Nutrition in pregnancy

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Abstract

The pivotal role of nutrition in pregnancy is well established and has important implications on subsequent maternal and offspring health, including outcomes in later adult life. Optimal nutrition periconception, if maintained throughout pregnancy, promotes optimal foetal growth and development. Growth trajectories *in utero* and size at birth are related to the offspring's risk of developing disease in later life, especially chronic non-communicable diseases such as hypertension, diabetes and coronary heart disease (the Barker hypothesis). This article aims to review nutritional requirements in pregnancy, describe their transport mechanisms and highlight the implications of inadequate or inappropriate intake. Nutritional requirements are broadly divided into issues surrounding quality (macronutrients and micronutrients) and quantity of intake with a final summary of current International Federation of Gynaecology and Obstetrics (FIGO) and Royal College of Obstetricians and Gynaecologists (RCOG) recommendations.

Keywords gestational weight gain; healthy eating; macronutrients; micronutrients; nutrient requirements; nutrition; pregnancy

Introduction

The fetus relies on maternal nutrition for growth and development. Additionally, nutrition forms the basis of maternal well-being and equips the mother for delivery and recovery post-natally. Nutrition is recognized to be associated with gestational diabetes and pre-eclampsia and therefore improved nutritional intake has the potential to reduce these complications and their associated short and long term morbidities. During the antenatal period, healthcare professionals have regular contact with pregnant women therefore pregnancy is an opportunity to help establish healthy dietary habits that can potentially be adopted by her family, establishing a beneficial background to optimal health for future generations.

The placenta links maternal and foetal circulation with syncytiotrophoblasts lining placental villi and consisting of two polarized membranes: microvillous membrane facing maternal circulation and basal plasma membrane facing foetal capillary epithelium. Thus, nutrients must pass through these two membranes before crossing the foetal capillary epithelium to enter the foetal circulation. The expression and activity of transporter mechanisms within the placental-foetal unit have been found to be associated with foetal growth restriction, macrosomia, diabetes, obesity and maternal nutrient availability.

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Healthy eating in pregnancy

The National Institute for Health and Clinical Excellence (NICE) form the basis of UK healthcare policy and include healthy eating approaches. Calorie restriction is not advised and recommendations focus on achieving and maintaining a healthy weight during pregnancy by basing meals on starchy foods (wholegrain if possible), eating fibre rich foods and consuming at least five portions a day of fruit and vegetables. Food high in fat and sugar (including fried, some drinks and confectionery) should be avoided. Pregnant women are also advised to eat breakfast, and to watch portion sizes and how often they are eating.

The RCOG has provided advice regarding healthy eating in pregnancy in alignment with NICE guidance. Low-fat dairy foods for a source of calcium are encouraged with a daily intake of protein in the form of lean meat, two portions of fish a week (one of which should be oily) or lentils, beans and tofu. The Government's Healthy Start voucher scheme has successfully improved dietary patterns in pregnancy with a reported relative increase in daily portions of fruit and vegetables.

Nutrient requirements in pregnancy

Energy and macronutrients

Energy requirements in pregnancy for individuals vary and guidelines differ between countries, however, it is agreed that additional requirements are relatively small. The RCOG recommends a modest increase of 200 kcal/day in the third trimester — an approximate 10% increase from the 1940 kcal/day recommendation in a non-pregnant adult woman.

Carbohydrate and fibre: carbohydrates form the main substrate for foetal growth, fuelling maternal and foetal organ function, biosynthesis and are additionally used in structural components of cells, co enzymes and DNA. Maternal and foetal brain functions use glucose from carbohydrate as their preferred source of energy with glucose providing at least 75% of foetal energy requirements. Glucose crosses the placenta by facilitated diffusion along a concentration gradient through members of the glucose transporter family (GLUT).

Carbohydrate type and quantity can affect glucose homeostasis via release of insulin. The glycemic index (GI) refers to the area under the curve for blood glucose concentrations during a 2-h period after consuming a test food. A low GI suggests slower rates of digestion and absorption of a food's carbohydrate, potentially relating to a lower insulin demand. It is therefore a modifiable macronutrient in the management of diabetes mellitus (gestational, type 1 and type 2), however, there is no evidence to support a low glycemic index diet for healthy pregnant women.

Fibre affects the postprandial insulin response by influencing the accessibility of carbohydrates and nutrients to digestive enzymes thus delaying their absorption. Fibre supports maternal digestive health, providing bulk to stool and absorbing water to aid transit time. This is especially beneficial as progesterone levels in pregnancy can result in constipation by increasing relaxation of intestinal smooth muscle.

Protein: protein forms the building blocks for both structural and functional components of cells. Requirements are highest during the second and third trimesters due to extra development and growth of both maternal and foetal tissue. It is an alternative energy source when carbohydrate intake is insufficient therefore adequate carbohydrate intake is required in order for cell synthesis to continue. Low socioeconomic status and women with limited dietary variety are at risk of suboptimal protein intake.

