studies classified as high quality.

Note 2: variation in direction of effect.

Note 3: rating was not assignable as this was a narrative systematic review.

6.27 There was very low certainty evidence from prospective cohort studies of an inconsistent association between maternal carbohydrate intake and GWG in women with a range of BMIs (10 prospective cohort studies, 8,315 participants, very low certainty (observational data downgraded due to evidence of risk of bias and evidence of inconsistency (in direction of effect)).

Table 6.5: GRADE assessment on carbohydrate intake during pregnancy and excess GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	6
Number of participants	7,864
Study design	Prospective cohort studies
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	Serious (note 1)
Inconsistency	No
Indirectness	No
Imprecision	Rating not assignable (note 2)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Inconsistent
Certainty	Very low

Note 1: one of 6 studies classified as high quality.

Note 2: rating was not assignable as this was a narrative systematic review.

6.28 There was very low certainty evidence from prospective cohort studies of an inconsistent association between maternal carbohydrate intake and excess GWG in women with a range of BMIs. Excess GWG was assessed based on different guidelines, 6 prospective cohort studies, 7,864 participants, very low certainty (observational data downgraded due to evidence of risk of bias).

Table 6.6: summary of the evidence on carbohydrate intake during pregnancy and GWG

Intervention or exposure	Outcome	Direction of effect	Certainty of evidence
Carbohydrate intake	GWG	Inconsistent	Very low
Carbohydrate intake	Excess GWG	Inconsistent	Very low

Total fat intake

GWG

6.29 Tielemans and others (2016) included 21 studies that reported on the association between maternal total fat intake and GWG. Eleven studies (52%) were conducted in HICs, all of which were prospective cohort studies (n = 9,640). Most of these studies included women of mixed pre-pregnancy weight status; where available, mean pre-pregnancy BMI of the recruited sample was in the healthy weight range (18.5kg/m^2 to 24.9kg/m^2).

6.30 Out of the 11 prospective cohort studies, one prospective cohort study (n = 6,959, high quality) reported that higher fat intake was associated with higher GWG. Eight prospective cohort studies (n = 2,331, 1 high quality) reported no consistent association between higher fat intake and GWG. Two of the prospective cohort studies reported the results in subgroups: one prospective cohort study (n = 194) reported higher fat intake was associated with higher GWG in women with BMI of 25kg/m^2 or above, but no consistent association was shown in women with BMI below 25kg/m^2. One prospective cohort study (n = 156) reported that higher fat intake during the first trimester, but not in other periods, was associated with greater GWG.

6.31 The 11 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

Adequacy of GWG

6.32 No evidence was identified on the association between maternal total fat intake and the adequacy of GWG.

Summary: total fat intake

6.33 The available evidence from SRs examining the effect of maternal fat intake during pregnancy and GWG is from one SR without MA (given a moderate confidence rating using the AMSTAR 2 tool).

6.34 The GRADE assessment on the certainty of the evidence on maternal fat intake during pregnancy and GWG is presented in Table 6.7.

Table 6.7: GRADE assessment on total fat intake during pregnancy and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	11
Number of participants	9,640
Study design	Prospective cohort studies
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	Serious (note 1)
Inconsistency	Serious (note 2)
Indirectness	No
Imprecision	Rating not assignable (note 3)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Inconsistent
Certainty	Very low

Note 1: 2 of 11 studies classified as high quality.

Note 2: variation in direction of effect.

Note 3: rating was not assignable as this was a narrative systematic review.

6.35 There was very low certainty evidence from prospective cohort studies of an inconsistent association between maternal total fat intake and GWG in women with a range of BMIs (11 prospective cohort studies, 9,640 participants, very low certainty (observational data downgraded due to evidence of risk of bias and evidence of inconsistency (in direction of effect)).

Saturated fat intake

GWG

6.36 Tielemans and others (2016) included 8 studies that reported on the association between maternal saturated fat intake and GWG. Seven prospective cohort studies (88%) were conducted in HICs, all of which were prospective cohort studies (n = 5,921). Most of these studies included women of mixed pre-pregnancy weight status; where available, mean pre-pregnancy BMI of the recruited sample was in the healthy weight range

(18.5kg/m^2 to 24.9kg/m^2). One study recruited women specifically living with obesity pre-pregnancy (BMI 30kg/m^2 or above).

6.37 Of the 7 prospective cohort studies, one (n = 3,360, high quality) reported an association with saturated fat intake and marginally higher GWG (no effect size reported, $p < 0.04$) assessed using measured weights in the first and third trimesters. Six prospective cohort studies (n = 2,561) reported no association between intake of saturated fats and GWG, although all used self-reported pre-pregnancy weight.

6.38 The 7 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

Adequacy of GWG

6.39 No evidence was identified on the association between maternal saturated fat intake and the adequacy of GWG.

Summary: saturated fat intake

6.40 The available evidence from SRs examining the effect of maternal saturated fat intake during pregnancy and GWG is from one SR without MA (given a moderate confidence rating using the AMSTAR 2 tool).

6.41 The GRADE assessment on the certainty of the evidence on maternal saturated fat intake during pregnancy and GWG is presented in Table 6.8.

Table 6.8: GRADE assessment on saturated fat intake during pregnancy and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	7
Number of participants	5,921
Study design	Prospective cohort studies
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	Serious (note 1)
Inconsistency	No
Indirectness	No
Imprecision	Rating not assignable (note 2)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Inconsistent
Certainty	Very low

Note 1: 2 of 7 studies classified as high quality.

Note 2: rating was not assignable as this was a narrative systematic review.

6.42 There was very low certainty evidence from prospective cohort studies of an inconsistent association between maternal saturated fat intake and GWG in women with a range of BMIs (7 prospective cohort studies, 5,921 participants, very low certainty (observational data downgraded due to evidence of risk of bias)).

Unsaturated fat intake

GWG

6.43 Tielemans and others (2016) included 5 studies that reported on the association between maternal unsaturated fat intake and GWG. Four studies (80%) were conducted in HICs, all of which were prospective cohort studies (n = 1,927). Three of these studies included women of mixed pre-pregnancy weight status; where available, mean pre-pregnancy BMI of the recruited sample was in the healthy weight range (18.5kg/m^2 to 24.9kg/m^2). One study recruited women specifically living with obesity pre-pregnancy (BMI 30kg/m^2 or above).

6.44 In 3 of the 4 prospective cohort studies, GWG was calculated using measured weight in the third trimester compared with self-reported pre-pregnancy weight. One prospective cohort study did not report the assessment method, or the period of pregnancy covered.

6.45 Out of the 4 prospective cohort studies, one (n = 1,388, high quality) reported that higher monounsaturated fat intake was associated with lower GWG. Three prospective cohort studies (n = 539) reported no association between polyunsaturated fat intake and GWG.

6.46 The 4 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

6.47 No specific evidence on n-3 polyunsaturated fats or n-6 polyunsaturated fats was identified.

Adequacy of GWG

6.48 No evidence was identified on the association between maternal unsaturated fat intake and the adequacy of GWG.

Summary: unsaturated fat intake

6.49 The available evidence from SRs examining the effect of maternal unsaturated fat intake during pregnancy and GWG is from one SR without MA (given a moderate confidence rating using the AMSTAR 2 tool).

6.50 The GRADE assessment on the certainty of the evidence on maternal unsaturated fat intake during pregnancy and GWG is presented in Table 6.9.

Table 6.9: GRADE assessment on unsaturated fat intake during pregnancy and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	4
Number of participants	1,927
Study design	Prospective cohort studies
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	Serious (note 1)
Inconsistency	No
Indirectness	No
Imprecision	Rating not assignable (note 2)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Inconsistent
Certainty	Very low

Note 1: 1 of 4 studies classified as high quality.

Note 2: rating was not assignable as this was a narrative systematic review.

6.51 There was very low certainty evidence from prospective cohort studies of an inconsistent association between maternal unsaturated fat intake and GWG in women with a range of BMIs (4 prospective cohort studies, 1,927 participants, very low certainty (observational data downgraded due to evidence of risk of bias)).

Trans-fat intake

GWG

6.52 No evidence was identified on the association between maternal trans-fat intake and GWG (continuously).

Adequacy of GWG

6.53 Tielemans and others (2016) included one prospective cohort study that reported on the association between maternal trans-fat intake and excess GWG. The prospective cohort study was conducted in a HIC (n = 1,388) and included women of mixed pre-pregnancy weight status (27% had pre-pregnancy BMI of 26kg/m^2 or above; mean BMI was not reported).

6.54 Excess weight gain was defined as gain greater than the upper limit for each woman's pre-pregnancy BMI category according to the NAM (formerly IOM) guidelines from 1990 and 2009. The prospective cohort study reported no association between trans-fat intake (per 2% of energy, compared with carbohydrates) and excess GWG in women with a BMI of 26kg/m^2 or above (odds ratio (OR) = 1.27 (95% confidence interval (CI) 0.39, 4.13)). The analysis was adjusted for pre-pregnancy BMI (in 5 percentile categories), maternal age (14 to 19 years, 20 to 24 years, 25 to 29 years, 30 to 34 years, 35 to 39 years, 40 years and over), race or ethnicity, smoking status, gestational age at delivery (weeks), and nausea in the first trimester of pregnancy.

Summary: trans-fat intake

6.55 The available evidence from SRs examining the effect of maternal trans-fat intake during pregnancy and GWG is from one SR without MA (given a moderate confidence rating using the AMSTAR 2 tool).

6.56 The GRADE assessment on the certainty of the evidence on maternal trans-fat intake during pregnancy and GWG is presented in Table 6.10.

Table 6.10: GRADE assessment on trans-fat intake during pregnancy and excess GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	1
Number of participants	1,388
Study design	Prospective cohort study
Summary effect estimate	OR = 1.27 (95% CI 0.39, 4.13) (note 1)
Risk of bias	No
Inconsistency	Rating not assignable (note 2)
Indirectness	Serious (note 3)
Imprecision	Serious (note 4)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Null
Certainty	Very low

Note 1: trans-fat intake (per 2% of energy, compared with carbohydrates).

Note 2: rating was not assignable as this was a single study.

Note 3: single study and single site.

Note 4: wide confidence intervals.

6.57 There was very low certainty evidence from a prospective cohort study indicating no association between trans-fat and excess GWG in women with a BMI 26kg/m^2 or above (one prospective cohort study, 1,388 participants, very low certainty (downgraded due to being observational data and concerns over indirectness (due to being a single study)).

Source of fat

GWG

6.58 Tielemans and others (2016) included one prospective cohort study that reported on the association between source of fat in the maternal diet and GWG. The prospective cohort study was conducted in a HIC (n = 207) and included women of mixed pre-pregnancy weight status (13% had pre-pregnancy BMI of 25kg/m^2 or above; mean BMI was not reported).

6.59 The prospective cohort study (n = 207) stratified fat intake on the basis of its source (that is, animal compared with vegetable-based source). Pregnant women's dietary intake during the second trimester was ascertained at the 27th week of pregnancy through a food-frequency questionnaire. The prospective cohort study reported that higher fat intake from animal sources was associated with higher GWG (2.56kg per standard deviation (SD) increase in intake (95% CI: 1.64, 3.48); $p < 0.01$), whereas higher vegetable-based fat intake was not associated with higher GWG (0.77kg per SD increase in intake (95% CI: -0.17, 1.71); $p = 0.11$). The analysis was adjusted for age, parity, pre-pregnancy BMI, maternal education, smoking, energy intake, gestational age at delivery, gender of the baby, maternal height and pre-pregnancy oral contraceptive use.

Adequacy of GWG

6.60 No evidence was identified on the association between source of maternal fat intake and the adequacy of GWG.

Summary: source of fat intake

6.61 The available evidence from SRs examining the effect of maternal source of fat during pregnancy and GWG is from one SR without MA (given a moderate confidence rating using the AMSTAR 2 tool).

6.62 The GRADE assessment on the certainty of the evidence on maternal source of fat during pregnancy and GWG is presented in Table 6.11 and Table 6.12.

Table 6.11: GRADE assessment on source of fat (animal sources) during pregnancy and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	1
Number of participants	207
Study design	Prospective cohort study
Summary effect estimate	Animal sources: 2.56kg per standard deviation increase in intake (95% CI 1.64; 3.48); $p < 0.01$
Risk of bias	No
Inconsistency	Rating not assignable (note 1)
Indirectness	Serious (note 2)
Imprecision	Serious (note 3)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Increase
Certainty	Very low

Note 1: rating was not assignable as this was a single study.

Note 2: single study and single site.

Note 3: insufficient sample size.

6.63 There was very low certainty evidence from a prospective cohort study that intake of fat from animal sources was associated with higher GWG in women with a range of BMIs (one prospective cohort study, 207 participants, very low certainty (observational data downgraded due to evidence of indirectness (single study, single site) and imprecision (small sample size)).

Table 6.12: GRADE assessment on source of fat (vegetable-based) during pregnancy and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	1
Number of participants	207
Study design	Prospective cohort study
Summary effect estimate	Vegetable-based: 0.77kg per standard deviation increase in intake (95% CI −0.17; 1.71); p = 0.11
Risk of bias	No
Inconsistency	Rating not assignable (note 1)
Indirectness	Serious (note 2)
Imprecision	Serious (note 3)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	No association
Certainty	Very low

Note 1: rating was not assignable as this was a single study.

Note 2: single study (single site).

Note 3: insufficient sample size.

6.64 There was very low certainty evidence from a prospective cohort study indicating no association between fat from vegetables sources and GWG in women with a range of BMIs (one prospective cohort study, 207 participants, very low certainty (observational data downgraded due to evidence of indirectness (single study and single site) and imprecision (small sample size)).

Protein intake

GWG

6.65 Tielemans and others (2016) identified 29 studies that reported on the association between maternal protein intake and GWG. Sixteen studies (57%) were conducted in HICs, all were prospective cohort studies (n = 61,876). Most of these studies included women of mixed pre-pregnancy weight status; where available, mean pre-pregnancy BMI of the recruited sample was in the healthy weight range (18.5kg/m^2 to 24.9kg/m^2). Two studies applied weight-status-based inclusion criteria; one study recruited women specifically living with obesity pre-pregnancy (BMI 30kg/m^2 or above) and another study recruited only women of average pre-pregnancy weight-for-height ratio.

6.66 Of the 16 prospective cohort studies, 3 (n = 7,656) reported higher protein intake was associated with higher GWG. One prospective cohort study (n = 3,360) reported higher protein intake was associated with lower GWG. Nine prospective cohort studies (n = 4,344) showed no association between protein intake and GWG. Three of the prospective cohort studies reported the results in subgroups: one prospective cohort study (n = 46,262) reported that protein intake was associated with lower GWG in women living with ‘normal’ weight and overweight, but no association was observed in women living with obesity. One prospective cohort study (n = 98) reported protein intake was associated with GWG in women aged 25 to 32 years, but not in women aged 18 to 24 years. One prospective cohort study (n = 156) reported a positive correlation during the first trimester of pregnancy, but a negative correlation with the change of protein intake later in pregnancy.

6.67 The 16 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

Adequacy of GWG

6.68 Tielemans and others (2016) included 11 prospective cohort studies that reported on the association between maternal protein intake and adequacy of GWG. Seven studies were conducted in HICs, all were prospective cohort studies (n = 9,424). Most of these studies included women of mixed pre-pregnancy weight status; where available, mean pre-pregnancy BMI of the recruited sample was in the healthy weight range (18.5kg/m^2 to 24.9kg/m^2).

6.69 In 3 of the prospective cohort studies, adequacy of GWG was determined according to NAM (formerly IOM) 2009 recommendations. In 2 of the prospective cohort studies, adequacy of GWG was determined according to NAM (formerly IOM) 1990 recommendations. In one prospective cohort study, adequacy of GWG was determined according to Icelandic guidelines (optimal GWG for ‘normal’ weight between 12.1kg and 18.0kg and for overweight between 7.1kg and 12.0kg). In one prospective cohort study adequacy of GWG was categorized as inadequate GWG less than or equal to 6.8kg and adequate GWG more than 6.8kg.

6.70 Seven prospective cohort studies (n = 9,252) were conducted in HICs. One prospective cohort study (n = 6,959, high quality) reported a higher prevalence of excess GWG. One prospective cohort study (n = 490) reported a lower prevalence of inadequate GWG. Five prospective cohort studies (n = 1,803) reported no association between protein intake and GWG adequacy.

