

# Dietary Factors in the Prevention and Management of Postpartum Depression: A Literature Review

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**Abstract** *Background:* The prevalence of postpartum depression (PPD) in women has become a major global mental health concern, thus how to conduct effective and safe intervention based on the pathogenesis of PPD has become an important research topic. *Discussion:* In this literature review, the aim was to identify the role of prenatal and postpartum healthy dietary factors in the management of PPD. Several dietary patterns, food groups, and nutrients (from food sources or supplements) that can be beneficial for PPD (or depression) were all discussed. Besides, dietary recommendations that may be effective in reducing the incidence of PPD were further summarized based on a review of the relevant literature (from the conclusion, the level of evidence of study design, the sample size, and the risk of bias) and dietary guidelines. *Conclusion:* Several existing healthy eating patterns (including some specific foods) and nutrient supplements for pregnant women and postpartum mothers are potentially effective means of managing the occurrence and symptoms of PPD through their nutritional contents (i.e., the possible mechanisms of those nutrients, such as anti-inflammatory action). Although some of the studies reviewed in this paper have had inconsistent results regarding the effects of certain nutrients and foods on PPD, considering that diet management of PPD is a more acceptable and feasible intervention for women during pregnancy and postpartum, more longitudinal studies are needed to further demonstrate the effectiveness of these diet-based interventions and to develop optimal dietary content-matching strategies for preventing and relieving PPD.

**Keywords:** *postpartum depression, pregnancy, dietary pattern, nutrient, food group*

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## 1. Introduction

Postpartum depression (PPD) is a mental disorder characterized by depression, anxiety, irritability, and other clinical manifestations after childbirth (at around six weeks postpartum). The occurrence of PPD is affected by many factors, including the production of hormones related to mood during delivery, the history of mental disorders, family economic level, educational level, social support system, and dietary pattern [1,2]. The overall etiology can be broken down into three major factors: biological, social, and lifestyle [3].

PPD is the most common disease among postpartum women, and it is a major public health problem worldwide. About 13% of postpartum women worldwide suffer from mental health problems, with the highest incidence being PPD. And in developing countries, the rate of PPD is even higher, at about 19.8% [4]. Most recently, according to relevant research data from 17 regions in China, the overall detection rate of cumulative PPD cases in China is 15% [5]. Besides, PPD is also a very common maternal psychological illness in Hong Kong. Data from some sources have identified that about one in ten local women

in Hong Kong suffers from this kind of mental disorder. Moreover, several relevant epidemiological studies have shown that the prevalence of PPD in Hong Kong women at 1 month and 3 months postpartum is 10.3% and 11.2%, respectively [6,7]. In addition, the previous prospective cohort study of 805 Hong Kong Chinese women between 2009 and 2010 found a 15.7% prevalence of depression in women two months after delivery [8].

The onset of PPD can have significant negative effects on both the mothers and their children. Some published studies have demonstrated that women with PPD can affect the emotional communication between them and their babies, and appear this kind of communication disorders can lead to the result of the emotional and social development of their infants may be the possibility of the derailment, and this situation may continue to influence their children from infancy to adolescence each developmental stage [9]. Besides, symptoms of depression in the early postpartum period also affect the nutritional status of women and their babies. The reason for this is that the PPD directly affects the length and difficulty of breastfeeding, which significantly increases the risk of poor infant feeding outcomes and hence malnutrition [10]. In addition, the occurrence of PPD may also damage family relationships and affect

children's intellectual development and other adverse consequences [11].

Therefore, in order to prevent and manage the potentially serious consequences of PPD, it is necessary to propose relevant strategies to improve this kind of mental illness by changing some variable influencing factors. Existing studies have shown evidence of possible associations between healthy eating patterns and depression, such as a healthy diet as defined by the WHO, which can help relieve depressive symptoms and reduce the risk of depression. But in fact, the factors that influence diet are diverse. In addition to specific healthy eating patterns, PPD is also influenced by food groups, such as fruits, fiber, and fat, as well as single foods rich in certain nutrients, such as fish rich in omega-3 fatty acids. However, few current studies on PPD have specifically and comprehensively explored the effects of various dietary factors on this kind of mental disorder. Whereas, if we can decrease the incidence of PPD by addressing the dietary problems of pregnant and postpartum women, it will be a cost-effective way to do so. Postpartum is the necessary period for postpartum women to increase their supplemental nutritional needs because it affects not only their own nutritional status but also the status of their breast milk in relation to the nutritional status of their children. Therefore, PPD is an important health issue worthy of public attention [3].

## 2. Objectives

The main purpose of this literature review is to explore the relationship between various dietary factors during pregnancy and postpartum and PPD, to summarize the relevant research studies in this field, and to discuss how to improve and manage the dietary patterns of pregnant and postpartum women (especially in Hong Kong women) to reduce PPD symptoms and its incidence. Finally, some suggestions will be put forward for future research in this unexplored area.

### 2.1. Dietary Pattern

Dietary patterns are combinations of food components, and the different combinations of food items included in a healthy eating pattern and the interactions between different combinations of foods can contribute to the lower risk of depression. Early research on the relationship between diet and rates of mental disorders has found that traditionally healthy eating patterns (including vegetables, fruits, beef, lamb, fish, grains, etc.) are associated with a lower likelihood of depression and anxiety disorders [12]. Further study has found that healthy eating patterns reduce the risk of depression due to the presence of mood-modulating and cognitive-related monoamines in healthy food combinations [13]. Besides, a previous study of older women explored that fewer cases of depression were reported if they ate a "healthy eating pattern" (including vegetables, fruits, and fish) or a "cooked starchy diet pattern" (including meat, pasta, rice, potatoes, and bread) [14]. In addition to the positive effects of a healthy diet on depression, an unhealthy eating pattern can also play an essential role in the development

of depression. A cross-sectional study suggested that unhealthy eating patterns (e.g., dessert, fast food, etc.) were associated with an increase in depressive symptoms [15]. And a number of published studies have begun to examine that the processed foods eaten by office workers and the Western eating patterns (e.g., candy, red meat, and cake) of teenagers are associated with poorer mental health. There has also been evidence that eating a "western" diet (including mince pies, processed meats, etc.) and fast food (e.g., hamburgers, pizza, etc.) are more likely to have symptoms of depression [14]. In addition, data from several studies have begun to examine a possible mechanism by which dietary patterns high in sugar and saturated fat may increase depressive symptoms due to such dietary patterns that can lead to higher levels of inflammation in the human body [16]. Although there is a large literature establishing an association between dietary patterns and depression, a population-based cohort study from the UK argued that there appeared to be no link between dietary patterns and depression when the role of other potential confounding factors in depressive symptoms was taken into account [17]. After reviewing the literature above, the combination of other factors and dietary factors also needs to be considered while defining what dietary patterns can benefit mental health. In addition, in establishing the relationship between eating patterns and mental disorders, it is also important to investigate each study's definition of the food content of a healthy eating pattern and the impact of local food culture differences in each region on the results of the study.

However, by discussing the relationship between depression and dietary factors, we can also establish the potential connection between PPD and dietary factors, as well as the therapeutic effect of dietary factors on PPD. The reason is that PPD is one type of major depression, and the pathological factors (e.g., physiological factors, social factors) of depression and PPD are broadly similar, but the difference is that the physiological factors of PPD are more related to endocrine hormones during childbirth, while depression is more related to norepinephrine. In addition, the occurrence of PPD has a specific population and period. However, their clinical symptoms (e.g., somatic symptoms, mood changes) and treatment methods (e.g., psychotherapy, drug therapy) are mostly the same [18,19]. So, diet as a treatment to prevent and treat depression by improving lifestyle can also have an effect on PPD.

On the premise of the relationship between diet and depression as well as between depression and PPD, the potential influence of dietary factors during pregnancy and postpartum on PPD can be further discussed. Dietary patterns during pregnancy need to be structured as much as possible according to their particular nutritional characteristics and involve nutrient-rich foods to fully meet the nutritional needs of the developing fetus. The nutritional requirements of the three stages of pregnancy are different, and the scientific distribution of dietary patterns during pregnancy is of great significance to the delivery of pregnant women. On the basis of numerous studies on depression and eating patterns, many researchers have begun to explore the relationship between various dietary patterns of pregnant women and mental disorders. Early research has examined that

unhealthy eating patterns affect anxiety and/or depression during pregnancy [20]. A Japanese study has conclusively been shown that western dietary patterns decrease perinatal depression, although dietary compliance is not the most important factor in reducing the incidence of depression, and this study has also found that no association between dietary patterns high in vegetables (as white, green and yellow vegetables), seaweed, potatoes, fruits, and kinds of seafood (e.g., fish) during pregnancy and the risk of PPD [21]. Further studies have reported that women who experience psychological pressure during pregnancy, such as depression or anxiety, tend to eat unhealthy eating patterns, which may in turn directly contribute to the biochemical pathways that underlie their depression [22,23]. However, in a subsequent study, Paskulin et al. concluded that the common-Brazilian dietary pattern (i.e., diet consists of foods rich in carbohydrates, such as sweets and sugar) of pregnant women in Brazil was associated with a higher incidence of depression. And existing published studies have established that the result of this study is that women who consume the types of foods contained in this dietary pattern over a long period of time show higher levels in regulating inflammation [24]. Most recent studies have identified that dietary patterns (including nuts, fruits, and seafood) of pregnant women are associated with a lower risk of PPD, but in these studies, no association was also found between other dietary patterns (including beverages, vegetables, grain-meat, and egg patterns) and PPD risk. Moreover, data from these studies have indicated that some healthy diets, such as the traditional Indian diet and soup-vegetable-fruit diet, are not significantly associated with PPD, which may be due to the conscious control of the pregnant women's eating habits during pregnancy. Besides, no association between Western dietary patterns and PPD symptoms was also found in either Chinese or Greek studies [15]. Although the relationship between dietary patterns of pregnant women and PPD is unclear, unhealthy dietary patterns during pregnancy (e.g., high-fat diets, high-sugar diets, etc.) can lead to adverse outcomes such as maternal obesity and hyperglycemia, which can directly affect the mental health of the mothers (e.g., several studies have found that perinatal depression and the connection between the maternal obesity) [25]. Therefore, further high-quality prospective studies are needed to consider how to combine food groups to form a healthy eating pattern that can help pregnant women prevent the risk factors for PPD (e.g., obesity).

