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Research Progress of Individualized Nutritional Intervention on the Impact of Gestational Diabetes

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ABSTRACT
Gestational diabetes mellitus, one of the diseases that predispose women during pregnancy, is a common metabolic abnormality during pregnancy. This disease may not only cause short and long term complications to the mother such as diabetes mellitus, hypertension, and obesity, but also the number of patients who suffer from gestational diabetes mellitus is increasing, and the prevalence of the disease is on the rise.Individualised nutritional interventions have been found to have a significant effect on gestational diabetes, but there is a lack of standardisation of intervention protocols in existing studies.The aim of this review is to systematically summarise the effects of individualised nutritional interventions and treatment strategies in clinical practice, and to provide a basis for the development of standardised individualised intervention protocols to enhance the practicality of GDM management.

KEYWORDS
Component; Individualized nutrition intervention; Pregnancy diabetes; Pregnancy outcome; Combined treatment strategy

1 Introduction

With the rapid development of China's economy and the significant improvement of the residents' material living standards, people's dietary structure presents to high calorie, high fat, high sugar intake offset, this nutritional structure imbalance phenomenon and the lack of exercise time to form a superimposed effect, China's adult residents overweight and obesity rate in the rising [1]. These factors are risk factors for pregnant women who may develop GDM [2], a disease that is closely linked to people's lifestyles and dietary habits, and poor dietary habits increase the risk of developing gestational diabetes in pregnant women [3].Therefore, it is important for pregnant women to strictly control their dietary intake during pregnancy to ensure the safety of maternal and infant health.

2 Definition and pathogenesis of gestational diabetes

Gestational diabetes mellitus(GDM) is a metabolic disease characterised by abnormalities in glucose metabolism that do not occur until pregnancy.In the early pregnancy, with the increase of the fetus' demand for nutrition in the mother's body, the secretion of insulin will be correspondingly increased in the pregnant woman's body, which will reduce the blood sugar level. When entering the middle and late pregnancy, the fluctuation of the hormone level in the pregnant woman's body will affect the insulin secretion level, which will inhibit the role of insulin, thus causing the increase of its blood sugar level, which may induce diabetes in pregnancy [4]. Diabetes during pregnancy may increase the risk of multiple complications of mothers and infants in the near and long term. Recent adverse complications such as macrosomia, fetal death, pre eclampsia, pregnancy induced hypertension syndrome, etc., and long-term adverse effects include the threat of obesity, type 2 diabetes, hypertension, and other complications that mothers and their offspring may face in the future [5].

3 Individualized nutrition intervention measures and methods for gestational diabetes

In traditional management, relying on health education intervention models often fails to achieve the desired outcomes; personalized interventions are necessary [6]. Unreasonable dietary structures during pregnancy can increase the risk of GDM. Developing a reasonable personalized diet plan not only helps maintain stable blood sugar levels for the mother but also meets the nutritional needs of both the mother and baby [7]. The effective implementation of personalized medical nutrition intervention in GDM management hinges on the patient's and their family members' ability to control blood sugar levels and adhere to treatment. Implementing precise nutritional intervention measures through a professional medical team can significantly enhance the effectiveness of the intervention [8].

Individualized nutritional interventions: ① Comprehensive assessment of pregnant women's metabolism and nutritional status: Professional nutritionists develop precise individualized dietary plans based on patients' BMI, dynamic changes in blood glucose levels, and actual nutritional conditions. Health ② education: Targeted health education for

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GDM patients, informing them about potential complications and risks associated with the disease, and explaining that nutritional intervention can control and reduce the occurrence of complications, thereby emphasizing the importance of diet control and improving their treatment compliance. ③ Development of a reasonable diet plan: Allocate daily energy intake for pregnant women at specific ratios—50% to 60% carbohydrates, 15% to 20% protein, and 25% to 30% fat, increase dietary fiber intake appropriately, choose low glycemic index (GI) foods (such as sweet potatoes, brown rice), use plant-based oils primarily for fats, and add more meal times on top of the three main meals per day. ④ Regular monitoring of blood glucose, BMI, and other indicators, with nursing staff guiding and supervising the pregnant women's daily diet, implementing management through online tracking methods such as WeChat follow-ups [9-11]. This structured intervention model effectively addresses the issues of poor patient compliance and insufficient implementation strength in traditional nutritional education by quantifying dietary management and utilizing digital tracking feedback mechanisms.

4 Clinical effects of individualized nutritional intervention

4.1 Improving blood glucose and lipid levels in GDM patients

4.1.1 Blood glucose indicators

Studies have shown that after personalized nutritional intervention, the fasting blood glucose (FPG), postprandial 2-hour blood glucose (2h PG), and glycated hemoglobin (HbA1c) levels in the observation group were significantly lower than those in the control group. This research result demonstrates that personalized nutritional intervention effectively controls blood sugar levels in pregnant women with gestational diabetes, significantly improving the efficacy of blood sugar control and ensuring maternal safety during pregnancy [12]. This finding corroborates the conclusions of multiple scholars, including Zhang Xiaorong, confirming that personalized nutrition plans can effectively enhance blood sugar control capabilities [13]. Blood sugar level changes in pregnant women with gestational diabetes are closely related to their pregnancy outcomes. Properly managing blood sugar fluctuations can improve the prognosis for these patients and reduce the risk of future complications. Personalized nutritional intervention allows for the creation of tailored dietary plans for GDM patients, and most pregnant women can achieve the goal of maintaining blood sugar within a certain range through effective control, thereby reducing the incidence of complications and providing crucial protection for maternal and neonatal safety, safeguarding the health of both the mother and the fetus.

