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ORIGINAL ARTICLE

Retrospective Study

Effect of individualized nutrition interventions on clinical outcomes of pregnant women with gestational diabetes mellitus

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Abstract

BACKGROUND

Gestational diabetes mellitus (GDM) can lead to excessive pregnancy weight gain (PWG), abnormal glucolipid metabolism, and delayed lactation. Therefore, it is necessary to provide appropriate and effective interventions for pregnant women with GDM.

AIM

To clarify the effects of individualized nutrition interventions on PWG, glucolipid metabolism, and lactation in pregnant women with GDM.

METHODS

The study population consisted of 410 pregnant women with GDM who received treatment at the Northern Jiangsu People's Hospital of Jiangsu Province and Yangzhou Maternal and Child Health Hospital between December 2020 and December 2022, including 200 who received routine in-terventions [control (Con) group] and 210 who received individualized nutrition interventions [research (Res) group]. Data on PWG, glucolipid metabolism [total cholesterol, (TC); triglycerides (TGs); fasting blood glucose (FPG); glycosylated hemoglobin (HbA1c)], lactation time, perinatal complications (cesarean section, premature rupture of

membranes, postpartum hemorrhage, and pregnancy-induced hypertension), and neonatal adverse events (premature infants, fetal macrosomia, hypo-glycemia, and respiratory distress syndrome) were collected for comparative analysis.

RESULTS

The data revealed markedly lower PWG in the Res group *vs* the Con group, as well as markedly reduced TG, TC, FPG and HbA1c levels after the intervention that were lower than those in the Con group. In addition, obviously earlier lactation and statistically lower incidences of perinatal complications and neonatal adverse events were observed in the Res group.

CONCLUSION

Individualized nutrition interventions can reduce PWG in pregnant women with GDM, improve their glucolipid metabolism, and promote early lactation, which deserves clinical promotion.

Key Words: Individualized nutrition interventions; Gestational diabetes mellitus; Pregnancy weight gain; Glycolipid metabolism; Lactation time

Core Tip: Gestational diabetes mellitus (GDM) will increase the risk of perinatal complications and neonatal adverse events. This study mainly analyzed the clinical application of individualized nutrition interventions in pregnant women with GDM from the perspective of pregnancy weight gain, glycolipid metabolism, lactation time, perinatal complications, and neonatal adverse events, aiming to provide an optimal choice for the pregnancy management of pregnant women with GDM.

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INTRODUCTION

Gestational diabetes mellitus (GDM), a condition of abnormal glucose tolerance that occurs during pregnancy, is related to glucose homeostasis imbalance due to pancreatic β cell dysfunction[1,2]. Evidence has linked GDM to perinatal complications in pregnant women and adverse events in newborns, as well as an increased risk of developing type 2 diabetes, obesity and cardiovascular diseases in both mothers and infants[3]. According to relevant epidemiological data, the incidence of GDM is as high as 42%, and the pregnancy and delivery expenses of mothers with GDM are nearly 7000 RMB higher than those of mothers without GDM[4,5]. In addition, women with GDM often suffer from excessive pregnancy weight gain (PWG), abnormal glucolipid metabolism, and delayed lactation[6-8]. Therefore, providing appropriate and effective intervention measures for pregnant women with GDM has great clinical implications for improving maternal and infant outcomes.

Lifestyle interventions have been indicated to control blood glucose (BG) in 70%-85% of mothers with GDM[9]. The clinical application value of individualized nutrition interventions as a lifestyle intervention in pregnant women with GDM needs further exploration. The intervention program introduced in this study included nutrition guidance during pregnancy, exercise guidance, BG monitoring, lactation massage and guidance, *etc.*, with the patient-centered intervention plan specified depending on the patient's physical condition, aiming to achieve the best outcome and service experience for both the mother and child[10,11]. Nutrition programs tailored to pregnant women's individual conditions have also shown substantial benefits for maternal and neonatal clinical outcomes[12]. In addition, exercise during pregnancy reduces not only maternal PWG but also the risk of GDM, according to a randomized controlled trial[13]. As reported by Rasmussen *et al*[14], exercise during pregnancy can help pregnant women with GDM better control their BG levels and help the body to regulate glucose and insulin levels. Another report by Park *et al*[15] suggests that giving pregnant women with GDM lactation massage and guidance can promote maternal and infant health and prevent related complications by improving breastfeeding methods.

