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ORIGINAL RESEARCH

Blood Glucose Management Protection Motivation Trajectory and Its Associated Factors in Pregnant Women with Gestational Diabetes Mellitus: A Longitudinal Study

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Purpose: To (1) explore the trajectories of blood glucose management protection motivation in pregnant women with gestational diabetes mellitus, based on a growth mixture model, and (2) identify factors associated with these trajectories.

Patients and Methods: This longitudinal study, conducted between December 2023 and June 2024 at a tertiary hospital in China, involved 313 pregnant women diagnosed with gestational diabetes mellitus who were not using medication to control their blood glucose levels. Participants were assessed at three time points: 24–28 gestational weeks, 29–35 gestational weeks, and 36–40 gestational weeks. The data collected included general demographic information and the level of blood glucose management protection motivation. A growth mixture model was employed to examine the trajectory of blood glucose management protection motivation, and binary logistic regression analysis was performed to identify predictors of the trajectory. This study was reported following the Reporting Observational Longitudinal Research statement.

Results: The study identified two distinct trajectories of blood glucose management protection motivation: a low-motivation group (slowly increasing then rapidly declining; 124, 39.62%) and a high-motivation group (rapidly then increasing slowly declining; 189, 60.38%). The independent predictors of these trajectory categories included age, per capita monthly household income, and pregnancy complications.

Conclusion: Significant heterogeneity existed in the developmental trajectories of blood glucose management protection motivation among pregnant women with gestational diabetes mellitus. Future research should prioritize developing targeted interventions that consider not only different developmental trajectories but also factors such as age, per capita monthly household income, and pregnancy complications. These strategies may foster blood glucose management protection motivation among pregnant women with gestational diabetes mellitus, addressing their specific needs and enhancing the effectiveness of care.

Keywords: blood glucose management, gestational diabetes mellitus, longitudinal study, protection motivation, trajectories

Introduction

Gestational diabetes mellitus (GDM), with a high incidence rate, poses substantial risks to mothers, infants, and their families, significantly contributing to the global disease burden.[1] GDM refers to blood glucose levels that are elevated but not high enough to meet the diagnostic criteria for diabetes. This condition develops during pregnancy.[2] According to the International Association of Diabetes and Pregnancy Study Groups, approximately 16.7% of women globally experience hyperglycemia during pregnancy, with GDM accounting for 80.3% of these cases in 2022.[3] In China, a systematic review and meta-analysis published in 2019 revealed that the prevalence of GDM was 14.8%.[4] Notably, 60–70% of women with GDM worldwide experience poor blood glucose control during pregnancy.[5,6] Poor blood glucose control can lead to adverse maternal and neonatal outcomes, with incidence rates ranging from 5% to 71%.[7,8] For pregnant women with GDM, poor blood glucose control not only increases the incidence of cesarean section deliveries but also heightens the risk of developing type 2 diabetes

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mellitus postpartum.[9] For infants, poor blood glucose control may cause various diseases, such as macrosomia, neonatal hypoglycemia, and metabolic syndrome.[9] Moreover, poor blood glucose control causes a heavy economic burden to the family, with the average treatment cost for pregnant women with GDM being 34% higher than for women without GDM.[10] Therefore, blood glucose control in GDM has become a major global issue.[1]

Blood glucose management behavior is a key factor in achieving effective blood glucose control for pregnant women with GDM.[11,12] Blood glucose management protection motivation is a critical driver of their blood glucose management behavior.[13] Blood glucose management protection motivation refers to the willingness to engage in appropriate blood glucose management practices after perceiving the health risks posed by poor control to both the mother and the fetus.[14,15] According to protection motivation theory, an individual's motivation to protect themselves is a predictor of their behavior.[16] A systematic review published in 2024 synthesized qualitative data, revealing that motivations such as the perceived negative consequences of poor self-management significantly influenced blood glucose management behavior in pregnant women with GDM.[17] Similarly, a 2023 quantitative study identified blood glucose management protection motivation as a statistically significant factor influencing these behaviors.[13] Understanding the level of protection motivation among pregnant women with GDM is thus essential for predicting and effectively intervening in their blood glucose management practices.