6.71 The 7 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

Summary: protein intake

6.72 The available evidence from SRs examining the association between protein intake during pregnancy and GWG is from one SR without MA (moderate confidence rating using the AMSTAR 2 tool).

6.73 The GRADE assessment on the certainty of the evidence on protein intake during pregnancy and GWG is presented in Table 6.13 and Table 6.14. The summary of the evidence is presented in Table 6.15.

Table 6.13: GRADE assessment on protein intake during pregnancy and GWG

Evidence characteristics	**Assessment of evidence characteristics**
Number of studies	16
Number of participants	61,876
Study design	Prospective cohort studies
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	No
Inconsistency	Serious (note 1)
Indirectness	No
Imprecision	Rating not assignable (note 2)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Inconsistent
Certainty	Very low

Note 1: variation in direction of effect.

Note 2: rating was not assignable as this was a narrative systematic review.

6.74 There was very low certainty evidence from prospective cohort studies of an inconsistent association between maternal protein intake and GWG in women with a range of BMIs (16 prospective cohort studies, 61,876 participants, very low certainty (observational data downgraded for evidence of inconsistency (in direction of effect)).

Table 6.14: GRADE assessment on protein intake during pregnancy and excess GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	7
Number of participants	9,424
Study design	Prospective cohort studies
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	Serious (note 1)
Inconsistency	Serious (note 2)
Indirectness	No
Imprecision	Rating not assignable (note 3)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Increase
Certainty	Very low

Note 1: evidence of risk of bias in 5 of 7 studies.

Note 2: variation in direction of effect.

Note 3: rating was not assignable as this was a narrative systematic review.

6.75 There was very low certainty evidence from prospective cohort studies that higher maternal protein intake may be associated with excess GWG in women with a range of BMIs (GWG adequacy was assessed based on different guidelines, 7 prospective cohort studies, 9,424 participants, very low certainty (observational data downgraded for evidence of risk of bias and for evidence of inconsistency (in direction of effect)).

Table 6.15: summary of the evidence on protein intake during pregnancy and GWG

Intervention or exposure	Outcome	Direction of effect	Certainty of evidence
Protein intake	GWG	Inconsistent	Very low
Protein intake	Excess GWG	Increase	Very Low

Overall summary of the evidence

6.76 The GRADE assessments on the certainty of the evidence on maternal energy and macronutrient intakes and GWG is summarized in Table 6.16.

Table 6.16: summary of the evidence on energy and macronutrient intake and GWG

Intervention or exposure	Outcome	Direction of effect	Certainty of evidence
Energy intake	GWG	Increase	Low
Energy intake	Excess GWG	Increase	Low
Carbohydrate intake	GWG	Inconsistent	Very low
Carbohydrate intake	Excess GWG	Inconsistent	Very low
Total fat intake	GWG	Inconsistent	Very low
Saturated fat intake	GWG	Inconsistent	Very low
Unsaturated fat intake	GWG	Inconsistent	Very low
Trans-fat intake	Excess GWG	Null	Very low
Source of fat (animal)	GWG	Increase	Very low
Source of fat (vegetable)	GWG	No association	Very low
Protein intake	GWG	Inconsistent	Very low
Protein intake	Excess GWG	Increase	Very low

7. Dietary components and patterns and GWG

Background

7.1 This chapter focuses on the evidence for modification of gestational weight gain (GWG) by dietary approaches. The studies included in this chapter report diet-only data. These represent the minority of a large number of studies which report interventions designed to reduce GWG and thereby improve pregnancy outcome. Mostly, interventions have combined dietary advice with encouragement to increase physical activity, or as a component of a complex intervention including elements of behavioural change.

7.2 Dietary patterns are defined as the quantities, proportions, variety or combination of different foods, drinks and nutrients (when available) in diets, and the frequency with which they are habitually consumed (United States Department of Agriculture (USDA), 2014).

7.3 Traditionally, dietary or nutritional exposures have been examined by investigating intakes of single nutrients, a combination of nutrients or consumption of individual foods or food groups. Dietary pattern analysis, which considers the whole diet, is a way to represent the totality of the diet and nutrient profiles more comprehensively because it can take into account relationships between individual foods, food groups and nutrients which cannot be captured by studying single dietary components (USDA, 2020c).

7.4 Dietary pattern analysis is used to examine dietary behaviours of populations and represents the combinations of foods and nutrients that are consumed in real life (Schulz and others, 2021). Many dietary patterns provide an indication of adherence to population dietary guidelines or the overall 'healthiness' of a diet, commonly described as 'diet quality' (Gherasim and others, 2020). Dietary pattern analysis can also identify other types of dietary patterns depending on the aim and method (Ocké, 2013).

Evidence in this chapter

7.5 Details of the systematic reviews (SRs) included in this chapter can be found in Annex 3. Quality assessment of the SRs using the AMSTAR 2 tool can be found in Annex 4 (Table A4.1). Additional data extracted from the primary studies can be found in Annex 5.

7.6 The criteria used to grade the evidence are provided in chapter 3 (see paragraphs 3.53 to 3.60).

Dietary interventions during pregnancy and GWG

7.7 Dietary intervention studies that included a diet-only component were considered in scope and are presented in the following paragraphs.

7.8 Two SRs were identified on dietary interventions during pregnancy and GWG (International Weight Management in Pregnancy Collaborative Group (i-WIP), 2017; Walker and others, 2018); these were graded separately due to an incomplete overlap of the studies included in each.

Walker and others (2018)

7.9 One systematic review (SR) with meta-analysis (MA) (Walker and others, 2018) was identified that examined the efficacy of interventions confined to changing diet alone on attenuating GWG. The primary outcome of the SR was prevention of excess GWG.

7.10 Walker and others (2018) (AMSTAR 2 confidence rating: moderate) included 9 randomised controlled trials (RCTs) (n = 2,049). Eight of the 9 RCTs were conducted in high income countries (HICs). The RCTs included women with singleton pregnancies, of all ages and ethnicities. Most studies included women of mixed pre-pregnancy weight status; where available, mean or median BMI of the recruited sample was mostly in the overweight range (25kg/m^2 to 29.9kg/m^2). Three studies recruited only women with BMI in the overweight (25kg/m^2 to 29.9kg/m^2) or obesity (30kg/m^2 or above) range. Full details are available in Annex 5.

7.11 The SR reported that dietary interventions were effective at attenuating GWG when compared with the control groups (weighted mean difference (WMD): -3.27kg; 95% confidence interval (CI): -4.96, -1.58, $p < 0.01$; $I^2 = 92.8\%$). A meta-regression revealed none of the study characteristics significantly influenced the pooled effect size.

7.12 The dietary interventions in the included RCTs varied in focus, methodologies and intensity between studies. Of the studies included in the MA, 5 involved calorie restriction, 2 included basic healthy eating advice, one was based on a low-glycaemic index (GI) dietary pattern, and one provided dietary advice with a probiotic. The interventions had varying degrees of intensity and frequency and were delivered to women individually except for one which delivered its intervention to both individuals and groups. All studies commenced in the first or second trimester (see Annex 5 for further details).

7.13 Meta-regression suggested that the type of diet, whether it be low-GI, calorie restriction, or simple healthy eating advice was not a factor that influences the outcome. However, SACN noted 2 RCTs that included more intensive dietary monitoring (via food records) were associated with a greater loss of GWG compared to those RCTs with less intensive monitoring.

i-WIP (2017)

7.14 One SR with MA (i-WIP, 2017) was identified that examined the effect of diet-only interventions on GWG. The primary outcomes of the SR were GWG, the maternal composite outcome (comprising gestational diabetes mellitus (GDM), pre-eclampsia or pregnancy-induced hypertension, pre-term delivery and Caesarean section) and an offspring composite outcome (comprising intrauterine death (ID), small for gestational age (SGA), large for gestational age (LGA) and admission to the neonatal intensive care unit (NICU)).

7.15 The International Weight Management in Pregnancy Collaborative Group (i-WIP, 2017) published both pooled analyses of individual participant data (IPD analyses) and non-IPD analyses combining RCTs providing IPD data with the RCTs not providing IPD data.

7.16 i-WIP (2017) (AMSTAR 2 confidence rating: moderate) included 103 randomised trials, 12 reported on the effects of diet-only interventions on GWG. Four of the 12 were included in the IPD analysis, and all 12 were included in the non-IPD analysis. The 12 trials were conducted in HICs. The RCTs included women of all ages and any ethnicity. Most studies included women of mixed pre-pregnancy weight status; where available, mean or median BMI of the recruited sample was mostly in the overweight range (25kg/m^2 to 29.9kg/m^2). Six studies recruited only women with BMI in the overweight (25kg/m^2 to 29.9kg/m^2) or obesity (30kg/m^2 or above) range. Full details are available in Annex 5.

7.17 The 4 RCTs (1,168 participants) included in the IPD analysis (see paragraph 7.16) reported no effect of diet-only interventions on GWG compared with standard dietary advice in pregnant women of any weight status (mean difference (MD): -0.72kg (95% CI: -1.48 to 0.04), I^2 = 0.0%). IPD analysis adjusted for baseline weight and clustering using analysis of covariance in each trial. Three of the RCTs recruited women of mixed BMI, whereas one RCT recruited only women with BMI in the obesity range (30kg/m^2 or above).

7.18 When non-IPD data (12 randomised trials, n = 2,017) were included, GWG was significantly lower in diet-only interventions (MD: -2.84kg (95% CI: -4.77 to -0.91), I^2 = 92.3%).

7.19 The dietary interventions in the included RCTs varied in focus, methodologies and intensity of contact with participants. The approaches included: following a diet aiming to limit dietary cholesterol and to reduce the intake of saturated fat, dietary counselling according to nutritional status, education sessions focused on low-GI foods and dietary consultations with trained dietitians where women were asked to eat a healthy diet according to official dietary recommendations (see Annex 5 for further detail). The authors considered participants to be adherent to the intervention based on the following criteria: completion of at least 70% of the intervention protocol, if the data set provided information on adherence in a yes-or-no format, or participant was deemed to be adherent according to the study criteria (see Annex 5). SACN noted 2 RCTs that included more intensive dietary monitoring (via food records) were associated with a greater loss of GWG compared to those RCTs with less intensive monitoring.

7.20 The RCTs differed in a number of ways, including the macronutrient and energy composition, method and duration of delivery of the intervention diets (see Annex 5 for further detail).

Summary: dietary interventions during pregnancy and GWG

7.21 The available evidence from SRs examining the effect of dietary interventions during pregnancy on GWG is from 2 SRs with MA (both given a moderate confidence rating using the AMSTAR 2 tool).

7.22 The Grading of recommendations, assessment, development and evaluation (GRADE) assessment on the certainty of the evidence on dietary interventions during pregnancy and GWG is presented in Table 7.1 and Table 7.2. The summary of the evidence is presented in Table 7.3.

Table 7.1: GRADE assessment on dietary interventions during pregnancy and GWG (Walker and others, 2018)

Evidence characteristics	Assessment of evidence characteristics
Number of studies	9
Number of participants	2,049
Study design	Randomised controlled trials
Summary effect estimate	WMD: -3.27kg; 95% CI: -4.96, -1.58, $p < 0.01$
Risk of bias	No
Inconsistency	Serious (note 1)
Indirectness	No
Imprecision	No
Publication bias	Strongly suspected (note 2)
Other (upgrading factors)	None
Direction of effect	Decrease
Certainty	Low

Note 1: I^2 = 92.8%.

Note 2: asymmetry in funnel plots.

Table 7.2: GRADE assessment on dietary interventions during pregnancy and GWG (i-WIP, 2017)

Evidence characteristics	Assessment of evidence characteristics
Number of studies	12
Number of participants	2,017
Study design	Randomised controlled trials
Summary effect estimate	MD: -2.84 kg (95% CI: -4.77 to -0.91)
Risk of bias	No
Inconsistency	Serious (note 1)
Indirectness	No
Imprecision	No
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Decrease
Certainty	Moderate

Note 1: I^2 = 92.3%.

7.23 There was low to moderate certainty evidence from RCTs that dietary interventions may reduce GWG in women with a range of BMIs (based on the findings of 2 SRs). One of the SRs reported MD: -2.84kg; 95% CI: -4.77 to -0.91, 12 RCTs, 2,017 participants, moderate certainty (downgraded for inconsistency due to the presence of heterogeneity (I^2 = 92.3%)). The other SR reported WMD: -3.27kg; 95% CI: -4.96 to -1.58, 9 RCTs, 2,049 participants, low certainty (downgraded for inconsistency due to the presence of heterogeneity (I^2 = 92.8%) and evidence of publication bias).

Table 7.3: summary of the evidence on dietary interventions during pregnancy and GWG

Intervention	Outcome	Direction of effect	Certainty of evidence
Dietary intervention (Walker)	GWG	Decrease	Low
Dietary intervention (i-WIP non-IPD)	GWG	Decrease	Moderate

Dietary interventions and postpartum weight

7.24 Diet-only intervention studies that started in pregnancy or in the postpartum period and reported on maternal weight in the postpartum period were considered in scope and are presented in the following paragraphs.

7.25 Two SRs were identified on dietary interventions and maternal weight in the postpartum period (Dalrymple and others, 2018; Dodd and others, 2018).

Dalrymple and others (2018)

7.26 One SR without MA (Dalrymple and others, 2018) was identified that examined the effectiveness of dietary interventions in pregnant or postpartum women who were at least 18 years old, with a BMI of at least 25kg/m^2, for managing postpartum weight retention up to 2 years after giving birth. The primary outcomes of the SR were maternal postpartum weight or body composition data from 3 months and up to 2 years after delivery.

7.27 Dalrymple and others (2018) (AMSTAR 2 confidence rating: critically low) included 5 RCTs reporting on diet-only interventions and postpartum weight retention. The 5 RCTs were conducted in HICs. The RCTs included women (pregnant or postpartum (up to 2 years after birth)) with a BMI of 25kg/m^2 or above, 18 years of age or over, and of any ethnicity (full details are available in Annex 5).

7.28 One of the 5 RCTs (n = 110) reported a significant effect of a 12-week postpartum diet-only intervention on lower postpartum weight retention when compared with the control groups: median (1st, 3rd quartiles) at the end of the intervention (intervention: -6.1kg (-8.4, -3.2kg), control: -1.6kg (-3.5, -0.4kg) ($p < 0.001$)) and at a 1-year follow-up (intervention: -10.0kg (-11.7, -5.9kg), control: -4.3kg (-10.2, -1.0kg) ($p = 0.004$)). Four of the 5 RCTs (n = 761) showed no significant effect of the intervention on changes in postpartum weight when compared to control groups.

7.29 The strategies used to modify dietary intake varied between the included RCTs. The approaches included dietary counselling, a low-carbohydrate diet, an energy-restrictive diet, and educational kits which focused on dietary habits, including portion sizes, vegetable and fruit intake, nutritious snacks and reading food labels. The RCT that reported a statistically significant effect on postpartum weight retention used an energy-restrictive diet with an end-of-intervention weight-loss goal of -6.0kg. One intervention started before 16 weeks gestation, 2 interventions started 6 weeks postpartum, one intervention started between 6 and 15 weeks postpartum, and one intervention started between 2 and 7 months postpartum (see Annex 5 for further detail).

Dodd and others (2018)

7.30 One SR with MA (Dodd and others, 2018) was identified that examined the effectiveness of postpartum dietary interventions to promote weight loss in the postpartum period. The primary outcomes of the SR were the mean change in weight (kg) between trial entry and end of intervention (or at time of conception in a subsequent pregnancy, if recorded) and the mean change in weight (kg) between trial entry and final assessment (after completion of the intervention, to determine weight maintenance).

7.31 Dodd and others (2018) (AMSTAR 2 confidence rating: critically low) included 2 RCTs on the effects of a dietary intervention alone compared with “standard postnatal care” or no intervention on postpartum weight loss. Both RCTs were conducted in HICs. The RCTs included women of all ages, any ethnicity, who had given birth to a healthy singleton infant, who were living with overweight or obesity, who had a ‘normal’ BMI upon commencing pregnancy but whose GWG exceeded the National Academy of Medicine (NAM) (formerly the Institute of Medicine (IOM)) guidelines or who had retained weight at the time of trial recruitment as defined by the trial authors (full details are available in Annex 5).

