Chapter

Undernutrition during Pregnancy

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Abstract

Experience in being pregnant is exciting but is very challenging. The term "undernutrition," as used in this chapter, focuses more on inadequate intake of energy and nutrients to meet the desired outcome of a healthy mother and her baby. Evidence shows that women with undernutrition before and during pregnancy have increased risk of metabolic disorders (i.e., gestational diabetes mellitus) and are at increased risk of complications during labor and birth. To date, nutritional therapies promoting healthier pregnancies fall into the following two major categories: (1) management of gestational weight gain and (2) the prevention or treatment of nutrient deficiencies related to pregnancy. A literature search on PubMed, the Cochrane library, Google scholar, and Cumulative Index of Nursing and Allied Health Literature was conducted to identify the relevant nutritional therapies. As a result, this chapter will analyze and discuss gestational weight gain and its effect on the health of women and her baby. The chapter briefly proposes evidence-based nutritional therapy for gestational diabetes as well as gestational common nutrient imbalance, such as vitamin D, folic acid, and omega-3 docosahexaenoic acid deficiency. The recommendations, in this chapter, would be a partial answer for these problems in Asia.

Keywords: gestational diabetes mellitus, gestational weight gain, folate deficiency, vitamin D deficiency, omega-3 docosahexaenoic acid, pregnancy outcomes

1. Introduction

The association between inadequate intake of energy and nutrients before and during pregnancy and severe maternal outcomes has been well documented in the observational studies. It is crucial for women to be fully aware of nutrition requirements without waiting until getting a positive pregnancy test result. The reason for this is that there are major changes associated with metabolism and physiology to support embryo development in the mother. The mother's diet is the only source of nutrition for her baby. Maternal undernutrition may affect the developing baby. Weight gain is a part of healthy pregnancy, but the recommendation for an optimal gestational weight gain is still controversial, especially in Asian countries. Moreover, some observational studies have shown that gestational diabetes and nutrient deficiencies during pregnancy may need to be considered differently for an individual's prenatal body mass index (BMI). Thus, in this chapter, an attempt was made to address these issues. Moreover, the role of personalized nutritional counseling, as discussed in each issue, needs to be understood carefully.

2. Gestational weight gain

Getting pregnant leads to significant changes of weight in the body of women. It is normal for women to put on more weight in the last two trimesters than the first trimester as it supports the growth of fetus, the placental development, and amniotic fluid as time goes. However, putting on weight very quick per week (i.e., 0.5–1 kg in a week) is strongly associated with a life-threatening condition, such as preeclampsia [1, 2], so it is worth to notice healthcare professionals about abnormal weight gain. A woman with prepregnancy overweight and obesity should take a plan of gestational weight gain GWG into account during prenatal visits. A cohort study of 3539 women with a follow-up period of 17 years demonstrated that overweight women (BMI > 25) at the beginning of pregnancy had an increased risk of diabetes, cardiac disease, or endocrine diseases later in their life [1]. Moreover, excessive or inadequate weight-gain levels during pregnancy can affect small or large gestational age, an increased risk of cesarean delivery, and other adverse pregnancy outcomes, including gestational diabetes mellitus and preeclampsia [1–4].