In addition to the dietary patterns described above during pregnancy, the postpartum diet may also play a role in PPD. Postpartum dietary pattern focuses on maternal health after childbirth and the nutrition of breast milk. During a recent study that confined the relationship between dietary patterns during confinement period and PPD follow-up survey, the researchers identified in Asian ethnic common four kinds of dietary patterns and found that insist on Traditional-Indian-Confinement diet and Soup-Vegetables-Fruits diet may have a protective effect on PPD symptoms while providing adequate nutrition for mothers. Nutrients rich in these two dietary patterns, such as vitamins B2, vitamin C, vitamin E, carotene, etc., are important reasons for beating PPD [26]. Moreover, there is a number of cross-sectional studies and cohort studies

that have suggested that following a healthy eating pattern after delivery can help manage symptoms of PPD. Take the traditional Indian healthy diet as an example, this kind of dietary pattern contains Indian herbs (e.g., saffron, fenugreek, curcumin, etc.) that have antioxidant, anti-inflammatory, and toning physiological properties that have been shown to be effective in relieving depressive symptoms. In addition, according to the Dietary Guidelines of the United States and Australia and Dietary Guidelines for Chinese Residents, the recommended various healthy dietary patterns that include foods groups (e.g., fruits, vegetables, grains) that have functions, such as enhancing neurotrophic factor and maintaining the normal neurological function, which can help reduce the incidence of PPD [3]. The causal relationship between healthy eating and PPD has not been clearly explained, although current research has shown that certain nutrients in some healthy eating patterns can protect against PPD. In the future study, a combination of foods containing nutrients that act on PPD could be considered to develop as an adjunct to the treatment of PPD. In addition, it is worth mentioning that the diet would be the best "medicine" to treat PPD because it is not only closely related to the daily life of pregnant and postpartum women but also using healthy dietary patterns to manage PPD without considering whether it will have side effects (e.g., side effects of western medicine: anorexia) or requiring multiple clinical trials to guarantee its safety. However, excessive dietary control may also increase the psychological burden of these women and increase the risk of depression as mentioned above. Therefore, while addressing the relationship between dietary patterns of pregnant and postpartum women and PPD, it is also necessary to consider how to avoid emotional problems in pregnant and postpartum women caused by changes in their diet in the future study.

Besides, it is worth noting that the review of the literature (as mentioned above) has some limitations: First of all, the food content of the dietary patterns useful for PPD was collected through the recall of participants (as pregnant and postpartum mothers) in most of the research; Secondly, the food items in some dietary assessment tools, such as FFQ, were determined by the researchers thus there may be a selection bias. To sum up, considering that the results of different studies may be influenced by the researchers' biases in food selection when defining dietary patterns and by regional differences in eating habits in combination with the literature reviewed above, it would be better to review the cause-and-effect relationship between some of the currently well-defined modern nutritional dietary patterns (e.g., the Mediterranean diet) and PPD.

### 2.1.1. Mediterranean Diet

The Mediterranean diet (Med Diet) is a healthy and light dietary pattern that is rich in naturally nutrient-based plant-based foods (e.g., fruits, vegetables, legumes, nuts, grains, etc.) [27]. Previous studies have identified the benefits of the Med Diet in the prevention of arteriosclerosis, coronary heart disease, and cancer, and then more recent studies on this dietary pattern have also found a link to mental health [28]. Besides, there have been reports that the Med Diet may improve mental health

by promoting changes in the body's gut, so it can be effective in preventing and helping to combat depression [29,30].

Several early studies have found that the Med Diet is rich in B vitamins (e.g., B1, B2, B12, B6, folic acid) and fatty acids (e.g., omega-3 fatty acids), both of which have a protective effect on depression through a variety of mechanisms, such as the stimulatory toxic effects of vitamin B6 on the central nervous system. A prospective cohort study conducted by a number of researchers has found an association between the prevalence of depression and vitamin B12 intake in women. And they also concluded that depression could be prevented by sticking to a Med Diet [27]. Moreover, previous studies have explored that long-term consumption of the Med Diet is associated with higher plasma concentrations of some beneficial biomarkers produced by the human body [31]. And in a prospective study, researchers found that middle-aged women who ate a "Mediterranean" diet (including garlic, peppers, mushrooms, salad vegetables, pasta, and red wine) had a lower incidence of depressive symptoms three years later. In addition, other studies have also attempted to explain the link between adhering to a Mediterranean dietary pattern (as high in fruits, vegetables, and kinds of seafood, moderate wine consumption, and low in meat and dairy products) and a reduced risk of depression. Although these above-mentioned dietary patterns differ in food content, they all conform to the characteristics of the Med Diet, and thus such characteristics of this kind of diet model may be the key to protecting against the development of depression or PPD. In a subsequent British study, data revealed a correlation between eating more "whole foods" (including vegetables, fruits, and fish) in Med Diet and fewer depressive symptoms five years later. Besides, a study in Crete has assessed the effectiveness of a "health-conscious" diet, such as a Med Diet, in reducing women's risk of PPD [14]. A Med Diet rich in olive oil and fruit also seemed to protect women from depression. The nutrients in olive oil play an important role in mood disorders. Not only does it play a role in maintaining the physical and chemical properties of the membrane, but also the components of the virgin olive oil restore the antioxidant defenses of the cells [32]. Natalie et al. conducted an RCT study has found that increasing the diversity of vegetables and beans in a Med diet significantly improved mental health, and there is a certain correlation between increasing the intake of omega-3 fatty acids and decreasing the intake of omega-6 fatty acids, and reducing mental health problems (including major depression). In addition, people with depression can supplement a Med diet with extra fish oil to relieve their symptoms [33]. Although there have been few studies on the Med Diet for PPD, the potential benefits of the Med Diet for PPD could be extended once its role in the treatment of depression is determined. Nevertheless, further prospective studies are needed.

The studies reviewed above are all about the direct effects of the nutrients and food groups in the Med Diet on depression or PPD. However, due to the association between PPD and chronic diseases (e.g., gestational diabetes mellitus, cardiovascular disease) and obesity, it is also necessary and possible to consider whether the Med Diet can indirectly reduce the risk of PPD by preventing

and regulating these disease factors that interact with PPD [34,35].

Obesity is currently a rapidly growing epidemic worldwide and it is also the most common complication during pregnancy and postpartum. The existing literature on the relationship between fat and depressive symptoms in non-pregnant, pregnant, and maternal populations has found that obesity not only endangers the nutritional health of both mothers and their children but also significantly increases the risk of PPD symptoms. In addition to the impact of obesity on PPD, several studies have also suggested a possible link between low gestational weight and PPD. Various studies have begun to explore the biological mechanisms of obesity affecting depression, and it turns out that fat tissue in obese people develops chronic inflammation, the production of inflammatory hormones, which is linked to depression. Besides, pregnant women who gain weight and worry about their appearance can also develop symptoms of PPD. In recent years, there has been an increasing number of prospective studies and cross-sectional studies that have found a significant positive association between pre-pregnancy obesity and PPD (i.e., PPD occurs between 6 and 3 months after delivery). Moreover, the severity of pre-pregnancy obesity has also been shown to influence the level of PPD. Besides, previous research has established that deviations between nutritional status and weight gain of pregnant women can be useful markers for assessing adverse psychological outcomes after delivery [25,36,37,38]. After the association between obesity and PPD has been established, it is the potential to prevent PPD by using the Med Diet to control the weight of pregnant and postpartum women. Based on some published literature on an analysis of the characteristics of the Med Diet, it has been proved to be the most effective way to preventing obesity-related diseases. And in recent years, the Med Diet is not just a food model for obesity prevention, but also as a sustainable medical intervention for healthy living [39]. Epidemiological and clinical studies such as that conducted by Stendell-Hollis et al. have demonstrated that food contents of Med Diet (e.g., linolenic acid in walnut, polyunsaturated fatty acids in olive oil, the fiber in whole grains, antioxidants in wine) can have beneficial effects on improving inflammatory responses (e.g., C-reactive protein reaction) and inflammatory biomarkers (e.g., TNF- $\alpha$ ). Therefore, adherence to the Med Diet can actively mediate weight loss/weight control in postpartum breastfeeding women and reduce persistent postpartum inflammation, as well as decrease the risk of obesity-related chronic diseases [40]. So, the effective management of obesity by the Med Diet during pregnancy and postpartum indicates that it can reduce the risk factors for PPD, which may indirectly prevent the occurrence of PPD.

Apart from obesity, the prevalence of gestational diabetes mellitus (GDM) is rising as the proportion of the worldwide population is overweight, and it is a major public health problem affecting pregnant women. GDM occurs in the second or third trimester of pregnancy, and it can lead to many complications (e.g., miscarriage, stillbirth, neonatal hyper bilirubin). An early study found that 34% of women with GDM had symptoms of PPD because the onset of GDM increases their risk of

developing the condition by interfering with their lifestyles (e.g., dietary control, blood glucose monitoring). And several further studies have also shown that the development of PPD can, in turn, continue to affect maternal health, such as the development of GDM into type 2 diabetes [41,42,43]. A large number of cross-sectional or cohort studies have identified the possible mechanisms for the establishment of the relationship between GDM and PPD, including the effects of mental stress-induced by treatment of GDM and physiological responses to GDM (i.e., hyperinsulinemia, dysregulation of the hypothalamic-pituitary-adrenal axis, dysregulation of serotonin, and inflammatory changes) on the thyroid gland, and this is the reason why GDM may be one of the most essential risk factors for PPD [44]. Therefore, it is feasible to further reduce the incidence of PPD through dietary intervention for the prevention and treatment of GDM. Previous studies on the Med Diet, which includes extra virgin olive oil (EVOO) and nuts, have found a significant role in the prevention of type 2 diabetes and GDM, and have also shown that Med diet intervention in early pregnant women is a very effective instrument to reduce the incidence of GDM. The mechanism by which the Med Diet works on them is partly due to the link between the Med diet and lower postprandial blood glucose levels and inflammation and immune regulation (e.g., The monounsaturated fatty acids in EVOO may improve inflammation to reduce postprandial blood glucose levels; Phytochemicals such as unsaturated fatty acids and fiber in pistachios have a potentially beneficial effect on insulin sensitivity, fasting blood sugar levels and inflammatory responses; Some other food ingredients are rich in phenolic compounds that regulate the immune system), and partly due to some certain food components (e.g., nuts) in the Med diet that increase the feeling of fullness in pregnant women and help them lose weight. In addition, the use of EVOO in the Med Diet (e.g., the traditional dietary pattern of Spanish cuisine) may help to increase vegetable intake and thus prevent GDM [45,46,47]. In a subsequent case-control study, it was established that the length of time Med Diet was taken during pregnancy affected the protective effect against GDM, and it has been shown that the protective effect is due to the synergistic and complex interactions between all the food components in Med Diet. Also, the low-consumption meat advocated by the Med Diet plays a positive role in inhibiting the development of GDM [42].

In addition to obesity and GDM, some studies have suggested that cardiovascular disease (CVD) and depression disorder seem to share physiological and pathological mechanisms (i.e., mechanism of the inflammatory response and metabolic process). Therefore, the Med Diet may be able to control the generation of depression by regulating the pathological mechanism similar to that of CVD [35]. Data suggest that a Med Diet supplemented with unsaturated fatty acids (as olive oil), complex carbohydrates (as whole grains, legumes), dietary fiber (as vegetables, fruits, cereals), vitamins and minerals (as vegetables, fruits, grains, olive oil), and other nutrients, may provide both preventive and therapeutic benefits for cardiovascular disease, respectively and simultaneously. And some of the mechanisms of action of these nutrients can be used in the same way to treat depression. So, these

further demonstrate the potential of the Med Diet for the treatment of PPD [48,49].

