Nutrition in pregnancy

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Abstract

Many pregnant women rely on their health professional for nutrition information during routine antenatal visits. This review offers information to assist health professionals with advising pregnant women of the important nutrition considerations during pregnancy. The roles of some of the key nutrients are discussed, including folic acid, iodine, iron, calcium, and vitamin D. Recommendations for each of the key nutrients are covered and examples of how these can be achieved are presented. The review also details additional nutritional considerations that should be discussed during antenatal consults, including energy balance and weight gain recommendations, the importance of food safety during pregnancy, the recommended safe levels of consumption of vitamin A, caffeine, and fish, and the importance of abstaining from alcohol. Educating and supporting women during pregnancy to make healthy food choices to fulfil their needs and the needs of their growing fetus, will help to promote a healthy start to life.

Keywords diet; food and nutrition; maternal health; pregnancy complications; preventive medicine

Introduction

Maternal nutrition is a crucial component of a healthy pregnancy that should be emphasised during antenatal consults. Optimal nutrition is essential for the growth and development of the fetus, the sustained health of the mother during pregnancy, and can have long-term effects on the health of the mother and her infant. Many pregnant women rely on their health professional (obstetrician, midwife, and general practitioner) for nutrition information during routine antenatal visits, as very few seek advice from a dietitian. With a large amount of information conveyed during antenatal visits, nutrition strategies are often not at the forefront of discussions. However, more emphasis should be placed on these important discussions, given the robust evidence demonstrating relationships between maternal nutrition and pregnancy complications/adverse infant outcomes. Pregnancy is often referred to as a "teachable moment" where women are motivated to make positive behavioural changes related to their health and well-being. This is particularly advantageous given the recent rise in research demonstrating that early life nutrition can program the long term health of the infant (Developmental Origins of Health and Disease). Some of the most commonly recognised relationships include the link between folic acid and neural tube defects; alcohol consumption and fetal alcohol spectrum disorders; and vitamin D and rickets. In the limited time available during antenatal consults, not all aspects of maternal diet can be covered in detail. Therefore, for the purpose of this review, our discussion will focus on some of the key nutritional components that should take priority during nutrition discussions in antenatal consults; energy balance and weight gain, key nutrients during pregnancy, and food safety.

Energy balance and weight gain during pregnancy

Gestational weight gain can be a delicate topic for many pregnant women who will inevitably experience substantial changes to their bodies throughout the course of their pregnancy. However, it is a topic that does require some attention during consults, albeit in a sensitive manner. Studies have shown excess weight gain during pregnancy is associated with an increased risk of gestational diabetes, pre-eclampsia, high birth weight, caesarean delivery, and postpartum weight retention. Inadequate gestational weight gain on the other hand, has also been shown to have potential negative consequences, including delivery of a low birthweight baby and an increased risk of preterm birth. There are currently no recognised evidence-based guidelines in the United Kingdom for recommended weight gain during pregnancy, but the Institute of Medicine (IOM)'s recommendations published in 2009 are used across many parts of the world (Table 1). The IOM recommendations are based on pre-pregnancy body mass index (BMI) and emphasise that women entering pregnancy with a low BMI should gain more weight during pregnancy than those with a higher BMI. Despite evidence that women entering pregnancy who are overweight or obese are more likely to develop pregnancy complications, it is not advised for women to try to lose weight during pregnancy. Instead, they should focus on maintaining or developing a healthy lifestyle that includes a nutrient-rich diet, nutrient supplementation where appropriate, and regular exercise.

A common myth that needs to be dispelled is that the expectant mother should be 'eating for two'. There can be detrimental effects to the health of the fetus and mother from eating in excess of requirements. The energy intake recommendations during pregnancy in the United Kingdom are to increase intake by around 200 calories (about 837 kilojoules) per day and only in the third trimester. An extra 200 calories is approximately equivalent to adding a banana and a pot of yogurt to the usual diet. These recommendations are based on the assumption that fetal growth and gestational weight gain stay within healthy parameters, so monitoring of both throughout pregnancy is essential to confirm that energy intake is adequate for the individual. It is also important to acknowledge that energy requirements can vary significantly between individuals and trimesters, depending on a range of variables, including the mother's level of physical activity and whether they are expecting a single baby or are pregnant with twins/multiples.