The Worth Health Organization definition of body mass index (BMI) is "a person's weight in kilograms divided by the square of the person's height in meters (kg/m^2)." For instance, a pregnant woman who weighs 50 kg and her height is 1.6 m will have a BMI of 19.5. BMI has been well recognized as an effective measurement to identify overweight and subsequent health risks in an individual. The increasing level of BMI from overweight to extreme obese is thought to accompany the increasing risk of health problems (Canadian Health Guideline 2004). The American Institute of Medicine (IOM) recommended the ideal amount of weight gained during pregnancy based on WHO-BMI ranges from underweight to obesity, but not all obesity classes were addressed (**Table 1**). The origin of the IOM recommendations about gestational weight gain (GWG) came primarily from the American population-based studies despite its popular applicability to European and Asian countries. In the Asian population-based studies reviewed, the recommendations of the IOM concerning gestational weight gain (GWG) have limited applicability for Asian women to get their desired GWG. The accumulated evidence on noncommunicable diseases demonstrated that Asian adults get more body fat and have greater risks of diabetes and cardiovascular diseases at their lower BMI in comparison with non-Asian population. Thus, Asian regional BMI cutoff points [6] developed by the panel of WHO consultation minimize these risks (**Table 2**). A large meta-analysis study with more than 300,000 Asian women confirmed that the IOM recommendations about GWG can be applicable in Asian countries when using regional BMI cutoff points for overweight or obese [7]. The evidence was not attempted to define a GWS guideline for all Asian women as the data of this study were based primarily on East Asian countries, such as China, Taiwan, Korea, and Japan. Moreover, Korean and Taiwanese women tend to gain more weight during pregnancy than other Asian women [8]. This requires more comparative studies in Asia. However, its strength confirmed that the guideline for GWG may need to be considered differently for Asian women. To date, a global consensus regarding a desired GWG is still understudied.

Recommendations	Underweight	Normal weight	Overweight	Obese
Prenatal BMI (kg/m^2)	<18.5	18.5–24.9	25.0–29.9	≥30
Total weight gain range (kg)	12.5–18	11.5–16	7–11.5	5–9

Table 1.
Recommended weight gain during pregnancy based on the 2009 Institute of Medicine (IOM) guideline [5].

	Asian BMI cutoff points (kg/m^2)	Total weight gain range (kg)*
Underweight	<18.5	12.5–18
Normal weight	18.5–22.9	11.5–16
Overweight	23–27.5	7–11.5
Obese	27.6–29.9 ≥30	7–11.5 5–9

**These recommendations suggested by the author should only be used as a reference for public health strategists, nutritional practitioners, or healthcare professionals in Asia. These recommendations were based on ideas in a large meta-analysis study [7]; thus, they are not considered as a completed guideline.*

Table 2.
The proposed gestational weight gain recommendation based on Asian regional BMI cutoff points [6].

An excessive amount of weight gained during pregnancy could be predictive of weight retention at 6 months postpartum [2] and of an increased risk of weight management challenges later in life [3, 4]. A meta-analytic study of over 65,000 women by Nehring et al. demonstrated that women with GWG above the IOM recommendations were likely to have an additional gain of 3 kg at 3 years and of 4.7 kg at 15 years after pregnancy, compared to those with GWG within the recommendations [3].

2.1 Brief nutrition recommendations for gestational weight gain

Transitions to a new weight gain during a pregnancy may need to meet additional calories every day. According to the IOM expert panel's recommendation on macronutrients for pregnant women with normal BMI, an estimation of additional 0, 340, and 452 kcal for the first, second, and third trimester, respectively [9, 10] was recommended. Moreover, additional calories should also be personalized to an individual's prenatal BMI [10].

- If prenatal BMI is less than 18.5 kg/m^2, the mother needs to begin an additional 150 kcal per day for her first 3 months, and continuously add 50 and 150 kcal for her second and third trimester, respectively. They can benefit from protein supplements [10].

- If women are overweight or obese, they do not need to add calories in their first trimester. In two last trimesters, they need to add between 450 and 500 kcal per day to meet their gestational weight gain. Prenatal overweight or obesity is strongly associated with an increased risk of pregnancy complications as well as postpartum weight retention. They may need supports to lose weight effectively during prenatal visits. Evidence has shown that overweight or obese women who reduced at least 3 BMI units before conception can lower the chance of developing gestational diabetes by two-fold [10, 11].

- For multiple pregnancy, woman with normal BMI should consume about 40–45 kcal/kg/day while an estimated 30–35 and 42–50 kcal/kg/day have been advised for overweight and underweight BMI, respectively [12–14].

Adding small meals or one or two extra snacks during the day may facilitate these targets. There is no need to stick on high-energy density diets, but, a balanced diet with nutrient-dense foods has the benefit of providing a range of vitamins and minerals.