Although the factors associated with the direct and indirect effects of the Med Diet on depression have been summarized, the relationship between the Med Diet during pregnancy and postpartum and PPD is still lacking and requires further study. However, it is important to note that a review of the literature on the relationship between indirect factors and PPD suggests that future studies could continue to explore the prevalence of PPD after the Med Diet controls for various risk factors for PPD. Besides, despite the Med diet model in the study of all the above will be affected by the difference caused by the eating habits of each country, but each Mediterranean dietary pattern conforms to its core characteristics and unique features, such as fat intake (virgin olive oil, nuts or rich oily fish), and moderate red wine consumption. So, compared with other “healthy diet” modes, Med Diet is still the typical dietary pattern [35]. Therefore, it is a very desirable way to choose the Med Diet as a representative model to establish the relationship between PPD and dietary patterns of pregnant and postpartum women.

### 2.1.2. Chinese Herbal Diet

Most of the dietary patterns to manage PPD are considered from the perspective of the pathology of western medicine, while the pathology of PPD from the perspective of traditional Chinese medicine (TCM) is quite different from that of western medicine. In the category of TCM, PPD is caused by the deficiency of the heart and spleen, internal obstruction of blood stasis, and stagnation of liver qi [50]. Therefore, it is also necessary to consider the prevention and treatment of PPD from the perspective of TCM by eating Chinese herbal diets (i.e., the dietary pattern of combining Chinese herbs with various food materials) before and after childbirth. In China, it is very common for pregnant women and women in confinement to use dishes containing herbs (e.g., ginseng) or formulas (e.g., si-wu-tang) to prevent diseases and stay/restore healthy [51]. Besides, Chinese herbs as dietary spices are also very popular in some Southeast Asian countries (e.g., India) [52]. Adding herbs (e.g., ginger, mint, cranberries, etc.) to women’s diets during pregnancy is also known to ease morning sickness, help sleep better, and prevent urinary tract infections, etc. [53]. And in addition to the effects of these herbs on prenatal and postnatal care, as for their efficacy in PPD, early studies have found that herbs, such as kava, are effective in alleviating some psychiatric symptoms, such as anxiety and depression, but the use of these herbs may have some toxic side effects [54]. Moreover, due to some other antidepressant drugs in western medicine adverse reaction (e.g., vomiting, lethargy, etc.), further studies have begun to examine the prescription composed of Chinese herbs (e.g., Xiaoyao formula) for the treatment of depression and possible adverse reactions, and these studies have found that formulas can not only inhibit depressive symptoms more effectively through the principle of treating the pathogenesis of depression in TCM (i.e., spleen deficient and liver depression), but also the use of formulas can significantly reduce the incidence of adverse reactions [55]. The reasons why Chinese herbal medicine is more effective in the treatment of depression include:

1) The use of Chinese herbal medicine is related to TCM syndrome differentiation (i.e., according to each the symptoms of depression patients); 2) Chinese herbs are often used in combination of multiple herbs (as Chinese herbal medicine can not only work synergistically but also eliminate their side effects and enhance their efficacy through their mutual regulation). Besides, some prescriptions, such as Xiaoyao formula and Chaihu Shugan formula, have been proven by relevant studies to have anti-depressant mechanisms both in TCM and Western medicine (including anti-inflammatory, immune regulation, relieving liver depression, etc.), and some Chinese herbal medicines (including rhizoma cyperi, platycladi seed, cortex albiziae, poria cocos, white atractylodes rhizome, etc.) have been identified as inhibiting depression by strengthening the spleen and soothing the heart, soothing the liver and calming the mind [56]. In addition to the dietary use of herbs (e.g., Chaihu) has been used in many western countries (e.g., the United States) for daily health care, the western mechanisms of their action on depression, such as the regulation of dopamine and neurotransmitters, have also been increasingly being recognized by a large body of western research, and thus further demonstrating their efficacy of depression [57]. Moreover, TCM is the earliest medical treatment, the appearance of depression has been mentioned in the “Huangdi Neijing”, and formulas for depression have also been recorded very early, such as the Pinellia magnolia formula [58]. Furthermore, the mechanism of antidepressant activity played by the combined regulation of a variety of biological factors in various herbs has been shown by recent studies, although the current evidence is not perfect and sufficient, their extensive use is still recommended [59]. Systematic reviews such as that conducted by Li et al. have demonstrated that it is very useful to prevent and treat PPD by improving the physiological characteristics of postpartum women with herbal intake [60]. Also, the traditional Indian diet for women after childbirth has been considered as a potential therapeutic medicated diet for PPD in the above review [26]. Therefore, although there are no studies specifically on the effect of Chinese medicinal diet on PPD, the addition of appropriate herbs in the prenatal and postpartum diet (i.e., Chinese herbal diet) can still be a potential effective mean in the management of PPD according to the Chinese herbal medicine in the effective role of depressive symptoms (e.g., adding appropriate Chinese herbs to some chicken soups can help prevent PPD from occurring while adding flavor and tonic). However, considering the special physical condition of pregnant and postpartum women, more careful consideration should be given to the choice of herbs in the Chinese herbal diet (e.g., sage has reproductive toxicity that can lead to miscarriage) [52]. In addition, as a dietary pattern with a clear therapeutic effect on PPD, the Chinese herbal diet is worthy of further study in order to eliminate health and safety risks for the management of PPD in pregnant women and postpartum women through this measurement.

## 2.2. Food Group

During pregnancy, postpartum and postpartum lactation, women should get the most complete and quality nutrition

for themselves and their children through the different collection of foods with similar nutritional properties or biological classifications. According to the guidelines of the World Health Organization (WHO) and the Hong Kong Department of Health, the types of food groups (e.g., grains, vegetables, fruits, meat, etc.) and the amount of food required during pregnancy and postpartum are recommended [61,62]. After discussing the effects of various dietary patterns on PPD, it was found that in addition to the effects of many combination food groups on PPD, a single food group has also been proposed to produce a positive therapeutic effect on PPD. Therefore, further analysis of the therapeutic effect of individual food groups on PPD by themselves and their role in the combined treatment effect is needed.

## 2.3. Plant-based Food

Plant-based foods mainly include food such as grains, legumes, fruits, and vegetables. And nutrients from these foods, such as vitamins and dietary fiber, play a positive role in protecting the immune system and maintaining a healthy weight [63]. Besides, plant-based foods are crucial for pregnant and lactating women who are vegetarian to supplement their nutritional needs. In a review of these dietary patterns and PPD studies, many of the “healthy dietary patterns” (e.g., Med Diet) that were inversely associated with the prevalence of depression in women included a high intake of this type of food. Therefore, the role of plant-based foods in PPD needs to be further discussed.

Fruits and vegetables (F&V) are typically plant-based foods, and they are the best sources of many vitamins and minerals, including iron, vitamin C, and more. The nutrients they provide contribute not only to the maintenance of the healthy nutritional status for pregnant and postpartum women but also to the prevention of disease (e.g., vitamin A in cherry maintains normal immune function; Folate in choy sum prevents anemia) [25,61]. Current studies have found that increasing F&V intake is associated with more positive changes in mental health interventions than physical activity [64], and F&V are always a big part of a healthy diet during pregnancy and postpartum that benefits PPD. Therefore, it is necessary to further review the literature on whether F&V play the most important role in a healthy diet to prevent PPD, as well as their own protective effect on PPD. A direct relationship between PPD and F&V intake was first investigated in 2011, but the size and diversity of the study population were insufficient at the time to establish such a relationship [65]. Further studies have found that the nutrients in F&V as a major source of biologically active compounds in a healthy diet have potential effects on brain health, and eating more F&V may improve mental health by fending off the negative effects of oxidative stress. In a subsequent survey conducted on the basis of the above research knowledge, the study explored that countries (e.g., Nepal, Bangladesh) with a low prevalence of F&V consumption had higher rates of depression, and countries (e.g., India) with five or more servings of F&V per day was associated with less risk of all levels of depression [66]. Furthermore, data from several systematic review and meta-analysis studies

suggest that high consumption of F&V was effective in preventing depression and that increasing the amount of F&V consumed was associated with a significantly lower risk of depression. Also, there is an important global dietary strategy that has been proposed to help boost brain function by increasing the intake of F&V. Besides, it is now well established from a variety of studies that the mechanism by which consuming fruits or vegetables alone and in combination can protect against depression is related to their nutritional contents. Some dietary nutrients in F&V (e.g., beta-carotene, vitamin E) are potent antioxidants that can modulate oxidative stress that causes depression, and some other nutrients (e.g., folate, vitamin B6) regulate levels of amino acids associated with mental illness and are involved in the synthesis of neurotransmitters that regulate mood and prevent depression [67]. In addition, other studies have had a further understanding of antioxidants in F&V, the mechanism of these antioxidants effect on depression associated with cognitive regulatory functions related to mental health (i.e., reducing DNA damage, the accumulation of beta-amyloid in the brain, etc.), and the vitamin A in F&V has also been identified as an important nutrient for reducing the incidence of depression due to its anti-inflammatory effects [68]. Therefore, since prevention and treatment of PPD can be achieved by reducing the inflammatory response and regulating central neurotransmitters, the effects of F&V on PPD can also be linked [18,19]. However, it has not been clear from a large body of research whether it is the total intake of F&V or the individual F&V intake that has an effect on mental illness. While F&V have similar chemical composition, but there have been a handful of studies that have found differences in the degree to which the two food groups are associated with depression risk, and some of these studies have suggested that fruits may be associated with depression through cognitive regulation. Also, several other studies have shown no significant association between fruit intake and depression, but have found a significant association between vegetable consumption and depression [69]. So, when discussing the influence of F&V on PPD, they can only be temporarily discussed as one food group, and the respective and combined effects of F&V on PPD need to be explored in further studies. Cross-sectional studies such as that conducted by Saghafian et al. have shown that high F&V intake was associated with a lower risk of depression in general, especially among women [70]. In addition, several lines of evidence in a health and nutrition examination survey suggest that dietary fiber in F&V can regulate the imbalance in the production and delivery of neurotransmitters associated with severe depression, and it can also regulate brain function by altering cytokines to improve the composition of the gut microbiota. Besides, some other micronutrients in F&V have been confirmed the effectiveness of protecting against depression, for example, calcium and iron are involved in the synthesis of neurotransmitters associated with depression (e.g., serotonin and dopamine), thiamine and riboflavin maintain a healthy immune and nervous system [64]. After highlighting the positive effects of raw F&V on depression, several studies have reported that processed F&V intake does not reduce their effects. And in addition,

to confirm the overall effectiveness of F&V intake, some other studies have identified the effects of specific types of F&V, such as oranges, spinach, and tomatoes, which are particularly associated with better mental health regulation, although the mechanism is not yet clear [71]. Moreover, the frequency of F&V consumption was significantly associated with the risk of depression, for example, some prospective studies in women have found that the more F&V you eat in a week or once a day, the less likely you are to have depression. Besides, independent effects of F&V on depression have been noted in the literature review above, but a recent study found that higher fruit intake was significantly protective against depressive symptoms in women, as the study showed that fruits contained higher levels of antioxidants and anti-inflammatory compounds than vegetables [72,73]. The most recent cross-sectional study established a direct relationship between a higher incidence of PPD and lower vegetable intake during postpartum [74]. F&V improves depression directly by improving the internal environment through its nutrients, and as mentioned above these mechanisms also apply to the treatment of PPD. Although few studies have explored the relationship between F&V and PPD, it is reasonable to establish a potential relationship by reviewing the literature on F&V in depression. So, increasing F&V consumption during pregnancy and postpartum may be an effective measure to reduce the occurrence of PPD. In addition to the direct link between depression and F&V, F&V are known to play a significant role in other diseases, including diseases that are risk factors for PPD. For example, F&V intake was inversely associated with the incidence of obesity, and a higher intake of green leafy vegetables was significantly associated with a lower incidence of GDM [75].

