The Impact of Dietary Management on Gestational Diabetes Mellitus and Its Complications

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Abstract. Given the numerous factors affecting both the mother and fetus, the incidence of complications related to gestational diabetes mellitus (GDM) is increasing. Consequently, research on GDM is extensive, and its prevalence continues to rise annually. Awareness of GDM is growing, and due to its associated risks, dietary management strategies have become one of the more common interventions. Among the prevalent dietary interventions for GDM, medical nutrition therapy (MNT) and the Mediterranean diet have been frequently utilized. Combining dietary management with exercise and lifestyle modifications has shown promising results in treating GDM. Current research primarily focuses on dietary management for GDM, but supplementation of other nutrients remains insufficient, and patient compliance is still lacking. Some research methodologies also suffer from incomplete data. This paper reviews the progress in studies related to MNT and other common treatment methods, identifying current treatment approaches, their status, and existing challenges. It aims to provide a foundational reference for future research, highlighting the need to refine nutrient supplementation strategies tailored to individual patient needs to improve compliance.

Keywords: gestational diabetes mellitus, risk factors, dietary approaches.

1. Introduction

Gestational Diabetes Mellitus (GDM) refers to a state of glucose intolerance that occurs during pregnancy, leading to abnormalities in glucose metabolism. It is characterized by the onset of diabetes in women who did not have glucose intolerance prior to pregnancy. GDM is the most common pregnancy complication worldwide, affecting one in seven pregnant women; in China, the prevalence of GDM ranges from 5.1% to 33.3%, showing an increasing trend year by year [1]. According to the International Diabetes Federation, patients with GDM may experience symptoms such as thirst, fatigue, and blurred vision, and it is recommended to conduct early screenings if related symptoms arise during pregnancy. GDM can significantly impact the growth and development of both the mother and fetus. Pregnant women with GDM often experience insulin resistance, which can lead to inflammation, subsequent infections, pregnancy-induced hypertension, and an increased risk of developing type 2 diabetes mellitus (T2DM) postpartum. Additionally, it may adversely affect the fetus, resulting in complications such as respiratory distress syndrome, macrosomia, and neonatal hyperglycemia [2].

Due to the risks posed by GDM to pregnant women, dietary intervention has become one of the key treatment methods for GDM. Currently, research on dietary interventions is growing, including approaches such as low-glycemic index (LGI) diets, self-family-environment empowerment (SFEE), and MNT based on the Mediterranean diet. These interventions have shown some improvements in GDM and its complications. However, many methods remain underdeveloped, and both pregnant women and their families have limited understanding of GDM. Therefore, this study aims to investigate the impact of nutrients and related complications on GDM, considering the increased glucose demands during pregnancy and the resulting insufficient insulin secretion and increased resistance. The research will also explore the therapeutic effects of MNT on patients with gestational diabetes, thereby evaluating the effectiveness of dietary management in addressing GDM and its complications, ultimately seeking to improve GDM outcomes and reduce complications for both mothers and fetuses.

2. Risk Factors

2.1. The Impact of Different Nutrients on GDM

Scientifically controlling nutrient intake can help maintain blood glucose homeostasis and provide necessary nutrition during pregnancy. The intake of different nutrients affects GDM and its complications. Carbohydrates (CHO) have a more significant impact on low GI than other nutrients; carbohydrates with a high GI can cause rapid blood glucose fluctuations. Consuming low-GI foods can reduce the incidence of GDM and decrease adverse maternal and fetal outcomes. Studies indicate that, compared to typical low-carbohydrate controls, complex carbohydrates can improve GDM. Experimental evidence supports the correlation between carbohydrates and GDM, suggesting the consumption of unprocessed whole grains and other low-GI foods to help control blood glucose levels [3].Fats are also important factors for fasting plasma glucose (FPG) and postprandial glucose (PPG); animal fats and cholesterol are associated with increased GDM risk, while plant proteins may reduce this risk [4].Therefore, it is advisable to limit red meat intake and be cautious of fish with high methylmercury content. Combining plant proteins can ensure adequate nutrition while controlling total protein intake, thereby not adversely affecting GDM. Additionally, vitamins and minerals are essential during pregnancy; for instance, folic acid is crucial for fetal growth and can prevent anemia and neural tube defects. However, excessive intake of vitamins and minerals can also be harmful; for example, excessive vitamin A may negatively affect the fetus. Foods high in fiber benefit blood glucose control and reduce the risk of complications, so increasing the intake of fiber-rich fruits and vegetables is recommended. Research shows that GDM patients' blood glucose levels are related to CHO, fats, and proteins, with a recommended intake ratio of 60%, 25%, and 15%, respectively, being more beneficial for GDM control compared to LGI diets [3]. Moreover, controlling nutrient intake facilitates monitoring the patients' condition, allowing for timely adjustments in nutrition to manage GDM. Research on dietary control can ease the recording and management of risk factors.