3. Management of gestational diabetes mellitus during pregnancy

Gestational diabetes mellitus (GDM) is one of the common pregnancy complications related to diet. Pregnancy is related with a biological reduction of insulin sensitivity by about 60% [15], which supports fetus development by an increase of glucose into the placenta. Some women were present with elevated blood glucose levels during their pregnancy although no diabetes was diagnosed before their pregnancy. The excessive blood glucose level can cause hyperglycemia which will develop gestational diabetes mellitus. Fortunately, the well-managed blood glucose levels typically turn normal after delivery. GDM globally happens in about 3–28% of pregnant women. The prevalence of GDM in European countries is about 5.4%, while 10.1% GDM occurs in Eastern and Southeastern Asian countries, except in Indonesia, the Philippines, Myanmar, Cambodia, and Laos [16]. Among the latter, Vietnam and Singapore have the greatest prevalence of GDM (about 20%). The prevalence of diabetes during a pregnancy has been increasing markedly in Africa and Asia [16]. It is closely associated with the increase of obesity and sedentary lifestyle. It is the most common medical complication during a pregnancy. Women with a healthy weight can be affected. This is likely due to participation of pregnancy-related hormones, such as human placental lactogen (HPL). A 30-fold increase of HPL by the 20th week of gestation causes improperly elevated blood sugar levels, which contributes to the developing GDM between the second and the third trimester [17, 18]. However, women who enter into pregnancy overweight or obese are at a markedly increased risk of developing GDM. The increased release of pro-inflammatory cytokines and adiponectin was associated with an accumulation of adipose tissues, particularly with central obesity [19–21]. These releases contribute to a severe GDM, including increased glucose blood levels [22], endoplasmic reticulum stress [23], and increased insulin resistance [21, 24]. Women, diagnosed with a lower adiponectin concentration at their early trimester, are likely to develop an increased insulin resistance and GDM later in their semesters [25].

Several adverse outcomes are associated with diabetes during a pregnancy: mothers with the untreated GDM have a higher risk of hypertension, preeclampsia, cesarean delivery, and labor complications; their babies are at increased risk of macrosomia, large for gestational age, fetal organomegaly, shoulder dystocia, hypoglycemia, and perinatal morbidity and mortality due to the excessive glucose flux into the placenta [26, 27].

3.1 Nutritional therapy for gestational diabetes mellitus

The role of nutrition in the management of gestational diabetes mellitus is now drawing considerable attention in public because of the natural process without side effects for women and their unborn baby. Diet-based interventions in the pregnancy aim to control maternal hyperglycemia as well as to lower risks of macrosomia. The concept of these interventions is a three-step nutritional therapy (NT), including a personalized dietary counseling, appropriate energy restriction, and promotion of a balanced diet.

Some observational studies reviewed that it is beneficial for women to take three-step NT into consideration in prenatal or early pregnancy visits if they have one or more of the following contributory factors for GDM [28–30]:

1. Being overweight or obese (BMI cut offs $\geq$23 kg/m^2 for Asian population; BMI $\geq$ 25 kg/m^2 for non-Asian population)

2. Having GDM or abnormal glucose tolerance in previous pregnancy

3. Having diagnosed polycystic ovary syndrome (PCOS)

4. Having macrosomia in previous pregnancy (birth weight > 4 kg)

5. Having a family member with diabetes

6. Hypertension (140/90 mm Hg) [12] or recurrent hypertension

7. Secondary lifestyle

8. HDL <35 mg/dL, triglyceride >250 mg/dL

9. High risk race: Asian, Indian subcontinent, Aboriginal and Torres Strait Islander, Pacific Islander, Maori, Middle Eastern, non-white African.

3.2 A personalized counseling for GDM

Women with diagnosed gestational diabetes need to be put on a proper diet. Thus, they should seek a tailored nutritional counseling by a registered nutritional therapist. Personalized dietary counseling was associated with a well-controlled maternal hyperglycemia and a proper weight gain due to the mothers' better awareness about GDM and meal plans [31, 32]. The dietary counseling needs to be tailored for an individual; this consists of things like not only her diet and lifestyle but her expectation and barrier. For instance, the nutritional advice on a restricted diet of fast foods should also discuss about where a patient can get healthy foods and her related barriers. Moreover, understanding the effects of the dietary advice on not only an individual but also her family members has shown the significant improvement of clinical outcomes [33, 34]. This is likely due to family member's additional support.