This study conducted an in-depth analysis of the clinical application of individualized nutrition interventions in pregnant women with GDM from the perspectives of PWG, glycolipid metabolism, lactation, perinatal complications, neonatal adverse events, *etc.*, aiming to provide a new choice for the management of mothers with GDM.

MATERIALS AND METHODS

Patient information

The study participants were 410 pregnant women with GDM selected between December 2020 and December 2022. Among these women, 200 were included in the control (Con) group and received routine interventions, and 210 were included in the research (Res) group and received individualized nutrition interventions. The two groups of pregnant women were clinically comparable, with no significant difference in general data ($P > 0.05$).

Eligibility and exclusion criteria

All the included patients met the diagnostic criteria for GDM, with singleton pregnancy and no history of diabetes before pregnancy.

Pregnant women with diabetes confirmed before pregnancy, overt diabetes diagnosed during gestation, the use of insulin therapy during pregnancy, pregnancy-induced hypertension, heart disease, threatened abortion or other high-risk pregnancies were excluded, as well as those with serious heart, lung, kidney, endocrine system and other medical conditions.

Methods

The Con group received routine interventions, including routine nutrition guidance, reduced fat consumption, increased fiber intake, and appropriate vitamin supplementation. In addition, the pregnant women were advised to eat multiple small meals and control their body mass and BG levels and were encouraged to exercise properly.

The Res group received the following individualized nutrition intervention measures: (1) Nutrition guidance during pregnancy: After gaining a comprehensive understanding of the mother's daily diet and specific condition, a professional dietitian developed an individualized nutrition plan according to her body mass index (BMI) and energy demands, with the calories needed reasonably distributed. Meals per day were divided into breakfast, an extra meal, lunch, an extra meal, dinner, and an extra meal, and the proportion of calories in each meal was strictly controlled at 15%-30%, 5%, 30%, 10%, 25%-30%, and 10%-15%, respectively, with all extra meals arranged 2.5 h to 3 h after the main meal; (2) Exercise guidance during pregnancy: After understanding the weight gain of the patients, the medical staff communicated with the patients and their families to encourage the pregnant women to continue to exercise (walking, yoga, aerobics, *etc.*), set reasonable exercise times and amounts, and be aware of the importance of exercise management during pregnancy. Exercise was generally carried out 30 min after meals and was not done on an empty stomach; (3) BG monitoring: The 2-h postprandial BG level of pregnant women should be controlled at 6.7 mmol/L and the fasting BG (FPG) level should be at 5.1 mmol/L. Insulin was used if the BG level still did reach the standard after two weeks of the individualized nutrition intervention; and (4) Lactation massage and guidance: Patients were given basic massage of the breast, lobule of the breast, acinus, and mammary ducts, as well as targeted massage to alleviate the corresponding symptoms of galactostasis, breast induration, short flat depression of the nipple and so on. At the same time, mothers were given guidance on breastfeeding to strengthen their confidence in breastfeeding and help them master the correct breastfeeding methods, breastfeeding skills, and preservation methods.

Outcome measures

The PWG of both cohorts was recorded, and glucolipid metabolism indices such as total cholesterol (TC), triglyceride (TG), FPG, and glycosylated hemoglobin (HbA1c) levels were determined before and after the intervention. The lactation initiation time of all patients was recorded. Maternal perinatal complications (*e.g.*, cesarean section, premature rupture of membranes, postpartum hemorrhage and pregnancy-induced hypertension) and the occurrence of neonatal adverse reactions (*e.g.*, premature birth, macrosomia, hypoglycemia and respiratory distress syndrome) were observed and recorded in both cohorts, and the corresponding incidence was calculated for evaluation.

Statistics and methods

In this study, the number of cases/percentage (n/%) is used to represent the counting data, and the χ^2 test was used for between-group comparisons. For measurement data described in the form of ($x \pm s$), between-group and intragroup (before and after the intervention) comparisons were performed using the t test and the paired t test, respectively. Data were statistically analyzed by SPSS 19.0 software, and statistical significance was considered at the $P < 0.05$ Level.