Only one study has yet evaluated the level of blood glucose management protection motivation in pregnant women with GDM. In 2021, a research team developed a scale based on protection motivation theory to assess blood glucose management protection motivation in GDM.[14] In 2023, they applied this scale to measure the level of blood glucose management protection motivation in 1261 participants.[13] The study reported participants' scores (mean ± standard deviation, total score for each dimension) across various dimensions: perceived threat vulnerability (21.86 ± 3.98, 25), perceived threat severity (22.67 ± 3.27, 25), intrinsic rewards (15.37 ± 5.18, 25), extrinsic rewards (14.07 ± 5.31, 25), response efficacy (23.99 ± 2.03, 25), self-efficacy (21.90 ± 4.13, 25), and response cost (11.94 ± 6.08, 25). It evaluated and reported participants' blood glucose management protection motivation at one time point during pregnancy.

Blood glucose management protection motivation may demonstrate fluctuations.[18] A quantitative study reported variations in the timing of blood glucose management protection behavior among pregnant women with GDM.[19] It collected data at three time points: 24–28 gestational weeks, 36–40 gestational weeks, and 12–16 weeks postpartum. The findings revealed that blood glucose management protection behavior varied across all three time points. Because motivation and behavior interact and influence each other,[13] blood glucose management protection motivation may also fluctuate at different stages. Additionally, a qualitative study that interviewed pregnant women with GDM about their blood glucose management protection motivation and behavior at the same three time points found similar variability in both motivation and behavior. However, existing research on blood glucose management protection motivation has primarily relied on single cross-sectional surveys,[13] which fail to consider changes in motivation over time.

Trajectory analysis is a method of longitudinal data analysis that identifies subgroups with similar patterns of change over time, based on repeated measurements of a study variable. It also explores the relationship between the dynamic changes in that variable and the development of outcomes. Fully utilizing longitudinal data and considering population heterogeneity, trajectory analysis has been widely applied in the medical field.[20,21] We used trajectory analysis to examine the changes in blood glucose management motivation among pregnant women with GDM, providing a foundation for future intervention studies.

Our study assessed blood glucose management protection behavior among pregnant women with GDM at three key time points: 24–28 gestational weeks (T1), 29–35 gestational weeks (T2), and 36–40 gestational weeks (T3). These time points were chosen based on findings from previous studies. First, 24–28 gestational weeks (T1) was selected because the participants were diagnosed with GDM during this period. Additionally, a longitudinal qualitative study identified T1 as the first time point for exploring blood glucose management protection motivation and behaviors among the same target population as our study.[19] Second, we recognized T3 as an important time point for changes in blood glucose management protective motivation and behaviors.[19] Therefore, T3 was determined as the third time point in our study, with 29–35 gestational weeks designated as the second time point.

This study aimed to (1) explore the trajectories of blood glucose management protection motivation in pregnant women with GDM, based on a growth mixture model, and (2) identify factors associated with these trajectories.

Methods

Study Design

This was a descriptive longitudinal study. Participants completed questionnaires at three key time points during pregnancy: 24–28 gestational weeks (T1), 29–35 gestational weeks (T2), and 36–40 gestational weeks (T3). The study was reported following the Reporting Observational Longitudinal Research statement.[22]

Participants and Settings

The study employed convenience sampling of pregnant women with GDM who were routinely attending prenatal check-ups at a tertiary hospital in Jiangsu Province between December 2023 and June 2024. The inclusion criteria were (1) women diagnosed with GDM via a 75-g oral glucose tolerance test at 24–28 gestational weeks,[23] (2) ability to complete the questionnaire independently, (3) willingness to join the study and sign the informed consent form, and (4) no involvement in other studies related to blood glucose management at the time of the survey. The exclusion criteria were (1) participants requiring medication to control blood glucose during the study, due to the applicability of the instrument,[14] (2) participants who give birth before 36 weeks of pregnancy, and (3) participants transferred to other hospitals during the study period.

At our hospital, after a GDM diagnosis, pregnant women receive health guidance from diabetes specialist nurses and are instructed to attend the diabetes behavior and nutrition clinic the following week. A multidisciplinary team reviews and adjusts their dietary diaries and lifestyle. During subsequent prenatal check-ups, the nurse continues to monitor the diaries and provide education, with weekly follow-up phone calls for ongoing support.