Apart from F&V, soy products also play an important role during pregnancy and after delivery, they provide the mother with main protein, vitamins, minerals, and other nutrients [61]. In addition to the nutrients mentioned above for maternal health, pigments in soy foods, such as isoflavones in soy, have been shown in several studies to have a positive effect on the prevention of diseases (e.g., cardiovascular disease, menopausal symptoms, etc.). Besides, the relationship between isoflavones in soy and depression symptoms in postmenopausal women has also been reported by a few studies. Therefore, since the causes of perinatal depression and menopausal depression are both characterized by ovarian hormone fluctuations, the potential relationship between PPD and soy isoflavones can be further discussed. There are several studies on healthy dietary patterns during pregnancy and postpartum that can reduce depressive symptoms and prevent PPD include soy products as a dietary feature of diet (e.g., Japanese cross-sectional study, 2010; Brazilian cohort study, 2014). In addition, associations between isoflavone intake and depressive symptoms were found in several cross-sectional studies. However, some other studies have shown that perimenopausal women taking soy isoflavone extracts do not improve depressive symptoms. Recently, data from several sources have suggested that intake of isoflavone in high soy products (e.g., tofu, boiled soybean, miso soup, etc.) is associated with the low incidence of depressive symptoms of pregnant women, and the

mechanism of this result is that high intake of isoflavones can increase the regulation of estrogen in adult hippocampal neurogenesis (e.g., anti-inflammatory effects, regulation of brain-derived neurotrophic factors), and thereby reduce the symptoms of gestational depression by participating in the repair of the hippocampus [76]. Although there is no relevant study to prove the relationship between PPD and legumes, the association between PPD and isoflavones can be further explored because of the positive effects of isoflavones on the mental health of pregnant women.

Plant-based foods are an important source of dietary fiber, which is a major part of a healthy diet. Historically, research investigating dietary fiber has focused on identifying its widespread use to regulate the gut, prevent chronic diseases (e.g., cardiovascular disease, diabetes, metabolic syndrome, etc.), and improve health [77]. But recently, there is a large number of published studies that have suggested a two-way regulation between gut flora and the brain, so the positive effect of dietary fiber on gut flora could potentially further improve depression. In a previous study, although it is unclear whether direct link mechanism between depression and dietary fiber, but the study found that increasing the intake of F&V fiber than the intake of cereal fiber is more likely to cope with emotions, and put forward that the mechanism is that dietary fiber fermentation in F&V is more likely to alter the intestinal flora and improve the mechanisms of inflammation. Also, some other studies have confirmed that the dietary fiber of F&V is easier to ferment because lactic acid bacteria contained in F&V have the functional characteristics of probiotics candidate bacteria, so it can change the fermentability. In addition, this previous study has proposed that soluble fiber is more likely to improve mental health because of its stronger fermentability [78]. Associations and non-association have been evaluated in a series of studies on the relationship between dietary fiber and depressive symptoms, and the differences in these findings may be related to population differences in these studies. So, a subsequent study, a comprehensive and representative sample of people, found a non-linear relationship between fiber intake and risk of depressive symptoms, and that consuming a diet rich in dietary fiber did have a protective effect on depressive symptoms. Besides, in the study of women's health, higher dietary fiber intake was associated with a reduction or remission of their depressive symptoms. And in exploring the possible mechanisms by which dietary fiber improves depression, in addition to those mentioned above, dietary fiber can also reduce postprandial blood glucose and inhibit the inflammatory process [79]. The potential relationship between PPD and dietary fiber is established because the vast majority of studies have reported that the occurrence of PPD is related to diseases containing inflammatory conditions due to their common biological mechanism, and chronic inflammation can be one of the causes of PPD, so the effective effect of dietary fiber intake on inflammatory markers may further affect PPD. In addition, a high fiber diet usually leads to weight loss to prevent obesity and reduce inflammation, and the previous literature review mentioned that obesity is an important risk factor for PPD, thus the studies in this aspect further support the positive effect of fiber on PPD. Besides,

dietary fiber intake during pregnancy may also play an indirect role in preventing PPD by regulating blood glucose and prevent GDM [18,19,77,80]. A recent animal study examining the direct relationship between PPD and dietary fiber has proved that high dietary fiber intake significantly inhibited appetite and thus prevented the development of PPD. And the reasons for this result could be a contributed in part to high dietary fiber intake regulating inflammatory response and intestinal flora remodeling through the production of short-chain fatty acids, and in part to inulin in dietary fiber regulating energy metabolism and fructo-oligosaccharide in dietary fiber regulating glucose and inhibiting appetite [81].

Although there are few independent studies on the relationship between plant-based foods during pregnancy and postpartum and PPD, it can serve as a bridge to the relationship between them by establishing a positive relationship between plant-based foods intake and depression. Most of plant-based foods improve the inflammatory response through their nutrients to improve mental illness, and the same mechanism of this action can also be applied to improve PPD. In addition, the consumption of plant-based foods during pregnancy has a beneficial effect on the prevention of obesity and GDM, thus indirectly preventing the occurrence of PPD.

### 2.3.1. Animal Source Food, Salt and Sugar

Animal source foods include fish, meat, milk, and eggs, etc., and these foods are important sources of calcium, iron, and omega-3 fatty acids during the postpartum period and pregnancy, which play a significant role in protecting the health of mothers and their children, such as preventing postpartum anemia and regulating immunity [61,62]. In the above review of the relationship between PPD and dietary pattern factors, it was found that some dietary patterns containing animal source foods either beneficial to PPD or conducive to PPD occurrence, so a further comprehensive review is needed. In addition, many unhealthy eating patterns (e.g., fast food, "western" diet) that contain meat are often associated with high levels of sugar and salt (e.g., processed red meat), thus foods rich in sugar and salt will be discussed together with animal source foods.

Seafood plays an important role during pregnancy and postpartum as it is a major food source of iodine and omega-3 fatty acids [61,62], and its effect on major depression and PPD has been proven. There are a series of historical studies in the area of seafood have found an association between seafood consumption and the prevalence of PPD, an association between fish consumption and the prevalence of major depression, and an association between regular fish consumption and self-reported depression. In subsequent studies, docosahexaenoic acid (DHA) (as a type of omega-3 fatty acid) and n-3 polyunsaturated fatty acids (n-3 PUFAs) were mentioned in seafood, which further explained the mechanism of the association between the intake of kinds of seafood during postpartum and PPD, because mothers with PPD tend to be deficient in n-3 PUFAs and DHA has reported by several studies. However, few prospective studies have shown that fish and n-3 PUFAs intake are not associated with the risk of PPD, but DHA may be associated with a slightly independent reduction in the risk

of PPD have been identified, and the mechanism of that may be related to the regulation of serotonin nervous system function (as DHA may inhibit signal transduction in the central nervous system). In addition, data from several sources have also found that DHA and fish consumption may have a significant protective effect on PPD in women who normally consume low amounts of fish, and the combination of eicosapentaenoic acid (EPA) (as a type of omega-3 fatty acid) and DHA in fish intake can alleviate depressive symptoms during pregnancy [82,83,84]. Meta-analysis studies such as that conducted by Li Fang et al. have investigated that a higher intake of fish can effectively prevent depression, and the analysis of the possible mechanism for three reasons, firstly may be due to the n-3 PUFAs by changing the membrane of the microstructure on the impact of neurotransmitter (i.e., Decreasing of n-3 PUFAs results in increased 5-HT<sub>2</sub> and decreased dopamine 2 receptor density in the frontal cortex), secondly may be due to the fish is rich in nutrients, such as high-quality protein and minerals, can have protection for depression happened, also may be due to healthy dietary pattern rich in fish can have a better nutritional status to indirect help reduce the risk of depression. Besides, some previous studies have speculated that differences in fish consumption, including the type of fish, the cooking method of fish, the amount of fish consumption, and the frequency of fish consumption may all have different effects on the management of depressive symptoms [85]. It is well established from a variety of Asian studies that the stronger association between increased fish intake and the risk of depression was in women, and this result may be due to physiological characteristics between the women (e.g., estrogen helps DHA biosynthetic). In addition, several studies have suggested the role of omega-3 fatty acids and EPA & DHA (as in omega-3 fatty acids) in fish (e.g., omega-3 fatty acids have anti-inflammatory properties, reduce the effects of oxidative stress and have a potent effect on neurotransmitters systems; EPA has a potential role in reducing inflammation; EPA and DHA play a role in reducing the oxidative stress that causes depression) [86,87]. Besides, what we know about that n-3 PUFAs have a dual role in the prevention and treatment of depression is largely based on observational studies. Further research showed that women with prenatal depression and PPD had significantly lower levels of n-3 PUFAs in their blood and that dietary supplements containing n-3 PUFAs during pregnancy and postpartum could help them reduce symptoms of depression. And dietary fish as a supplement of n-3 PUFAs is a better choice because several studies have proven a stronger correlation between n-3 PUFAs in dietary fish and blood n-3 PUFAs after dietary intake than n-3 PUFAs in other dietary foods. Except for the efficacy of n-3 PUFAs in fish, some other nutrients in fish (e.g., vitamin D, calcium) have also been shown to help reduce the prevention of perinatal depression [88]. Therefore, eating proper practice and reasonable amount of fish is an effective preventive measure against the occurrence of PPD.