7.32 The 2 RCTs (n = 75) reported that women who were provided with a dietary intervention in the postpartum period were more likely to have significant weight loss at the completion of the intervention (12 weeks) compared with women who received no intervention (MD: -1.82kg; 95% CI: -2.19 to -1.44kg).

7.33 The dietary interventions varied between the included RCTs but both targeted energy intake. The approaches included an 11-day personalised diet plan programme with a 35% energy deficit and a dietary modification plan to achieve a reduction of 500kcal per day. One dietary intervention started between 8 and 12 weeks postpartum and one started between 8 and 16 weeks postpartum (see Annex 5 for further detail).

7.34 The 2 RCTs differed in a number of ways, including the macronutrient and energy composition, method and duration of delivery of the intervention diets (see Annex 5 for further detail).

Summary: dietary interventions and postpartum weight

7.35 The available evidence from SRs examining the effect of diet-only interventions (both pre- and postpartum) on postpartum weight retention or postpartum weight loss is from 2 SRs, one with MA and one without MA (both given a critically low confidence rating using the AMSTAR 2 tool).

7.36 The GRADE assessment on the certainty of the evidence on diet alone interventions during pregnancy and the postpartum period and postpartum weight is presented in Table 7.4 and Table 7.5. The summary of the evidence is presented in Table 7.6.

Table 7.4: GRADE assessment on dietary interventions during pregnancy and in the postpartum period and postpartum weight retention

Evidence characteristics	Assessment of evidence characteristics
Number of studies	5
Number of participants	871
Study design	Randomised controlled trials
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	Serious (note 1)
Inconsistency	Serious (note 2)
Indirectness	No
Imprecision	Rating not assignable (note 3)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Inconsistent
Certainty	Low

Note 1: 4 of 5 studies had moderate or high risk of bias.

Note 2: inconsistent size of effect.

Note 3: rating was not assignable as this was a narrative systematic review.

7.37 There was low certainty evidence from RCTs of an inconsistent relationship between dietary interventions during pregnancy and/or in the postpartum period and postpartum weight retention in women with a BMI of 25kg/m^2 or above (5 RCTs with 871 participants, low certainty (downgraded for risk of bias and inconsistency (size of the effect)).

Table 7.5: GRADE assessment on postpartum dietary interventions and postpartum weight loss

Evidence characteristics	Assessment of evidence characteristics
Number of studies	2

Evidence characteristics	Assessment of evidence characteristics
Number of participants	75
Study design	Randomised controlled trials
Summary effect estimate	MD, −1.82 kg; 95%CI, −2.19 to −1.44 kg
Risk of bias	No
Inconsistency	No
Indirectness	No
Imprecision	Serious (note 1)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Increase in weight loss
Certainty	Moderate

Note 1: insufficient sample size.

7.38 There was moderate certainty evidence from RCTs that dietary interventions in the postpartum period may support weight loss among women living with overweight or obesity in the postpartum period who were a healthy weight pre-pregnancy (MD: −1.82kg; 95% CI −2.19 to −1.44, 2 RCTs with 75 participants, moderate certainty (downgraded due to imprecision (insufficient sample size)).

Table 7.6: summary of the evidence on diet alone interventions and postpartum weight

Intervention	Outcome	Direction of effect	Certainty of evidence
Dietary intervention in pregnancy and/or postpartum in women with a BMI 25kg/m^2 or above	Postpartum weight retention	Inconsistent	Low
Postpartum dietary intervention in women living with overweight or obesity	Weight loss	Increase in weight loss	Moderate

Maternal dietary patterns during pregnancy and GWG

7.39 The dietary patterns included in this section have been assessed using a variety of approaches, such as adherence to a priori patterns (indices or scores), data-driven patterns (factor or cluster analysis), reduced rank regression, or other methods, including

RCTs. The studies identified mostly considered Mediterranean dietary patterns and ‘healthy’ or ‘unhealthy’ dietary patterns.

7.40 Three SRs were identified on maternal dietary patterns during pregnancy and GWG (Abdollahi and others, 2021; USDA, 2020a; Zhang and others, 2022).

Zhang and others (2022)

7.41 One SR with MA (Zhang and others, 2022) was identified that examined the relationship between adherence to a ‘Mediterranean’ dietary pattern in pregnant women with various levels of glycaemic metabolism dysfunction and mean GWG (kg) in early pregnancy, before a later diagnostic test for GDM. The primary outcome of the SR was the incidence of GDM. Multiple secondary outcomes were considered, including GWG.

7.42 Zhang and others (2022) (AMSTAR 2 confidence rating: critically low) included 3 RCTs of a ‘Mediterranean’ dietary pattern and GWG in pregnant women. One of the 3 RCTs was a pilot trial. All 3 RCTs were conducted in HICs. The RCTs included women of all ages and any ethnicity. One RCT recruited pregnant women with a BMI ranging from 18.5kg/m^2 to 39.9kg/m^2 (69% were in the obesity range), and in another RCT, mean BMI was in the healthy weight range pre-pregnancy and at baseline in pregnancy. Full details are available in Annex 5.

7.43 All 3 RCTs comprised an intervention group (a ‘Mediterranean’ dietary pattern) and a control group but the protocols varied. (see Annex 5 for full detail on the composition, method and duration of delivery of the intervention diets).

7.44 One intervention involved lifestyle guidance from dietitians one week after inclusion in a one-hour group session. The guidance was based on basic ‘Mediterranean’ dietary pattern recommendations as follows:

- at least 2 servings per day of vegetables
- at least 3 servings per day of fruit (avoiding juices)
- 3 servings per day of skimmed dairy products
- wholegrain cereals
- 2 to 3 servings per week of legumes
- moderate to high consumption of fish
- low consumption of red and processed meat

- avoidance of refined grains, processed baked goods, pre-sliced bread, soft drinks and fresh juices, fast foods and precooked meals
- daily consumption of at least 40ml per day of extra virgin olive oil (EVOO) and a handful (25g to 30g per day) of pistachios; the women were provided at visit one and 2 with 10 litres of EVOO and 2kg of roasted pistachios each

7.45 Another intervention was delivered by trial dietitians and trained researchers over 3 face-to-face sessions, it was based on a Mediterranean-style dietary pattern as follows:

- high intake of nuts, extra virgin olive oil, fruit, vegetables, non-refined grains, and legumes; participants in the intervention arm were provided with mixed nuts (30g per day of walnuts, hazelnuts, and almonds) and EVOO (0.5 litres per week) as the main sources of cooking fat
- moderate to high consumption of fish
- low to moderate intake of poultry and dairy products such as yoghurt and cheese
- low consumption of red meat and processed meat
- avoidance of sugary drinks, fast food, and food rich in animal fat

7.46 The third intervention was a 15-minute structured dietary advice session encouraging the consumption of particular foods that are consistent with the 'Mediterranean' dietary pattern. The intervention was administered by a researcher or hospital dietitian using a booklet - no energy restrictions were suggested, the target of at least 5 portions of vegetables and fruit per day was emphasised but no food or cooking supplies were provided to participants.

7.47 A MA of the 3 RCTs (n = 1,367) showed that pregnant women who consumed a 'Mediterranean' dietary pattern had a modest reduction in GWG compared with those on a control intervention (a standard diet): SMD = -0.15 (95% CI = -0.26 to -0.05), p = 0.004, I^2 = 0%, test for overall effect: p = 0.004.

7.48 In each RCT, a 'Mediterranean' dietary pattern was recommended as the intervention. In 2 out of the 3 RCTS identified, participants were given olive oil and nuts to consume, therefore the generalisability of the specific interventions may be limited. The duration and start time of the interventions were different and the included women had various levels of glycaemic metabolism dysfunction, including a small number of women with GDM.

Abdollahi and others (2021)

7.49 One SR with MA (Abdollahi and others, 2021) was identified that examined the relationship between maternal dietary patterns ('healthy' and 'unhealthy' - as characterised by the SR authors) and GWG (including excess GWG) in adult mothers (18 years and over). The outcomes of the SR were caesarean delivery, maternal depression, GWG, GDM and gestational hypertensive disorders.

7.50 The SR (Abdollahi and others, 2021) authors grouped the dietary patterns into 3 categories based on constituent foods: 'healthy', 'unhealthy', and 'mixed' dietary patterns. Foods characterising each dietary pattern were selected based on the dietary recommendations for the prevention of chronic diseases. Authors determined a healthy diet was characterised by high intakes of fruits, vegetables, wholegrains, low-fat dairy products, vegetable oils, and fish. An unhealthy diet was characterised by refined grains, foods high in saturated fats, red meat, processed meat, fast foods, and high sugary foods.

7.51 Abdollahi and others (2021) (AMSTAR 2 confidence rating: moderate) included 15 prospective cohort studies on maternal dietary patterns ('healthy' or 'unhealthy') and GWG or excess GWG. The dietary patterns were defined by the SR authors. The prospective cohort studies included women of any ethnicity. Most studies recruited women of mixed pre-pregnancy weight status; where available, mean or median BMI at whole sample or sub-group level was mostly in the healthy weight and/or overweight range (18.5kg/m^2 to 29.9kg/m^2). Three studies recruited only women with pre-pregnancy BMI outside the underweight range (BMI of at least 18.5kg/m^2), and one of these studies also excluded women with BMI 40kg/m^2 or above. Full details are available in Annex 5.

'Healthy' dietary pattern and GWG

7.52 Nine prospective cohort studies assessed the relationship between a 'healthy' dietary pattern and GWG, 7 of which were conducted in HICs.

7.53 A MA of the 9 prospective cohort studies (n = 9,803) showed that the highest adherence to a 'healthy' dietary pattern was associated with more GWG compared to the lowest adherence (Hedges' g: 0.15, 95% CI: 0.03 to 0.28, p = 0.01).

7.54 The tools for assessing dietary intake varied between the included prospective cohort studies. They included a food record, food-frequency questionnaires and an automated self-administered 24 hour dietary assessment tool (ASA24) (see Annex 5 for further detail).

7.55 The 9 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

‘Healthy’ dietary pattern and excess GWG

7.56 Six prospective cohort studies assessed the relationship between a ‘healthy’ dietary pattern and excess GWG, 5 of which were conducted in HICs.

7.57 A MA of the 6 prospective cohort studies (71,719 participants) showed no association with the odds of excess GWG comparing extreme categories of a ‘healthy’ dietary pattern (OR: 0.87, 95% CI: 0.73 to 1.04, p = 0.13).

7.58 The tools for assessing dietary intake varied between the included prospective cohort studies. They included an automated self-administered 24 dietary assessment tool (ASA24), food-frequency questionnaires, and a Diet History Questionnaire II (DHQ II) (see Annex 5 for further detail).

7.59 The 6 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

‘Unhealthy’ dietary pattern and GWG

7.60 Two prospective cohort studies assessed the relationship between an ‘unhealthy’ dietary pattern and GWG, one of which was conducted in a HIC.

7.61 A MA of the 2 prospective cohort studies (n = 3,356) showed no association between adherence to an ‘unhealthy’ diet and GWG (OR: 0.00, 95% CI: -0.09 to 0.09, p = 0.99).

7.62 The 2 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

‘Unhealthy’ dietary pattern and excess GWG

7.63 Two prospective cohort studies assessed the relationship between an ‘unhealthy’ dietary pattern and excess GWG, one of which was conducted in a HIC.

7.64 A MA of the 2 prospective cohort studies (n = 2,076) showed a significant association between adherence to an ‘unhealthy’ dietary pattern and excess GWG (OR: 1.43, 95% CI: 1.06 to 1.92, p = 0.01).

7.65 The 2 prospective cohort studies differed in their adjustment for confounders (see Annex 5 for further detail).

USDA (2020a)

7.66 One SR without MA (USDA, 2020a) was identified that examined the relationship between maternal dietary patterns during pregnancy and GWG. The SR formed part of the evidence base examined by the 2020 USDA Dietary Guidelines Advisory Committee (see paragraphs 3.61 to 3.69). The goal of the SR was to examine the relationship between dietary patterns during pregnancy and GWG.

7.67 The primary outcome of the SR was GWG. The outcome of GWG was reported in a number of ways across the different studies including total GWG, GWG for a specified time period, GWG rate, and GWG adequacy. The majority of studies that assessed GWG adequacy classified GWG as inadequate, adequate, or excess according to the NAM (formerly IOM) guidelines.

7.68 USDA (2020a) (AMSTAR 2 confidence rating: high) included 23 studies (4 RCTs and 19 prospective cohort studies, reported in 26 articles). Most studies were in adult women who had singleton pregnancies and were of predominantly white ethnicity (where reported). Seven studies enrolled predominantly or exclusively women living with overweight or obesity. One study enrolled women with metabolic risk factors, including women living with obesity.

7.69 USDA authors defined dietary patterns as the quantities, proportions, variety, or combination of different foods, drinks, and nutrients (when available) in diets, and the frequency with which they were consumed. Dietary patterns were assessed using: index or score analysis, factor analysis and principal component analysis (PCA), experimental diet, or reduced rank regression.

7.70 Of the 15 studies that assessed maternal dietary patterns using an index or score method, 8 showed an association with GWG. Four of the 8 showed that greater adherence to a beneficial dietary pattern was either associated with a: lower risk of excess GWG, lower rate of GWG, or lower mean GWG. An additional study showed that greater adherence to a 'detrimental' dietary pattern was associated with excess GWG. However, 3 studies showed that higher adherence to a beneficial dietary pattern (that is, Dietary Approaches to Stop Hypertension (DASH), DASH optimal macronutrient intake (OMNI), 'Mediterranean' dietary pattern, healthy eating index (HEI)) was associated with higher GWG, either in all participants or only in women living with obesity. Six of the 8 articles that showed an association adjusted for one or more of the key confounders.

7.71 Among the 7 studies that assessed maternal dietary patterns using an index or score method that did not show an association, 4 did not adjust for any of the key confounders, nor were they primarily designed to address the association between dietary patterns and GWG. In 2 of these, the timing of exposure assessment was also different, with one assessing maternal diet at the end of the second trimester and the other during the third trimester. Two other articles that did not show an association were both conducted with the same cohort.

7.72 Of the 5 studies that assessed maternal dietary patterns using factor analysis or PCA, 4 showed significant associations between a maternal dietary pattern and GWG.

One study showed that greater adherence to a beneficial dietary pattern was associated with lower GWG while the same study and 3 others showed that greater adherence to a non-beneficial dietary pattern was associated with higher GWG. Three of the 4 studies that showed an association adjusted for some of the key confounders. The only study that showed no association between dietary pattern and GWG did not adjust for any of the key confounders.

7.73 The SR identified 3 RCTs that reported on dietary patterns assessed experimental (intervention) diets and GWG. Two of these 3 RCTs were included in the Zhang and others (2022) SR with MA (see paragraphs 7.41 to 7.48 for further details) and are not reported again here.

7.74 The SR identified one study that assessed dietary patterns by reduced rank regression. The study showed that women with greater adherence to pattern 1 (characterised by higher consumption of poultry, nuts, cheese, fruits, whole grains, added sugars, and solid fats) had significantly greater GWG compared with women with lower adherence (p for trend < 0.001). Similarly, women with greater adherence to pattern 2 (characterised by higher consumption of eggs, starchy vegetables, solid fats, fruits, and non-whole grains and a lower consumption of dairy foods, dark-green vegetables, and whole grains) had significantly greater GWG compared to women with lower adherence (p for trend = 0.03). However, none of the key confounders were adjusted for in the analysis.

7.75 The SR identified one RCT and one prospective cohort study that assessed the association between diets based on macronutrient distributions and GWG. Both studies reported no significant difference in GWG based on varying percentages of total energy intake from fat. The studies were not designed to assess the relationship between macronutrient proportions and GWG.

7.76 The dietary patterns examined in this SR were characterised by combinations of different foods and beverages. The patterns that were consistently shown to be associated with lower risk of excess GWG were: higher in vegetables, fruits, nuts, legumes, and fish and lower in added sugar and red and processed meat.

7.77 The USDA 2020 Dietary Guidelines Pregnancy and Lactation Subcommittee assessed the evidence using their nutrition evidence systematic review (NESR) process for conducting systematic reviews. The process included predefined criteria for grading the strength of evidence, based on 5 grading elements, to support specific conclusion statements.