Some meta-analysis and systematic review studies demonstrated that women with GDM had encountered the weight management, in particular overweight or obese people [32]. A majority of these cases are largely associated with their unhealthy lifestyle choices, including low physical activities, problematic portion control, and poor diet. In the context, the counseling needs to take these issues into consideration. Moreover, it is important to promote healthy food choices in the consultation. Importantly, the nutritional advice for GDM is tailored, relevant, and applicable to the patient.

3.3 Energy restriction and appropriate weight gain for GDM

Energy restriction aims to ensure that women and their babies get enough energy to develop and grow, but minimizes the reductant amount of weight gained. The influence of energy balance on dietary macronutrient intake and physical activity could be considered as a primary factor in the reduced fat composition. There is some established evidence that moderate caloric restriction can improve maternal hyperglycemia as well as reduce insulin requirement, but, there is no association between restricted caloric intake and birth weight. However, severe caloric restriction to either less than 1200 kcal per day or 50% of daily energy requirement is related to the production of ketonuria and ketonemia, which is called ketosis [35, 36]. According to the recommendations of American Diabetes Association about energy restriction, obese women with GDM can benefit from a 30–33% energy restriction or a limit of 25 kcal per kg per day, but there was no report related to GDM women with normal weight [35, 37, 38]. Some studies suggested a caloric restriction of 30–34 kcal/kg (actual weight of pregnant women) for those with normal BMI [36]. However, further interventional studies are needed to take this recommendation into action.

3.4 Promotion of a balanced diet with high fiber and low carbohydrate

The transport of glucose into the placenta depends on how accelerated the mother's postprandial blood glucose concentrations are. The excessive amount of glucose crosses the placenta, which can affect birth weight. A postprandial high blood glucose levels in GDM women is typically higher. Insulin is a metabolic hormone released from beta-cells in the pancreas, which play an essential role in the blood glucose regulation. Dietary carbohydrate is absorbed into the intestine and converted into simple glucose, which leads to a significant increase of maternal blood glucose concentrations. After a meal, GDM women found normoglycemia very challenging. They sometimes need medications to turn their blood glucose normal. One of the major purposes in the GDM nutritional management is thus to achieve normoglycemia after meal. The postprandial blood glucose level depends on the amount of glucose absorbed in the intestine and released into the bloodstream. There is some established evidence that a diet rich in fibrous carbohydrate, such as vegetables and fruits, and low in starchy and high glycemic index carbohydrate, may be helpful to reduce postprandial blood glucose as well as to change body fat composition [39, 40]. The American Diabetes Association guideline focuses on how much energy from dietary carbohydrate a GDM woman consumes [41]. The guideline demonstrated that the consumption of dietary carbohydrate among women with GDM should be limited to 40–45% of total daily energy, with a smaller percentage at breakfast than at lunch or dinner.

Glycemic index (GI) is a measurement related to the amount of carbohydrate in certain foods and its effect on a blood glucose increase after eating, a rank of values from 0 to 100. A high GI in foods (≥70) causes a sharp increase in blood glucose compared with a food with a medium (56–69) or low GI (≤55). Some established evidence recommended that the GDM women can consume low GI or complex carbohydrates, even greater than 45% of the total energy, without a quick response of increased blood glucose [42, 43]. Glycemic control can be achieved by increasing the consumption of foods with low GI, such as whole grains, green vegetables, and legumes, instead of high-GI foods like potatoes or sweet foods. Rice, a starchy food, is routinely eaten by 60% of world population, primarily in Asian countries. Approximately three-fourths of the total carbohydrate calorie requirement in Southeast Asia comes from rice [44]. Like potatoes or white breads in western countries, white rice can be a staple part of Asian meals. Unfortunately, the refined white rice may increase risk of hyperglycemia. It is a challenge for Asian women with GDM to avoid white rice due to its preferred taste or flavor, but following a low-GI diet guideline along with white rice will facilitate their glycemic control (**Table 3**). Several conventional studies demonstrated that the different types of rice have variations in GI value. For instance, among 12 types of rice commercially available in the United Kingdom, a nonblind, randomized trial indicated that rice noodles, long-grain rice, white basmati rice, and easy-cook long-grain rice were classified as low-GI foods, compared with others [45]. This is likely due to the difference in amylose composition and its effect on gelatinization [46, 47] rather