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Institute of Medicine's guidelines for weight gain during pregnancy (2009)

Pre-pregnancy body mass index (kg/m^2)	Recommended total weight gain	Recommended total weight gain if expecting twins
Less than 18.5 (underweight)	12.5—18 kg	Not available
18.5—25 (healthy weight)	11.5—16 kg	17—25 kg
25—30 (overweight)	7—11.5 kg	14—23 kg
More than 30 (obese)	5—9 kg	11—19 kg

Table 1

Key nutrients of importance during pregnancy

A healthy, varied maternal diet is advantageous to the health and well-being of the mother and infant. Pregnant women should focus on diet quality and be encouraged to choose nutrient-rich foods high in important vitamins and minerals. Overall dietary guidelines and recommendations have been generated and published in a Royal College of Obstetricians and Gynaecologists (RCOG) statement to assist with food selection conducive to an overall healthy diet during pregnancy (see below for their list of recommendations):

1) Base meals on starchy foods such as potatoes, bread, rice and pasta.
2) Choose wholegrains and fibre-rich foods where possible such as oats, beans, lentils, grains and seeds, wholegrain bread, brown rice and wholemeal pasta.
3) Eat at least five portions of different fruit and vegetables every day (potatoes do not count towards this target). Do not count pure fruit juice for more than one portion of the five-a-day.
4) Eat as little fried food as possible and avoid drinks that are high in added sugars, and other foods such as sweets, cakes and biscuits that have a high fat and/or sugar content.
5) Eat some protein every day; choose lean meat when selecting meat sources. Lentils, beans and tofu are also a good source of protein.
6) Aim to eat two portions of fish a week.
7) Eat dairy foods regularly but choose low-fat varieties such as skimmed milk or low-fat yogurt.
8) Stay mindful of the portion size of meals and snacks consumed, and how often you eat.
9) Always eat breakfast.

In addition to the recommendations designed to help pregnant women follow an overall healthy diet, there are some key nutrients that deserve particular attention. It is first worth noting that the absorption and metabolism of a range of essential nutrients from the diet and from maternal stores is significantly increased during pregnancy. As such, although nutrient requirements are increased due to the demands of pregnancy, for many nutrients the dietary recommendations do not exceed the recommendations for non-pregnant women. However, it is crucial to emphasise to pregnant women the importance of aiming to meet the recommendations. The demands of pregnancy will put women entering pregnancy with low nutrient stores at a heightened risk of nutritional deficiencies. Nutrient deficiencies in pregnancy will have an impact not just on the mother but on the health of the fetus.

Folic acid/folate

Folic acid is important for the development and regulation of the genetic material in the body and consequently, the expression of RNA, and production of proteins. Requirements are increased during pregnancy because of increased rates of growth, DNA production, and cell division. Folic acid deficiency has been found to be closely linked with the development of neural tube defects (NTDs). NTDs occur when the neural tube fails to close completely, around the fourth week of gestation. The most common forms of NTDs which present are spina bifida, anencephaly, and encephalocele.

Folic acid is the synthetic form of folate and is found in fortified foods and nutritional supplements. Folic acid is up to two times more bioavailable than its natural folate equivalents. In the United Kingdom it is recommended that a 400 μg folic acid supplement is consumed daily prior to conception and through to the twelfth week of gestation, in addition to a folate-rich diet, to reduce the risk of NTDs. Taking folic acid supplements on an empty stomach has been shown to improve the bioavailability of folic acid. Women at risk of NTDs are recommended to take 5 mg per day of folic acid during pregnancy. Women are considered to be at risk of NTDs if they:

- have had a NTD-affected pregnancy previously,
- have a family history of NTD or their partner has a family history of NTD,
- are on insulin to manage diabetes, or
- are taking medications that could affect folic acid metabolism. Medications that interfere with folic acid metabolism include some anti-epileptic drugs, infertility treatment, insulin, and acne medications.