7.78 The USDA subcommittee stated that the dietary patterns examined were characterised by combinations of different foods and beverages. The patterns that were consistently shown to be associated with lower risk of excess GWG were: higher in vegetables, fruits, nuts, legumes, fish and lower in added sugar, red and processed meat, although not all foods were part of the same pattern, and the evidence did not show a consistent association between grains or dairy and GWG.

7.79 The USDA subcommittee concluded there was limited evidence suggesting that certain dietary patterns (those that were higher in vegetables, fruits, nuts, legumes, fish, and lower in added sugar, and red and processed meat) during pregnancy are associated with a lower risk of excess GWG during pregnancy. The conclusions statement received a 'limited' grade. This means that the conclusion statement is based on a limited body of evidence as assessed by risk of bias, consistency, directness, precision, and generalisability. The level of certainty in the conclusion is limited, such that if new evidence emerges, modifications to the conclusion are likely to be required.

7.80 The USDA subcommittee highlighted that the ability to draw strong conclusions was limited by the following issues:

- there were few RCTs and thus data was primarily observational in nature, limiting the ability to determine causal effects of dietary patterns on GWG
- key confounders were not consistently controlled for in most of the studies
- studies had risk-of-bias issues, including exposure misclassification, self-reported outcomes, and selection bias
- most of the studies were not designed to assess the association between dietary patterns and GWG
- people with lower socioeconomic status, adolescents, and racially and ethnically diverse populations were underrepresented in the body of evidence

Summary: dietary patterns and GWG

7.81 The available evidence from SRs examining the effect of dietary patterns during pregnancy and GWG is from 3 SRs, 2 with MA (one given a moderate confidence rating and one given a critically low confidence rating using the AMSTAR 2 tool) and one without MA (given a high confidence rating using the AMSTAR 2 tool).

7.82 The GRADE assessment on the certainty of the evidence on dietary patterns during pregnancy and GWG is presented in Table 7.7 to Table 7.11. The summary of the evidence is presented in Table 7.12 and Table 7.13.

Table 7.7: GRADE assessment on adherence to a 'Mediterranean' dietary pattern and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	3
Number of participants	1,367
Study design	Randomised controlled trials
Summary effect estimate	SMD = -0.15; 95% CI = -0.26 to -0.05; p = 0.004
Risk of bias	No
Inconsistency	No
Indirectness	No
Imprecision	Serious (note 1)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Decrease
Certainty	Moderate

Note 1: upper confidence interval close to the null.

7.83 There was moderate certainty evidence from RCTs that consuming a 'Mediterranean' dietary pattern during pregnancy may lower GWG in women with a range of BMIs (SMD: -0.15, 95% CI: -0.26 to -0.05, 3 RCTs with 1,367 participants, moderate certainty (downgraded due to evidence of imprecision)).

Table 7.8: GRADE assessment on the association between a 'healthy maternal dietary pattern' and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	9
Number of participants	9,803
Study design	Prospective cohort studies
Summary effect estimate	Hedges' g: 0.15; 95% CI: 0.03 to 0.28; p = 0.01
Risk of bias	Serious (note 1)
Inconsistency	Serious (note 2)
Indirectness	No

Evidence characteristics	Assessment of evidence characteristics
Imprecision	No
Publication bias	Undetected
Other (upgrading factors)	None
Direction of effect	Increase
Certainty	Very low

Note 1: 8 of 9 studies had serious risk of bias.

Note 2: I^2 = 85.5%.

7.84 There was very low certainty evidence from prospective cohort studies that a maternal 'healthy' dietary pattern may be associated with increased GWG in women with a range of BMIs (Hedges' g: 0.15, 95% CI: 0.03 to 0.28, 9 prospective cohort studies with 9,803 participants, very low certainty (downgraded due to being observational data, evidence of risk of bias and evidence of heterogeneity)). 'Healthy' dietary pattern was characterised by higher intakes of fruits, vegetables, whole grains, low-fat dairy products, vegetable oils, and fish.

Table 7.9: GRADE assessment on the association between a 'healthy maternal dietary pattern' and excess GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	6
Number of participants	71,719
Study design	Prospective cohort studies
Summary effect estimate	OR: 0.87; 95% CI: 0.73 to 1.04; p = 0.13
Risk of bias	Serious (note 1)
Inconsistency	No
Indirectness	No
Imprecision	No
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Null
Certainty	Very low

Note 1: 4 of 6 studies had serious risk of bias.

7.85 There was very low certainty evidence from prospective cohort studies indicating no association between a maternal 'healthy' dietary pattern and excess GWG (OR: 0.87, 95% CI: 0.73 to 1.04, 6 prospective cohort studies, 71,719 participants, low certainty (observational data downgraded for evidence of risk of bias)). 'Healthy' dietary pattern was characterised by authors as higher intakes of fruits, vegetables, whole grains, low-fat dairy products, vegetable oils, and fish.

Table 7.10: GRADE assessment on the association between an 'unhealthy maternal dietary pattern' and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	2
Number of participants	3,356
Study design	Prospective cohort studies
Summary effect estimate	Hedges' g: 0.00; 95% CI: −0.09 to 0.09; p = 0.99
Risk of bias	No
Inconsistency	No
Indirectness	No
Imprecision	No
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Null
Certainty	Low

7.86 There was low certainty evidence from prospective cohort studies indicating no association between a maternal 'unhealthy' dietary pattern and mean GWG (Hedges' g: 0.00; 95% CI: −0.09 to 0.09, 2 prospective cohort studies with 3,356 participants, low certainty (observational data)). 'Unhealthy' dietary pattern was characterised by authors as refined grains, foods high in saturated fats, red meat, processed meat, 'fast foods', and high sugar foods and drinks.

Table 7.11: GRADE assessment on association between an 'unhealthy maternal dietary' pattern and excess GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	2
Number of participants	2,076
Study design	Prospective cohort studies
Summary effect estimate	OR: 1.43; 95% CI: 1.06 to 1.92; p = 0.01
Risk of bias	No
Inconsistency	No
Indirectness	No
Imprecision	No
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Increase
Certainty	Low

7.87 There was low certainty evidence from prospective cohort studies that a maternal 'unhealthy' dietary pattern may be associated with excess GWG (OR: 1.43, 95% CI: 1.06 to 1.92, 2 prospective cohort studies with 2,076 participants, low certainty (observational data)). 'Unhealthy' dietary pattern was characterised by study authors as greater consumption of refined grains, foods high in saturated fats, red meat, processed meat, 'fast foods', and high sugar foods and drinks.

7.88 Evidence was also considered from the USDA Dietary Guidelines Advisory Committee. The USDA considered there to be 'limited' evidence (equivalent to 'low' evidence certainty on GRADE) suggesting that certain dietary patterns during pregnancy are associated with a lower risk of excess GWG during pregnancy (4 RCTs and 19 prospective cohort studies, predominantly in women of mixed BMIs). The patterns identified were higher in vegetables, fruits, nuts, legumes, fish, and lower in added sugar, and red and processed meat. There was a degree of overlap with some studies identified through the literature search for this risk assessment. The conclusions drawn by USDA and SACN were consistent.

Table 7.12: summary of the evidence on ‘dietary patterns’ during pregnancy and GWG

Intervention or exposure	Outcome	Direction of effect	Certainty of evidence
‘Healthy’ dietary pattern	GWG	Increase	Very low
‘Healthy’ dietary pattern	Excess GWG	Null	Very low
‘Unhealthy’ dietary pattern	GWG	Null	Low
‘Unhealthy’ dietary pattern	Excess GWG	Increase	Low
‘Mediterranean’ dietary pattern	GWG	Decrease	Moderate

Table 7.13: summary of the evidence on ‘dietary patterns’ during pregnancy and GWG as assessed by USDA

Intervention or exposure	Outcome	Direction of effect	Certainty of evidence
Dietary patterns higher in vegetables, fruits, nuts, legumes, fish and lower in added sugar, red and processed meat	Excess GWG	Decrease	Limited (note 1)

Note 1: certainty of the evidence assessed by the USDA 2020 Dietary Guidelines Pregnancy and Lactation Subcommittee using their NESR process for conducting systematic reviews. Grading the certainty of evidence as “Strong, Moderate, Limited, or Grade Not Assignable”. The process included predefined criteria for grading the strength of evidence. Grade limited definition: the conclusion statement is based on a limited body of evidence as assessed by risk of bias, consistency, directness, precision, and generalisability. The level of certainty in the conclusion is limited, such that if new evidence emerges, modifications to the conclusion are likely to be required.

Low glycaemic load (GL) dietary pattern and GWG

7.89 Low glycaemic load dietary patterns have been considered in relation to a range of health outcomes, including weight gain and obesity in a range of population groups (Knudsen and others, 2013).

7.90 Glycaemic index (GI) and glycaemic load (GL) are measures of the post-prandial (that is, after a meal) blood glucose response to foods.

7.91 GI is a relative measure of the capillary blood glucose response to a specific food compared with the response to a reference food matched for the same amount (usually 50g) of available carbohydrate (either as pure glucose or from an alternative carbohydrate food such as white bread). GI assigns a value (relative to the reference food, which is given 100) for the total increase in blood glucose concentration over 2 hours after consumption of carbohydrate-containing foods or ingredients (Jenkins and others, 1981). In general, carbohydrate sources with a low GI value (up to 55), which include most intact fruits, vegetables, nuts and legumes, are digested and absorbed more slowly, leading to a lower and slower rise in blood glucose and, therefore usually, insulin. Carbohydrate foods with a high GI value (70 or higher) cause a more substantial increase in blood glucose concentration. High-GI foods include many types of refined grain and cereal products and boiled potatoes.

7.92 A food's GL (GI multiplied by the amount of carbohydrate in a serving of that food) takes account of both the GI of the carbohydrate food and the quantity of available carbohydrate (Brouns and others, 2005).

7.93 GI and GL are predominantly influenced by the types and structures of carbohydrates present in foods and, to lesser extents, by the types and amounts of protein, fat and non-starch polysaccharide present. External influences affecting the GI and GL of a food include milling, cooking, cooling and storage conditions (Brouns and others, 2005, Venn and others, 2007).

7.94 One SR with MA was identified on low GL dietary patterns and GWG (Muktabhant and others, 2015).

Muktabhant and others (2015)

'Low GL' dietary patterns and mean GWG

7.95 One SR with MA (Muktabhant and others, 2015) was identified that examined the relationship between a 'low-GL' dietary pattern and GWG and postpartum weight retention in women of any BMI. The primary outcome of the SR was excess GWG (as defined by investigators). Secondary outcomes included mean GWG, low GWG and postpartum weight retention.

7.96 Muktabhant and others (2015) (AMSTAR 2 confidence rating: high) included 5 RCTs (1,497 participants). All 5 RCTs were conducted in HICs. The studies included women with a mix of ages and ethnicities. Most RCTs included women of mixed pre-pregnancy BMI; where available, mean BMI was in the healthy weight range (18.5kg/m^2 to 24.9kg/m^2 in 2 studies) or the overweight range (25kg/m^2 to 29.9kg/m^2 in one study). One RCT recruited only women with pre-pregnancy or first-trimester BMI in the overweight or obesity range (25kg/m^2 to 45kg/m^2). One of the studies was conducted in women with GDM.

7.97 The 5 RCTs differed in a number of ways, including the composition, method and duration of delivery of the intervention diets (see Annex 5 for further detail).

7.98 Muktabhant and others (2015) identified 5 RCTs (n = 1,480 for analysis) that reported the effect of a low GL diet when compared with a control group and mean GWG. Due to substantial heterogeneity the data was not pooled.

7.99 All 5 RCTs comprised an intervention group and a control group but the protocols varied across the 5 RCTs.

7.100 In one RCT, women, at 8 weeks' gestation, were randomised to one of the following diets:

- a diet containing low-glycaemic carbohydrate (CHO) sources including whole grains and unprocessed rice, beans and other non-tuberous vegetables, pasta (unless overcooked), most fruits and unsweetened juices, unsweetened chocolate, nuts and dairy products
- a diet containing high-glycaemic CHO sources including processed grains (flour, bread, cereals), tuberous vegetables (potato, carrot, parsnip), typical desserts (baked goods, confectionery), soft drinks and sweetened juices, other snack foods, maize, ripe bananas and some tropical fruit

7.101 One RCT compared a low-GI diet with a conventional high-fibre, moderate GI diet. The diets had a similar protein (15% to 25%), fat (25% to 30%), and carbohydrate (40% to 45%) content but one had a low GI (target GI: less than or equal to 50) and the other had a high-fibre content and a moderate GI (target GI: approximately 60).

7.102 One RCT compared a low-glycaemic diet with a conventional healthy diet. There was no difference in the macronutrient distribution in the diets – only carbohydrate-rich foods were substituted with low-GL alternatives in the experimental group.

7.103 One RCT compared a low-GI diet with a low-fat diet – both groups receiving nutrition education and dietary counselling.

7.104 One RCT compared a low-GI dietary intervention with routine dietary advice. The low-GI intervention included one 2-hour dietary education session given by a dietitian where women received written resources about low-GI foods, with follow-up reinforcement sessions held at 28 and 34 weeks' gestation.

7.105 Of the 5 RCTs, 2 reported that a ‘low-GL’ dietary pattern reduced mean GWG in the intervention group compared with the control group. Three RCTs found no statistically significant difference between intervention and control arms.

‘Low GL’ dietary patterns and excess GWG

7.106 Muktabhant and others (2015) identified 2 RCTs (n = 835) that reported that low GL dietary intervention significantly reduced the risk of excess GWG in the intervention group compared with the control group (RR 0.77, 95% CI 0.66 to 0.91, $Tau^2 = 0$, $Chi^2 = 0.72$, df =1 (p = 0.4), $I^2 = 0\%$, test for overall effect: Z = 3.1 (p = 0)).

7.107 The SR also reported stratified results and considered studies recruiting women with a normal BMI to have a 'low risk' of weight-related complications at baseline and studies of women living with overweight and/or obesity, or high-risk women, as defined by the investigators, to have a 'high risk' status. In the low-risk population (one study), the ‘low-GL’ dietary intervention significantly reduced the risk of excess GWG in the intervention group compared with the control group (RR 0.60, 95% CI 0.38 to 0.94, I^2 is not applicable, test for overall effect: Z = 2.25 (p = 0.02)) but in the high-risk population (2 studies), there was no significant effect (RR 0.81, 95% CI 0.61 to 1.08, $Tau^2 = 0.02$, ChiQ = 1.35, df = 1(p = 0.24), $I^2 = 26\%$, test for overall effect: Z = 1.43 (p = 0.15)).

7.108 The interventions varied across the 2 RCTs. One RCT compared a low-GI diet (target GI: less than or equal to 50) with a conventional high-fibre, moderate GI diet (target GI: approximately 60). Both diets contained similar protein (15% to 25%), fat (25% to 30%), and carbohydrate (40% to 45%) content. One RCT compared a low GI dietary intervention (one 2-hour dietary education session given by a dietitian where women received written resources about low-GI foods, with follow-up reinforcement sessions were held at 28 and 34 weeks' gestation) with routine dietary advice.

‘Low GL’ and postpartum weight retention

7.109 Muktabhant and others (2015) identified one RCT (n = 414) that reported the effect of a ‘low-GL’ dietary pattern when compared with routine dietary advice on postpartum weight retention. The study reported that a ‘low-GL’ dietary intervention significantly reduced the risk of postpartum weight retention in the intervention group compared with the control group (MD -1.4kg, 95% CI -2.63 to -0.17).

7.110 The RCT compared a low GI dietary intervention (one 2-hour dietary education session given by a dietitian where women received written resources about low-GI foods, with follow-up reinforcement sessions were held at 28 and 34 weeks' gestation) with routine dietary advice.

Summary: 'low-GL' dietary patterns and GWG

7.111 The available evidence examining the effect of low-GL diet during pregnancy and GWG and postpartum weight retention is from one SR with MA given a high confidence rating using the AMSTAR 2 tool.

7.112 The GRADE assessment on the certainty of the evidence on low-GL diets and excess GWG, mean GWG and postpartum weight retention is presented in Table 7.14 to Table 7.16. A summary of the evidence is presented in Table 7.17.

