
SPECIAL ARTICLE

Nutrition during Pregnancy

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ABSTRACT

Maternal nutrition is the only source of support fetal growth and has effects on offspring health. Nutrition management is important during pregnancy, and this should start from preconception. Women should have a normal prepregnancy BMI and optimal gestational weight gain to have favorable pregnancy outcomes. It is suggested that pregnant women have a healthy balanced diet with adequate calories. The proportion of total daily energy should consist of carbohydrate 45 - 65%, protein 10 - 15%, and fat 20 - 35% from various sources to ensure a sufficient intake of macronutrients and micronutrients. Because of increased demand during pregnancy, some supplements may be necessary. Folic acid and iron supplementation is generally recommended. Supplementation with iodine and calcium should be considered in pregnant women at risk of low dietary intake. Pregnant women should concern about food safety, foods to avoid during pregnancy, and beware of excessive vitamin A and iodine intake.

Keywords: Nutrition, preconception, pregnancy.

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Having good obstetric care and healthy pregnancy lifestyles consisting of good nutritional status, staying physically active and good mental well-being, can lead to favorable pregnancy outcomes. Maternal nutritional status is important due to growing fetuses can only receive nutrition through their mothers. Recently, the 'early life programming' theory has indicated that environmental factors and lifestyles during pregnancy determine the risk of developing chronic diseases later in life and influence

lifelong health in offspring. Nutrition in early life may be one mechanism that programs through epigenetic phenomena or deoxy-ribonucleic acid (DNA) methylation and affects gene expression. Either maternal undernutrition or overnutrition can result in reprogramming of fetal tissue⁽¹⁾.

A singleton pregnancy requires an additional 80,000 kcal, 46% for the fetus and placental, 27% for blood volume, extravascular volume, including breast tissue, and 27% for maternal accumulation. Excess caloric intake

leads to maternal fat accumulation, whereas inadequate caloric intake results in protein metabolism^(2,3). To determine maternal nutritional status, gestational weight gain (GWG) can be one of the important anthropometric assessments.

Optimal gestational weight gain

The National Academy of Medicine (NAM), formerly called the Institute of Medicine (IOM), has recommended optimal GWG in singleton pregnancy according to prepregnancy body mass index (BMI) categories (Table 1)^(4, 5).

Table 1. The recommended optimal gestational weight gain in singleton pregnancy according to prepregnancy body mass index categories^(4, 5).

Pre-pregnancy BMI (kg/m ²)	Pre-pregnancy weight category	Total weight gain range (kg)	Weight gain rate in the second and third trimesters (kg/week)
< 18.5	Underweight	12.5 - 18.0	0.51 (0.44 - 0.58)
18.5 - 24.9	Normal weight	11.5 - 16.0	0.42 (0.35 - 0.50)
25.0 - 29.9	Overweight	7.0 - 11.5	0.28 (0.23 - 0.33)
≥ 30	Obesity	5.0 - 9.0	0.22 (0.18 - 0.27)

Inadequate GWG was associated with low birth weight (LBW), small for gestational age (SGA), and preterm birth. In contrast, excessive weight gain during gestation could result in macrosomia, large for gestational age (LGA), increased rate of cesarean sections, pregnancy-induced hypertension, gestational diabetes, postpartum weight retention and the obesity in both mother and offspring^(6,7). These consequences were more evident in underweight women with inadequate GWG and in overweight women with excessive GWG. Currently, pregnant women tend to be overweight and have an excessive GWG. Some randomized control trials had shown that interventions, for example, diet control, exercise, in person visits, text messages, mobile application or combination, could decrease GWG, but did not affect perinatal outcomes⁽³⁾. Furthermore, in women with obesity, gestational weight loss could cause increased risks of SGA, LBW, and preterm delivery without any benefit in reducing the risk of preeclampsia and gestational diabetes³. As a result, IOM has recommended that all women should have a normal BMI before becoming pregnant and have appropriate

GWG.