High levels of folic acid supplementation can mask vitamin B12 deficiency, so it is important to consider the women's vitamin B12 status prior to prescription of high-dose supplementation, particularly in groups susceptible to B12 deficiency such as vegetarians/vegans.

In addition to supplementing with folic acid, it is recommended that women consume 200 μg of folate from food each day, throughout pregnancy. Folate, the naturally occurring form of folic acid, can be found in leafy green vegetables, citrus foods, wholegrain breads, legumes, and some fortified foods such as breakfast cereals. It is difficult to achieve the recommended levels through food alone so folic acid supplementation is required.

Iron

Iron is an important mineral involved in red blood cell development, particularly haemoglobin, however iron is also required for the function of other enzymes in the body, has a role in the immune system and synthesis of connective tissue components, and is a cofactor in neurotransmitter formation. Although the daily iron requirements during pregnancy do not differ from the 14.8 mg per day recommended for non-pregnant females in the United Kingdom, pregnant women are at an increased risk of iron deficiency and iron-deficiency anaemia due to the demands from

increased blood volume and fetal requirements. A large number of women in the United Kingdom enter into pregnancy with low stores of iron and are at an increased risk of deficiency when faced with the additional demands of pregnancy. Iron deficiency in pregnancy can lead to complications such as pre-term delivery, perinatal mortality, low birthweight, and can have negative effects on infant cognition and behaviour.

The best way to achieve the 14.8 mg per day recommended is to consume iron-rich foods. Consuming excess amounts of iron when not necessary can decrease absorption of other nutrients such as zinc and copper, and may be associated with maternal side effects such as constipation. It is recommended that pregnant women only take supplements if they have clinically determined low iron stores or have received advice to do so from a registered health professional. There are two types of iron in food; haem and non-haem. Haem iron can be found in meats, poultry, fish, and seafood, and approximately 20–30% is absorbed. Non-haem iron is also found in these foods, but additionally found in nuts, seeds, legumes, fortified food products (such as some breakfast cereals), and green leafy vegetables, and only around 5% is absorbed. Women following a vegetarian diet pre-conception and/or during pregnancy are particularly vulnerable to iron deficiency and their iron levels should be monitored throughout pregnancy. There are dietary components that can increase or decrease the absorption of non-haem iron and advising pregnant women of these can help to optimise their iron absorption. Vitamin C increases iron absorption, whereas some polyphenols, such as those found in tea and coffee, have been shown to inhibit iron absorption. Two simple strategies to increase iron absorption include avoiding tea and coffee at mealtimes, and consuming iron-containing foods with foods high in vitamin C (e.g. citrus fruits, pepper, tomatoes).

Iodine

Iodine is an essential mineral for healthy thyroid hormone production. Iodine deficiency can result in problems with both maternal and fetal thyroid hormone production and consequently affect fetal growth and development, and also the mental health of the infant. The iodine recommendation during pregnancy in the United Kingdom is 140 μg per day, the same amount as recommended for non-pregnant females. Sources of iodine in the diet include: iodised salt, low-fat milk products, eggs, fish, seafood, and seaweed. Seaweed and kelp tablets are high in iodine but can contain iodine at toxic levels, and are therefore not recommended during pregnancy.

Vitamin D

Vitamin D is an important nutrient for the bone health of the developing fetus. Vitamin D regulates blood calcium levels by affecting the absorption of calcium and phosphorous from the small intestine and losses from bone. Vitamin D deficiency can negatively affect fetal growth and bone formation and is a risk factor for the development of childhood rickets. Rickets is a condition where the bones are soft or weakened, not formed to their full potential, and can result in deformities. In humans, vitamin D levels are achieved through dietary consumption of vitamin D in the forms of cholecalciferol and ergocalciferol or via conversion of precursors in the skin to cholecalciferol, following ultra violet (UV) light exposure (sunlight). However, sunlight exposure and its conversion is highly variable among individuals and is affected by variables such as skin colour, skin exposure, and season. Groups at risk of low vitamin D status include women with cultural practices that require them to wear attire that reduces the amount of exposed skin and women with darker skin. The UV strength of sunlight during winter months is significantly reduced and therefore, dietary vitamin D intake is important during winter, as well as for those women that do not get sufficient sun exposure year round.