4.1.2 Blood lipid indicators

The increase of triglyceride level may be a key factor in the pathogenesis of gestational diabetes. After intervention, the control of total cholesterol (TC), triacylglycerol (TG) and other levels in patients with gestational diabetes is significantly better than that in patients with GDM without intervention, and the incidence of adverse pregnancy outcomes is also lower than that in the control group [14]. In the study by Zhang Yan et al. [15], the results showed that personalized nutritional intervention can effectively regulate the blood pressure levels of pregnant women and reduce the cesarean section rate. By monitoring and controlling the TC, TG and other blood lipid levels of pregnant women with diabetes, and providing reasonable nutritional guidance, potential metabolic abnormalities can be found early, and timely intervention measures can be taken to control the nutritional intake of pregnant women.

4.2 Pregnancy outcomes and complications after individualized nutritional intervention

4.2.1 Pregnancy outcomes and complications of pregnant women

Research has confirmed that the incidence of postpartum complications (including premature rupture of membranes, postpartum hemorrhage, and gestational hypertension) in the observation group after individualized nutritional intervention is significantly lower than that in the control group [16], which is similar to the research conclusion of Fu Zhihua et al. [17]. The risk of complications is reduced after intervention. In Cai Suxia's study [18], it was found that the observation group had lower rates of cesarean section and polyhydramnios compared to the control group, but the difference in the incidence of postpartum hemorrhage and preeclampsia between the two groups was not significant. The difference in postpartum hemorrhage occurrence between the two studies may be due to differences in intervention measures. In summary, multiple studies have shown that personalized nutritional interventions can effectively alleviate the adverse effects of high blood sugar on pregnant women and fetuses, thereby improving the overall outcome of pregnancy [19].

4.2.2 Infant outcomes

Studies have shown that after nutritional intervention, the blood flow indicators of the umbilical and renal arteries (peak systolic to peak diastolic ratio (S/D), resistance index (RI), and pulsatility index (PI)) are significantly lower than those in the control group treated with conventional therapy [20]. From a pathological and physiological perspective, excessive

arterial resistance can affect the blood flow status of the fetus, thereby affecting its growth and development in the later stages. Individualized nutritional intervention for pregnant women can improve the blood flow status of the umbilical and renal arteries of the fetus. Research by Luo Xilan [21] found that the observation group receiving personalized nutritional intervention had a significantly lower probability of adverse neonatal outcomes such as neonatal death, intrauterine distress, neonatal asphyxia, and low-quality infants compared to the control group not receiving intervention. This is similar to the research conclusion of Pan Lihong [22], that personalized nutrition intervention has good clinical application effects on improving neonatal outcomes, and combined with appropriate exercise guidance, can significantly reduce the incidence of macrosomia, fetal distress, and premature birth.

5 Individualized nutritional intervention combined with treatment strategy

5.1 Individualized Nutritional Intervention Combined with Exercise Therapy

Compared to nutritional interventions alone, combined exercise therapy significantly improves blood glucose control (fasting blood glucose (FPG), 2-hour postprandial blood glucose (2h PG), and glycated hemoglobin (Hb A1c)) and has a lower incidence of adverse pregnancy outcomes such as intrauterine growth restriction, fetal distress, and large-for-gestational-age infants [23]. Regular exercise not only reduces the risk of adverse neonatal outcomes but also effectively controls patient weight, decreases body fat percentage, reduces oxidative stress, increases insulin receptor sensitivity, promotes glucose absorption and utilization, and eliminates insulin resistance [24]. These findings align with the research results of Huang Tiantian et al [25]. These studies indicate that dietary intervention combined with exercise therapy can reduce the risk of potential adverse pregnancy outcomes, thereby effectively preventing and controlling adverse complications of gestational diabetes.

5.2 Individualized Nutritional Intervention Combined with Psychological Nursing

Individualized nutritional intervention and psychological care both play positive roles in the treatment and management of GDM patients, leading to reductions in fasting and postprandial 2-hour blood glucose levels, triglycerides (TG), and total cholesterol (TC) after intervention. However, combined treatment interventions result in greater decreases in blood glucose indicators. The combination of individualized nutritional intervention and psychological care can more effectively reduce anxiety and depression levels in GDM patients and lower the incidence of perinatal complications, thereby increasing patient satisfaction with nursing services [26]. Nursing staff observe changes in the emotions of GDM patients and guide family members to provide more emotional support and care for the pregnant women. Implementing psychological care can effectively help GDM patients alleviate negative emotions such as anxiety and depression, reducing the psychological stress caused by pregnancy and illness [27-28]. A positive mindset can encourage pregnant women to adhere more actively to dietary plans, thus facilitating effective blood sugar control.

6 Conclusion

Previously, healthcare professionals only provided health education to GDM patients, who had to manage their diet and lifestyle on their own. However, there may be many misunderstandings or blind spots in the patients' and their families' cognition, which makes traditional interventions less effective. Personalized nutritional intervention achieves professional management of GDM patients through multidisciplinary collaboration, which can better improve lipid and blood sugar levels in GDM patients, reduce the incidence of adverse pregnancy outcomes, and lower the risk of short-term and long-term complications for both mother and child. Combining personalized nutritional intervention with treatment strategies can further stabilize metabolic levels. However, current research on combined personalized nutritional intervention treatment plans is insufficient, and more investment is needed. We hope that more studies will be conducted on combined nutritional intervention treatment plans to provide stronger support for clinical treatment.

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