Given that our research design is a cross-sectional survey study and based on preliminary data from 100 participants in our pilot study which yielded a standard deviation (σ) of 8, we have applied the following formula: $n = \frac{Z_{\alpha}^2 * \sigma^2}{\delta^2}$. With the parameters set at $\delta = 1$, $\alpha = 0.05$, and $\sigma = 8$,[24] we have calculated the required sample size of 246 participants. To account for a potential 10–20% rate of invalid questionnaires,[25] we plan to recruit between 271 and 296 pregnant women for our study.

A tertiary hospital in China, classified as a "Class 3 Grade A" hospital, represents the highest level of the national healthcare system. These large, comprehensive institutions provide specialized care and advanced diagnostics and are often affiliated with medical schools or research institutes. Serving as regional hubs, they manage both routine care and complex referrals from lower-tier facilities. Additionally, tertiary hospitals play a pivotal role in medical education and clinical research and are renowned for their expertise and cutting-edge technology, positioning them at the forefront of healthcare in China. The tertiary hospital from which we recruited participants manages over 1,200 cases of GDM annually, with more than 2,500 GDM pregnancies resulting in deliveries at the hospital each year, ensuring strong study feasibility.

Measures

Participants' Demographic and Clinical Characteristics

We developed the participants' demographic and clinical characteristic items based on existing studies and research experience. The demographic characteristics comprised age, residence location, work status, education level, per capita monthly household income, and medical payment method. The clinical characteristics were pre-pregnancy body mass index (BMI), primipara status, history of adverse pregnancy events, method of conception, family history of diabetes, history of GDM, and pregnancy complications. The method of conception was classified into natural conception (occurring through sexual intercourse) and assisted conception (involving techniques such as artificial insemination and in vitro fertilization with embryo transfer to facilitate pregnancy). Pregnancy complications referred to other diseases coexisting with GDM in pregnant women, including hypertensive disorders of pregnancy, intrahepatic cholestasis syndrome, premature labor, and premature rupture of membranes.[26]

Blood Glucose Management Protection Motivation

We used the Blood Glucose Management Protection Motivation Questionnaire for Patients with Gestational Diabetes Mellitus to measure participants' blood glucose management protection motivation. This scale was developed in 2021 by Zhou.[14] After we obtained permission from the corresponding author, our study adapted and tested the questionnaire among individuals not using insulin during pregnancy. The Cronbach α coefficient of the questionnaire was 0.731. The

questionnaire comprises seven dimensions and 29 items: vulnerability (four items), severity (five items), intrinsic rewards (four items), extrinsic rewards (four items), response efficacy (four items), self-efficacy (four items), and response costs (four items). A 5-point Likert scoring system is used, wherein 1 signifies "strong disagreement" and 5 denotes "strong agreement". The total score ranges from 29 to 145 points. The three dimensions of the scale (intrinsic rewards, extrinsic rewards, and response costs) are reverse-scored. After correcting the reverse scores, a higher total score indicates stronger motivation for blood glucose management. See Supplementary Material for the questionnaire.

Data Collection

The first author is a graduate student in nursing currently interning at the Affiliated Maternity and Child Health Hospital of Jiangnan University. After obtaining approval from the department head, the first author collected data from December 2023 to June 2024 by recruiting pregnant women with GDM during their prenatal check-ups at the hospital's obstetric outpatient clinic. These check-ups typically occur at three stages of pregnancy: 24–28 gestational weeks, 29–35 gestational weeks, and 36–40 gestational weeks. Participants received their prenatal check-ups at the same hospital. The first author explained the purpose of the study to the participants, reminded them that the questionnaire responses were anonymous, and inquired about their interest in participating. Those who expressed interest were provided with an informed consent form containing detailed information about the study. Women who agreed to participate signed the consent form and completed the printed questionnaires. The first author reviewed the questionnaires to ensure no information was missing and reminded participants to complete any incomplete sections.