Table 7.14: GRADE assessment on 'low-GL' dietary patterns and excess GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	2
Number of participants	835
Study design	Randomised controlled trial
Summary effect estimate	Relative risk: 0.77, 95% CI = 0.66 to 0.91, Z = 3.1 ($p < 0.01$)
Risk of bias	No
Inconsistency	No
Indirectness	No
Imprecision	No
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Decrease
Certainty	High

7.113 There was high certainty evidence from RCTs that consuming a 'low-GL' dietary patterns during pregnancy compared with other dietary patterns during pregnancy may reduce excess GWG in women with a range of BMIs (RR: 0.77, 95% CI 0.66 to 0.91, 2 RCTs with 835 participants, high certainty). Low GL diets include foods that raise blood sugar more slowly following a meal, such as most fruit and vegetables, unsweetened dairy products and meats, nuts, pulses and wholegrain foods.

Table 7.15: GRADE assessment on 'low-GL' dietary patterns and mean GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	5
Number of participants	1,480
Study design	Randomised controlled trials
Summary effect estimate	Not applicable (results presented narratively in the SR)
Risk of bias	No
Inconsistency	Serious (note 1)
Indirectness	No
Imprecision	Rating not assignable (note 2)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Inconsistent
Certainty	Moderate

Note 1: variation in direction of effect and wide variation in effect estimates

Note 2: rating was not assignable as this was a narrative systematic review

7.114 There was moderate certainty evidence from RCTs of an inconsistent association between a 'low-GL' dietary patterns during pregnancy and mean GWG in women with a range of BMIs (5 RCTs with 1,480 participants, moderate certainty (downgraded for inconsistency (due to variation in direction of effect and wide variation in effect estimates)).

Table 7.16: GRADE assessment on 'low-GL' dietary patterns and postpartum weight retention

Evidence characteristics	Assessment of evidence characteristics
Number of studies	1
Number of participants	414
Study design	Randomised controlled trial
Summary effect estimate	Single centre RCT (MD (kg) −1.4, 95% CI −2.63 to −0.17)
Risk of bias	No
Inconsistency	Rating not assignable (note 1)
Indirectness	Serious (note 2)
Imprecision	Serious (note 3)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Decrease
Certainty	Low

Note 1: rating was not assignable as this was a single study

Note 2: single study and centre (limited population)

Note 3: wide confidence intervals

7.115 There was low certainty evidence from an RCT that consuming a 'low-GL' dietary patterns compared with other dietary patterns may reduce postpartum weight retention in women with a range of BMIs (MD −1.4kg, 95% CI −2.63 to −0.17, 1 RCT with 414 participants, low certainty (downgraded for indirectness (single study with a limited population) and imprecision (wide confidence intervals)).

Table 7.17: summary of the evidence on ‘low-GL’ dietary patterns during pregnancy and GWG

Intervention	Outcome	Direction of effect	Certainty of evidence
‘Low-GL’ dietary pattern	Excess GWG	Decrease	High
‘Low-GL’ dietary pattern	Mean GWG	Inconsistent	Moderate
‘Low-GL’ dietary pattern	Postpartum weight retention	Decrease	Low

Frequency of eating and GWG

7.116 One SR was identified on frequency of eating during pregnancy and GWG (USDA, 2020b). This SR did not identify any studies published between January 2000 and September 2019 that met the SR inclusion criteria.

Milk and dairy intake and GWG

7.117 One SR was identified on milk and dairy intake and GWG (Achón and others, 2019).

Achón and others (2019)

7.118 One SR (Achón and others, 2019) was identified that examined the relationship between milk and dairy intake during pregnancy and GWG. The SR included a large number of outcomes, including GWG. The authors did not state any primary outcome or secondary outcomes.

7.119 Achón and others (2019) (AMSTAR 2 confidence rating: low) included 2 prospective cohort studies. One was conducted in a HIC. This study included women aged 18 to 40 years from all BMI categories (40% were in the overweight or obesity range; full details are available in Annex 5). Total dairy intake included milk (whole, reduced-fat, and fat-free), yoghurt, and cheese (including cottage and cream cheese). Details on the fat content were not specified.

7.120 The prospective cohort study (n = 98) reported that a reduction in total dairy intake (g per day) between the first (mean ± standard deviation (SD): 350.1 ± 149.5g per day) and second trimester (mean ± SD: 340.6 ± 228.9g per day) was negatively associated with maternal weight gain during pregnancy (unstandardised regression coefficient (β) = −0.007, p = 0.02).

7.121 The prospective cohort study adjusted for mother's weight, height, and pre-pregnancy BMI and weight gain during gestation, smoking status, neonatal sex, gestational age, socioeconomic characteristics, educational level, energy intake and compliance to Mediterranean diet (score).

Summary: milk and dairy intake and GWG

7.122 The available evidence from SRs examining the effect of milk and dairy intake during pregnancy and GWG is from one SR with MA given a low confidence rating using the AMSTAR 2 tool.

7.123 The GRADE assessment on the certainty of the evidence on milk and dairy intake during pregnancy and GWG is presented in Table 7.18. The summary of the evidence is presented in Table 7.19.

Table 7.18: GRADE assessment milk and dairy intake during pregnancy and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	1
Number of participants	98
Study design	Prospective cohort study
Summary effect estimate	Single centre prospective cohort study; β = −0.007 (95% CI: −0.014 to −0.001) grams per day, p = 0.020
Risk of bias	No
Inconsistency	Rating not assignable (note 1)
Indirectness	Serious (note 2)
Imprecision	Serious (note 3)
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Decrease
Certainty	Very low

Note 1: rating was not assignable as this was a single study.

Note 2: limited population - single study and centre.

Note 3: wide confidence intervals.

7.124 There was very low certainty evidence from a prospective cohort study that a reduction in total dairy product intake between the first and the second trimesters was negatively associated with GWG in women with mixed BMIs: g per day β = -0.007, 95% CI -0.014 to -0.001, one prospective cohort study with 98 participants, very low certainty (observational data downgraded for indirectness (due to limited population) and for imprecision (due to wide confidence intervals)).

Table 7.19: summary of the evidence on milk and dairy intake during pregnancy and GWG

Exposure	Outcome	Direction of effect	Certainty of evidence
Reduction in milk and dairy intake	GWG	Decrease	Very low

Probiotic dietary supplementation and GWG

7.125 The World Health Organization (WHO) defined probiotics as "live microorganisms which when administered in adequate amounts confer a health benefit on the host" (FAO and WHO, 2006). Probiotics are available in a variety of food products, such as yoghurt or fermented milks, or as dietary supplements that can be without a prescription.

Chatzakis and others (2019)

7.126 One SR with MA (Chatzakis and others, 2019) was identified that examined the effect of probiotic dietary supplementation on GWG. The primary outcome of the SR was the development of GDM. Secondary outcomes included increased GWG.

7.127 Chatzakis and others (2019) (AMSTAR 2 confidence rating: moderate) included 4 RCTs (n = 871). Three of the 4 RCTs were conducted in HICs. The studies included women living with overweight or obesity only (BMI 25kg/m^2 or above). Women of all ages and ethnicities were included. Women with pre-existing diabetes were excluded (full details are available in Annex 5).

7.128 Chatzakis and others (2019) reported no effect of probiotic dietary supplements compared to control on increased GWG in women living with overweight or obesity (BMI 25kg/m^2 or above): MD 0.2kg, 95% CI -0.69 to 1.10, I^2 = 43%, random effects model, 4 RCTs, n = 871.

7.129 The interventions varied across the 4 RCTs. One RCT conducted in Iran delivered an intervention of probiotic yoghurt (100g per day containing Lactobacillus acidophilus La5 and Bifidobacterium lactis Bb12) from 24 weeks of gestation until delivery. One RCT conducted in Australia reported an intervention of probiotic capsules (a minimum dose of 1×10^9 colony-forming units (CFU) containing Lactobacillus rhamnosus (LGG) and Bifidobacterium animalis subspecies lactis (BB-12)) taken once daily from enrolment (before 20 weeks gestation) until delivery. One RCT conducted in New Zealand reported an intervention of probiotic capsules (minimum dose of 6.5×10^9 CFU containing Lactobacillus rhamnosus GG and Bifidobacterium lactis BB1) taken daily from enrolment (before 18 weeks gestation) until delivery. One RCT conducted in Ireland reported an intervention of probiotic capsules (100mg Lactobacillus salivarius UCC118 freeze-dried powder to achieve a target dose of 10^9 CFU) taken daily for a 4-week period from 24 to 28 weeks gestation.

Summary: probiotic dietary supplementation and GWG

7.130 The available evidence examining the effect of probiotic dietary supplementation during pregnancy and GWG is from one SR with MA given a moderate confidence rating using the AMSTAR 2 tool.

7.131 The GRADE assessment on the certainty of the evidence on probiotic dietary supplementation during pregnancy and GWG is presented in Table 7.20. The summary of the evidence is presented in Table 7.21.

Table 7.20: GRADE assessment on probiotic dietary supplementation during pregnancy and GWG

Evidence characteristics	Assessment of evidence characteristics
Number of studies	4
Number of participants	871
Study design	Randomised controlled trials
Summary effect estimate	MD: 0.2kg; 95% CI: −0.69 to 1.10
Risk of bias	No
Inconsistency	No
Indirectness	No
Imprecision	No
Publication bias	Not assessed by SR authors
Other (upgrading factors)	None
Direction of effect	Null
Certainty	High

7.132 The only evidence identified on dietary supplements in relation to maternal weight outcomes related to probiotic supplements. No evidence was identified on micronutrient supplements in relation to GWG. There was high certainty evidence from RCTs that in women with BMI 25kg/m^2 or above, there was no difference in GWG between those receiving probiotic dietary supplementation during pregnancy and those receiving no supplement or placebo (MD 0.2kg, 95% CI 0.69 to 1.10, 4 RCTs with 871 participants, high certainty).

Table 7.21: summary of evidence on probiotic dietary supplementation during pregnancy and GWG

Intervention	Outcome	Direction of effect	Certainty of evidence
Probiotic dietary supplementation in women with a BMI 25kg/m^2 or above	GWG	Null	High

Overall summary of evidence

7.133 The GRADE assessments on the certainty of the evidence on maternal dietary patterns and GWG is summarized in Table 7.22.

Table 7.22: summary of the evidence on maternal dietary patterns and GWG (note 1)

Intervention or exposure	Outcome	Direction of effect	Certainty of evidence
Pregnancy dietary interventions	GWG	Decrease	Low to moderate
Pregnancy and/or postpartum dietary interventions (in women with a BMI 25kg/m^2 or above)	Postpartum weight retention	Inconsistent	Low
Postpartum dietary interventions in women living with overweight or obesity	Postpartum weight loss	Increase	Moderate
'Healthy' dietary pattern	GWG	Increase	Very low
'Healthy' dietary pattern	Excess GWG	Null	Very low
'Unhealthy' dietary pattern	GWG	Null	Low
'Unhealthy' dietary pattern	Excess GWG	Increase	Low
'Mediterranean' dietary pattern	GWG	Decrease	Moderate
Dietary patterns higher in vegetables, fruits, nuts, legumes, fish and lower in added sugar, red and processed meat (USDA assessment)	Excess GWG	Decrease	Limited (note 2)
'Low-GL' dietary pattern	Excess GWG	Decrease	High
'Low-GL' dietary pattern	GWG	Inconsistent	Moderate
'Low-GL' dietary pattern	Postpartum weight retention	Decrease	Low
Reduction in milk and dairy intake	GWG	Decrease	Very low
Probiotic supplement (in women with a BMI 25kg/m^2 or above)	GWG	Null	High

Note 1: abbreviations: BMI, body mass index; GL, glycaemic load; GWG, gestational weight gain.

Note 2: the certainty of this evidence was assessed differently (more detail is available in chapter 7, Table 7.13 and in chapter 3, paragraphs 3.61 to 3.69).

8. Summary and conclusions

Background

8.1 This report considered nutrition and maternal weight outcomes; wider UK dietary recommendations for women of childbearing age are considered as part of the accompanying position statement.

Evidence considered

8.2 This risk assessment was informed by a range of evidence.

8.3 Previous assessments undertaken by SACN were considered, in particular the SACN Dietary Reference Values for Energy report.

8.4 Data on the weight status of pregnant women (as indicated by body mass index (BMI)) was obtained from: the Maternity Services Data Set (MSDS) in England (NHS England, 2024b); Public Health Scotland (Public Health Scotland, 2023); Maternity and Birth Statistics in Wales (Welsh Government, 2022); and the Public Health Agency in Northern Ireland (Public Health Agency, 2025) .

8.5 Weight status data on girls and women of childbearing age was obtained from: the National Diet and Nutrition Survey (NDNS) (2014 and 2019) (PHE, 2020a) for the UK; the Health Survey for England (HSE) (2022) (NHS England, 2024a); the Scottish Health Survey (2023) (Scottish Government, 2024); the National Survey for Wales (2022 to 2023) (Welsh Government, 2023); and the Health Survey Northern Ireland (2023 to 2024) (Department of Health Northern Ireland, 2024).

8.6 Evidence on dietary intakes and nutritional status of girls and women of childbearing age from the National Diet and Nutrition Survey (NDNS) (2014 to 2019) (PHE, 2020a) and associated modelling of estimated energy intakes based on height and weight data from the HSE (2017 to 2019) were considered. NDNS data is not currently available for pregnant or lactating women. Energy and macronutrient intakes were interpreted against the UK dietary reference values (DRVs).

8.7 Systematic reviews (SRs) and meta-analyses (MAs) of randomised controlled trials (RCTs) and prospective cohort studies were identified through systematic searches.

8.8 A review of the relationship between dietary patterns consumed during pregnancy and gestational weight gain (GWG) undertaken by the United States Department of Agriculture (USDA) was also considered (USDA, 2020a).

Weight outcomes

8.9 Maternal preconception BMI, both below and above the healthy range (18.5kg/m^2 to 24.9kg/m^2), is an important risk factor for maternal complications in pregnancy and for sub-optimal fetal growth (IOM and NRC, 2009).

8.10 A range of national surveys in the UK indicated that the prevalence of overweight and obesity among girls and women of childbearing age in the UK is high and increasing. Slight differences were observed based on the survey population and methods, reporting time and age of participants.

8.11 The NDNS (2014 to 2019) (PHE, 2020a) reported that 31% of girls and women of childbearing age were living with overweight and 21% were living with obesity. The prevalence of living with overweight or obesity (BMI of at least 25kg/m^2) ranged from 41% in the 19 to 29 year old age group to 64% in the 40 to 49 year old age group. Two per cent of women aged 19 to 49 years were underweight (BMI below 18.5kg/m^2).

8.12 The HSE (2022) reported that among women aged 16 years and older, 38% of 16 to 24 year olds, 57% of 25 to 34 year olds, 61% of 35 to 44 year olds and 64% of 45 to 54 year olds were living with overweight, including obesity (NHS England, 2024a). The prevalence of obesity among non-pregnant women was 17% in 16 to 24 year olds, 26% in 25 to 34 year olds, 33% in 35 to 44 year olds and 34% in 45 to 54 year olds. The HSE (2022) also reported that 9% of non-pregnant 16 to 24 year old women were underweight. Findings from national surveys in Scotland, Wales and Northern Ireland indicated similar levels of overweight and obesity.

8.13 The highest rates of overweight and obesity are seen in the most deprived areas of the UK. The Health Survey for England 2022 and Scottish Health Survey 2022 found that over two-thirds of non-pregnant women (aged 16 years and over) in the most deprived areas were living with overweight, including obesity, compared to around half of women in the least deprived areas.

8.14 Data from the MSDS (2018 to 2019) showed that for women in early pregnancy, around half were living with overweight or obesity (50.3%): 28.0% were living with overweight (BMI 25kg/m^2 to 29.9kg/m^2) and 22.3% were living with obesity (BMI 30kg/m^2 or above) when they attended their first antenatal appointment. Additionally, 3.1% of women were living with underweight (BMI below 18.5kg/m^2) (Schoenaker and others, 2023). More recent MSDS data (2023 to 2024) indicated that the proportion of women living with obesity in early pregnancy had increased to 25.4% in 2022 and 26.2% in 2023.

Energy and nutrient intakes

8.15 Throughout this report, contribution of energy from carbohydrates and fats are expressed as a percentage of energy excluding energy from ethanol (alcohol) (shortened to 'percentage of energy').

8.16 Data from the NDNS (2014 to 2019) indicates that, in common with the population as a whole, most girls and women of childbearing age are not achieving UK dietary recommendations, including for vegetables and fruit, fibre or oily fish, sugar, salt or saturated fat intake.