However, the IOM recommendations for optimal GWG came from studies in western countries that included a small proportion of Asian women. Furthermore, the World Health Organization (WHO) had issued different weight categories for Asian⁸ (underweight BMI < 18.5 kg/m², normal weight BMI 18.5 - 22.9 kg/m², overweight BMI 23.0 - 27.5 kg/m², obese BMI ≥ 27.5 kg/m²). Some Asian countries such as Japan and Vietnam had developed the national guideline for optimal GWG due to concerns that the IOM classification might not be appropriate for Asian women. In Australia, different recommendations have been used for non-Asian and Asian women⁽⁹⁾. However, the IOM classification is still used in most countries, Thailand included^(9,10).

In 2016, a retrospective study in China had compared pregnancy outcomes between 13,717 subjects with optimal GWG according to the IOM BMI cut-off points and the WHO Asian BMI cut-off points. The result showed that although the rate of preterm birth, pregnancy induced hypertension, and gestational diabetes was not significantly different between

groups, there was a significantly lower risk of macrosomia and LGA in women with optimal GWG according to the WHO Asian BMI cut-offs. Therefore, it was possible that GWG ranges based on IOM BMI cut-offs would classify some women in lower prepregnancy BMI categories and suggest they gain more weight, which can put them at higher risk for macrosomia and LGA⁽⁶⁾.

Nutrition management in pregnant women of normal weight

Macronutrients

Macronutrients, consisting of carbohydrates, protein, and fat, are the nutrients that provide energy to the body and are needed in large quantities. The energy requirement in Thai women adults (aged 19 to 60) is approximately 1,500 - 1,800 kcal/day. Pregnant women require additional energy for 50 to 100 kcal/day in the first trimester, 250 to 300 kcal/day in the second trimester, and 450 to 500 kcal/day in the third trimester^(10,11). The main energy sources of the body are carbohydrates and fats, which are needed for 45 - 65% and 20 - 35% of the total daily energy requirement, respectively. On the other hand, proteins that should account for 10 - 15% of total daily energy are used mainly for the structure, function, and regulation of tissues and organs rather than for energy⁽¹⁰⁻¹²⁾.

Carbohydrates

Carbohydrates are important for developing fetuses because glucose is used as an energy-producing substrate in fetal tissues, especially the brain^(10,12). Carbohydrates are classified into simple carbohydrates consisting of monosaccharides and disaccharides, and complex carbohydrates, which are starch, glycogen, and dietary fiber. In addition to the appropriate proportion of energy from carbohydrates, the IOM has also recommended that metabolically available dietary carbohydrate intake be not less than 175 grams/day or approximately 12 portions⁽¹²⁾. One carbohydrate portion is equal to 15 grams of carbohydrate, which can be found in a slice of bread,

one third cup of cooked rice or noodles, a cup or 8 ounces of low-fat milk, a small banana or apple for examples⁽¹³⁾. Good sources of carbohydrates are whole grains, brown rice, whole wheat, and starchy vegetables. Fruits have a high level of simple sugar but are rich in micronutrients and dietary fibers, thus regular consumption of a variety of fruits is suggested. Foods to avoid are sweets, candy, soda pop, cake and bakery^(10,12).

There was concern that non-nutritive sweeteners (NNS) could be consumed during pregnancy or not. Non-nutritive sweeteners such as saccharin, acesulfame-K, and sucralose can be transferred to fetuses through the placenta, while aspartame is completely metabolized in the maternal body, and there is insufficient data for steviolosides. To date, no studies have investigated maternal glycemic outcomes of NNS consumption. No studies show the teratogenicity or fetal toxicity of NNS; however, some studies have revealed that NNS may cause an alteration in the maternal gut microbiome and the induction of fetal tissue programming. Regular consumption of maternal NNS has been associated with a higher risk of having overweight or obese offspring^(14,15). Currently, there is no recommendation on NNS consumption during pregnancy.

Dietary fibers are non-metabolically available carbohydrates. IOM recommends that pregnant women consume 28 grams/day of dietary fiber from whole grains, legumes, fruits, and vegetables. Adequate fiber consumption and water intake of 2 - 3 liters/day from both foods and beverages can improve constipation during pregnancy; however, excessive fiber intake can result in gastrointestinal distress and mineral absorption disturbance^(10,12).