Data Analysis

SPSS 25.0 and Mplus 8.3 software were used for data analysis. Mean, standard deviation, frequency, and percentage were used to describe the data. For blood glucose management protection motivation, growth mixture modeling (GMM) was used to identify the sub-trajectories over time.[27] GMM combines the characteristics of traditional growth models and latent class growth analysis. It estimates the average growth curve for each class and captures individual differences around these growth curves by estimating the growth factor variances within each class.[27]

This process began with a single category, progressively increased the number of categories, and assessed the model's fit based on the interpretability and clinical relevance of the results. The optimal model was then selected. The criteria for evaluating the model fitting results were the Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample size–adjusted BIC (aBIC) values. The smaller these values, the better the model fit.[28] The entropy value ranges from 0 to 1. A value of 1 indicates that the population is perfectly divided into latent categories. The average high entropy value is 0.8, suggesting that 80% of individuals are correctly classified into latent categories. The average medium entropy value is 0.60, and the average low entropy value is 0.40. Therefore, a classification result with an entropy value >0.6 can be accepted.[29] To determine whether the fitting of a k-category model is significantly improved compared to a k-1 category model, the Lo, Mendell, and Rubin likelihood ratio test (LMRT) and the bootstrapped likelihood ratio test (BLRT) are commonly used.[30] If both tests yield $P<0.05$, it suggests that the fitting effect of the k-category model is superior. The proportion of individuals classified into a certain trajectory should generally be at least 5%.[31]

After determining the number of trajectory categories, independent-sample tests, one-way analysis of variance, and chi-square tests were employed for univariate analysis. Factors with $P<0.05$ in the univariate analysis were included in the binary logistic regression analysis. Before conducting the binary logistic regression analysis, we performed a collinearity test on the included factors. Factors to be included in the binary logistic regression model were selected based on the results of this collinearity assessment. A variance inflation factor value of less than 5, ideally below 3, was considered acceptable for inclusion.[32] $P<0.05$ was considered significant.

Ethical Considerations

This study was approved by the Medical Ethics Committee of the Maternity Hospital, Jiangnan University (Approval No. 2023–01-1213-50). It was conducted in accordance with the National Research Ethics Guidelines and Regulations,[33] which align with the principles set forth in the Declaration of Helsinki.[34]

Results

Participant Characteristics

A total of 346 participants joined the study. However, 23 participants (9.54%) were excluded for various reasons, including refusal to participate (5 participants), transfer to other hospitals (2 participants), use of medication (4 participants), and premature birth (4 participants). A total of 346 participants were enrolled in the study. This left 313 completed questionnaires (90.46%) for analysis. For the number of participants at each data collection stage, please refer to Figure 1.

Table 1 presents the baseline sociodemographic and clinical characteristics of the participants. The participants had a mean age of 31.84 years (SD=4.29), and their average BMI was 23.76 kg/m^2 (SD=3.95). More than four fifths had medical insurance as their primary payment method (276, 88.18%), conceived naturally (265, 84.66%), and had no history of GDM (264, 84.35%). Approximately half held a bachelor's degree or higher (147, 46.96%), had a history of adverse pregnancy outcomes (153, 48.88%), and had a family history of diabetes (165, 52.72%). Around one third were multiparous and had experienced additional complications during pregnancy, apart from GDM (98, 31.31%). Approximately one quarter of participants resided in non-urban areas (79, 25.24%), were unemployed (66, 21.09%), and had a per capita monthly household income of less than 5,000 RMB (85, 27.16%).