Groups	Foods
Starchy foods	Limit a cup of white rice a day. Avoid white rice or glutinous rice in breakfast or late dinner. Swap white rice for the low-GI starchy foods, such as rice noodles, brown rice, udon noodles, whole spaghetti, and sweet corn. Should be chosen preferentially
Raw Fruits	***Swap fruit juices or soft-drinks for low-GI raw fruits***, such as apple, orange, grapefruit, green grape, and banana; 1–2 servings (80–160 g) a day. ***Accepted fruit juices***: Apple and orange
Vegetables and legumes	Boiled/steamed/raw vegetables or vegetable soups from carrots, sweet potato, pumpkin, green banana and green leafy vegetables (i.e., spinach, green broccoli, or Moringa leaves); 3–4 servings (240–320 g) per day. ***Low-GI legumes***: red kidneys, soy beans, and black beans; 1–2 servings per week.
Dairy products	Natural/white yogurts; 1–2 servings a day.
Meats	About 20% of total energy with smaller proportions in red meats than oily fish and chicken.
Things to avoid	• Fast foods and animal fat or skin. • Skipping meals. • Alcohol or alcoholic drinks. • Drinking soft drinks or sugary foods between meals. • Very big meal; keeping meals medium sized and regular will prevent hyperglycemia throughout the day. Additional healthy snacks would be beneficial.

Table 3.
Recommended low-GI diet for Asian pregnancy with GDM.

than the dietary fiber content solely [46]. Rice with higher amylose composition has greater GI. The gelatinization represents the thickening of starch granules when heated in the presence of water. Thus, rice with greater gelatinization, such as glutinous rice, will have higher GI [48].

The evidence stated that the consumption of a high amount of fat, particularly with saturated fatty acids, can affect both the insulin-induced signaling pathway on cell membranes and lipid metabolism after a meal [49, 50]. Saturated fatty acids in strong relation to insulin resistance are well documented in not only epidemiological but also intervention studies [51]. Moon demonstrated that diets rich in saturates appear to impair the insulin-induced normal signaling by reducing IRS-1 expression and phosphorylated PI3K levels [52]. This results in significantly decreased transfer of glucose across the muscle cell membrane via GLUT-4, glucose transporter proteins, and the increased serum glucose. In addition, in a current study on mice with impaired Toll-like receptor-4, Zhou also demonstrated that saturated fatty acids are associated with glucose intolerance through reducing functions of nucleotide-binding oligomerization domain 1 (NOD1) in insulin-stimulated glucose uptake in adipocytes [53]. Thus, women with GDM may need to avoid saturated fats, but increase consumption of polyunsaturated fatty acids, especially fish oil [54]. A randomized double-blinded, placebo-controlled trial on fish oil supplementation and its effects on GDM demonstrated that omega-3 supplementation was associated with upgraded expression of genes related to insulin activities and inflammation among GDM women [55]. To date, taking omega-3 supplements routinely has not been recommended for the treatment of GDM due to lack of evidence. However, omega-3 supplements may need to be considered additionally for pregnant women if they find fish consumption challenging.