Proteins

The Thai Bureau of Nutrition has recommended that Thai adults should have 1 gram/kilogram body weight/day of protein intake with additional protein intake in pregnant women for 1 gram/day in the first trimester, 10 grams/day in the second trimester and 31 grams/day in the third trimester. However, for

convenience, the Thai Bureau of Nutrition suggests the consumption of 12 tablespoons of a variety of lean meat, legumes, eggs and tofu per day, together with a low-fat or fat-free milk consumption⁽¹⁰⁾.

A whole egg contains 6 grams of protein. The yolk egg is rich in micronutrients but has a high level of fat. However, the consumption of 1-2 whole eggs a day in healthy people does not affect blood lipid concentration⁽¹⁶⁾. During pregnancy, low-fat and fat-free pasteurized or ultra-high temperature (UHT) milk is recommended. Milk is not only a source of protein and calcium, but it also has a growth promoting effect in offspring. The Danish National Birth Cohort showed that daily maternal milk consumption of more than 150 milliliters had a protective effect on SGA, while consumption of more than 1,200 milliliters increased the risk of LGA⁽¹⁷⁾. A recent systematic review and meta-analysis of 18 studies found a curved relationship between maternal dairy consumption and birth anthropometrics, which increased first and then decreased, suggesting that there was an optimal amount of dairy consumption during pregnancy⁽¹⁸⁾. However, no interventional study has investigated this issue. The US Department of Agriculture (USDA) dietary guideline recommends consuming dairy products 3 cups/day (720 milliliters)⁽¹⁹⁾, but this is still controversial among dietary experts. The dietary reference intake by the Thai Bureau of Nutrition has suggested that daily milk consumption of 1-2 cups should be appropriated⁽¹⁰⁾. There is concern about maternal milk consumption and the risk of food allergy in offspring, but there is insufficient evidence to determine the relationship between restricted consumption of cow milk products during pregnancy and the risk of childhood allergy at present⁽²⁰⁾.

Fats

In addition to being a source of body energy, fat aids in the absorption of fat-soluble vitamins. There is insufficient data to determine a definite level of fat intake, but approximately 20-35% of the total daily energy requirement is recommended^(10,12). Although saturated fatty acids, which can be found in meat,

dairy products, coconut oil, and palm oil, should be consumed less than 10% of total daily energy, moderate intake of monounsaturated and polyunsaturated fatty acids is known to have a positive effect on health. Olive oil is an example of food high in monounsaturated fatty acids. Linoleic acid (omega-6) and α -linolenic acid (omega-3) are essential since these two polyunsaturated fatty acids (PUFA) cannot be synthesized in the body but are only derived from the consumption of nuts and vegetable oil such as soybean oil, rice bran oil, and canola oil. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are also omega-3 PUFAs, but can be synthesized from α -linolenic acid, or directly derived from eating seafood, especially cold-water fatty fish such as salmon^(10,12).

EPA and DHA are precursors of a variety of compounds that help resolve inflammatory responses and oxidative stress. Furthermore, DHA is involved in the development of retinal and brain function^(12,21). Many studies have investigated the effects of fish oil supplements and certain issues, for example: preterm labor, preeclampsia, neurodevelopment, childhood allergy, and risk of bleeding. In 2018, a Cochrane systematic review that included 70 randomized trials that included participants in 19,927 showed that 500 - 1,000 milligrams/day of fish oil supplement started before 20 weeks of gestation significantly reduced the risk of preterm birth but could increase the rate of postterm pregnancy without increasing the rate of cesarean section and induction of labor⁽²¹⁾. In the following year, a multicenter randomized double-blind controlled trial that included 5,544 participants revealed a contradictory result. The 900 milligrams / day fish oil supplement did not appear to reduce preterm birth even after a subgroup analysis of baseline DHA levels⁽²²⁾. The fish oil supplement did not prevent preeclampsia and did not increase blood loss during delivery or postpartum hemorrhage⁽²¹⁾. Regarding neurodevelopment, a single center randomized double-blind controlled trial in Denmark showed that a 2.4 gram/day fish oil supplement continued from 24 weeks of gestation to 1 week