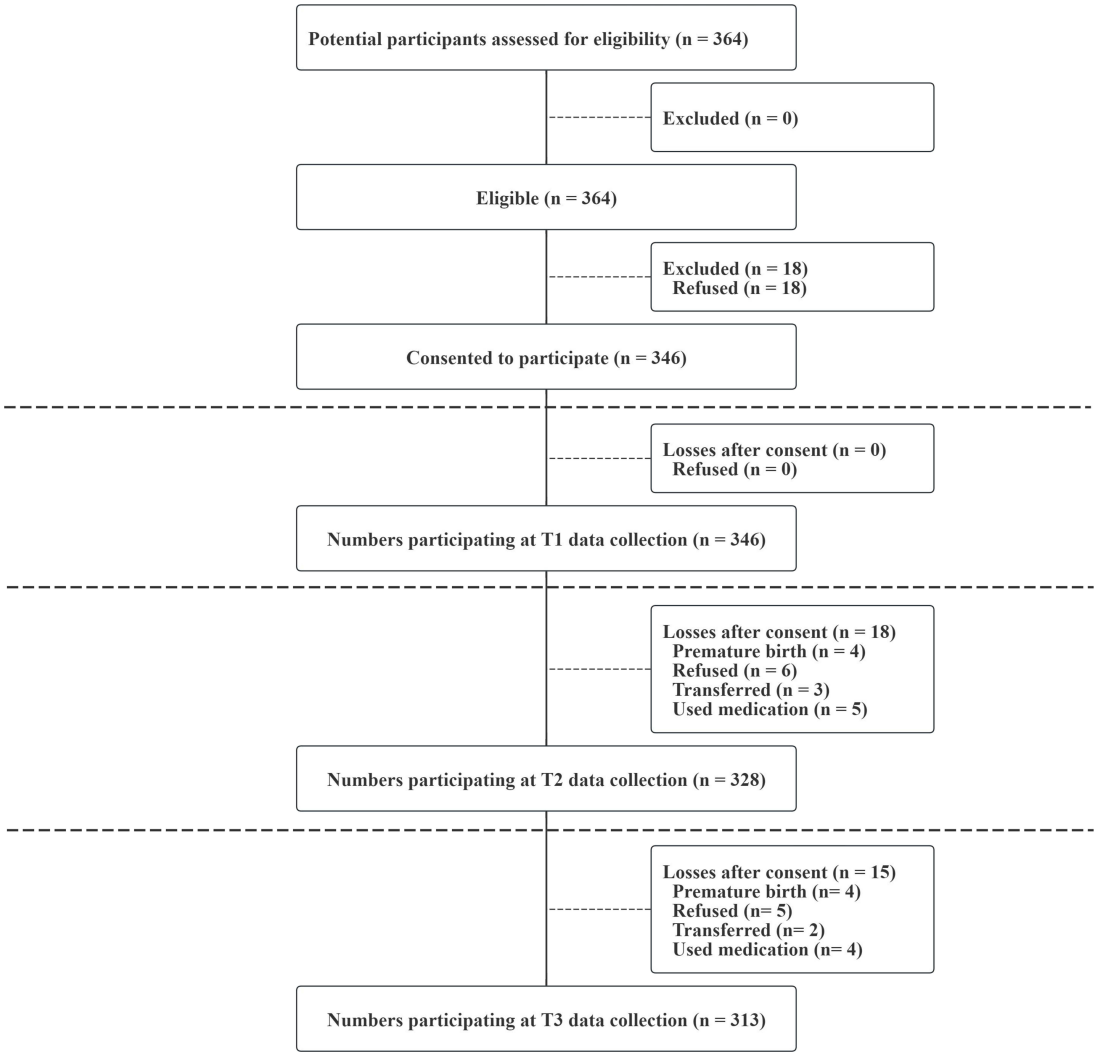

Figure 1 Flow diagram for clarifying participation.

Notes: T1, 24–28 gestational weeks; T2, 29–35 gestational weeks; T3, 36–40 gestational weeks. Flow Chart is reproduced from Tooth L, Ware R, Bain C, Purdie DM, Dobson A. Quality of Reporting of Observational Longitudinal Research. *Am J Epidemiol.* 2005;161 (3):280–288 by permission of Oxford University Press.[22]

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Table 1 Sociodemographic and Clinical Characteristics of Participants (N=313)

Variable	Category	n (%)/M±SD
Age (years)		31.84±4.29
Residential location		
	Urban	234 (74.76)
	Non-urban	79 (25.24)
Work status		
	Employed	247 (78.91)
	Unemployed	66 (21.09)
Education level		
	Pre-high school	41 (13.10)
	High school	45 (14.38)
	Junior college	80 (25.56)
	Bachelor or higher	147 (46.96)
Per capita monthly household income (RMB, yuan)		
	<5,000	85 (27.16)
	5,000–8,000	91 (29.07)
	8,000–15,000	92 (29.39)
	>15,000	45 (14.38)
Medical payment method		
	Medical insurance	276 (88.18)
	Own expense	37 (11.82)
BMI (kg/m^2)		23.76±3.95
Primipara		
	Yes	203 (64.86)
	No	110 (35.14)
History of adverse pregnancy		
	With	153 (48.88)
	Without	160 (51.12)
Method of conception		
	Natural conception	265 (84.66)
	Unnatural conception	48 (15.34)
History of GDM		
	With	49 (15.65)
	Without	264 (84.35)
Family history of diabetes		
	With	165 (52.72)
	Without	148 (47.28)
Pregnancy complications		
	With	98 (31.31)
	Without	215 (68.69)

Abbreviations: M, mean; SD, standard deviation; BMI, body mass index; GDM, gestational diabetes mellitus.