Energy

8.17 Ideally, women should begin pregnancy at a healthy body weight; weight loss during pregnancy is not advised (SACN, 2011a). The 2025 National Institute for Health and Care Excellence (NICE) guideline NG247 also states that 'intentional weight loss during pregnancy is not recommended because of potential adverse effects on the baby' (NICE, 2025a).

8.18 Women do not need to "eat for two" and other than avoiding specific foods and drinks, they do not need a special diet during pregnancy (NICE, 2025a). During the last trimester of pregnancy, an increment of around 200kcal per day (0.8 MJ per day; 191kcal per day) should be added to the estimated average requirement (EAR) based on the mother's preconception body weight (SACN, 2011a).

8.19 Based on a breastmilk output of 500kcal per day and an average weight loss of 0.8kg per month (which is equivalent to 170kcal per day), an increment of 1.38MJ per day (330kcal per day) to the EAR is recommended in the first 6 months postpartum for those women who are exclusively breastfeeding (SACN, 2011a).

8.20 The NDNS (2014 to 2019) (PHE, 2020a) indicated that for women aged 14 to 49 years, average energy intakes were 77% to 85% of the EAR. Underreporting of energy intake is known to be an issue for all dietary surveys and studies where the assessment of usual diet relies on self-reporting (OHID, 2023, SACN, 2011a).

8.21 Findings from a DLW sub-study of the NDNS (OHID, 2023) indicated that mean TEE of the small sample of women aged 16 to 49 years studied was 10.6MJ per day (2,535kcal per day) compared with a mean reported energy intake of 7.2MJ per day (1,710kcal per day). Therefore, participant-reported energy intake was only 67% of likely habitual energy intake based on DLW measurements. In addition, modelling of HSE data indicated that women in England aged between 20 and 59 years old who are living with overweight or obesity consume approximately 1.2 and 1.4MJ per day (275 and 324kcal per day) above the EAR (OHID, 2024).

Carbohydrates

8.22 The UK dietary recommendations for carbohydrates are based on advice from SACN (SACN, 2015) and relate to average population intakes. These population recommendations also apply to pregnant and lactating women.

8.23 The UK dietary recommendation for total carbohydrate intake is that the population average intake should be at least 50% of energy (SACN, 2025). Data from NDNS indicated that intakes for total carbohydrates were below the dietary reference value (DRV) except in girls aged 14 to 18 years (PHE, 2020a).

8.24 The UK dietary recommendation for free sugars is that the population average intake should be no more than 5% of energy (SACN, 2025). Data from NDNS indicated that only 13% of girls and women aged 14 to 49 years met this recommendation (PHE, 2020a).

8.25 The UK dietary recommendation for dietary fibre is 25g per day for girls aged 14 and 15 years old and 30g per day for women aged 16 to 49 years (SACN, 2015). Data from NDNS indicated that only 4% of girls and women met the DRV (PHE, 2020a).

Dietary fat

8.26 The UK dietary recommendation for total dietary fat is that the population average intake should be no more than 35% of energy (Department of Health, 1991; SACN, 2025). These population recommendations also apply to pregnant and lactating women. Data from the NDNS indicated that 49% girls and women aged 14 to 49 years met the DRV.

8.27 The UK dietary recommendation for saturated fat intake is that the population average intake should be no more than 10% of energy (SACN, 2025). These population recommendations also apply to pregnant and lactating women. Data from NDNS indicated that 22% girls and women aged 14 to 49 years met the DRV (PHE, 2020a).

Protein

8.28 The UK dietary recommendation for protein intake for girls aged 14 years is 41.2g per day and for women aged 15 to 49 years is 45g per day (Department of Health, 1991). There are increments to the recommendation for protein for pregnancy and lactation. These are +6g per day during pregnancy, +11g per day for months 0 to 4 for lactation and +8g per day for after 4 months of lactation. Mean protein intake (g per day) exceeded the recommendation in all age categories (mean intakes in girls and women aged 14 to 39 was 147% of the RNI) (PHE, 2020a).

Vegetable and fruit intake

8.29 The UK dietary recommendation for vegetable and fruit intake is to consume at least 5 portions (80g each) of a variety of vegetables and fruit every day. Mean vegetable and fruit consumption in girls and women (aged 14 to 49 years) was 3.8 portions per day with only 27% meeting the 5-a-day recommendation (PHE, 2020a).

Oily fish consumption

8.30 The UK recommendation for oily fish is to consume one portion of oily fish (140g) per week. Mean oily fish consumption in girls and women (aged 14 to 49 years) was equivalent to 42g per week, well below the recommended one portion per week (PHE, 2020a).

Red and processed meat consumption

8.31 The UK recommendation for red and processed meat is to reduce consumption of red and processed meat to no more than 70g per day if usually consuming more than 90g per day. Mean red and processed meat consumption in girls and women (aged 14 to 49 years) was 47g per day (PHE, 2020a).

Evidence from systematic reviews and meta-analyses

8.32 The quality of the evidence identified from systematic reviews (SRs) and meta-analyses (MAs) was assessed using AMSTAR 2; the SRs and MAs with higher AMSTAR 2 ratings were prioritised. The certainty of the evidence identified was assessed using Grading of recommendations, assessment, development and evaluation (GRADE). The approaches taken followed the updated SACN Framework (SACN, 2023).

8.33 The majority of studies identified in the SRs reported mean GWG; only a minority of studies disaggregated inadequate or excess GWG. Results presented are for general populations of women with a range of BMI unless otherwise stated.

8.34 GWG is physiologically normal in pregnancy, reflecting fetal and placental growth, and maternal components such as increased blood volume (Champion and others, 2020, IOM and NRC, 2009). On average, increases in body fat represent about a quarter of the overall weight gained.

8.35 The US National Academy of Medicine (NAM), formerly the Institute of Medicine (IOM), has published guidelines for appropriate GWG in the US. These guidelines are stratified by preconception BMI status (IOM and NRC, 2009). These have been used by authors of many published studies or reviews to assess inadequate or excess GWG. There are currently no national guidelines in the UK.

8.36 Study authors considered a broad range of dietary interventions and patterns. These included:

- interventions that provided dietary counselling, consultation with dietitians, education sessions or basic healthy eating advice
- consideration of ‘healthier’ and ‘unhealthier’, ‘mediterranean’, ‘low glycaemic load’, and lower fat dietary patterns

8.37 The evidence identified from systematic reviews is summarised below. The certainty of the evidence, assessed using GRADE, is in brackets. The included studies considered a broad range of dietary interventions and patterns. The dietary patterns are as they were defined by study authors. The information below was graded as high, moderate or low certainty. Evidence for other dietary factors and interventions was either graded as very low certainty or was not identified through systematic literature searches.

Energy intake and GWG

8.38 There was low certainty evidence from prospective cohort studies that higher maternal total energy intake during pregnancy may be associated with higher GWG (21 prospective cohort studies, 15,713 participants, low certainty (observational data)).

8.39 There was low certainty evidence from prospective cohort studies that higher maternal total energy intake during pregnancy may be associated with excess GWG (10 prospective cohort studies, 10,985 participants, low certainty (observational data)).

Dietary interventions and GWG

8.40 There was low to moderate certainty evidence from RCTs that dietary interventions during pregnancy may reduce GWG, based on the findings of 2 SRs. Two SRs were graded separately due to incomplete overlap of the included studies. One of the SRs reported weighted mean difference (WMD): -3.27kg, 95% CI: -4.96 to -1.58, 9 RCTs, 2,049 participants, low certainty (downgraded for inconsistency due to the presence of heterogeneity (I^2 = 92.8%) and evidence of publication bias) (Walker and others, 2018). The other SR reported mean difference (MD): -2.84kg, 95% CI: -4.77 to -0.91, 12 RCTs, 2,017 participants, moderate certainty (downgraded for inconsistency due to the presence of heterogeneity (I^2 = 92.3%)) (i-WIP, 2017).

Dietary interventions and postpartum weight retention and postpartum weight loss

8.41 There was low certainty evidence from RCTs of an inconsistent relationship between dietary interventions during pregnancy and/or in the postpartum period and postpartum weight retention in women with a BMI of 25kg/m^2 or above (5 RCTs with 871 participants, low certainty (downgraded for risk of bias and inconsistency (size of the effect)).

8.42 There was moderate certainty evidence from RCTs that dietary interventions in the postpartum period may support weight loss among women living with overweight or obesity in the postpartum period and who were of a healthy weight pre-pregnancy (MD: -1.82kg, 95% CI: -2.19 to -1.44, 2 RCTs with 75 participants, moderate certainty (downgraded due to imprecision (insufficient sample size)).

Maternal dietary patterns and GWG

8.43 There was low certainty evidence from prospective cohort studies that maternal adherence to an ‘unhealthy’ dietary pattern may be associated with excess GWG (OR: 1.43, 95% CI: 1.06 to 1.92, 2 prospective cohort studies with 2,076 participants, low certainty (observational data)). The ‘unhealthy’ dietary pattern was characterised by study authors as greater consumption of refined grains, foods high in saturated fats, red meat, processed meat, fast foods’, sugary foods and sugary drinks.

8.44 Evidence was also considered from the USDA Dietary Guidelines Advisory Committee (USDA, 2020a). The USDA considered there to be ‘limited’ evidence (equivalent to ‘low’ evidence certainty on GRADE) suggesting that certain dietary patterns during pregnancy are associated with a lower risk of excess GWG during pregnancy (4 RCTs and 19 prospective cohort studies). The patterns identified were higher in vegetables, fruits, nuts, legumes, fish, and lower in added sugar, and red and processed meat. There was a degree of overlap with some studies identified through the literature search for this SACN risk assessment. The conclusions drawn by USDA and SACN were largely consistent.

8.45 There was high certainty evidence from RCTs that consuming a ‘low glycaemic load’ (GL) dietary pattern during pregnancy compared with other dietary patterns during pregnancy may reduce excess GWG (RR: 0.77, 95% CI 0.66 to 0.91, 2 RCTs with 835 participants, high certainty). ‘Low GL’ dietary inventions include foods that raise blood sugar more slowly following a meal, such as most fruit and vegetables, unsweetened dairy products and meats, nuts, pulses and wholegrain foods.

8.46 There was moderate certainty evidence from RCTs that consuming a ‘Mediterranean’ dietary pattern during pregnancy may lower GWG (SMD: -0.15, 95% CI: -0.26 to -0.05, 3 RCTs with 1,367 participants, moderate certainty (downgraded due to evidence of imprecision)).

8.47 There was low certainty evidence from prospective cohort studies indicating no association between maternal adherence to an ‘unhealthy’ dietary pattern and mean GWG (Hedges’ g: 0.00, 95% CI: -0.09 to 0.09, 2 prospective cohort studies with 3,356 participants, low certainty (observational data)). The ‘unhealthy’ dietary pattern was characterised by authors as refined grains, foods high in saturated fats, red meat, processed meat, ‘fast foods’, and high sugary foods and drinks.

8.48 There was moderate certainty evidence from RCTs of an inconsistent association between a ‘low-GL’ dietary pattern during pregnancy and mean GWG (5 RCTs with 1,480 participants, moderate certainty (downgraded for inconsistency (due to variation in direction of effect and wide variation in effect estimates)).

Maternal dietary patterns and postpartum weight retention

8.49 There was low certainty evidence from an RCT that consuming a ‘low-GL’ diet compared with other dietary patterns may reduce postpartum weight retention: MD -1.4kg, 95% CI -2.63 to -0.17, 1 RCT with 414 participants, low certainty (downgraded for indirectness (single study with a limited population) and imprecision (wide confidence intervals)).

Supplements and GWG

8.50 The only evidence identified on dietary supplements in relation to maternal weight outcomes related to probiotic supplements. No evidence was identified on micronutrient supplements in relation to GWG. There was high certainty evidence from RCTs that in women with BMI of 25kg/m^2 or above, there was no difference in GWG between those receiving probiotic dietary supplementation during pregnancy and those receiving no supplement or placebo (MD 0.2kg, 95% CI 0.69 to 1.10, 4 RCTs with 871 participants, high certainty).

Summary of certainty of the evidence

8.51 Table 8.1 and 8.2 provide a summary of the evidence from SRs and MAs of RCTs and prospective cohort studies assessed as ‘low’, ‘moderate’ or ‘high’ certainty using GRADE.

Table 8.1: summary table of the systematic review evidence on the relationship between diet and maternal gestational weight outcomes

Intervention	Outcome	Direction of effect	Certainty of evidence
‘Unhealthy’ dietary pattern (characterised by diets high in refined grains, saturated fats, red meat, processed meat, fast foods and high sugary foods and drinks) (note 1)	Excess GWG	Increase	Low

Intervention	Outcome	Direction of effect	Certainty of evidence
‘Low GL’ dietary pattern	Excess GWG	Decrease	High
‘Healthier’ dietary patterns higher in vegetables, fruits, nuts, legumes, fish, and lower in added sugar, red and processed meat (USDA) (note 1)	Excess GWG	Decrease	USDA defined as limited
Higher energy intake	Mean GWG	Increase	Low
‘Mediterranean’ dietary pattern	Mean GWG	Decrease	Moderate
‘Low-GL’ dietary pattern	Mean GWG	Decrease	Moderate
‘Unhealthy’ dietary pattern (characterised by refined grains foods high in saturated fats, red meat, processed meat, fast foods, and high sugary foods and drinks) (note 1)	Mean GWG	No association	Low
Varied diet-only interventions (note 2)	Mean GWG	Decrease	Low or moderate
Supplements - probiotic dietary supplementation in women with a BMI 25kg/m^2 or above	Mean GWG	No effect	High

Note 1: author defined.

Note 2: varied diet-only interventions including calorie-restriction, basic healthy eating advice, low-GI diet, dietary advice with a probiotic, limiting dietary cholesterol and reducing the intake of saturated fat, dietary counselling according to nutritional status.

Table 8.2: summary table of the systematic review evidence on the relationship between diet and postpartum weight outcomes

Intervention or exposure	Outcome	Direction of effect	Certainty of evidence
Dietary interventions in the postpartum period	Postpartum weight loss	Increase	Moderate
‘Low GL’ diet	Postpartum weight retention	Decrease	Low
Dietary intervention during pregnancy and/or in the postpartum period in women with a BMI 25 kg/m^2 or above	Postpartum weight retention	Inconsistent	Low

8.52 The evidence for the following exposure to outcomes relationships was assessed to be of very low certainty:

- higher protein intake and excess GWG
- study author defined ‘healthy’ dietary pattern (characterised by higher intakes of fruits, vegetables, whole grains, low-fat dairy products, vegetable oils, and fish) and excess GWG
- maternal protein intake, maternal total fat and mean GWG
- saturated fat intake and mean GWG
- unsaturated fat intake and mean GWG
- source of fat (animal sources) and mean GWG
- source of fat (vegetable sources) and mean GWG
- carbohydrate intake and mean or excess GWG
- total dairy intake and mean GWG

Limitations

8.53 A range of limitations were identified in the evidence base that was considered in this risk assessment (that is, national survey data, SRs and MAs).

Dietary survey data

8.54 There is no national dietary data set available on pregnant or lactating women in the UK. Analysis has therefore been based on NDNS data for women of child-bearing age who are not pregnant or lactating (NDNS 2014 to 2019 did not collect data from women who were pregnant or lactating). It is likely that the diets, including use of dietary supplements, and nutritional status of pregnant and lactating women differ in some respects from those who are not pregnant or lactating. Caution is therefore required in drawing conclusions from this analysis.

Misreporting

8.55 This assessment focused on weight outcomes, for which robust data on energy intake is critical. The misreporting of energy intake (generally underreporting) is a known issue for all dietary surveys and studies (Poslusna and others, 2009). It is also not known whether the components of energy intake (that is, protein, fat, carbohydrate, alcohol) are misreported equally or differentially, for example whether fat intake may be over or underreported to a greater degree than protein. Wider evidence also indicates that recall of dietary intake data varies by BMI.

8.56 In addition to underreporting of actual dietary consumption in self-reported dietary methods, assumptions also have to be made on food composition, recipes and portion sizes. These can affect the accuracy of consumption estimates.

Evidence from SRs and MAs

8.57 The eligibility criteria for the SRs and MAs included studies of women of any weight status and aged 16 years or over. Consequently, evidence relating to girls aged 14 and 15 years may have been missed.

8.58 The majority of literature in this field considered diet interventions in combination with physical activity. Few studies considered diet alone.