postpartum significantly improved language development at 1 year. Interestingly, only boys in the fish oil supplement group could achieve gross motor milestones at a younger age, had a greater cognitive improvement at 2.5 years and had less impact on emotional and behavioral problems at 6 years. It is possible that the involvement of testosterone in the inhibition of DHA synthesis may be involved in this sex preference benefit⁽²³⁾. In the same study, the effect of fish oil on asthma prevention was also investigated and appeared to significantly reduce risk at 3 and 6-year of follow-up⁽²⁴⁾. There is insufficient data from the interventional study to determine the effect of the fish oil supplement on the prevention of food allergy in childhood⁽²⁵⁾.

Despite controversy surrounding the fish oil supplement, regular consumption of fish during pregnancy is highly recommended. Fish is an excellent source of protein, is low in saturated fat, and

contains a high amount of EPA and DHA compared to other types of meat. The US Food and Drug Administration (FDA) and the US Environmental Protection Agency (EPA) advise fish intake 8 - 12 ounces/week (227 - 340 grams) from choices lower in mercury^(2,19). The Thai Bureau of Nutrition recommends that pregnant women consume 2 tablespoons of fish every day or 4 tablespoons of fish every other day from various types of sea fish and freshwater fish⁽¹⁰⁾. As mentioned above, fish together with other lean meats, legumes, eggs, and tofu should be 12 tablespoons in total daily amount.

In summary, the eating pattern during pregnancy should be a healthy balanced diet that is rich in nutrients and has optimal calories. Meals should consist of whole grains, a variety of protein foods, low-fat or fat-free dairy products, soy products and a variety of fruits and vegetables in the appropriate amount (Fig. 1)⁽¹⁹⁾.

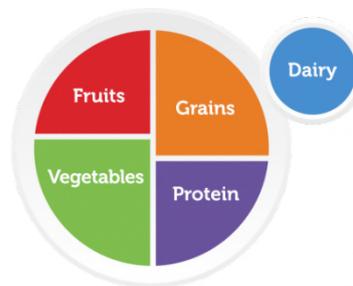


Fig. 1. The appropriate amount of each composition in meal⁽¹⁹⁾.

Micronutrients

Minerals and vitamins are needed in a very small amount, but they have a critical impact on health. Dietary reference intake (DRI) is usually indicated as recommended dietary allowance (RDA), which is the average daily dietary intake level that is sufficient to meet the nutrient requirement of 97 - 98% of healthy individuals in a group, or adequate intake (AI), which is a value based on observed or experimentally determined approximations of nutrient intake by a group of healthy people. Another

reference value that must be considered is tolerable upper intake level (UL), the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects to almost all individuals in the general population⁽²⁶⁾.

The RDA or AI of minerals and vitamins for a singleton pregnancy suggested by IOM is shown in Table 2⁽²⁶⁾. However, pregnant women who have healthy balanced meals should meet almost of these requirements and may need only several supplements, such as calcium, iron, iodine, and folic acid.

Table 2. The recommended dietary allowance or adequate intake of minerals and vitamins for a singleton pregnancy⁽²⁶⁾.

Minerals	Amount (mg/day)	Vitamins	Amount (mg/day)
Calcium	1,000	Vitamin A	0.77 (2,567 IU)
Iron	27	Vitamin D	600 IU/day
Iodine	0.22	Vitamin E	15
Chromium	0.03	Vitamin K	0.09
Copper	1.5	Thiamin (B1)	1.4
Fluoride	3	Riboflavin (B2)	1.4
Magnesium	300	Niacin (B3)	18
Manganese	2.5	Pantothenic acid (B5)	6
Molybdenum	0.05	Pyridoxine (B6)	1.9
Phosphorus	700	Biotin (B7)	0.03
Selenium	0.06	Folic acid (B9)	0.6
Zinc	11	Cobalamin (B12)	0.002
Potassium	4,700	Choline	450
Sodium	1,500	Vitamin C	85
Chloride	2,300		