In the United Kingdom, it is recommended that all adults take a daily supplement containing 10 μg of vitamin D. This recommendation is particularly important for pregnant women at risk of lower vitamin D status, and during the winter months when sun exposure is low. Dietary sources of vitamin D include oily fish (herring, salmon, mackerel), eggs, and vitamin D fortified products e.g., some margarine/spreads.

Calcium

Calcium is involved in healthy bone and teeth formation and maintenance. As well as being important for achieving optimal bone health, calcium may protect against hypertensive disorders in pregnancy, e.g. pre-eclampsia. The recommended daily intake during pregnancy is 700 mg per day. Although calcium recommendations during pregnancy do not exceed the recommendations for non-pregnant women, it is essential that expectant mothers aim to achieve these recommendations so calcium stores (including bone mass) are not compromised to fulfil fetal requirements. Food sources rich in calcium include milk, cheese, yoghurt, nuts, canned fish with bones, and green leafy vegetables. Pregnant women consuming dairy alternatives such as soy milk or nut milks, should choose calcium fortified substitutes.

Vitamin B12

Vitamin B12 is important for healthy blood and neurological function. The recommended dietary intake for pregnant women does not differ from the 1.5 μg per day recommended for non-pregnant women. However, intake of vitamin B12 during pregnancy is particularly important as the fetal supply relies on dietary intake, which is favourably transported by the placenta, regardless of maternal stores. Dietary sources of vitamin B12 are all animal-based, as the bacteria that synthesises vitamin B12 are found only in animal products such as meat, poultry, fish, seafood, eggs, and dairy products. Vitamin B12 intake is often compromised in the diets of pregnant women following a vegetarian or vegan diet. Vegetarian women should ensure they are consuming adequate milk and dairy products to achieve the daily vitamin B12 recommendations. For women who are vegan or choose to exclude all animal products from their diets (including milk, dairy, and eggs) a vitamin B12 supplement should be considered (Table 2).

Food safety and precautions

Pregnancy is a time of compromised immunity and as such a pregnant woman is at a greater risk of contracting food-borne illnesses from pathogens such as listeria, salmonella, *Toxoplasma gongii*, and campylobacter. Table 3 lists the main food sources that are likely to harbour the pathogens of concern and

Recommended intakes of key nutrients in pregnancy and examples of how to achieve the recommendations

Key nutrient	Recommended supplement	Recommended dietary intake	Food sources	Example to meet dietary recommendation [a]
Folic acid	Through to 12th week: **400 μg/day OR 5000 μg/day** for women at high risk of NTDs	200 μg/day	Leafy green vegetables, citrus foods, wholegrain breads, legumes, fortified foods such as breakfast cereals	2 eggs ½ cup cooked baby spinach
Iron	If prescribed by a registered health professional	14.8 mg/day	Haem iron: meats, poultry, fish, and seafood Non-haem iron: Above foods + nuts, seeds, legumes, fortified food products, green leafy vegetables	2 slices wholegrain toast 2 eggs ½ cup edamame/ baby soybeans 1 small tin of salmon (~90 g) cup hummus ½ cup cooked baby spinach 2 grilled lean lamb leg steaks (~120 g)
Iodine		140 μg/day	Iodised salt, low-fat milk products, eggs, fish, seafood, seaweed	2 eggs 1 glass of low-fat cow's milk (~200 ml) 1 pot of plain low-fat yoghurt (~120 g)
Vitamin D	**10 μg/day**		Oily fish, eggs, and fortified products	
Calcium		700 mg/day	Milk and dairy products, fortified milk substitutes, nuts, canned fish with bones, green leafy vegetables	1 glass of low-fat cow's milk (~200 ml) 1 pot of plain low-fat yoghurt (~120 g) 1 matchbox size piece of edam cheese (~40 g)
Vitamin B12		1.5 μg/day	Meat, poultry, fish, seafood, eggs, milk and dairy products	2 eggs

[a] Based on McCance and Widdowson's composition of foods integrated dataset.