Apart from kinds of seafood, the nutritional value of dairy products (e.g., protein, calcium, zinc, potassium, etc.) also makes them an important part of the diet of animal-derived sources during pregnancy and after delivery

[61,62]. Although an early cohort study has found that no link between dairy intake during pregnancy and the risk of PPD, subsequent cross-sectional studies of pregnancy have shown that an association between calcium intake (as mainly from dairy products) and the risk of depression. In addition, there are several further published studies describing the role of intake of yogurt and calcium in the incidence of depressive symptoms during pregnancy, and these studies have also suggested that increased yogurt intake during pregnancy may reduce depressive symptoms because calcium or other undetected nutrients in yogurt play a role. Moreover, studies such as those conducted by Torres et al., have begun to explain the possible mechanism by which increasing calcium reduces depression by regulating extracellular calcium fluctuations through the role of calcium ions on neurotransmitter processes [89]. A cohort study examining the relationship between dairy products and PPD has identified an independent association between increased milk intake during pregnancy and a reduced risk of PPD symptoms but failed to identify an effect of increased intake of total dairy products (including yogurt, cheese, etc.) during pregnancy on PPD. In addition, the protective mechanism of milk intake on PPD may be related to the beneficial bioactive substances (e.g., protein, vitamin, immunoglobulin, etc.) contained in milk, but this protective mechanism cannot be fully explained [90]. Therefore, increasing dairy products during pregnancy and postpartum, such as milk and yogurt, can not only ensure the nutritional needs of mothers but also effectively manage the occurrence and symptoms of PPD. And in addition to the dairy products, a protective effect of moderate consumption of red meat on depression has also been shown by some observational studies, and the mechanism of that may be related to the nutrients (e.g., vitamin B<sub>12</sub>, zinc, etc.) contained in red meat [91].

In addition to the benefits of animal-based foods for PPD, some animal-based foods also appear to increase the incidence of PPD. For example, although some of the fats provided by animal-based foods are essential in the diet, these foods (as most of these animal-based foods are high in oil or salt) can become a major source of unhealthy eating patterns if consumed in large amounts, and excessive consumption of these unhealthy diets can increase the risk of high cholesterol, PPD symptoms, and other factors. Moreover, as mentioned above, some foods that are high in salt and sugar (e.g., preserved foods, sweet drinks, cakes, etc.) are also part of such unhealthy dietary patterns that cause PPD. These types of foods not only have little nutritional value, but also provide a lot of calories, and may directly cause psychological disorders. Most “Western” diets are mainly made up of processed animal-based foods rich in saturated fatty acids, and these unhealthy high-fat diet not only affect the human body’s homeostasis and brain health, but also cause obesity, type 2 diabetes (T2D), and other diseases. There are some studies have shown that diabetes mellitus (e.g., T2D, GDM) and depression (e.g., PPD) have common pathophysiological characteristics (e.g., inflammation, increased cortical expression, decreased expression of neurotrophic factors, etc.), and obesity triggers inflammation in the central nervous system (as leads to dysregulation of 5-hydroxyserotonin (5-HT) in the central

nervous system) that causes depression (e.g., PPD). Therefore, processed animal-based foods rich in fat to cause obesity and diabetes can be used as a bridge between them and PPD. Also, evidence from several other studies has directly proven that such unhealthy diets rich in fat reduce the volume of the hippocampus to increase susceptibility to depression [81,92]. Besides, eating processed red meat (as is high in saturated fat) promotes inflammation to increase the development and progression of depression has been shown by a lot of studies, and the reason for that can be related to the consumption of nitrates and some other components in processed meat. Also, intake of high-fat meat or processed red meat can further increase the risk of depression by causing adverse cardiovascular effects on pro-inflammatory activities (e.g., microvascular dysfunction) [91]. Except for the effect of processed red meat on depression, several studies have identified the role of unprocessed red meat consumption in the development of depression, and there is three biological mechanism causes associated with high red meat intake and a higher risk of depression, including: 1) The cholesterol and other nutrient substances in red meat are risk factors for some chronic diseases (e.g., obesity, CVD, etc.), and the occurrence of these chronic diseases can lead to inflammation (or systemic oxidative stress); 2) Some components (e.g., Arachidonic acid) contained in red meat can synthesize inflammatory mediators and cause the imbalance of inflammatory levels; 3) Animal protein in red meat can lead to changes in intestinal flora (e.g. increase in Bacteroides) and thus affect the communication system with the brain. Moreover, several recent studies have further shown that reducing red meat consumption can be used to treat depression [93]. Therefore, the intake of red meat in the prenatal and postnatal diet is still not recommended considering that red meat has both a positive protective effect and a negative aggravation effect on PPD. In addition, as mentioned above, sugar accounts for a large proportion of unhealthy diet and also plays an important role in the unhealthy diet on PPD. Several cross-sectional studies have shown an association between sugar consumption and the risk of depression, and higher consumption of soft drinks and pastries is associated with a significantly increased risk of depression. And there are five possible incentives for depression caused by high sugar intake, including: 1) High sugar intake can affect the level of brain-derived neurotrophic factor to lead to hippocampal atrophy and depression; 2) Carbohydrate consumption in a high-sugar diet causes an increase in inflammatory markers that inhibit mood; 3) The effect of high sugar intake on insulin levels; 4) The effect of frequent sugar intake on dopaminergic neurotransmission mechanisms; 5) Obesity caused by high sugar intake is a mediator between it and depression. Besides, further prospective studies have reported that sugar intake from sweets and beverages is associated with depression, and in turn may lead to increased sugar intake when depression occurs, and such phenomenon of interaction can lead to relapse or exacerbation of depression [94]. Also, meta-analysis studies exploring the relationship between sweetened beverages consumption and the risk of depression such as that conducted by Hu et al. (2019) have found that increased sweetened beverage consumption increased the

risk of depression in a non-linear dose-response relationship, with a threshold of 2 cups of cola per day (as the risk of depression may increase significantly when this threshold is exceeded). Besides, the biological explanation that sweet drink consumption can cause depression is that sweet drink contains a large amount of sugar. As mentioned in the literature review above, sugar consumption can directly cause depression (e.g., Causing the disorder of stress response and the increase of glucocorticoids; Stimulation of the hypothalamic axis involved in the development of depression; A two-way relationship between depression and obesity and between depression and type 2 diabetes) [95]. Therefore, animal-based foods with a high salt or excessive fat and foods with high sugar should be tried to avoid eating during pregnancy and postpartum, because they may cause obesity and inflammation, which can lead to PPD.

Overall, when consuming animal source foods to supplement the nutrients needed during pregnancy or postpartum, it is also necessary to consider their types and cooking methods to ensure that maternal health can be maintained and PPD can be actively and effectively prevented or managed by reducing the incidence of risk factors such as GDM and obesity.

## 2.4. Nutrient

Pregnant and breastfeeding women need to get enough nutrients by choosing nutrient-rich foods to ensure good health status. These nutrient-rich foods also provide a host of disease-prevention nutrients, such as vitamin D, zinc, and iodine, etc. [61,62]. In the literature review above, nutrients play a significant and direct role in both healthy eating patterns and food groups that help manage PPD. Therefore, the effects of various nutrients on PPD and their roles in all kinds of foods need to be reviewed and discussed in more detail.

### 2.4.1. Zinc

Demand for various minerals (including zinc) increases during pregnancy and postpartum. Intake of zinc (Zn) can help maintain the appetite and immunity of pregnant women and new mothers, and most food sources of Zn are malt, fish, lean meat, etc. [61,62]. Previous studies on Zn have confirmed its significance in physiological aspects, including aid in development, treatment of gastrointestinal and skin-related diseases, and regulation of mood disorders, etc. And these previous studies have also shown that people with depressive symptoms generally have low levels of Zn in their plasma, which may be related to mood affecting appetite and thus reducing dietary Zn intake. In addition, staying lower Zn status can continue to promote the development of depression has been found, and the mechanism of that may be related to the effect of Zn on neurotransmitter processes by causing cell membrane instability [96]. Subsequent studies have identified that Zn deficiency is relatively common in pregnancy (as possibly one of complications of pregnancy), and Zn deficiency can significantly and seriously affect maternal behavior, which may lead to emotional instability in women after delivery and even the development of PPD. And since there may be a link between PPD and Zn levels in blood tests, increasing Zn

intake through a Zn -containing diet is a potentially effective way to prevent or treat PPD has also been suggested [97]. Furthermore, in order to understand the reasons of Zn in improving depression, there are several reports and studies to mention the relevant mechanism of that, including: 1) The regulation of Zn on brain-derived neurotrophic factors in the hippocampus; 2) The antioxidant, anti-inflammatory, and immunomodulatory properties of Zn; 3) The beneficial effect of Zn on bone mineral density, which is associated with depression [141]. Besides, the data came from some observational studies that discussed that dietary Zn deficiency significantly increased the risk of major depressive disorder in women of child-bearing age, and that serum Zn levels in women (as Iranian women) were positively associated with their depressive symptoms. Moreover, these observational studies have also shown that dietary Zn deficiency can inhibit growth in humans (e.g., Zn's important role in DNA replication; Zn's role as a neurotransmitter in brain homeostasis, etc.) and reduce anti-depressant activity, so it is necessary to supplement Zn from a diet rich in Zn-containing foods [98]. In addition, it is worth mentioning that although a lot of studies have indicated that a strong independent association between Zn intake from diets and subsequent depressive symptoms in pregnant women (as intake of dietary Zn can be used as the adjustment of the mental disorders factor), there are still many pregnant women who do not consider Zn-rich foods when choosing their dietary patterns because of their socioeconomic status (as some foods high in zinc, such as oysters and red meat, are expensive). Therefore, external factors (e.g., personal financial ability) also need to be considered when using zinc supplements from diets to prevent or treat PPD [99]. A piece of evidence from experimental animal studies has proven that Zn supplementation can effectively reverse depression caused by zinc deficiency, and Zn combined with monoamine antidepressants can produce significant antidepressant effects in preclinical models. Besides, depression is also associated with reduced peripheral blood Zn levels, since serum Zn deficiency, which results from chronic dietary Zn deficiency (as lack of Zn intake from foods), can directly affect depression-related albumin levels and lead to depression [100]. However, although many studies mentioned above have examined the association of Zn with depression in pregnant and postpartum women, some further studies have argued that Zn supplementation does not interfere with PPD even though these postpartum women with PPD have lower levels of serum Zn in biochemical examinations [101,102]. But on the contrary, several recent studies examining Zn-rich foods have found a link between Zn and depression, for example, the protective effect of moderate consumption of Zn-rich red meat on depression has been proven, and the reason for that is Zn in red meat can inhibit the development of depressive symptoms by stimulating increased neurogenesis [91].

Although the role of Zn in regulating depression through various effects on the brain has been demonstrated in various studies, the role of Zn in PPD remains unclear (as there are conflicting arguments for and against this). Furthermore, Zn-rich food themes (e.g., red meat) have been shown to improve depressive symptoms in some studies, but due to the multiple

nutrients contained in these food themes, it is unclear whether the effect is Zn alone or in combination with other nutrients. Besides, although there is no definite evidence that dietary supplementation of Zn can improve PPD, the benefits of Zn in pregnant and postpartum women and its potential prevention and improvement effect on depression still indicate that foods containing Zn are a necessary component of dietary factors affecting PPD.