Minerals

Calcium

Fetal skeletal development requires approximately 30 grams of calcium throughout pregnancy, primarily in the last trimester. Calcium-regulating hormones adjust maternal calcium absorption, so that the adequate calcium intake level does not increase during pregnancy^(10,26). IOM recommends 1,000 milligrams of calcium per day, while the Thai Bureau of Nutrition suggests that the 800 milligrams per day intake should be sufficient for Thai adults⁽¹⁰⁾. However, it was found that Thai people usually had suboptimal dietary calcium intake which was approximately 360 milligrams/day on average. Although pregnant women consume milk 1-2 cups a day, without adjustment of the diet, the dietary calcium intake may not meet the requirement. In addition to dairy products, pregnant women should consume high-calcium foods, for example

tofu, fortified soy products, dried shrimp, crispy anchovy, beans, sesame, and leafy greens. High-oxalate vegetables such as spinach, noni leaf, betel leaf, and turkey berries should be avoided due to the inhibitory effect on calcium absorption⁽¹⁰⁾.

Insufficient calcium intake, especially an intake of less than 500 milligrams/day for a long time, can lead to reduced bone mass during pregnancy. Excess calcium intake may cause kidney stone and interfere with other mineral absorption^(10,26). The WHO recommends calcium supplementation in pregnant women who have low dietary calcium intake to reduce the risk of preeclampsia and gestational hypertension^(28,29). There are several forms of calcium supplements which have a different amount of elemental calcium. Calcium carbonate has the highest elemental calcium which is 40%, while calcium citrate, calcium lactate, and calcium gluconate have elemental calcium 21%, 13%, and

9%, respectively. Calcium absorption is approximately 30%⁽¹⁰⁾.

Iron

In a healthy pregnant woman, 1,000 milligrams of iron are required during pregnancy, mainly after mid-trimester, but few women have sufficient iron stores or dietary intake to supply this amount⁽²⁹⁾. Dietary iron in the form of heme iron found in meat and blood curd has better bioavailability, which is 20-30% absorption. On the other hand, the absorption of nonheme iron which is found in egg, milk, beans, and leafy greens is only 2 - 10%. Furthermore, the phytate in beans and vegetables usually interferes with iron absorption, causing the total iron bioavailability on a Thai meal to be 10% in average^(10,26).

Pregnant women with inadequate iron intake can cause iron deficiency anemia and increase the risk of prematurity and low birth weight, while those with excessive iron intake can have gastrointestinal effects such as nausea, vomiting, constipation, and diarrhea^(10, 26, 29). Dietary reference intake of iron and recommendations for supplementation vary across countries. Some countries have promoted the fortification of foods with iron and do not routinely recommend iron supplement except for pregnant women who are at risk of iron deficiency. However, the WHO recommends iron supplementation of 30 - 60 milligrams/day to all pregnant women to prevent anemia⁽³⁰⁾. Accordingly, Thai Bureau of Nutrition also recommends 60 milligrams/day iron supplementation during pregnancy⁽¹⁰⁾. There are four types of oral iron supplement, ferrous fumarate which has 33% elemental iron, ferrous sulfate which has 20% elemental iron in hydrated form and 30 - 37% in desiccated form, ferrous gluconate which has 12% elemental iron, and lastly, iron hydroxy polymaltose complex, which is a non-ionic preparation with better bioavailability and less gastrointestinal side effects.

Iodine

Iodine is an essential component to produce

thyroid hormone that plays an important role throughout pregnancy. The adequate level of iodine increases 50 micrograms/day during pregnancy due to increased maternal thyroid hormone production, fetal and placental iodine uptake, and increased renal excretion. Iodine deficiency has potentially harmful effects, for example, goiter, maternal and/or neonatal hypothyroidism, greater risk of abortion, stillbirth, and cretinism^(10, 26). People in Bangkok and southern Thailand generally have adequate iodine intake, as well as in central and northern Thailand where people have borderline sufficiency in iodine consumption. However, people in some area of northeastern Thailand have a suboptimal iodine intake⁽¹⁰⁾.