8.59 The broad range of methods used makes it difficult to identify the most effective interventions. In particular:

- interventions varied in the provision of dietary advice (from brief advice or education to counselling sessions with a dietitian). A minority also provided foods. This leads to uncertainty in the impact and generalisability of these interventions

- a range of dietary assessment methods were used (for example, food-frequency questionnaires, 24-hour recalls, food diaries). Accurate and reliable assessment of dietary intake is difficult, and each method is associated with measurement error

- variations in dietary composition, method, duration and mode of delivery hinders identification of the most effective interventions for reduction of excess GWG

8.60 It was unclear how study findings were impacted by preconception BMI. The majority of preconception BMI values were self-reported (and may have been subject to reporting bias) or were represented by first trimester BMI data as a proxy. Wider evidence indicates that recall of dietary intake data varies by BMI.

8.61 The identified SRs rarely included information on markers of adherence (such as repeated dietary assessment, blood biomarkers, qualitative assessment). This was the case both for the intervention or control, or fidelity to protocol. Many SRs also did not report on any adverse outcomes or negative experiences associated with exposures or interventions.

8.62 Interventions tended to be of a short duration as almost all started in the second trimester of pregnancy. No SRs relating to interventions preconception were identified, and few continued into the postpartum period.

Evidence on nutrition and GWG

8.63 Assessment of the relationships between nutrition and GWG is hampered by the lack of an agreed definition for appropriate and excess GWG. The use of 'mean' GWG in many studies is particularly problematic because it is unclear whether reported associations are due to an appropriate or inappropriate weight gain. Additionally, studies assessing GWG by BMI status at the start of pregnancy were limited.

8.64 No evidence was identified on fasting and GWG. There was also no evidence identified on population subgroups and maternal weight outcomes particularly for women from racially and ethnically diverse groups, groups experiencing multiple disadvantage, adolescent girls, and women who follow specific dietary practices (such as those following a vegan diet). This was due to a lack of reporting or stratified analyses (where sample sizes were adequate).

8.65 The majority of studies addressing relationships between GWG and pregnancy outcomes are for total weight gain across gestation and therefore do not allow identification of trimester-specific information.

8.66 GWG as an outcome measure has limitations because several of the components of GWG are highly variable in healthy pregnancies. The multicomponent nature of GWG leads to wide variability and can detract from how it is interpreted, including as a proxy outcome of health.

Quality and certainty of the evidence

8.67 The overall evidence on the relationship between nutrition and GWG was of limited quantity and certainty. There was either no evidence or 'low' or 'very low' certainty SR evidence for a number of dietary exposures and maternal weight outcomes which were included in the scope and literature search for this risk assessment.

8.68 The process of considering published SR and MA evidence meant that the assessment of the evidence was largely dependent on author assessment of included study quality and risk of bias.

8.69 GRADE has benefits in giving additional transparency to SACN's deliberations and allows comparison with the work of other organisations. However, the application of GRADE to public health topics such as nutrition can be challenging. Issues of particular relevance are that:

- randomisation may be impossible, difficult and/or costly for the issues considered in this report; most of the evidence identified was observational, and GRADE assigns observational evidence as ‘low’ certainty at the outset, however well designed and executed

- effect sizes for observed associations are unlikely to be large; however, SACN noted that small average effect sizes could potentially make a meaningful difference at a population level

Conclusions

Weight status, energy intakes and requirements

8.70 In this report, SACN has focused its considerations on the prevention of underweight, overweight and obesity prior to pregnancy as together with a healthy diet, this is likely to be associated with greatest benefits to maternal and child health outcomes. In the UK population, this predominantly refers to prevention of overweight and obesity prior to pregnancy.

8.71 SACN has previously highlighted the importance of women beginning pregnancy at a healthy weight (SACN, 2011a), and this is also recognised in existing advice. While excess or inadequate GWG can increase the risk of adverse health outcomes for the mother and fetus, maternal preconception BMI, both below and above the healthy range (18.5kg/m^2 to 24.9kg/m^2), is likely to be a greater determinant of poor maternal and fetal outcomes compared with excess or inadequate GWG.

8.72 Intentional weight loss is not recommended during pregnancy because of potential adverse effects on the baby (NICE, 2025a). SACN notes that updated NICE guidance also highlights the health benefits of losing weight before pregnancy.

8.73 A range of national surveys in the UK indicate that the prevalence of overweight and obesity among women of childbearing age is high and increasing. For example, the NDNS (2014 to 2019) (PHE, 2020a) reported that 52% of non-pregnant and non-lactating women aged 14 to 49 years were living with overweight or obesity. The increasing number of people classified as living with overweight or obesity is consistent with evidence showing that habitual energy intakes are above requirements. There are currently no national dietary survey data available for pregnant or lactating women in the UK. This is an important evidence gap on which SACN has made a recommendation in this report.

8.74 Evidence identified from SRs in this report indicates that higher energy intakes during pregnancy are likely to be associated with excess GWG. While the certainty of the evidence on energy intakes was low, it is prudent for pregnant women, lactating women and women of childbearing age, particularly those who are planning a pregnancy or who may become pregnant, to avoid excess intakes of energy.

8.75 In 2011, SACN recommended retaining the increment of around 200kcal per day in the last trimester of pregnancy (as set by Committee on Medical Aspects of Food and Nutrition Policy (COMA)), where the EAR is based on the mother's preconception body weight, rather than being set at healthy body weights for non-pregnant women (SACN, 2011a). SACN noted that "women entering pregnancy who are [living with] overweight [or obesity] may not require this increment but current data are insufficient to make a recommendation regarding this group" (SACN, 2011a).

8.76 Similarly, the increment SACN set in 2011 for the lactation period takes into account the energy stored in tissues during pregnancy which is then mobilised to cover some of the additional energy needs associated with breastfeeding, based on an average weight loss of 0.8kg per month (SACN, 2011a). Evidence identified in SACN's report on feeding in the first year of life (SACN, 2018) indicates that breastfeeding is associated with greater postpartum weight loss. Evidence identified indicates that exclusive breastfeeding (for the first 6 months of an infant's life) is associated with greater postpartum weight loss, and the duration of any breastfeeding is associated with lower maternal BMI in the longer term (SACN, 2018).

8.77 Evidence considered in this report indicated already high energy intakes of women of childbearing age. Therefore, usual levels of energy consumption for women living with overweight or obesity may meet or exceed energy requirements during pregnancy and lactation, and no further increase may be required. However, there remains insufficient evidence regarding whether there would be any unintended consequences of changing existing advice. SACN has therefore not changed advice in relation to energy intakes during pregnancy and lactation.

8.78 Women who are underweight at the beginning of pregnancy are also at risk of poor maternal and fetal outcomes (SACN, 2011a). In 2011, SACN noted that women who were underweight at the beginning of pregnancy may have a higher energy requirement than other women.

8.79 Adolescents at the beginning of pregnancy who have not completed their growth may have a higher EAR than other women. In 2011, SACN noted that "The energy requirements for pregnancy also need to take into account the protection of vulnerable groups. Adolescents who become pregnant must meet the dietary requirements to achieve normal growth, in addition to the demands of pregnancy and lactation" (SACN, 2011a). Limited evidence was identified in this report on adolescent girls before, during and after pregnancy, including what is an appropriate GWG for this age group. SACN also noted concerns in relation to growth and that underweight is more prevalent in this age group. Overweight and obesity is also an issue among adolescents though a lower proportion are living with overweight and obesity than in older age groups. The energy needs of adolescents in pregnancy and lactation are not clearly understood and further research is warranted. Current advice for pregnant adolescents remains unchanged, that is to follow general advice for energy intake during pregnancy and lactation.

Dietary patterns

8.80 Adhering to population dietary recommendations may support women of childbearing age to achieve and maintain a healthy weight. However, many women of childbearing age have poor dietary patterns and are not achieving UK dietary recommendations (which are based on advice from SACN or its predecessor, COMA). For example, only 13% of girls and women aged 14 to 49 years meet the DRV for free sugars, 27% meet recommendations for fruit and vegetables and 4% meet recommendations for fibre.

8.81 Study authors used varying definitions of 'healthy' dietary patterns but these generally aligned with existing UK dietary recommendations. 'Mediterranean' dietary patterns and 'low-GL' dietary patterns considered by authors were similarly aligned with UK dietary recommendations. Dietary patterns and components considered by authors included higher vegetables, fruits, nuts, legumes, fish, whole grains, low-fat dairy products and/or vegetable oils and lower refined grains, foods high in saturated fats, red meat, processed meat, 'fast foods', and/or 'sugary' foods. The evidence identified from SRs in this report indicated that a healthier diet may be effective in preventing excess GWG, reducing postpartum weight retention and increasing postpartum weight loss.

8.82 While some of the evidence identified on dietary patterns was of low certainty, the evidence identified indicated that modifying diets during pregnancy and in the postpartum period led to modest beneficial effects on GWG and postpartum weight. No evidence was identified that consuming a healthier dietary pattern or avoiding an unhealthy dietary pattern before, during or after pregnancy resulted in negative health outcomes.

8.83 When making recommendations, SACN also recognised that a broad range of determinants need to be considered if population dietary intakes are to be improved. Given the short timeframe available for interventions during pregnancy and in the postpartum period, SACN noted the importance of supporting women to achieve a healthy BMI ahead of pregnancy and in-between pregnancies. Encouraging a healthier dietary pattern and achieving and maintaining a healthier weight is likely to be associated with a wide range of benefits for all women, especially those planning a pregnancy or who may become pregnant.

8.84 The current evidence base does not support the use of dietary supplements, in relation to GWG, for the general population. No evidence was identified for a role of micronutrient supplements and there is evidence of no effect of probiotic supplements on GWG.

Development of recommendations

8.85 Recommendations made in this report specifically relate to maternal weight outcomes and not to other outcomes in pregnancy and the postpartum period. SACN's recommendations should be read alongside those made by NICE guideline NG247.

8.86 SACN considered the totality of evidence in formulating its recommendations. This included:

- previous assessments undertaken by SACN, in particular the SACN Dietary Reference Values for Energy (SACN, 2011a)
- survey data on the prevalence of overweight and obesity in both pregnant and non-pregnant girls and women of childbearing age, and modelled energy intakes
- evidence on dietary intakes and nutritional status of women of childbearing age from the NDNS
- evidence from SRs and MAs

8.87 This is the first report in which SACN has applied GRADE to consider the certainty of the available evidence. According to the SACN Framework (SACN, 2023), recommendations are generally made when evidence is graded as 'high' or 'moderate' certainty.

8.88 The SACN Framework (SACN, 2023) allows for expert judgement to be used to make recommendations which are based on evidence graded as 'low' (or in exceptional circumstances, 'very low' certainty). This is on the basis that there is a clear rationale, the evidence may be strengthened in future and a precautionary recommendation is deemed appropriate.

8.89 For this report, SACN agreed to only make recommendations based on evidence assessed as low, moderate or high certainty. The committee did not deem it appropriate to make recommendations based on very low certainty evidence, which included additional considerations relating to inconsistency of the data, lack of studies or where data originated from a single study.

9. Recommendations

9.1 This report considered nutrition and maternal weight outcomes. Recommendations are for girls and women of childbearing age (age 14 to 49 years) and pregnant or breastfeeding women. They are made in the context of existing UK government dietary recommendations and should be read alongside the NICE guidelines:

- Maternal and child nutrition: nutrition and weight management in pregnancy, and nutrition in children up to 5 years (NG247)
- Overweight and obesity management (NG246)

Population subgroups

9.2 The needs of the following groups should be a particular focus when considering all the recommendations:

- vulnerable groups (such as adolescent girls and older mothers)
- racially and ethnically diverse groups
- people experiencing multiple disadvantage

When collecting data on body weight status, and nutrient intake and status, specific consideration should be given to study design to allow assessment of these population subgroups.

Existing UK dietary recommendations

9.3 SACN reiterates existing UK government dietary recommendations for women of childbearing age. These include avoiding energy intakes that exceed requirements. Achieving and/or maintaining a healthy weight is a priority before pregnancy and between pregnancies. See Table 2.1 for a summary of current UK dietary recommendations for energy and macronutrients for women of childbearing age (and the increments for pregnancy and lactation).

9.4 Women who are pregnant or breastfeeding, and women of childbearing age, particularly those who are planning a pregnancy or who may become pregnant, should follow existing UK dietary recommendations.

9.5 SACN reiterates existing recommendations on energy requirements for women during pregnancy and breastfeeding made in SACN's Dietary Reference Values for Energy report, which are that:

- 0.8MJ a day (191kcal a day) is added to a pregnant woman's estimated average requirement (EAR) for energy during the last trimester (EAR is calculated using the woman's weight before pregnancy)

- 1.38MJ a day (330kcal a day) is added to a mother's EAR for energy in the first 6 months after giving birth for women who are exclusively breastfeeding (EAR is calculated using the woman's weight before pregnancy)

Maternal weight gain and postpartum weight loss

9.6 For maternal weight gain during pregnancy and postpartum weight loss, SACN recommends:

- avoiding energy intakes that exceed requirements

- eating a healthy balanced diet in line with existing UK dietary recommendations

- exclusive breastfeeding for around the first 6 months of an infant's life and continued breastfeeding into the second year of life and beyond

Recommendations for the government to consider

9.7 SACN recommends that government considers:

- continuing to collect data on measured maternal body weight status nationally at the start of pregnancy and reporting this data by BMI category

- collecting detailed, nationally representative data on nutrient intakes and status of pregnant and breastfeeding women

- continuing to collect (through the National Diet and Nutrition Survey) detailed nationally representative data on nutrient intake and status of women of childbearing age

- focusing prevention activities on reducing prevalence of overweight and obesity before pregnancy as this is where maternal and child health benefits are likely to be greatest

- strategies to support women of childbearing age to maintain or achieve a healthy BMI

- strategies to support women of childbearing age, particularly those planning a pregnancy, to eat a healthy balanced diet, in line with UK dietary recommendations

- strategies to promote and support breastfeeding, particularly exclusive breastfeeding for around the first 6 months

10. Research recommendations

10.1 A number of gaps in the evidence were identified during the development of this report. In addition, a number of limitations in study design were identified that should be considered in future research.

Specific evidence gaps

10.2 SACN recommends that further research be undertaken to:

- determine the physiological impact of energy intake and expenditure in the following population groups in order to derive updated energy requirements for: pregnant women who are living with overweight or obesity; pregnant adolescent girls who are still growing; and pregnant women living with underweight
- examine the relationship between energy intakes above the EAR and gestational weight gain (GWG) in pregnant women including in population subgroups (for example, racially and ethnically diverse groups, adolescent girls who are still growing and populations who experience multiple disadvantage)
- develop and evaluate practical and accurate methods to measure maternal gestational fat accrual as an adjunct or an alternative to GWG
- evaluate the consequences of maternal energy intakes that fail to meet energy requirements and/or result in weight loss, particularly in the last trimester of pregnancy and during lactation, on maternal and fetal outcomes
- examine the impact of dietary interventions on maternal and child outcomes among pregnant women living with underweight
- investigate the impact of multiple disadvantage on nutrition and maternal weight outcomes
- investigate the impact of dietary practices of racially and ethnically diverse groups in the UK on maternal weight outcomes
- investigate the impact of vegan and vegetarian diets and different forms of fasting used in some diet regimens, on maternal weight outcomes

Considerations for study design

10.3 SACN recommends that future research should:

- ensure representative population groups of pregnant women and women of childbearing age, including vulnerable groups (such as adolescent girls and older mothers), racially and ethnically diverse groups as well as people who are experiencing multiple disadvantage
- ensure the sampling method in heterogenous cohorts enables adequate stratification of population subgroups, including for women in different BMI categories
- if GWG is being reported, avoid reporting mean GWG only and report the distribution of GWG; use commonly used thresholds for inappropriately low or high GWG, or standard deviation scores to estimate the distribution of GWG, ideally by each trimester
- evaluate and assess markers of maternal adiposity in pregnancy other than GWG
- report preconception BMI, use measured heights and weights and avoid self-reported data
- use validated, robust dietary assessment methods including better methods to capture different dietary patterns common in the UK
- disaggregate the effects of diet and physical activity on maternal weight outcomes
- use accurate and reliable measures of free-living total energy expenditure (TEE)
- stratify dietary interventions based on different preconception BMI categories
- include a trial arm that uses existing UK dietary recommendations in dietary interventions to allow comparison
- include measures of fidelity to protocol and measures of compliance by participants in randomised controlled trials of dietary interventions

11. Roles, membership and acknowledgements

SACN's role and membership

The role of SACN is to provide independent scientific advice on and risk assessments of nutrition and related health issues. It advises the 4 UK health departments, and other government departments and agencies.