Trajectories of Blood Glucose Management Protection Motivation

Table 2 presents the fitting models for the trajectory of blood glucose management in pregnant women with GDM. Increasing the number of latent classes from one to two resulted in a gradual decrease in AIC, BIC, and aBIC values. Both the LMRT and BLRT tests were statistically significant ($P<0.05$), with an entropy value of 0.741. This means that the two-class model was better than the one-class model. However, when the latent classes increased to three, although AIC, BIC, and aBIC values continued to decrease, the *P*-values for LMRT and BLRT rose above 0.05. This indicates that the three-class model did not significantly improve model fit compared to the two-class model. Further, when moving from three to four classes, AIC, BIC, and aBIC values continued to decrease, and the *P*-values for LMRT and BLRT

Table 2 Fitting Effects of Four Models

Number of Subgroups	AIC	BIC	aBIC	Entropy	LMRT (*P*-value)	BLRT (*P*-value)	Category Probability (%)
1	7955.888	7974.619	7958.761	–	–	–	–
2	7805.024	7834.993	7809.620	0.741	<0.001	<0.001	39.62/60.38
3	7781.649	7822.857	7787.969	0.675	0.108	0.119	22.36/38.02/39.62
4	7768.206	7820.653	7776.250	0.697	0.026	0.030	33.23/13.42/48.24/5.11

Abbreviations: AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, adjusted Bayesian information criterion; LMRT, Lo–Mendell–Rubin likelihood ratio test; BLRT, bootstrap likelihood ratio.

remained below 0.05, suggesting that the four-class model improved model fit over the three-class model. However, the entropy for the four-class model (0.697) was notably lower than for the two-class model (0.741). Therefore, we selected the two-class model as the optimal-fitting model.

Using the two growth mixture models, we identified the developmental trajectories of protection motivation for blood glucose management among pregnant women with GDM (Figure 2). The first trajectory, consisting of 124 cases (39.6%), was characterized by lower protection motivation scores across the three time points compared to the second trajectory. In this group, the scores exhibited a slow increase followed by a rapid decline from T1 to T3, leading to the designation "low motivation–slowly increasing then rapidly declining." The second trajectory included 189 cases (60.4%) and was marked by higher protection motivation scores across all three time points compared to the first trajectory. In this group, the scores showed a rapid increase followed by a slower decline from T1-T3, thus earning the name "high motivation—rapidly increasing then slowly declining."

At the three time points, the scores for blood glucose management protection motivation in the low-motivation group were 95.07±16.48, 99.64±11.97, and 87.42±9.44, respectively. In the high-motivation group, the scores were 106.53±15.17, 120.15 ±10.27, and 115.53±10.01, respectively.

Factors Related to Changes in Blood Glucose Management Protection Motivation Sub-Trajectories

In the latent variable growth mixture model, which considered two latent categories as dependent variables and 13 others as independent variables, significant statistical differences were observed in age, education level, per capita monthly household income, history of adverse pregnancy, and pregnancy complications ($P<0.05$). See Table 3 for further details.