#### 2.4.2. Magnesium

During pregnancy and breastfeeding, the fetus and placenta absorb nutrients (as magnesium accounts for more and an essential component of the nutrients absorbed) from the umbilical cord and breast milk, but PPD has been linked to low levels of magnesium (Mg) in the mothers (e.g., lack of Mg intake from mothers' diets while providing Mg to their children) by several studies. Mg acts on the nervous system through a range of effects (e.g., the positive effect of neurotransmitter release, inhibition of neurotransmission associated with calcium-ion protein kinases, etc.) that regulate symptoms associated with mental disorders, such as depression [103].

Several subsequent studies of Zn and Mg on PPD have found an association between intake of Mg and treatment of depression (as Zn is not involved), and the data from these studies have also shown that patients with PPD have lower serum Mg levels on blood tests. Moreover, related studies have attempted to elucidate the mechanism of Mg's effect on PPD, including: 1) Its antidepressant activity as a potent antagonist of an amino acid receptor complex involved in the pathological process of depression; 2) It reduces depression by controlling hypothalamic-pituitary-adrenal activity and reducing hormone-releasing hormone levels [101]. Some other studies have identified the effect of Mg supplementation on PPD, and while Mg supplementation does not prevent PPD in non-depressed women, antidepressant supplementation with Mg intake can significantly reduce PPD symptom severity in women [102]. Furthermore, current studies have been controversial as to whether Mg supplementation (as from dietary aspects) can improve depressive symptoms by increasing levels of Mg in women (as some studies have shown significant effects and others have shown no association). Mg is a scarce micronutrient (as increased consumption of foods high in Mg should be encouraged in general) that is essential for the biochemical processes (e.g., DNA transcription, etc.) involved in emotional pathways (e.g., hormones, enzymes, neurotransmitters, etc.), and in addition to the above mentioned mechanism of Mg on PPD, several lines of evidence from recent studies have identified some other possible mechanisms of Mg on depressive symptoms, including: 1) The regulation of calcium (as the role of calcium channels and calcium balance in depression is mentioned in the review above); 2) Anti-inflammatory effects (as dietary Mg intake influences inflammatory markers, such as serum C-reactive protein, etc.); 3) Immunomodulatory effect; 4) Alter the role of the gut biota (as changes in the intestinal biota affect oxidative and inflammatory responses associated with depression); 5) Reduce the incidence of multiple chronic diseases, such as GDM and CVD (as risk factors for PPD); 6) Direct effects on brain

regions; 7) Regulation of vitamin D metabolism. Therefore, supplementation with Mg-related foods (e.g., green leafy vegetables, nuts, whole grains, etc.) or supplementation with Mg-medications may potentially improve PPD symptoms or prevent its occurrence by regulating Mg levels in the body and increasing the effects of Mg in depression regulation [104,105].

Among the healthy diets mentioned above that have effective effects on PPD, the role of Mg is also suggested. Although it is not clear whether the effect of Mg alone or in combination with other nutrients in foods, Mg-rich foods (e.g., nuts) can play a significant role in managing PPD has been proven. Therefore, supplementation of Mg (as from diets) during pregnancy and postpartum is crucial, not only to meet daily needs (as for the mothers themselves and their children) but also to prevent the occurrence of PPD by regulating the mood through Mg's biochemical functions. However, there are no current studies specifically focused on the direct effects of Mg in an Mg-rich diet on PPD, thus relevant studies are needed to further confirm this potential effect in the future. Besides, it is worth mentioning that supplementation with a diet rich in both Zn and Mg is also a potentially effective intervention for PPD in conjunction with the discussion of various studies.

#### 2.4.3. Iron

Iron is a mineral used in the diet during pregnancy (or postpartum period) to support fetal development and growth (e.g., brain growth) and to prevent certain diseases (e.g., anemia) in pregnant women, and it can be obtained from pork, animal liver, flowering cabbage, etc. [61,62]. According to relevant statistical data, iron deficiency is common among women (as accounts for 50% worldwide, and postpartum women account for the majority), and there is a correlation between postpartum hemoglobin concentration and postpartum iron status and PPD, based on several previous studies on postpartum mothers who did not consume enough iron in their diet and significantly developed symptoms (e.g., depression, anxiety, etc.) [106,107]. Besides, not only does iron play a necessary role in regulating brain functions (e.g., the regulation of neurotransmitter catabolism and hormones), it is also a part of the formation of many essential proteins and enzymes, and cofactors (e.g., hemoglobin, neurotransmitter synthase, etc.). Hence, in light of the physiological and biochemical functions of iron mentioned above, some studies have begun to examine the impact of iron deficiency on women's mental health, and have found that deficiency of iron and hemoglobin can have devastating effects on psychological aspects (as leading to depression) following biochemical tests in many PPD women. Also, subsequent research has shown that postpartum women who develop iron deficiency anemia after giving birth are more likely to have depressive symptoms [103]. A large number of studies such as that conducted by Aubuchon-Endsley et al. (2012) have identified iron as an important protective factor in the occurrence of PPD that can be reduced by dietary interventions (as containing iron diets) and iron supplementation. In addition, a significant association between mineral supplements (including iron) and the occurrence of PPD has also been demonstrated in some

exploratory research. Further studies have indicated that the use of iron supplements to intervene in the symptoms of mothers with PPD is related to the relative dose of iron supplements, but those studies cannot provide an exact range of recommended iron supplements for patients with PPD. Moreover, numerous studies have attempted to explain the possible mechanisms of iron that can improve depression-related symptoms, including: 1) The effect of iron on the production of oxidation-related proteins and enzymes (e.g., cytochrome C, which is a protein involved in depression); 2) The effect of iron on various neurotransmitters (e.g., the proportional association between iron concentration and dopamine function levels); 3) Potential mechanisms of action of iron on neurons (e.g., iron intervention on amino acid metabolism) [108]. However, despite the many studies mentioned above that anemia as a risk factor for PPD can be intervened by iron, there is still a piece of evidence of research that has argued that no relationship between iron and PPD, and the reason for that has two parts, in part because researchers have suggested that through the complementary composite supplements (as including vitamins and minerals) to intervene PPD that iron seems to account for very little of effect, another part of the reason is that several of these studies have reported that the occurrence of postpartum anemia is associated with other factors, such as postpartum bleeding (as that the PPD of these women may be related to those adverse experience of childbirth). Also, it is worth mentioning that it has been difficult to determine whether iron is the primary factor or whether other nutrients are the primary factor (or a combination of all nutrients) in regulating maternal mood by supplementing iron-rich foods. In addition, the absence of a correlation between hemoglobin regulation and iron supplementation during pregnancy has also been noted in several studies (i.e., reduced hemoglobin levels are influenced by many factors, such as inflammation) [109]. Up to now, most studies have demonstrated that iron supplementation is an effective means to prevent and improve PPD symptoms in clinical practice [110]. Therefore, supplementation with iron-rich foods can also be an effective dietary measure to potentially interfere with anemia or inflammation and thus improve PPD. In the above review of vegetables and animal-based foods on PPD, the significant role of iron in these kinds of foods has also been mentioned, for example, iron has a regulatory effect on neurotransmitters that protect PPD-related connections. Although few studies have specifically investigated the therapeutic or preventive effects of iron-rich foods on PPD, eating iron-rich foods during pregnancy and postpartum is still a potentially effective dietary factor for PPD intervention, based on iron's intervention of risk factors for PPD and iron's own protective effects on PPD.

#### 2.4.4. Calcium

Supplementation with calcium (Ca)-rich foods (e.g., dairy products, vegetables, fish eaten by the bones, etc.) during pregnancy and the postpartum period is often used to prevent the occurrence of some diseases, such as premature birth [61]. However, the effect of Ca and Ca-rich dairy products on depressive symptoms is also gaining attention, with an early study finding that intake

of Ca may have a protective effect on depressive symptoms in pregnant women. An independent association was also found in a cross-sectional study that looked at Ca intake (as supplemented with yogurt) and depression in pregnant women, and some other studies have shown that Ca intake from foods (or intake from Ca carbonate) has significant protection on depression. Furthermore, some subsequent studies have begun to explain the mechanism of Ca regulation on depression, which may be related to the process of Ca ion formation and excitatory transmission between neurons, and when increasing calcium intake (i.e., increasing calcium concentration in the body) may reduce depressive symptoms by adjusting the fluctuation of Ca ions outside the cell [89]. And the role of Ca in milk's effect on PPD was also mentioned in a previous cohort study, but it was not clear whether Ca had an independent protective effect [90]. In addition, according to the two-way effect between bone mineral density and depressive symptoms mentioned in the review above, intake of Ca may have a potential role in reducing depression as a bone health-related factor (e.g., maintain bone density) [111,141]. Recent studies have suggested that dietary Ca intake from diets may act as a mediator in reducing the risk of some non-communicable diseases, such as obesity, metabolic syndrome, etc., and the reason for that is the intake of Ca can reduce inflammatory reaction by reducing the circulation of some hormone (e.g., parathyroid hormone) levels or regulating the production of related inflammatory cytokines [112]. Therefore, the moderating effect of Ca on these PPD inducements can further prove the potential intervention effect of consuming a Ca-rich diet on PPD. To date, several studies have demonstrated that vitamin D can regulate Ca or the combined effect of vitamin D and Ca to prevent PPD, although the direct protection of Ca from foods against PPD is not clear, supplementation with a Ca-rich diet before and after birth may be effective in protecting bone development and other chronic diseases (as risk factors of PPD), and thus potentially preventing PPD.

#### 2.4.5. Selenium

Selenium (Se) is a mineral that can be fully supplemented from the diet (as Se-rich foods include seafood, lean meat, nuts, etc.), and its health effect in the human body makes it play an effective protective role in the management and treatment of PPD. A large body of evidence from research has clearly demonstrated the necessary role of Se in human physiological metabolism, such as its anti-inflammatory effects on the immune system (as Se-formed enzymes act as antioxidants to limit the production of pro-inflammatory cytokines). Previous studies have found that levels of Se in the body influence the development of depression, and have also suggested that the combination of Se and antioxidants, such as vitamin C, can help improve psychological problems effectively. Further studies have reported that only people with low Se levels were able to take Se supplements to improve mental health. In addition, several studies have shown that consuming a high-Se diet increases levels of Se in the body and reduce mood disorders. Besides, some subsequent studies have attempted to explain the mechanism of Se on depression and proposed three

possible mechanisms, including: 1) the effect of Se-formed enzymes on thyroid function; 2) the effect of Se level on the regulation of dopamine metabolism; 3) The immune function of Se. Moreover, data from several studies showing an association between Se and PPD have found that intervention with Se supplementation in postpartum women can reduce the incidence of PPD. However, although there is a large body of evidence that intake of Se is an effective intervention for mental disorders, some other studies have argued that no association between supplementation with Se and mood improvement [113]. The effectiveness of prenatal supplementation of various nutrients in reducing PPD and Se plays a key role in these nutrients has been demonstrated in a series of studies such as those conducted by Leung et al. [114]. What's more, several lines of evidence from some studies have pointed out that due to the physiological functions of Se is of vital importance in brain function (e.g., metabolic processes in the brain), which makes it an effective nutrient for preventing the happening of the PPD during pregnancy. Also, relevant statistics from those studies have further suggested that Se is beneficial for women during pregnancy to prevent PPD since pregnant women generally tend to have lower serum Se concentrations [107]. Thus far, a recent prospective study has explored that intake of Se from the daily diet (as dietary patterns include foods like bread made from kinds of wheat rich in Se) does not appear to affect plasma Se concentrations, but increased intake of Se from Se-rich foods does have a potential reduced effect on the incidence of PPD (as although the mechanism and conclusion are not fully determined) [115]. Although there are few studies on Se-rich foods and PPD at present, the use of Se-rich dietary patterns to intervene and manage PPD is worth further exploration and research due to the vital role of Se in anti-depression.