Membership of SACN and the register of members' interests at the time of publication is provided in the relevant annual report, which is available on the SACN webpage, alongside SACN's code of practice. The code of practice also provides information on the roles of members, the secretariat and official observers.

SACN's secretariat

SACN is supported by a scientific secretariat based at DHSC. Members of SACN's secretariat involved in the production of this report were:

- Dr Rachel Allen
- Susannah Brown (from January 2021 to January 2025)
- Dr Adrienne Cullum
- Dr Mariana Dineva (from January 2025)
- Dr Daphne Duval (until January 2021)
- Rachel Elsom
- Rebecca Hillier (from January 2025)
- Neeve Pearce (from May 2021)
- Heiko Stolte
- Gillian Swan

Observers

Departmental representatives and advisers attend SACN meetings as official observers. Observers for this report were:

- Dr Aoibheann Dunne (Food Standards Agency in Northern Ireland)
- Caroline Litts (Food Standards Scotland)
- Dr Sarah Rowles (Welsh Government)
- Margie van Dijk (OHID, Department of Health and Social Care)

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- Professor Louisa Ells (Leeds Beckett University)
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- Dr Jamie Matu (Leeds Beckett University)
- Dr Oliver Shannon (Newcastle University)
- Dr Andrew Jones (University of Liverpool)

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11.6 Scientific Advisory Committee on Nutrition. Nutrition and maternal weight outcomes. 2026.

12. Abbreviations

ALA: alpha linolenic acid

AMSTAR 2: a measurement tool to assess systematic reviews

AOAC: Association of Analytical Chemists

ASA24: automated self-administered 24-hour dietary recall

BB-12: bifidobacterium animalis subspecies lactis

BMI: body mass index

CFU: colony-forming units

CHO: carbohydrate

CI: confidence interval

COMA: Committee on Medical Aspects of Food and Nutrition Policy

COT: Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment

DH: Department of Health

DHQ II: Diet History Questionnaire II

DASH: dietary approaches to stop hypertension

DLW: doubly labelled water

DRI: dietary reference intakes

DRV: dietary reference value

EAR: estimated average requirement

EER: estimated energy requirements

EFSA: European Food Safety Authority

EVOO: extra virgin olive oil

FAO: Food and Agricultural Organization

FSA: Food Standards Agency

GD: gestational diabetes

GDM: gestational diabetes mellitus

GI: glycaemic index

GL: glyceamic load

GRADE: Grading of recommendations, assessment, development and evaluation

GNI: gross national income

GWG: gestational weight gain

HIC: high income country

HSE: Health Survey for England

IOM: Institute of Medicine

IMD: index of multiple deprivation

IPD: individual participant data

i-WIP: International Weight Management in Pregnancy Collaborative Group

kJ: kilojoule

LIC: low income country

LGA: large for gestational age

LRNI: lower reference nutrient intake

MA: meta-analysis

MD: mean difference

MJ: megajoule

MSDS: Maternity Services Data Set

MUFA: monounsaturated fatty acids

NAM: National Academy of Medicine

NDNS: National Diet and Nutrition Survey

NESR: Nutrition Evidence Systematic Review

NICE: National Institute for Health and Care Excellence

NICU: neonatal intensive care unit

NRSI: non-randomised studies of intervention

NVP: nausea and/or vomiting in pregnancy

OHID: Office for Health Improvement and Disparities

OMNI: optimal macronutrient intake

OR: odds ratio

PCA: principal component analysis

PHE: Public Health England

PROSPERO: International Prospective Register of Systematic Reviews

PUFA: polyunsaturated fatty acids

RCT: randomised controlled trial

RNI: reference nutrient intake

RoB: risk of bias

RR: relative risk

SACN: Scientific Advisory Committee on Nutrition

SD: standard deviation

SMD: standardized mean difference

SMCN: subgroup on maternal and child nutrition

SR: systematic review

SSB: sugars sweetened beverages

SWS Southampton Women's Study

TDEI: total dietary energy intake

USDA: United States Department of Agriculture

UN: United Nations

UNU: United Nations University

WG: weight gain

WHO: World Health Organization

WMD: weighted mean difference

13. Glossary

Adolescent girls

The World Health Organization defines adolescence as “the phase of life between childhood and adulthood, from ages 10 to 19 years”. For this report, adolescent girls refers to girls aged 14 to 19 years old.

Breastfeeding

Breastfeeding is the feeding of an infant with milk taken from the breasts, either directly by the infant or expressed and given to the infant via a bottle or other drinking vessel.

Body mass index (BMI)

An individual’s body mass index is their weight in kilograms divided by the square of height in metres (kg/m^2). Often used as an indicator of adiposity with recognised limitations (Pietrobelli and others, 1998).

Confounding factor

A confounding factor is an unmeasured variable that influences both the exposure of interest (for example, nutrient intake) and the outcome (for example, body weight). These include sex, physical activity, social and economic influences, and ethnicity.

Congenital anomalies

Congenital anomalies are defined as being present at delivery, originating before birth. They include structural, chromosomal and genetic anomalies. This term is used to describe conditions such as cleft palate, spina bifida and Down’s syndrome. Screening during pregnancy can detect some congenital anomalies, while some are found at birth. Others are detected as a baby grows older.

Dairy

Dairy refers to milk produced by an animal, specifically a mammal such as goats, sheep, cows or even camels and water buffalo. All mammalian milk is considered dairy but there are differences in butterfat content, lactose and protein.

Dietary fibre

Dietary fibre includes constituents of plant cell walls, such as cellulose, and is the most diverse of the carbohydrate groups. The SACN report ‘Carbohydrates and health’ (SACN, 2015) defines dietary fibre as all carbohydrates that are neither digested nor absorbed in the small intestine and have a degree of polymerisation of 3 or more monomeric units, plus lignin.

Dietary reference values (DRVs)

DRVs provide benchmark levels of nutrient requirements that can be used to compare mean values for population intakes.

Although information is usually inadequate to calculate precisely and accurately the range of requirements for a nutrient in a group of individuals, it has been assumed to be normally distributed. This gives a notional mean requirement or estimated average requirement (EAR) with the reference nutrient intake (RNI) defined as 2 notional standard deviations above the EAR.

Intakes above the RNI will almost certainly be adequate to meet the needs of 97.5% of the population. The lower reference nutrient intake (LRNI), which is 2 notional standard deviations below the EAR, represents the lowest intakes which will meet the needs of approximately 2.5% of individuals in the group. Intakes below this level are almost certainly inadequate for most individuals.

Doubly labelled water (DLW) method

Doubly labelled water is water in which both the hydrogen (H) and oxygen (16O) have been partly or completely replaced for tracing purposes (that is, labelled) with ‘heavy’, non-radioactive forms of these elements: 2H and 18O.

The DLW method measures the rate of disappearance of these 2 tracers given to an individual in water as they are washed out of the body. 18O disappears faster from the body than 2H because it is lost in both urine and as carbon dioxide in breath. 2H is only lost from the body in urine. The difference between how fast 2H and 18O disappear provides a measurement of carbon dioxide production and this can then be converted into the amount of energy used.

DLW is the most accurate research method for measuring people’s energy expenditure while they go about their everyday lives. The amount of energy expended by the body equates to energy intake when body weight is stable. The DLW technique provides an indication of the extent to which reported energy intake is likely to reflect usual energy intake and/or an indication of the degree of under reporting.

Estimated average requirement (EAR)

The EAR is the nutrient intake value that is estimated to meet the requirement of 50% of individuals in a life stage and sex group. About half of a defined population will usually need more than the EAR, and half less.

Factorial approach to estimating energy intakes

When people are in energy balance (that is, when their weight is stable) it can be assumed that their energy intake equals their energy expenditure, therefore measurement of their total energy expenditure (TEE) will provide an estimate of energy requirements.

TEE is calculated by multiplying basal metabolic rate (BMR) by physical activity level (PAL).

BMR values were predicted with the Henry equations at median height and weight values (HSE 2017 to 2019) for each age and sex group.

The population PAL value of 1.63 was assumed. A PAL of 1.63 represents the median PAL value of a reference.

Free sugars

Free sugars are defined according to Swan and others, 2018:

- all added sugars in any form
- all sugars naturally present in vegetable and fruit juices, concentrates, smoothies, purées and pastes, powders, extruded vegetable and fruit products (and similar products in which the structure has been broken down)
- sugars naturally present in honey and syrups
- all sugars in drinks (except for lactose naturally present in dairy-based drinks)
- lactose and galactose added as ingredients

This definition excludes sugars naturally present in:

- milk and dairy products
- fresh and most types of processed vegetables and fruit
- cereal grains, nuts and seeds

Gestational weight gain (GWG)

Gestational weight gain is defined as the weight gained during pregnancy starting by the weight documented from the first prenatal visit and ending with the weight at the last prenatal visit.

Glucagon-like peptide-1 (GLP-1) receptor agonists

Glucagon-like peptide-1 (GLP-1) receptor agonists are a class of medications used to treat type II diabetes mellitus and obesity. These medicine help people feel fuller by mimicking a natural hormone released after eating.

Hedges’ g statistic

Hedges’ g statistic is used to measure the effect size for the difference between means.

Heterogeneity

Heterogeneity is the variation in study outcomes between studies.

The term is used generically to refer to any type of significant variability between studies contributing to a meta-analysis that renders the data inappropriate for pooling. This may include heterogeneity in:

- diagnostic procedure
- intervention strategy
- outcome measures
- population
- study samples
- study methods

The term heterogeneity can also refer to differences in study findings. Statistical tests can be applied to compare study findings to determine whether differences between the findings are statistically significant. For example, significant heterogeneity between estimates of effect from intervention studies suggests that the studies are not estimating a single common effect.

In the presence of significant heterogeneity, it is more appropriate to describe the variations in study findings than to attempt to combine the findings into one overall estimate of effect.

High income country (HIC)

The World Bank defines economies into 4 income groupings:

- low
- lower-middle
- upper-middle
- high

Income is measured using gross national income (GNI) per capita, in US dollars, converted from local currency using the World Bank Atlas method.

Estimates of GNI are obtained from economists in World Bank country units. The size of a country’s population is estimated by World Bank demographers from a variety of sources, including the United Nation’s biennial World Population Prospects.

In 2023, a HIC was defined as having a GNI per capita of $13,205 or more (The World Bank, 2025).

I^2

I^2 is a statistical index which measures the percentage of variation across the studies included in a meta-analysis that is due to heterogeneity (that is, differences between study results) rather than chance.

Index of multiple deprivation (IMD)

The index of multiple deprivation (IMD) is the official measure of relative deprivation in England and is part of a suite of outputs that form the indices of deprivation.

MD follows an established methodological framework in broadly defining deprivation to encompass a wide range of an individual’s living conditions. People may be considered to be living in poverty if they lack the financial resources to meet their needs, whereas people can be regarded as deprived if they lack any kind of resources, not just income.

Kilocalorie

Kilocalories are units used to measure the energy value of food, 1kcal = 4.18kJ (kilojoule).

Kilojoule or megajoule

Kilojoules or megajoules are units used to measure the energy value of food, 1kJ = 1,000 joules, 1MJ = 1 million joules.

Large for gestational age (LGA)

There is no standardised definition of LGA. The term is used when a baby exceeds the expected weight for its gestational age. The most common UK definition is birth weight above the 90th centile.

Low income country (LIC)

In 2023, a LIC was defined as having a GNI per capita of $1,085 or less (The World Bank, 2025).

For more information, see the definition of 'high income country' in this glossary.

Macronutrients

Macronutrients are nutrients that provide energy, including fat, protein and carbohydrates.

Macrosomia

Fetal macrosomia is a term used when a fetus is larger than expected for gestational age. It is usually defined by an absolute weight or in relation to centiles. The most common UK definition is a birth weight above 4kg.

Meta-analysis

A meta-analysis (MA) is a quantitative pooling of estimates of effect of an exposure on a given outcome, from different studies identified from a systematic review of the literature.

MA is a specific method of statistical synthesis that is used in some systematic reviews, where the results from several studies are quantitatively combined and summarised. The pooled estimate of effect from a MA is more precise (that is, has narrower confidence intervals) than the findings of each of the individual contributing studies, because of the greater statistical power of the pooled sample.

Micronutrients

Micronutrients are essential nutrients required by the body in small quantities, including vitamins and minerals.

National Diet and Nutrition Survey (NDNS)

NDNS is a continuous cross-sectional survey of food consumption, nutrient intakes and nutritional status in adults and children living in private households in the UK. It is designed to be representative of the UK population and has been running since 2008.

Until 2024, the UK sample included 500 adults and 500 children per year. It also excluded children under 18 months, pregnant and breastfeeding women, and people living in institutions. Since then, the sample size has increased to 2,000 adults and 2,000 children per year, the lower participant age range extended to 12 months and pregnant and lactating women are no longer excluded.

Until 2019, dietary assessment was carried out using a paper diary completed for 4 consecutive days. Since then, the dietary assessment has been carried out using an automated online tool, Intake24.

Details of the rationale, design and methods of the survey have been described elsewhere (Venables and others, 2022).

The NDNS is jointly funded by the Department of Health and Social Care (DHSC) and the UK Food Standards Agency (FSA).

Odds ratio (OR)

Odds ratio (OR) is a measure of association between an exposure and an outcome. It represents the odds that an outcome will occur given a particular exposure, compared with the odds of the outcome occurring in the absence of that exposure.

The OR is adjusted to address potential confounding.

P-value (p)

The p-value is a statistical measure that indicates whether or not an effect is statistically significant.

Ponderal index

Ponderal index is an indication of a person's weight relative to their length. It is used as a proxy measure of adiposity, similar to BMI.

Ponderal index is calculated as weight (kg) divided by cubed height or length in infants (m^3).

Postpartum weight retention

Postpartum weight retention is calculated as the difference between body weight at a given time postpartum and early or pre-pregnancy body weight.

Randomised controlled trial (RCT)

A randomised controlled trial is a study in which eligible participants are assigned to 2 or more treatment groups on a random allocation basis. Randomisation assures the play of chance so that all sources of bias, known and unknown, are equally balanced.

Reference nutrient intake (RNI)

Reference nutrient intake is the average daily intake of a nutrient sufficient to meet the needs of almost all members (97.5%) of a healthy population. Values set may vary according to age, sex and physiological state (for example, pregnancy or breastfeeding).

Relative risk (RR)

Relative risk is the ratio of the rate of disease or death among people exposed to a factor, compared with the rate among the unexposed, usually used in cohort studies (World Cancer Research Fund and American Institute for Cancer Research, 2007).

Risk of bias

Risk of bias relates to the quality of a study and is an essential component of a systematic review across studies.

Risk factor

A risk factor is a factor demonstrated in epidemiological studies to influence the likelihood of disease in groups of the population.

Small for gestational age (SGA)

A fetus is considered SGA when individual biometric measurements or a combination of measurements used to estimate fetal weight fall below set parameters and requires accurate assessment of gestational age.

Commonly, the definition of SGA refers to a fetus with a predicted weight or an abdominal circumference measurement less than the 10th centile. SGA at birth is commonly diagnosed based on a birthweight below the 10th centile and often birthweight charts are adjusted for the sex of the baby.

Standardised mean difference (SMD)

Standardised mean difference is a summary statistic in a meta-analysis when the studies all assess the same outcome but measure it in a variety of ways.

Starch

Starch is a polymer of glucose, found in foods such as rice, bread, pasta and potatoes.

Subgroup analysis

A subgroup analysis is an analysis that is repeated for a subset of participants or for a subset of studies.

Sugar-sweetened beverages

In this report, a sugar-sweetened beverage (SSB) is any (non-dairy) beverage (carbonated drinks, fruit-based drinks, squashes, flavoured water) where free sugars have been specifically added as a sweetener. Where possible, these are distinguished from 100% fruit juices (with naturally occurring levels of sugars).

Systematic review

A systematic review is an extensive review of published literature on a specific topic using a defined search strategy, with a priori inclusion and exclusion criteria.

Total carbohydrates

Total carbohydrates are the sum of starch plus total sugar.

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