RESULTS

Baseline data of pregnant women with GDM in the two groups

The age, gestational age, prepregnancy BMI, primiparity (yes/no), and educational level of the two cohorts were analyzed, and no significant difference was identified in the above baseline data between the groups ($P > 0.05$), indicating clinical comparability (Table 1).

Influence of individualized nutrition interventions on PWG in pregnant women with GDM

By analyzing PWG in the two groups, it was found that the PWG was significantly lower in the Res group than in the Con group ($P < 0.05$) (Figure 1).

Table 1 Baseline data of the two groups of pregnant women with gestational diabetes mellitus

Factors	Control group (*n* = 200)	Research group (*n* = 210)	χ^2/t value	*P* value
Age (yr)	29.66 ± 4.94	29.44 ± 6.07	0.401	0.688
Gestational age (wk)	38.90 ± 5.16	39.16 ± 5.32	0.502	0.616
Pre-pregnancy BMI (kg/m^2)	20.10 ± 2.27	20.36 ± 2.38	1.131	0.259
Primiparity (yes/no)			0.995	0.318
Yes	119 (59.50)	135 (64.29)		
No	81 (40.50)	75 (35.71)		
Educational level			0.432	0.511
Junior college or below	104 (52.00)	116 (55.24)		
Bachelor degree or above	96 (48.00)	94 (44.76)		

BMI: Body mass index.

Table 2 Perinatal complications in the two groups of pregnant women with gestational diabetes mellitus

Factors	Control group (*n* = 200)	Research group (*n* = 210)	χ^2	*P* value
Cesarean section	14 (7.00)	7 (3.33)	-	-
Premature rupture of membranes	7 (3.50)	4 (1.90)	-	-
Postpartum hemorrhage	10 (5.00)	0 (0.00)	-	-
Pregnancy induced hypertension	20 (10.00)	6 (2.86)	-	-
Total	51 (25.50)	17 (8.10)	22.430	< 0.001

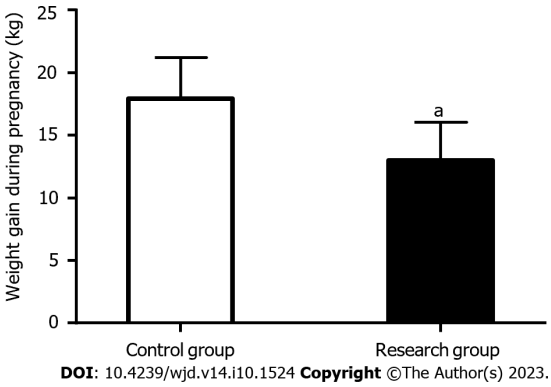

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Figure 1 The influence of individualized nutrition interventions on pregnancy weight gain in pregnant women with gestational diabetes mellitus. $^aP < 0.01$ *vs.* control group.

Influence of individualized nutrition interventions on glucolipid metabolism in pregnant women with GDM

We also analyzed the glucolipid metabolism levels of both groups of pregnant women with GDM. No evident intergroup differences were identified in preintervention TG, TC, FPG, and HbA1c ($P > 0.05$) levels; these indices of both groups were significantly reduced after the intervention ($P < 0.05$), with even lower values in the Res group ($P < 0.05$) (Figure 2).

Impact of individualized nutrition interventions on lactation in mothers with GDM

Statistical analysis of the lactation initiation time showed markedly earlier lactation in the Res group than in the Con group, with statistical significance ($P < 0.05$) (Figure 3).

Influence of individualized nutrition interventions on perinatal complications in mothers with GDM

Through the comparative analysis of perinatal complications (cesarean section, premature rupture of membranes, postpartum hemorrhage and pregnancy-induced hypertension) in mothers with GDM, we found an overall incidence of 8.10% in the Res group and 25.50% in the Con group, with statistical significance ($P < 0.05$) (Table 2).