2.2. Patient Factors Leading to GDM

While the exact causes of GDM are not clear, obesity increases the likelihood of developing GDM during pregnancy. Furthermore, weight gain and BMI that do not align with the recommendations from the Institute of Medicine (IOM) can exacerbate GDM complications and increase future obesity risk for the fetus [4]. Some experiments suggest that controlling BMI and GI before and during pregnancy reduces the risk of complications in children; however, GI remains correlated with childhood obesity [5]. According to the recommendations of the Institute of Medicine (IOM), pregnant women with GDM are advised against weight loss and should instead focus on managing weight gain during pregnancy. Given the adverse outcomes associated with GDM and its complications, as well as the risk of future diseases, it is essential for pregnant women to maintain a healthy lifestyle and implement a well-structured dietary plan to control blood glucose fluctuations and reduce the incidence of complications. Additionally, genetic factors are recognized as a risk for GDM. Research indicates that a family history of diabetes significantly impacts the likelihood of developing GDM, with the risk increasing if one or both parents have diabetes [6]. Age is another critical factor influencing GDM risk; women aged 30 and older are at a higher risk compared to younger women, with the likelihood being 1.86 times greater [7]. Therefore, based on individual circumstances, early-pregnancy patients are advised to take preventive measures, schedule regular check-ups, and pay attention to daily lifestyle habits.

2.3. Future Risks Associated with GDM for Patients

Research indicates that GDM is associated with adverse outcomes for the fetus, including a higher risk of macrosomia, hyperglycemia, and even fetal mortality compared to women without GDM [8]. This is primarily due to insulin resistance in pregnant women, which results in elevated blood glucose levels being transmitted to the fetus, promoting excessive nutrient absorption and leading to conditions like macrosomia that affect fetal growth and development. Additionally, high blood sugar

levels can reduce hemoglobin binding, leading to hypoxia and contributing to other adverse outcomes [8]. Beyond the immediate risks to the fetus, women who have had GDM face a significantly increased risk of developing T2DM in the future. Studies show that the risk of T2DM is ten times greater in women who had GDM compared to healthy controls [9]. Therefore, GDM presents numerous risk factors for affected individuals, necessitating careful attention to lifestyle and dietary health during and after pregnancy to minimize the likelihood of disease development.

3. Dietary Planning and Management Interventions

3.1. Dietary Planning

According to the 2022 guidelines for the management of hyperglycemia in pregnancy, women should plan their dietary intake based on their pre-pregnancy body mass index (BMI) and the rate of weight gain during pregnancy. This involves controlling daily food intake and ensuring a balanced intake of the six essential nutrients: carbohydrates (CHO), fats, proteins, minerals, vitamins, and water. Nutritional interventions should be tailored to the individual circumstances of the pregnant woman, determining appropriate nutrient levels to manage GDM, monitor weight, and ensure adequate nutrition for both the mother and fetus, thereby reducing the risk of complications. Carbohydrates should primarily consist of low-glycemic, high-fiber foods to meet the developmental needs of both mother and fetus. Early in pregnancy, when uric acid levels may rise, it is advisable to consume fish in moderation and limit high-fat foods. The protein intake should be adjusted to increase the proportion of plant proteins, such as legumes, while monitoring animal protein consumption and red meat intake, with low-fat dairy products as a recommended option. Based on this discussion, it is suggested that mothers prioritize whole grains like buckwheat as staples, increase the consumption of high-fiber foods, limit fruit intake, and consume animal products with high-fat content sparingly, as well as minimize juice consumption. Attention should also be paid to vitamin and mineral supplementation; for instance, iron and calcium deficiencies are common during pregnancy, with a minimum calcium intake of 500 mg recommended and iron needs being tailored to individual circumstances. Moreover, specific minerals should be provided according to the nutritional needs of the pregnant woman [10]; Essential vitamins, such as folic acid and vitamin D, should be adequately supplemented, with vitamin D playing a role in reducing diabetes risk and folic acid being critical during pregnancy [10]. To improve GDM and stabilize glycemic levels, it is advisable to have smaller, more frequent meals and incorporate exercise as an adjunctive measure.