Iodine is high in seafood, seaweed, and iodized salt. Most prenatal multivitamins and minerals usually consist of iodine. The RDA for iodine is in the range of 0.20 to 0.25 milligrams/day, slightly varying between recommendations. The American Thyroid Association (ATA) recommends a 0.15 milligram/day iodine supplement during pregnancy unless pregnant women consume levothyroxine regularly^(10, 26, 31). The tolerable upper intake level of iodine is 1.1 milligrams/day. Excessive iodine intake, uncommon, but may be a result of supplements, can lead to fetal goiter and thyroid dysfunction^(10, 26).

Vitamins

Folic acid

Folate or folic acid is an essential coenzyme in the metabolism of nucleic acids, and the amino acid, methionine cycle and involves in DNA replication and cell division process^(10, 26). Generally, a daily 0.1 - 0.2 milligrams of folate is derived from natural foods such as meat, beans, and leafy greens. The folic acid found in fortified foods and dietary supplements has greater bioavailability, with 80 - 90% absorption. The Thai Bureau of Nutrition recommends 0.55 mg/day of folic acid intake. Inadequate folic acid intake can lead to macrocytic anemia, but excessive intake can mask vitamin B12 deficiency and lead to persistent neurological damage. For pregnant women, folic acid

supplementation is recommended to reduce the risk of neural tube defect (NTD) in the fetus^(10, 26). A previous study in Thailand found that preconception folic supplementation was used in only 9.7%⁽³²⁾.

In all women with an average risk of fetal NTD, a daily 0.4 mg folic acid supplement is recommended at least 1 month before conception to 12 weeks of gestation. A history of NTD in a previous child or a personal history of NTD in either parent poses a high risk of NTD, therefore a high dose of folic acid supplement for 4-5 milligrams/day is strongly recommended 1-3 months before conception to 12 weeks of gestation to reduce the risk of NTD in a fetus for 70%⁽³³⁻³⁶⁾. For women with moderate risk, for example: having a family history of other folic acid-sensitive congenital anomalies including cleft lip/palate, heart defect, and limb reduction defect, and having maternal medical conditions related to folic acid depletion, recommendations vary regarding these conditions. However, after 12 weeks of gestation, it is recommended to reduce the dose of folic acid supplement to 0.4 milligrams/day⁽³³⁻³⁷⁾.

Vitamin A

Vitamin A is important for vision, gene expression, reproduction, immune function, embryo development, and growth^(10,26). It can be found as retinoids in meat, eggs, milk, and as carotenoids in fruits and vegetables. Thai Bureau of Nutrition recommends vitamin A intake of 0.7 mg/day⁽¹⁰⁾. Inadequate vitamin A intake results in xerophthalmia, night blindness, and decreased immune function. Vitamin A deficiency is not a serious problem in Thailand; therefore, the importance of the recommendation for vitamin A intake is mainly based on tolerable upper intake level, which must not exceed 3 mg/day or 10,000 IU. A higher amount than this reference can cause defects in the cranial neural crest in fetuses, and a very large amount of vitamin A intake can lead to hypervitaminosis A^(10, 26, 38). However, carotenoids do not lead to vitamin A toxicity and teratogenicity. A prenatal multivitamin tablet always contains vitamin A at a lower level than 10,000

IU unless pregnant women have multiple supplements.

Vitamin D

Vitamin D plays an important role in calcium and phosphate homeostasis. It also supports cellular processes, neuromuscular function, and bone ossification. Eighty to ninety percent of derived vitamin D is synthesized from UVB in the skin and 10-20% comes from foods, found mainly in fortified milk and dietary supplements. A small amount of vitamin D is found in natural food sources^(10, 26, 39).