#### 2.4.6. Vitamin D

Supplementing foods rich in vitamin D, such as salmon, eel, liver, and eggs, etc., is an important part of a healthy diet during pregnancy and the postpartum period [62]. About the mental effects of vitamin D, some previous studies have found that levels of vitamin D can influence an increase in depressive symptoms in the general population, and have also reported a role of vitamin D<sub>3</sub> in depressive symptoms (as there has been debate over whether supplementation has an effect in a given season or does not have an effect). Besides, a small number of studies have begun to mention the effect of vitamin D on postpartum mood disorders, and subsequent studies have proven that low levels of vitamin D during the third trimester of pregnancy are associated with a higher risk of PPD symptoms three days after delivery, so one way to prevent PPD is to get enough vitamin D (as from foods or vitamin supplements) during pregnancy [116]. Moreover, in some prospective study found that pregnant women in different periods of the lack of vitamin D has significant effects on varying degrees of PPD symptoms, and some of the research has also pointed out that vitamin D is a kind of can synthetic potential nerve steroids in the body, by regulating the immune system (e.g., cellular immunity, humoral immunity) and the motor system to improve PPD

(as these systems are closely related to the symptoms of depression, such as fatigue, movement function, etc.). In addition, excessive vitamin D requirements of fetuses and infants from pregnant women and breastfeeding mothers may also contribute to PPD formation [117]. Furthermore, a series of data has shown that vitamin D deficiency caused by improper diet during pregnancy resulting in PPD is also related to some other factors, such as inflammatory reaction (as vitamin D anti-inflammatory effects can inhibit the brain of the mother environment affected by inflammation), hormone adjustment (as vitamin D's role in promoting absorption of calcium can adjust boost estrogen levels), the risk of diabetes and CVD (as vitamin D protects against these risk factors that cause PPD). Therefore, vitamin D supplementation (as from diets or supplements) during pregnancy is an effective and safe measure to intervene and prevent PPD [118,119,120,121], and the protective effect of vitamin supplements (e.g., vitamin D<sub>3</sub>) intake on PPD has been demonstrated in relevant RCT studies [122]. After understanding the mechanism of vitamin D on PPD and the effective effect of this type of vitamin supplementation on PPD, the effect of vitamin D-rich foods on PPD can be further discussed. In the related studies on PPD of dairy products and fish (as fish oil) in animal-derived foods mentioned above, the effective role of vitamin D in these foods has been found. However, the role of vitamin D in these foods have the effect of prevention of PPD is mostly combined with other nutrients (e.g., calcium), so its independent role in food items still needs more research to explore [88,89,90]. Besides, although a small number of studies have begun to examine the relationship between the use of a vitamin D-rich diet alone during pregnancy and the prevention of PPD symptoms, the quality and the statistical evidence of the studies are still insufficient to support the establishment of such a relationship. But anyway, based on the biological mechanism of vitamin D in the body and the effectiveness of its supplements, it is the potential to prevent PPD with a diet rich in vitamin D, therefore, more high-quality studies about that are needed in the future [123].

All in all, taking a vitamin D-rich diet during pregnancy and postpartum is essential to maintain nutritional status while regulating their mood, although the mechanism of such a diet rich in it alone still needs to be explored.

#### 2.4.7. Vitamin B

Some B vitamins are important for pregnant and postpartum women, such as folic acid (as helps prevent anemia in pregnant women), and also, foods rich in B vitamins, such as grains, are necessary for a healthy diet during pregnancy and postpartum [61,62]. In addition to the obvious effect of B vitamins on the prevention of mother and infant-related diseases (e.g., developmental diseases in infants), the possible role of B vitamins on mental disorders in women has been gradually explored. Although several early studies have not yet found some B vitamins (e.g., riboflavin) direct effect of PPD but these studies have put forward that the B vitamins (e.g., vitamin B<sub>2</sub>, folate, vitamin B<sub>12</sub>) on the role of the central nervous system function (as regulate the biosynthesis of the neurotransmitter), and that folate intake from diets or

levels of vitamin B<sub>6</sub> in plasma has an obvious correlation with depression [124]. Besides, although the occurrence of mood disorders is usually associated with deficiency of various B vitamins has been proven, most of the research on B vitamins for PPD has focused on folate (as possible because of its proven functions in metabolic circulation and neurological function, and its importance in the diet of pregnant and postpartum women) [125,126]. In addition, the effect of vitamin B<sub>9</sub> and B<sub>12</sub> on cardiovascular inflammation during amino acid conversion, the effect of vitamins B<sub>6</sub>, B<sub>9</sub>, and B<sub>12</sub> on hormone synthesis, and lower levels of vitamin B<sub>9</sub> in people with depressive symptoms, all have the potential to relate to B vitamins to the occurrence of depression have been suggested by several further studies. However, the previous evidence for the effect of these B vitamins on PPD is not significant, as most of these studies have found no association between vitamin B<sub>6</sub>, B<sub>9</sub> and B<sub>12</sub> and PPD (although a small number of studies have identified a possible association between vitamin B<sub>2</sub> and PPD, the relevant data evidence is insufficient) [107,113]. Recent studies confirmed the decision PPD nutritional factors include folic acid and vitamin B<sub>12</sub>, and also cohort studies such as those conducted by Yan et al. have indicated that long-term intake of vitamin B<sub>9</sub> (as from supplements) during pregnancy (as more than 6 months) can reduce the prevalence of PPD (as the long-term use of folate can significantly improve the levels of folate in women to activate the antidepressant related folate's physiological function). In addition, combining with the data from related studies' conclusions and the biochemical mechanisms of folate in depression mentioned above, intake enough level of vitamin B<sub>9</sub> during pregnancy can be a potentially effective intervention in the management of PPD. However, the relationship between PPD and folate remains controversial, for example, some current studies have still failed to establish an association, and some other studies have suggested that vitamin B<sub>9</sub> intake in pregnant women is only a protective factor of PPD rather than a therapeutic factor of PPD. All in all, research on folate or other B vitamins in PPD risk is limited, thus, the specific relationship between them cannot be concluded for certain at present. In addition, it is worth mentioning that in some countries, such as China, it is already common for women to take in more folate during pregnancy, which increases the interference factor of related research [127].

Although on the basis of the possible role of various B vitamins in PPD and the role of foods containing B vitamins in PPD (as has been mentioned in the previous review of healthy diets and plant-based foods in PPD), it remains unclear whether the role of B vitamins alone or in combination with other nutrients. However, dietary combinations contain multiple nutrients, and the protective nutrients of PPD are also diverse. Therefore, the appropriate addition of relevant B vitamins-containing foods during pregnancy and postpartum is recommended when determining the possible role of this kind of vitamin. Whereas, since there are so many types of B vitamins, the discussion of that can be made with more consideration for those that are more needed in the diets of pregnant and postpartum women, such as folate.

### 2.4.8. Fatty Acids

Some fatty acids, such as omega-3 fatty acids, have been shown to be beneficial to both pregnant and postpartum women (e.g., protecting brain development), and supplementation with them is commonly found in fish, such as salmon, spadefish, dace, etc. [61,62]. Since the protective effect of all kinds of fish on PPD has been gradually discovered, the mechanism of various fatty acids in fish on PPD has also been further explored. DHA and n-3 PUFAs may play a key role in reducing the risk of PPD through the intake of fish has been found in early cross-sectional studies. Several data from prospective studies have suggested that DHA from the diet may independently reduce the risk of PPD, and that continuous doses of DHA supplements can have a significant effect on the improvement of depressive symptoms. Also, those prospective studies have demonstrated that the possible mechanism of DHA action on PPD is related to the regulation of DHA on the central nervous system [82]. The concentration of fatty acids (e.g., EPA) in the blood affects the likelihood of depression and the consumption of omega-3 fatty acids in seafood can effectively reduce perinatal depression has also been confirmed by several previous studies [128]. Although there have been numerous studies related to PPD symptoms in pregnant and postpartum women due to their DHA deficiency, some studies have still argued that no association between dietary intake of various fatty acids (e.g., n-3 PUFAs) in fish and PPD, and the results of those studies have been contradictory with the results of some earlier studies [84]. Subsequent studies have shown that n-3 PUFAs inhibit the development of depression by acting on neuroprotective effects, such as regulating anti-stress and promoting cell membrane renewal [141]. A lot of evidence showing polyunsaturated fatty acid (PUFA) of depression may benefit by regulating the immune system has put forward two kinds of mechanism: 1) n-3 PUFAs can reduce some key inflammatory cytokine levels in the body to prevent depression-related inflammatory state; 2) n-3 PUFAs can regulate the process of the neurotransmitter. In addition, the protective effect of n-3 PUFAs on CVD, which has common pathogenesis with depression, has also been shown by several studies, and thus it can be further explained the possibility of the regulation of n-3 PUFAs level in the prevention of depression. Moreover, the data from some observational studies have shown that patients with depressive symptoms usually consume less n-3 PUFAs (as from the diet). As for the role of n-3 PUFAs in PPD, several studies have reported that PPD is caused by low n-3 PUFAs levels in pregnant and lactating mothers who are prone to lack of n-3 PUFAs (e.g., DHA) [113]. Subsequent studies have explored a clear relationship between dietary intake of omega-6 fatty acids and omega-3 fatty acids ratios during pregnancy and PPD, and those studies have also shown that increased maternal DHA concentration (as obtaining supplements from the diet) after delivery reduces PPD [129]. Besides, the size of the omega-6 fatty acids and omega-3 fatty acids ratios is associated with the pro-inflammatory cytokines involved in the development of depression has been further proven, thus some dietary guidelines (e.g., Dietary Guidelines for Americans) have been published that specify the appropriate proportion of omega-6 fatty acids and omega-

3 fatty acids in the daily diet and the daily amount of DHA intake (as from fatty acid-rich fish, nuts, and vegetables) for pregnant and postpartum women [107]. A large number of studies have gradually found that n-3 PUFAs may play a dual role in the management of PPD (including prevention and treatment) through the regulation of neurotransmitters, anti-inflammatory, antioxidant, and other neurological effects. In addition, data from several studies have shown that taking fatty acids (e.g., n-3 PUFAs) from foods has a greater effect on the level of fatty acids in the human body than taking supplements, but it is important to note that in studying the effects of fatty acid-rich foods (e.g., fish) on PPD, these foods also contain many other nutrients, such as vitamin D, that may help reduce the risk of PPD, so the strength of the individual role of fatty acids in these foods is not entirely clear [88,130]. Overall, obtaining some beneficial fatty acids from foods is an effective means to protect the occurrence of PPD, but the amount of fatty acids intake needs to be controlled to achieve a better effect.