4. Management of vitamin D deficiency during pregnancy

Vitamin D is essential for absorption of dietary calcium and phosphate in the small intestine and for the deposition of calcium and phosphate in the mother's bones, and for her baby's as well. Moreover, maternal vitamin D was known as the only source for the unborn baby. Gestational vitamin D deficiency during pregnancy is related to infantile rickets. Moreover, the lack of vitamin D in the first trimester of pregnancy is predictable to preeclampsia and gestational diabetes mellitus [56, 57]. Maternal vitamin D is primarily synthesized under her skin while exposed to sunlight. First, due to sunlight, the 7-dehydrocholesterol under skin will be converted into cholecalciferol (vitamin D3). Then, the hydroxylation of vitamin D3 in the liver occurs to form 25(OH)D. Finally, 25(OH)D is continuously hydroxylated in the kidney to become a biologically more active form, 1,25(OH)2D. Serum 25(OH)D concentrations are clinically measured to indicate an individual's vitamin D status due to its stable half-life of 2–3 weeks. There is some established evidence that inadequate serum vitamin D concentrations at early childhood puts individuals into a higher risk of metabolic disorders later in their life, such as heart disease and diabetes as vitamin D receptors are present in almost tissues.

Those women who smoke, use sunscreen, or cover their skin with clothing increase significantly risk of vitamin D deficiency. Unfortunately, some individuals have encountered getting an adequate amount of vitamin D due to their darker skin tone. A global sunshine calendar developed by the Vitamin D Day (https://www.vitamindday.net/) suggested a practical tip for an individual to get enough vitamin D while exposed to sunlight, no matter where he or she lives.

One of the biggest concerns about getting vitamin D from sun is skin cancer due to ultraviolet (UV) radiation exposure. There was an association between less education and misconception of vitamin D from sunlight. A cross-sectional survey of 3922 participants in the United States demonstrated that individuals with a high school diploma or less had misconception of a longer sunlight exposure related to achievement of a sufficient vitamin D, which may need more studies about vitamin D-related sun exposure behaviors and risk of skin cancer [58]. In natal visits, it is important for registered nutritional practitioners to take women's vitamin D knowledge as well as their sun safety behaviors into consideration [59].

Mushroom, oily fish, egg yolks, and vitamin D fortified milk is a dietary source of vitamin D. Oral vitamin D supplementation is as available as drops or tables, which can be taken over the counter or on registered nutritional practitioner's prescription. Oral vitamin D supplementations among pregnant population have shown to improve maternal vitamin D status and lower risk of premature birth delivery. According to the guideline of the Royal College of Obstetrics and Gynecology (RCOG), a daily vitamin D supplementation of 400 units is recommended for women with singleton gestation [60]. To date, there is still no vitamin D guideline for twin or multiple pregnancies although it shares an increased risk of gestational outcomes. Some experts from the Society of Maternal Fetal Medicine suggested that women with twin gestations should consume daily vitamin D supplementations of 1000 units [61]. Oral vitamin D supplementations within the guideline, plus sunlight exposure, will not lead to symptoms of excessive vitamin D.

There is a hypothetical concern that which is better: taking vitamin D supplementation alone or in combination with calcium? The evidence from a Cochrane systematic review confirmed that the consumption of vitamin D combined with calcium is related to an increased risk of premature birth [62]. The effect and cause behind the evidence were not well documented. Thus, it is important for the registered nutritional practitioners or nutritional therapist to take measures to manage this risk when making a description of vitamin D combined with calcium for preeclampsia. It is beneficial for public to take vitamin D supplement alone over the counter within the guideline.

Women who enter into pregnancy obese are also at increased risk of nutrient deficiencies, in particular, deficiencies of vitamin D. Also in pregnant women, BMI is inversely associated with the serum concentrations of vitamin D. Obese women are at a markedly increased risk of vitamin D deficiency compared to women with BMI in the normal range, and the offsprings of obese women also have lower levels of vitamin D in their cord blood. The prevalence of vitamin D deficiency in pregnant women can be quite high in some populations, reaching, for example, one third in the USA, 35% in the UK, and 77% in Germany [63]. Vitamin D is believed to be sequestered in the adipose tissue, making it less available in obese people.

Hence, obese women have an even higher prevalence of vitamin D deficiency during pregnancy. Recently, the RCOG guidelines recommended that obese pregnant women should be taking at least 1000 units a day of vitamin D supplementation, compared with a daily vitamin D supplementation of 400 units for those women with healthy BMI [60, 64].

Women at higher risk of vitamin D deficiency, such as obesity, need to follow a maternal vitamin D assessment in prenatal, first trimester, and last trimester visits to ensure a proper vitamin D supplementation.