3.2. Methods of Dietary Management Interventions

Currently, there are many dietary management methods for GDM, including LGI diets, Mediterranean diets, and MNT. This paper primarily explores the impact of MNT-based dietary interventions on GDM and its complications. MNT involves individualized dietary planning for patients, aiming to control blood glucose levels within a specific range based on their glucose readings. The integration of MNT with physical activity and blood glucose monitoring is highly significant in the treatment of GDM. Combining exercise with MNT can more effectively manage GDM, as recommended by the German Diabetes Association (DDG), which advocates for self-monitoring of blood glucose (SMBG). This coordinated approach enhances adherence to the treatment plan and improves outcomes related to GDM and its complications. MNT aims to maintain adequate nutrition while keeping blood glucose levels within normal ranges, thereby improving insulin resistance. This method focuses on regulating the intake of carbohydrates, fats, and proteins, showing a certain degree of improvement in adverse perinatal outcomes associated with GDM and reducing the incidence of complications. Recent studies on MNT indicate that there has been insufficient research on dietary interventions in China, particularly regarding the balance of carbohydrates, fats, and proteins. Some studies have shown that the control over certain nutrients, like protein, does not meet standards (with only 52.45% of teams adhering to the guidelines), while control over carbohydrates can be overly stringent (with 63.77% of teams meeting standards), which may hinder the effective implementation

of MNT [11]. Certain nutrients significantly affect GDM, necessitating individualized treatment and ensuring adequate nutritional intake for pregnant women. The overly strict control of proteins, carbohydrates, and sugars can lead to insufficient or excessive intake, which may affect GI fluctuations, resulting in adverse outcomes and impacting the nutritional growth and development of both the mother and fetus. In Australia, a review of MNT practices over the past decade reveals ongoing issues with carbohydrate control, with significant variations in carbohydrate intake among patients. Adherence to guideline recommendations is generally low. Existing studies demonstrate that MNT can indeed improve GDM outcomes; however, the primary challenge remains to ensure that nutritionists adhere to these guidelines to appropriately enhance patient conditions through MNT [12]. Currently, MNT is a frontline treatment for GDM. However, many clinical settings struggle to achieve standard control of nutrient levels in individualized dietary plans, hindering optimal implementation and improvement for patients. Future developments should focus on identifying effective strategies to maximize the benefits of MNT for patients and reduce adverse outcomes. On the other hand, patient adherence to MNT remains a significant issue. It is essential to enhance patients' understanding of MNT to facilitate its effective implementation moving forward [13].

3.3. Current Other Dietary Approaches

The Mediterranean diet (MD) has shown notable success in managing GDM. As GDM primarily focuses on blood sugar control, a healthy dietary approach can effectively manage blood glucose levels and reduce the risk of complications. The MD is well-known for its health benefits, including lowering the risk of heart disease. It emphasizes the consumption of vegetables, whole grains, and fish, aligning well with the nutritional needs of GDM patients. A statistical analysis of relevant studies, after excluding redundant data, incorporated ten studies that demonstrated a beneficial impact of the MD on GDM, contributing positively to the reduction of adverse outcomes [14]. A low GI diet also plays a significant role in managing GDM. Low GI foods are digested more slowly, leading to a reduced spike in blood sugar levels, which helps stabilize blood glucose and improve GDM outcomes. Research has shown that low GI dietary interventions can enhance pregnancy outcomes by effectively controlling fluctuations in blood sugar levels [15]. There are many intervention strategies available for managing GDM. However, it is essential to ensure that interventions are carried out effectively, with adequate supplementation of various nutrients to improve maternal compliance. A combined approach that integrates dietary methods and exercise can effectively reduce adverse outcomes associated with GDM.

4. Conclusion

For patients with GDM, implementing exercise interventions can be challenging for some individuals, and certain medications may have negative side effects. In contrast, dietary management is generally more manageable and allows for easier control of food-related factors, making it more adaptable. This article outlines that dietary management can significantly improve outcomes for individuals with GDM. When combined with exercise and appropriate medication, it can effectively mitigate the impacts on both the patient and the fetus, thereby reducing adverse outcomes. However, there is currently a lack of sufficient sample sizes in research on dietary management for GDM, and its application in clinical settings is limited. Most dietary advice is provided informally by healthcare providers, with minimal impact on dietary management practices. It is essential to increase sample sizes to enhance data accuracy and ensure that findings are more widely applicable in clinical settings. Furthermore, there should be an emphasis on educating both patients and their families about relevant dietary knowledge and raising awareness through targeted campaigns. There is considerable potential for progress in the dietary management of GDM, with many opportunities for future development.

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