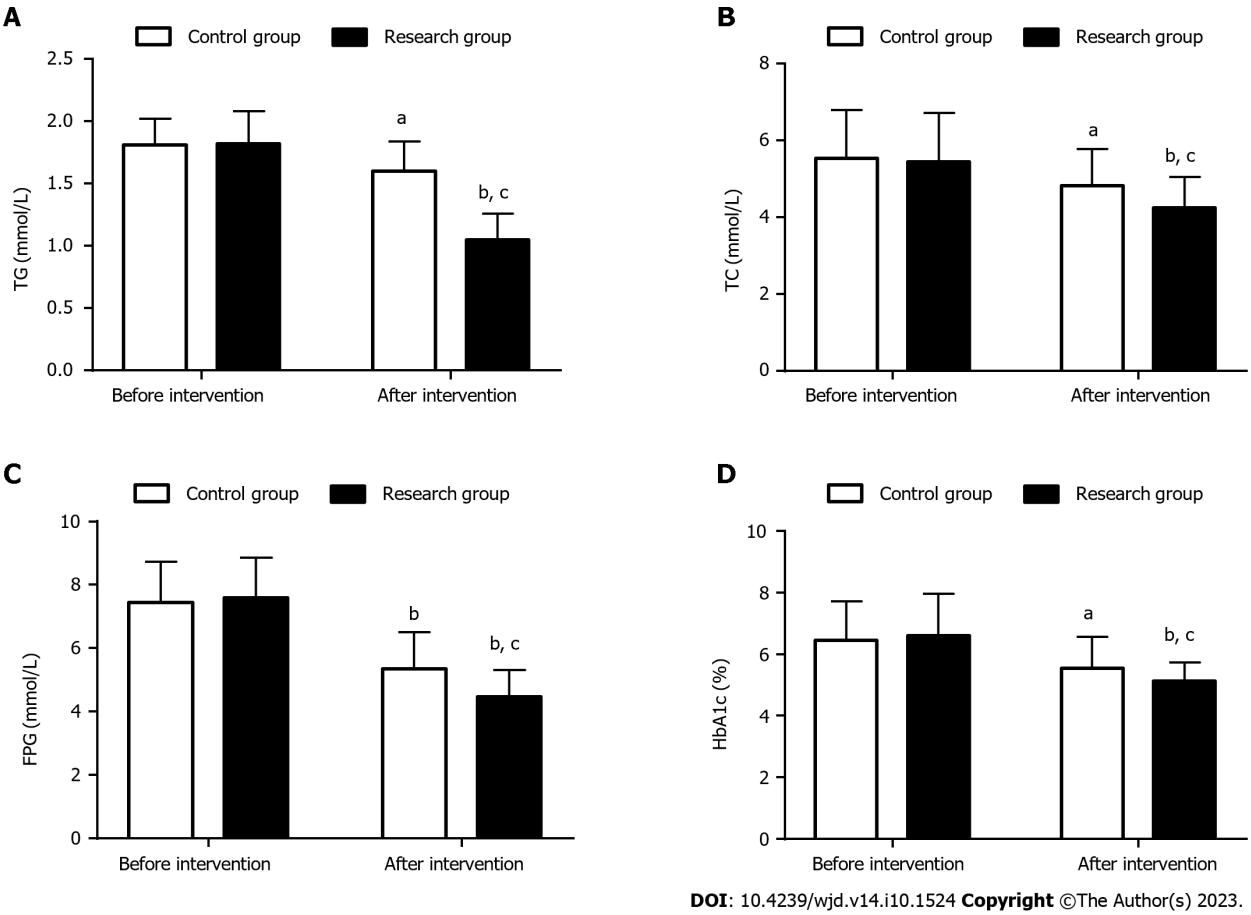

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Figure 2 Influence of individualized nutrition interventions on glucolipid metabolism in pregnant women with gestational diabetes mellitus. A: Pre- and postintervention total cholesterol levels in both groups of pregnant women with gestational diabetes mellitus (GDM); B: Pre- and postintervention triglyceride levels in both groups of pregnant women with GDM; C: Pre- and postintervention fasting blood glucose levels in both groups of pregnant women with GDM; D: Pre- and postintervention glycosylated hemoglobin levels in both groups of pregnant women with GDM. $^{a}P < 0.05$ *vs.* before treatment; $^{b}P < 0.01$ *vs.* before treatment; $^{c}P < 0.05$ *vs.* control group. FPG: Fasting blood glucose; HbA1c: Glycosylated hemoglobin; TC: Total cholesterol; TG: Triglyceride.