Plasma concentrations of most amino acids are higher in foetal circulation. Over 15 different amino acid transporters mediate their transport against a concentration gradient. Systems include System A and System L. System A is sodium dependent for small neutral amino acids while System L is sodium independent for large neutral amino acids with branched or bulky side chains.

Fats and essential fatty acids: fat aids transport of fat-soluble vitamins A, K, D and E and are required for structural (e.g. membrane lipids) and metabolic functions (e.g. precursor for steroid hormones). PUFAs (poly unsaturated fatty acids) are important for neurological development including foetal brain, nervous system and retina. Oily fish, nuts, seeds, vegetable oils, margarines and green leafy vegetables are encouraged to obtain a greater intake of PUFA.

Essential fatty acids linoleic and alpha linolenic acid are precursors for n-6, n-3 LCPUFA and prostaglandins; these are components of the inflammatory process with a role in diseases characterized by inflammation, reproductive health, cervical ripening and initiation of labour. Systematic reviews of RCTs have found little or no effect of n-3 LCPUFA supplementation in pregnancy on cognitive development, birth weight, gestational diabetes mellitus or pre-eclampsia. There is, however, a beneficial effect on increasing gestational length and reducing risk of preterm birth.

Placental triglyceride lipases break down triglycerides into fatty acids. Fatty acids and ketone bodies (produced by maternal lipolysis) cross the placenta by diffusion. Cholesterol-carrying lipoproteins LDL, HDL and VLDL transport cholesterol into foetal circulation. Syncytiotrophoblasts express lipoprotein specific receptors e.g. LDL receptor, scavenger receptor class B type 1 and VLDL receptor. Binding cassette transporter A1 and GI in the foetal endothelium allow cholesterol to enter the foetal circulation. The fetus also synthesizes cholesterol endogenously.

Micronutrients

Iron and vitamin C: iron is a component of haemoglobin required for foetal development, placental growth and expansion of maternal red blood cell mass. Vulnerability to iron deficiency occurs, especially in late pregnancy as iron transfer to the fetus becomes marked in order to meet increased demands. Deficiency has been associated with a higher risk of preterm delivery, low birth weight, infant iron deficiency and long-term cognition and brain function. Replete stores are required in preparation for childbirth as significant blood loss may occur intrapartum. Iron transfer to the fetus is facilitated through placental transferrin receptors for endocytosis of transferrin-bound iron.

Vitamin C aids iron absorption and competes for placental receptors with glucose, however maternal hyperglycaemia does not result in foetal hypovitaminosis C. A recent Cochrane review suggested that vitamin C might have a role in preventing placental abruption (RR 0.64, 95% CI 0.44–0.92) and prelabour rupture of membranes (RR 0.98, 95% CI 0.70–1.36). However, women supplemented with vitamin C alone or in combination with other supplements were more likely to self-report abdominal pain. Gestational age at birth was increased amongst these women. Supplementation with vitamin C alone reduced the risk of preterm PROM and term PROM but the risk of term PROM was increased when supplementation included vitamin C with vitamin E. The risk of stillbirth, neonatal death, IUGR and pre-eclampsia were not affected by vitamin C supplementation.

Folate and vitamin B12: the prevention of neural tube defects with periconceptional folic acid is well established. Folic acid supplementation has no clear effect on cleft palate/lip or congenital cardiovascular defects. Five percent of the general population has marginal to severe folate deficiency and therefore all women are advised to take 400 mcg/day folic acid prior to conception until the 13th week of pregnancy with higher doses in certain circumstances (Table 1).

Folate binding receptors maintain a high foetal–maternal concentration gradient for DNA synthesis while vitamin B12 is transported via placental receptors. Both micronutrients are associated with a reduction in megaloblastic anaemia, placental vascular disorders, preterm birth, low birth weight and SGA via regulation of circulating homocysteine levels. Homocysteine levels are influenced by the activity of methylene tetrahydrofolate reductase (MTHFR). The C6777T variant has impaired MTHFR function and its presence is associated with an increased risk for pre-eclampsia and recurrent pregnancy loss, potentially via elevated homocysteine levels. Low dietary intake of folic acid can exacerbate this but evidence is lacking with regard to whether pregnant women carrying the C6777T variant should take a higher folic acid supplement.

Vitamin D and calcium: vitamin D is required for immune and nervous system function and mediates the accumulation of foetal calcium from maternal stores in skeletal growth. Vitamin D deficiency can result in rickets, craniotabes and osteopenia. Calcium supplementation reduces the development of hypertensive disorders of pregnancy and an increasing body of evidence demonstrates a relationship between vitamin D deficiency