**Application of nutrients in the management of PPD:** Various nutrients in foods may act individually or in combination to play a crucial role in preventing PPD. In addition to the nutrients mentioned above (as have significant effects on PPD) that have been extensively explored and studied, there are still some other nutrients (as although few studies have been conducted or have not yet been found) that play a beneficial role in pregnancy and postpartum that have the potential to manage PPD. For example, vitamin A (as from carrots, cod liver oil, etc.) has functioned as an immune modulator and a modulator of inflammatory cytokine levels, and it also ameliorates depression-related symptoms such as fatigue, so its potential effect on PPD and its role in some foods that have an effect on PPD deserves further investigation [61,131]; Iodine (as from egg yolk, kelp, seaweed, etc.) plays an obvious helping role in the health problems of pregnant women and lactating women, and as a trace element closely related to thyroid function (e.g., participating in the synthesis of thyroid hormone), it also has a physiological mechanism to inhibit the occurrence of PPD, although there are not many studies on it and no conclusions can be drawn [61,132]. Therefore, F&V (as contain nutrients such as vitamin C, folate, and iron) play a very important part in the prenatal and postnatal diet in the management of PPD, and kinds of seafood (as considering the role of omega-3 fatty acids, iodine, etc.) should be the first choice when choosing animal-based foods, but the intake of red meat should be moderate (as the effect of it and the nutrients it contains on PPD cannot be fully determined in relevant studies at present). To sum up, the combination of nutrients in various foods can improve prenatal and postnatal diets to manage PPD, but the specific ratio of various foods and which nutrients may reduce their own effect in the combined use still need to be further explored.

## 3. Discussion

According to the above literature summary, the development of appropriate recommended food types in the prenatal and postnatal diet can be a potentially

effective intervention to help alleviate PPD. And for the dietary recommendations, they need to take into account both the nutrient contents of all types of foods and the proportion of various food combinations. Although there are not many existing published studies on the relationship between the ratio of various foods and PPD, it is still possible to estimate the combinations of the types and amounts of foods consumed based on the ratios of nutrients that are more conducive to managing PPD and the more effective correlations between nutrients. Based on a review of all the literature mentioned above and Hong Kong dietary guidelines for pregnancy and postpartum, there is a summary of healthy foods in diets for the possible prevention or treatment of PPD. First of all, there is no optimal recommendation for the selection of fruit types because the current research has not pointed out which specific fruit has a particularly effective effect on PPD, but leafy vegetables (e.g., spinach) among vegetables are strongly recommended, and it is necessary for pregnant women and postpartum mothers to keep more than 5 servings of F&V in their daily diet (as this amount is guaranteed to reduce the incidence of depressive symptoms). Secondly, there is no specific recommendation on the type of legumes, grains, and nuts that should be consumed as long as they are consumed in moderation (as refer to the Med Diet for combinations of these kinds of food items in a dietary pattern). The next is that the meat food type choice is more advisable to eat kinds of seafood (as especially fish), because not only they can effectively manage for PPD, and also it is extremely important for pregnant women and postpartum mothers to get adequate nutritional supplements and prevent other underlying diseases. Besides, it is worth noting that red meat can be advised to consume in small amounts or not because of a lot of recent studies on the positive management of PPD, both for and against (as thus it is not specifically recommended for use in the dietary pattern of PPD management). Last but not the least, the intake of eggs and dairy products is necessary and effective, but foods rich in high sugar, high salt, and high

fat are highly advised not to include in the daily diet [61,62].

To sum up, only several relevant suggestions and guidance have been put forward on how to choose the appropriate food types and the appropriate amounts of food in the dietary pattern with prevention and mitigation of PPD. However, if we need to develop a stronger and more effective diet for PPD management in the future, it is still recommended to add some appropriate herbs (as the use of Chinese herbal medicine needs to be based on the diagnosis of pregnant and parturient Chinese medicine syndrome differentiation). Besides, the better combination of herbs and specific foods (as nutrients in food that have an effective effect on PPD) may have a potentially stronger effect on relieving or preventing PPD, thus that is worth further explore in future research. In addition, there are very limited studies on the effect of dietary factors on PPD in Hong Kong. Therefore, if a cohort study can be conducted under sufficient conditions (e.g., with sufficient manpower and material resources), the contents of dietary patterns of Hong Kong women during pregnancy can be collected and better associated with PPD. Although this paper is a comprehensive review of the influence of various dietary factors on PPD, some dietary factors may not be applicable to reduce the incidence of PPD in Hong Kong women due to regional dietary differences. Therefore, further studies on dietary factors for the management of PPD that are more in line with the dietary habits of Hong Kong women are needed.

After reviewing the definite or potential effects of various dietary factors on PPD, this paper will further classify these dietary factors (as the selected studies are almost all studies that directly examine the relationship between diet/food/nutrient and PPD) according to the level of evidence of various study designs [133], the sample size, the risk of bias, and the conclusions of related studies. Then, this paper will evaluate and provide the corresponding degrees of recommendations. Dietary recommendations are shown in the following three tables:

**Table 1. Recommended healthy diets for preventing or managing PPD**

Reference	Types of dietary pattern	Period of use	Study design	Recommended level
Opie et al., 2020 [3]	Follow the principles of a healthy eating pattern that includes fruits, vegetables, legumes, nuts, and whole grains, as well as foods that are low in sugar, fat, and salt	Postpartum	Systematic Review	Beneficial
Chatzi et al., 2011 [134]	Diet (including vegetables, fruits, pulses, nuts, dairy products, fish, and olive oil)	Pregnancy	Cohort	Beneficial
Teo et al., 2018 [26]	Traditional-Indian-Confinement diet (including ethnic bread, Indian herbs, whole milk, seed herbs, butter/ghee, curry-based gravies, legumes/pulses, allium, coffee/tea, garlic, and white bread) Soup-Vegetables-Fruits diet [including vegetable/meat/fish/seafood soup, noodles (in soup), vegetables (cruciferous, leafy, yellow/orange/red, and other vegetables), and stir fried/boiled potato]	Postpartum	Cohort	Beneficial
Barker et al., 2013 [135]	Diet (including white fish/ tuna/other fish, pulses/nuts/soya meat, and cabbage/green vegetables/carrots/other root vegetables)	Postpartum	Longitudinal	Beneficial
Rienks et al., 2013 [14]	Mediterranean-style diet	/	Cohort	Good
Shi et al., 2020 [136]	Diet (including higher vegetable, fruit, fish, and poultry consumption, but lower meat consumption)	Pregnancy	Case-control	Good
Cao et al., 2020 [15]	Diet based on seafood or nuts-fruits	Pregnancy	Case-control	Good

**Table 2. Recommended healthy foods for preventing or managing PPD**

Reference	Types of food	Period of use	Study design	Recommended level
Hibbeln, 2002 [95]	Seafood	/	Ecological analysis	Beneficial
Miyake et al., 2006 [124]	Seaweed (functional nutrient: Vitamin B2)	Pregnancy	Cohort	Beneficial
Hamazaki et al., 2018 [137]	Fish [functional nutrients: omega-3 fatty acids (DHA+EPA)]	Pregnancy	Cohort	Beneficial
Miyake et al., 2016 [90]	Milk (functional nutrients: Vitamin D, Calcium)	Pregnancy	Cohort	Beneficial
Mihrshahi et al., 2015 [75] Baharzadeh et al., 2018 [72]	Fruit and Vegetable	/	Cohort	Good
Zhao, J., 2020 [74]	Vegetable	Postpartum	Cross-sectional	
Miyake et al., 2015 [89]	Yogurt (functional nutrient: Calcium)	Pregnancy	Cross-sectional	Good

**Table 3. Recommended nutrients (from food sources or supplements) for preventing or managing PPD**

Reference	Types of nutrient	Period of use	Study design	Recommended level
Amiri et al., 2019 [119] Vaziri et al., 2016 [122] Gur et al., 2014 [88] Robinson et al., 2014 [116]	Vitamin D	/	Systematic review Randomized Controlled Trial Cohort Cohort	Beneficial
Tian et al., 2020 [110] Sheikh et al., 2017 [108]	Iron	/	Systematic review & Meta-analysis Randomized Controlled Trial	Beneficial
Harrison-Hohner et al., 2001 [138] Miyake et al., 2015 [89]	Calcium	Postpartum Pregnancy	Randomized Controlled Trial Cross-sectional	Beneficial
Paoletti et al., 2013 [139]	Vitamins (Vitamin A, B, C, D, E) + Minerals (Ca, Fe, Mg, Mn, Cu, P, Zn) / Calcium + Vitamin D	/	Randomized Controlled Trial	Beneficial
Judge et al., 2014 [140]	DHA	Pregnancy	Randomized Controlled Trial	Beneficial
Wang et al., 2020 [132]	Iodine	Pregnancy	Randomized Controlled Trial	Beneficial
Miyake et al., 2006 [124] Yan et al., 2017 [127]	B Vitamins (Vitamin B2, B6, B9, B12)	Pregnancy	Cohort	Good
Leung et al., 2013 [114]	Selenium	Pregnancy	Cohort	Good
Lin et al., 2019 [130]	n-3 PUFAs/Vitamin B2	Postpartum	Cross-sectional	Good
/	Zinc/Magnesium/Vitamin A	/	/	---

Several studies of some dietary factors with the potential role in PPD were excluded from the tables of recommended dietary factors shown above. Because while these dietary factors may be effective in the prevention or management of depressive symptoms through some of their components or nutrients, and considering that the commonality between depression (as occurring in pregnant women or the general population) and PPD may have an underlying mechanism for PPD, However, the exact effect still needs to be proved by a large number of further studies (e.g., the cohort study).

#### 4. Conclusion

This literature review provides evidence of the impact of prenatal and postnatal dietary factors on PPD symptoms. Specifically, the intake of healthy eating patterns (e.g., Med Diet, Chinese medicated diet) and certain food items (e.g., kinds of seafood, fruits, vegetables, dairy products, etc.) may play an effective role in the prevention and treatment of the onset and development of PPD through the nutrients they contain (e.g., vitamin D, Zn, Mg, etc.) have been explored by recent studies. Although studies of the effects of some nutrients and foods on PPD have shown mixed results, the way of diet management of PPD is more acceptable and feasible for pregnant and lactating postpartum women, because diet factors are closely related to their lives, and Hong Kong women usually pay more attention to their nutrition during pregnancy and

postpartum. Therefore, considering that dietary intervention with PPD can significantly reduce the possible side effects on pregnant and postpartum women compared with drug intervention with PPD, how to match the optimal dietary strategy for PPD intervention is still a potentially important direction of future research, and more longitudinal studies in Hong Kong women are needed to further prove its effectiveness.

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