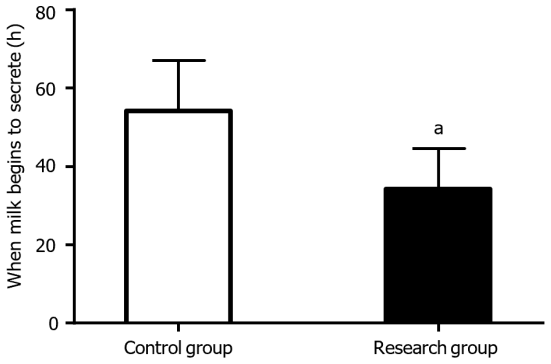

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Figure 3 Impact of individualized nutrition interventions on lactation time in pregnant women with gestational diabetes mellitus. $^{a}P < 0.01$ *vs* control group.

Effect of individualized nutrition interventions on adverse events in the neonates of mothers with GDM

According to statistics, the incidence of adverse events in neonates born to mothers with GDM in the Res group was 9.05%, which was markedly lower than that of 28.50% in the Con group ($P < 0.05$) (Table 3).

Table 3 Adverse events in neonates born to mothers with gestational diabetes mellitus in the two groups

Factors	Control group (*n* = 200)	Research group (*n* = 210)	χ^2	*P* value
Premature infant	18 (9.00)	12 (5.71)	-	-
Macrosomia	15 (7.50)	3 (1.43)	-	-
Hypoglycemia	11 (5.50)	0 (0.00)	-	-
Respiratory distress syndrome	13 (6.50)	4 (1.90)	-	-
Total	57 (28.50)	19 (9.05)	25.670	< 0.001

DISCUSSION

GDM, as a maternal metabolic disorder, not only complicates the pregnancy process but also has long-term negative effects on the newborn[16]. It is known that developing fetuses rely primarily on glucose from the placenta for energy. The abnormal increase in glucose levels due to GDM can promote fetal insulin secretion, resulting in hypertrophy of tissues such as the myocardium, fat, and liver (manifested as macrosomia), which may adversely influence maternal and infant outcomes[17]. To minimize the negative impact of GDM on maternal and infant outcomes, an in-depth analysis of reasonable, effective, and reliable intervention methods for the treatment of GDM was the focus of this study.

Under individualized nutrition interventions, individualized intervention programs were formulated based on the pregnant women's daily diets, specific illnesses, BMI, energy demands, weight gain, BG levels, and breasts, which provided support for mothers in all aspects of pregnancy while taking into account the control and maintenance of the BG level and body mass[18,19]. This intervention model has also been shown to be effective in reducing frailty and enhancing physical performance in older adults and in improving the long-term prognosis of colorectal cancer patients [20,21]. In this study, we compared the effects of individualized nutrition interventions *vs* routine interventions. The PWG was statistically lower in the Res group than in the Con group, indicating a more significant suppression of PWG and a better ability to control weight within the healthy range in pregnant women with GDM by individualized nutritional interventions. Ferrara *et al*[22] reported that individualized nutrition interventions could reduce excessive PWG in pregnant women by improving their health behaviors and modulating insulin resistance markers, similar to our findings. The statistically lower postinterventional TG, TC, FPG, and HbA1c levels in the Res group suggested that individualized nutrition interventions had a more significant effect on regulating and improving glucolipid metabolism in mothers with GDM. In the research of Fard *et al*[23], individualized nutrition interventions significantly reduced TG, TC, and high-density lipoprotein cholesterol levels in pregnant women while effectively modulating the body's blood lipids. There is also evidence indicating the potent inhibition action of individualized nutrition interventions against FPG, HbA1c and other BG indices and its effective control of BG in pregnant women with GDM 42 d after delivery[24], which supports our findings. An earlier onset of lactation was also observed in the Res group, suggesting that individualized nutrition interventions have a positive effect on lactation in pregnant women with GDM. In terms of maternal and infant outcomes, the Res group had a lower incidence of maternal complications (*e.g.*, cesarean section, premature rupture of membranes, postpartum hemorrhage and pregnancy-induced hypertension) and a markedly reduced incidence of neonatal adverse events (*e.g.*, premature birth, macrosomia, hypoglycemia and respiratory distress syndrome) than the Con group. This indicates the effectiveness of individualized nutrition interventions in improving maternal and infant outcomes compared with routine interventions and the ability to effectively prevent maternal complications and neonatal adverse events. In the study by Li *et al*[25], individualized nutrition interventions were effective in reducing the incidence of complications such as macrosomia and hyperbilirubinemia in older pregnant women, consistent with our research results.