The IOM and the Thai Bureau of Nutrition recommend a vitamin D intake of 600 IU/day, while the US endocrine society recommends 1,500 - 2,000 IU/day. The difference between both recommendations from the US IOM report and the US Endocrine Society guideline reflects different definitions of vitamin D deficiency and the goals of treatment. Insufficient vitamin D consumption causes impaired bone mineralization and can lead to rickets or osteomalacia. Excess vitamin D consumption may lead to hypervitaminosis D, which is a rare condition^(10, 40, 41).

Regarding the effects of vitamin D intake on pregnancy outcomes, there was no difference in pregnancy duration, birth weight, stillbirth, and neonatal death between pregnant women who received vitamin D and placebo⁽³⁹⁾. Recent evidence suggested that women with vitamin D deficiency were at increased risk of miscarriage, but there was limit data to determine whether vitamin D would decrease the risk⁽⁴²⁾. Due to the actions of vitamin D that are involved not only in calcium homeostasis and suppression of vascular smooth muscle cell proliferation but also regulate renin-angiotensin system and have immunomodulatory effects, vitamin D supplementation for the prevention of preeclampsia has been investigated. However, the advantage of supplementation is still inconclusive. It was also found that co-administration of vitamin D and calcium did not bring any additional benefit compared to vitamin D or calcium supplementation alone^(43, 44).

To what extent micronutrient supplementation is necessary may still be difficult to conclude. Although

there was evidence that micronutrient deficiencies negatively affected maternal health and pregnancy outcomes, no single micronutrient was responsible for adverse effects. Furthermore, most of the interventional studies on supplementation had been conducted in developed countries where severe deficiencies were rare⁽⁴⁵⁾. Therefore, some effects of supplementation may not be clearly seen.

Food safety concerns

During pregnancy, food safety recommendations should be followed to prevent foodborne illness. Good hand hygiene is the first step, as well as kitchen utensils that must be clean before preparing food or having meals. The knives used with meat and those used with fruits or vegetables should be separated to prevent cross-contamination. The ingredients should be thoroughly cooked at proper cooking temperatures. Uneaten or leftover foods should be immediately stored in the refrigerator. Lastly, there are some foods to avoid during pregnancy. Cold cuts, smoked seafood, uncooked bean sprouts, ready-to-eat foods such as salads and sausages can be contaminated with listeria, as well as soft cheeses such as brie cheese blue cheese, and feta cheese which are usually made from unpasteurized milk. These foods should be avoided or cooked properly to prevent listeriosis. Undercooked meat, raw seafood, and unwashed fruits and vegetables can be contaminated with toxoplasma and salmonella. Sometimes salmonella may be contained in raw eggs, particularly from a low-quality source. Therefore, only cooked eggs should be consumed and some desserts that include raw eggs such as tiramisu, mousse, and frozen egg ice cream should be avoided. In addition, alcohol consumption should be prohibited during pregnancy. Liver and liver sausage consumption should be limited in early pregnancy due to the high level of vitamin A. Caffeine, not only found in coffee and tea, but also in chocolate and soda pop, should be limited to not exceed 200 milligrams/day due to the increased risk of miscarriage^(36, 46).

Conclusion

Maternal nutrition is the only source of support fetal growth and has effects on offspring health. Nutrition management is important during pregnancy, and this should start from preconception. For favorable pregnancy outcomes, women should have a normal prepregnancy BMI and optimal gestational weight gain. It is suggested that pregnant women have a healthy balanced diet with adequate calories. The proportion of total daily energy should consist of carbohydrate 45 - 65%, protein 10 - 15%, and fat 20 - 35% from various sources to ensure a sufficient intake of macronutrients and micronutrients. Because of increased demand during pregnancy, some supplements may be necessary. Folic acid and iron supplementation is generally recommended. Supplementation with iodine and calcium should be considered in pregnant women at risk of low dietary intake. Although vitamin D is known to be involved in many cellular processes, now there is no evidence that vitamin D supplement has a positive effect on pregnancy outcome. Supplementation with DHA or fish oil is still controversial and further evidence may be needed to determine the advantage of supplementation. Pregnant women should concern about food safety, foods to avoid during pregnancy, and beware of excessive vitamin A and iodine intake.

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