Table 2

details the health consequences associated with contracting food-borne illness from the specified pathogens during pregnancy. It is worth noting that pregnant women can be infected by these pathogens without showing physical signs/symptoms, so precautionary measures are essential to protect the health of the fetus, which can still be negatively affected if the mother is asymptomatic.

Alcohol

Alcohol intake during pregnancy can have detrimental effects on the health of the developing fetus, as alcohol in the maternal blood stream can readily cross the placenta. The wide spectrum of health consequences are referred to as fetal alcohol spectrum disorders. The effects of alcohol consumption during pregnancy vary depending on the amount consumed and the developmental stage of the fetus. Some of the consequences of alcohol consumption include a growth restricted baby, facial abnormalities, and learning and behavioural disorders. Women who have consumed high amounts of alcohol during pregnancy are also at an increased risk of preterm birth. What is less well known and understood are the effects of low levels of intake. Due to this uncertainty, the

Key food-related pathogens to avoid during pregnancy

Food-related pathogen	Health Consequences	Foods to avoid	Precautions that can be taken
Listeria monocytogenes	Miscarriage Stillbirth Preterm labour Low birthweight Infant death	Unpasteurised milk or juice Soft cheeses such as camembert, brie, ricotta, blue-vein Cheese made from unpasteurised milk Pâte Undercooked meat or poultry Pre-prepared/pre-packaged salads Cold-cured meats such as salami, prosciutto	Listeria is destroyed by heat, so heat pre-prepared meals thoroughly
Salmonella	Miscarriage Premature labour	Raw or partially cooked eggs Mayonnaise and mousse (made with raw eggs) and soft serve ice cream Undercooked meat; especially poultry and seafood Raw sprouts	Store raw meat, seafood, and fish separately to cooked foods or foods that do not require cooking, to avoid cross-contamination
Campylobacter	Premature labour Spontaneous abortion Stillbirth	Undercooked meat or poultry	Cook and heat all meat and poultry thoroughly before eating
Toxoplasma gongii	Hearing loss Blindness Intellectual disability Brain or eye problems	Undercooked meat or poultry	Contamination can occur through exposure to cat faeces. Avoid contact with potentially affected soil and cat litter trays, or wear gloves if contact is required. Clean hands thoroughly before handling food

Table 3

Caffeine content in common food sources

Food source	Caffeine content [a]
Instant coffee (1 teaspoon in 250 ml)	80 mg
Espresso (50 ml)	145 mg
Black tea (250 ml)	50 mg
Chocolate (50 g)	Up to 25 mg
Caffeinated carbonated beverages (250 ml)	80 mg
Cola beverage (375 ml can)	50 mg

[a] Based on Food Standards Australia New Zealand information sheet on Caffeine (2018).

Table 4

recommendation proposed in the United Kingdom Chief Medical Officer's guideline (2016) is to abstain from drinking during pregnancy, as no level of maternal alcohol intake is known to be safe.

For some women, alcohol consumption may have occurred in their early stages of pregnancy, before finding out they were pregnant. According to the report from the UK Chief Medical Officer, the risk of harm from low levels of exposure to alcohol in the early stages of pregnancy is likely to be low. However, women should be advised to avoid any further alcohol consumption during their pregnancy.

Caffeine

Caffeine is a naturally occurring compound and one of the most widely consumed stimulants worldwide. High levels of maternal caffeine consumption have been linked to increased risk of low birthweight babies and in some studies, have been associated with miscarriage. It is recommended by RCOG that during pregnancy women should consume no more than 200 mg of caffeine a day. This equates to approximately two instant coffees, although the caffeine content of food and beverages varies between brands and by food/beverage preparation methods. Caffeine is found most commonly in coffee, teas, caffeinated beverages, and chocolate. Table 4 lists approximate values of the caffeine content in some common caffeine-containing food sources. Some over-the-counter cold/flu and pain medications also contain caffeine.