Some limitations of this study need to be mentioned: (1) This study had a limited sample size; the sample size should be increased in future studies to better understand more information; (2) This was a single-center study; it would be beneficial if the scope of sample inclusion could be expanded to multiple centers, which would help eliminate potential information collection bias; and (3) The analysis of influencing factors for perinatal complications and neonatal adverse events could be supplemented to help further understand potential approaches to risk reduction in this area. In the future, research will be gradually improved based on the above recommendations.

CONCLUSION

Conclusively, individualized nutrition interventions are of higher clinical value than routine interventions in pregnant women with GDM, as they not only effectively control PWG, improve glucolipid metabolism, and promote lactation but also exert a significant preventive effect on maternal complications and neonatal adverse events, which is clinically beneficial.

ARTICLE HIGHLIGHTS

Research background

Gestational diabetes mellitus (GDM) is a kind of impaired glucose tolerance during pregnancy. Women with GDM often have problems such as excessive pregnancy weight gain (PWG), abnormal glucolipid metabolism, and delayed lactation.

Research motivation

Appropriate and effective intervention measures for pregnant women with GDM are of great value and clinical significance to improve maternal and infant outcomes.

Research objectives

This paper intends to determine the effects of individualized nutrition interventions on PWG, glucolipid metabolism, and lactation in pregnant women with GDM.

Research methods

The study population constituted 410 pregnant women with GDM who received treatment at the Northern Jiangsu People's Hospital of Jiangsu Province between December, 2018 and December, 2022, including 200 cases receiving routine interventions [control (Con) group] and 210 cases receiving individualized nutrition interventions [research (Res) group]. PWG, glucolipid metabolism [total cholesterol (TG); triglyceride (TC); fasting blood glucose (FPG); glycosylated hemoglobin (HbA1c)], lactation time, perinatal complications, and neonatal adverse events were collected for comparative analysis.

Research results

A markedly lower PWG and obviously reduced TG, TC, FPG and HbA1c were determined in the Res *vs* the Con after intervention. In addition, obviously earlier lactation and statistically lower incidences of perinatal complications and neonatal adverse events were determined in the Res.

Research conclusions

Individualized nutrition interventions can reduce PWG in pregnant women with GDM, improve their glucolipid metabolism, and promote early lactation, which deserves clinical promotion.

Research perspectives

This study verified the clinical advantages of individualized nutrition interventions for pregnant women with GDM from the perspectives of PWG, glycolipid metabolism, lactation, perinatal complications, and neonatal adverse events, which can provide a new option for the management of mothers with GDM.

FOOTNOTES

Author contributions: Luo JY and Chen LG contributed equally to this work; Luo JY and Chen LG designed the research study; Yan M, Mei YJ, Cui YQ and Jiang M contributed reagents and analytic tools; Luo JY, Chen LG and Jiang M analyzed the data; Luo JY and Chen LG wrote the manuscript; all authors have read and approved the final manuscript.

Institutional review board statement: The study was reviewed and approved by the Medical Ethics Committee of Northern Jiangsu People's Hospital of Jiangsu Province (Approval No. 2023ky150).

Informed consent statement: This is a retrospective study, and since the analysis used anonymous clinical data approved by the Ethics Committee of Northern Jiangsu People's Hospital of Jiangsu Province, the need for informed consent from subjects or guardians was waived.

Conflict-of-interest statement: The authors declare no competing interests.

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