5. Management of folic acid deficiency during pregnancy

Folate or vitamin B9, a family member of water-soluble vitamins, plays an important role in the production of neurotransmitters and synthesis of DNA in cells, especially in early pregnancy. Folate is naturally found in dark green leafy vegetables and legumes while folic acid, a synthetic form of vitamin B9, is generally added in supplements or fortified milk or foods. Folate deficiency in pregnancy generally occurs when maternal dietary supply does not meet a suddenly increased folate requirement for the embryogenesis [65]. This requires an adequate amount of folate prior to conception and continuing throughout within next 28 days, an essential period of neural tube formation. The failure will lead to abnormal fetus development, even death. New parents are often unaware of their pregnancy as well as unprepared of an increased folate demand of this important event [65, 66].

All pregnant women need to consume a daily folate supplementation of 400 μg or 0.4 mg. Folate deficiency is strongly associated with abnormal neural tube development. Evidence has shown that the risk of neural tube defects among obese pregnant women is double that of women with normal BMI. As a result, a higher dosage of folate supplementation is recommended for pregnant women with high BMI. It is important for these women to take this raised amount of folic acid at least a month prior to conception to their first trimester. The Center for Maternal and Child Enquiry jointly with the Royal College of Obstetrics and Gynecology recommends that women with a body mass index higher than 29.9 should take a supplement on top of their diet, with 5 mg of folic acid daily [67]. In contrast, the recommended folic acid dosage for women with a healthy BMI, of course, is only 0.4 mg daily.

6. DHA in a pregnancy

Omega-3 docosahexaenoic acid (DHA; 22:6n-3) is an important component in the cell membrane, specially brain cells. It has been postulated that low maternal

DHA concentrations could be related with increased risk of postpartum depression and preterm birth. During the embryogenesis, maternal DHA levels significantly increased, which may contribute to reduce oxidative stress-induced impairment of the neurotrophic factors [68]. Omega-3 DHA is pronouncedly found in a fetus brain from the last trimester to 12 months after delivery [69, 70]. Oily fish, river eels, and wide carps are often a rich source of omega-3 essential fatty acids (FA). DHA in the diet can be obtained from river eels, wide carps, and marine-derived fatty fish, such as salmon, mackerel, anchovies, sardines, and sea trout. One of the biggest concerns about seafood consumption is risk of mercury exposure. According to the United States Environmental Protection Agency (EPA)'s fish advice, it is safe for pregnant women to consume 2 servings (6.2 ounces or 175 g) of certain cooked fish with a low average mercury concentration (≤0.15 μg/g) [71, 72]. Some oily fish species labeled as "the best choice to consume" are Atlantic mackerels, anchovies, herrings, haddocks, lobsters, salmon, sardine, and light tuna. However, women, who might become pregnant, should avoid or consume less than 100 g per week predatory fish species, such as bigeye tuna, swordfish, marline, shark, and orange roughy [73–75]. Alternatively, oral DHA supplementation alone of 200–300 mg was recommended for all pregnant women [72].

7. Conclusion

Based on the present work, there are three main conclusions which may help women have a healthy baby during their pregnancy. First, an increase in body weight is necessary during the last two trimesters. However, the gestational weight gain should be interpreted with some cautions related to prenatal BMI, especially overweight or underweight. Second, gestational diabetes is strongly associated with a greater risk of poor pregnancy outcomes. Once diagnosed, diet-based interventions aim to control maternal hyperglycemia. As a result, seeking a tailored nutritional counseling by a registered nutritional therapist will put on a proper diet, including the appropriate management of energy restriction and the promotion of a balanced diet with high fiber and low GI carbohydrate. Moreover, the management of blood glucose during pregnancy may benefit from avoiding saturated fats, but increasing consumption of polyunsaturated fatty acids. Last, it has clearly been shown that pregnant women may find it harder to consume enough specific nutrients, such as vitamin D, folate, and omega-3 DHA. Consuming fortified or enriched foods or oral nutrient supplementations may optimize a diet.

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