Fish

There are many health advantages to consuming fish (well-cooked) during pregnancy. Fish is a lean source of quality protein, and some canned fish such as sardines, contains bones, which are a good source of calcium. Oily fish such as salmon, mackerel, and sardines also contain high amounts of

long chain omega-3 fatty acids such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) that are beneficial for brain and eye health, and nervous system function. However, fish can also be a source of some environmental contaminants such as mercury, dioxins, and polychlorinated biphenyls (PCBs). Mercury is a heavy metal that occurs naturally in the environment and can accumulate in the ocean. As such, mercury can be found in the flesh of fish. The highest levels are found in fish high up the food-chain, i.e. shark, swordfish, orange roughy, and southern Bluefin tuna. High maternal mercury exposure from fish consumption can have negative effects on the brain and nervous system of the developing fetus, and studies have shown that maternal exposure can result in lifelong neurological problems for their infant. Dioxins and PCBs are environmental contaminants which can occur naturally (i.e. from forest fires and volcanic activity) but are most commonly man-made (from combustion by-products and industrial processes), and accumulate in the fat deposits in fish. These compounds have been found to negatively affect reproductive and immune systems, disrupt hormone function, and cause cancer. Some studies have also found that high maternal exposure to PCBs and dioxins can increase the risk of developing neural tube defects.

Recommendations to restrict fish intake during pregnancy due to concerns regarding environmental contaminants has led to confusion around fish consumption and in some cases, avoidance. It is important for health professionals to correctly communicate the benefits of fish consumption and how the potential risks can be minimised without restricting all fish consumption during pregnancy.

It is recommended that pregnant women consume at least two portions of fish each week.

However, to prevent over-exposure to mercury and PCBs/dioxins during pregnancy, additional recommendations have been made by the National Health Service to:

- consume no more than two portions of oily fish per week (e.g. salmon, mackerel, trout, herring, sardines),
- consume no more than two fresh tuna steaks or four medium-sized cans (about 140 g per can) of tuna per week,
- avoid eating shark, swordfish or marlin, and
- minimise the intake of dogfish, sea bass, sea bream, turbot, and halibut.

Vitamin A

Vitamin A is a fat-soluble vitamin found in food as retinol or vitamin A precursors such as carotenoids. Maternal vitamin A intake is important for eye health, the immune system, and for fetal growth. However, excess intake of vitamin A can have teratogenic effects on the fetus, increasing the risk of birth defects. Pregnant women should avoid supplements that contain more than 700 μg of vitamin A, unless they are deficient and/or have been advised otherwise by a registered health professional. It is also recommended that women do not consume liver or liver products such as pâte, or fish liver oils during pregnancy, to avoid excess vitamin A consumption. ◆

Practice points

- Pregnant women often rely on their health professional (obstetrician, midwife, and general practitioner) for nutrition information during routine antenatal visits. Health professionals should encourage women to eat a healthy, varied diet during pregnancy, to ensure nutrient requirements are met.
- Both excess and inadequate weight gain during pregnancy have been associated with adverse outcomes. Recommendations during pregnancy are to increase energy intake by ~200 calories per day and only in the third trimester.
- To prevent the development of neural tube defects (NTDs) such as spina bifida, a daily 400 μg folic acid supplement is recommended prior to conception and through to the 12th week of gestation. Women at risk of NTDs are recommended to take 5 mg per day of folic acid.
- It is recommended that pregnant women take a daily supplement containing 10 μg of vitamin D. This recommendation is particularly important during the winter months and for those women at risk of lower vitamin D status.
- Dietary sources of vitamin B12 are animal-based. For pregnant women who are vegan or choose to exclude all animal products from their diets (including milk, dairy, and eggs) a vitamin B12 supplement should be considered.
- Food safety and hygiene is important during pregnancy as it is a time of compromised immunity. Pregnant women should pay special attention to food safety practices to avoid contracting food-borne illnesses from pathogens such as listeria, salmonella, *Toxoplasma gongii*, and campylobacter.
- Health professionals should advise pregnant women of specific recommendations around safe levels of vitamin A, fish, and caffeine consumption, and abstaining from alcohol during pregnancy.

FURTHER READING

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