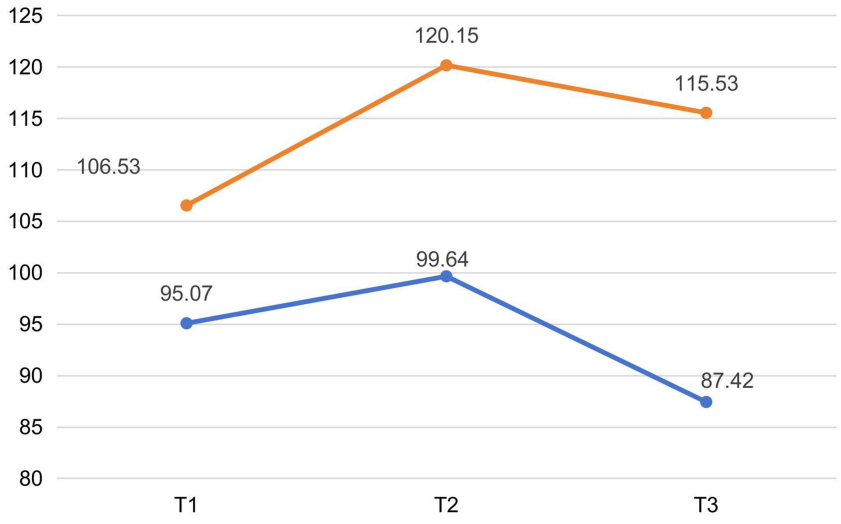

Figure 2 Optimal Fitting Model for the Trajectories of Blood Glucose Management Protection Motivation in Pregnant Women with GDM (2-Class Trajectory Model).
Notes: T1, 24–28 gestational weeks; T2, 29–35 gestational weeks; T3, 36–40 gestational weeks. —●—: High motivation-rapidly increasing then slowly declining group (189, 60.38%); —●—: Low motivation-slowly increasing then rapidly declining group (124, 39.62%).

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The trajectory categories of blood glucose management protection motivation were used as the dependent variable. Variables that yielded a univariate analysis $P<0.05$ were selected as independent variables for the binary logistic regression analysis. During this process, continuous variables were incorporated in their original form, whereas categorical variables underwent pre-entry value assignment, with the specific method detailed in Table 3. The findings revealed that age, per capita monthly household income, and pregnancy complications significantly influenced the latent categories of blood glucose management protection motivation ($P<0.05$), as illustrated in Table 4.

Table 3 Univariate Analysis of Sociodemographic and Clinical Characteristics of Pregnant Women with GDM Among Different Blood Glucose Management Protection Motivation Trajectories

Variable	Trajectory 1	Trajectory 2	t/F	P
Age (years)	32.70±4.41	31.27±4.13	2.922[a]	0.004
BMI	23.96±4.34	23.62±3.67	0.748[a]	0.455
Residential location			0.769[b]	0.380
Urban	96 (77.42)	138 (73.02)		
Non-urban	28 (22.58)	51 (26.98)		
Work status			1.890[b]	0.169
Employed	93 (75.00)	154 (81.48)		
Unemployed	31 (25.00)	35 (18.52)		
Education level				
Pre-high school	20 (16.13)	21 (11.11)	16.135[c]	0.001
High school	27 (21.77)	18 (9.52)		
Junior college	34 (27.42)	46 (24.34)		
Bachelor's or higher	43 (34.68)	104 (55.03)		
Per capita monthly household income (RMB, yuan)			44.088[c]	<0.001
<5,000	49 (39.52)	36 (19.05)		
5,000–8,000	48 (38.71)	43 (22.75)		
8,000–15,000	23 (18.55)	69 (36.51)		
>15,000	4 (3.23)	41 (21.69)		
Medical payment method			0.703[b]	0.402
Medical insurance	107 (86.29)	169 (89.42)		
Own expense	17 (13.71)	20 (10.58)		
Primipara			1.722[b]	0.189
Yes	75 (60.48)	128 (67.72)		
No	49 (39.52)	61 (32.28)		
History of adverse pregnancy			5.766[b]	0.016
With	71 (57.26)	82 (43.39)		
Without	53 (42.74)	107 (56.61)		
Method of conception			1.633[b]	0.201
Natural conception	101 (81.45)	164 (86.77)		
Assisted conception	23 (18.55)	25 (13.23)		
History of GDM			3.158[b]	0.076
With	25 (20.16)	24 (12.70)		
Without	99 (79.84)	165 (87.30)		
Family history of diabetes			0.143[b]	0.706
With	67 (54.03)	98 (51.85)		
Without	57 (45.97)	91 (48.15)		
Pregnancy complications			10.780[b]	0.001
With	52 (41.94)	46 (24.34)		
Without	72 (58.06)	143 (75.66)		

Notes: [a]independent-sample test; [b]one-way analysis of variance; [c]chi-square test.

Abbreviations: SD, standard deviation; Trajectory 1, low motivation—slowly increasing then rapidly declining; Trajectory 2, high motivation—rapidly increasing then slowly declining.

Table 4 Multiple Logistic Regression Analysis of Sociodemographic and Clinical Characteristics of Pregnant Women with GDM Among Different Blood Glucose Management Protection Motivation Trajectories

Independent variable	Estimate	SE	Wald	P	OR	95% CI	
						L	U
Age (years)	−0.077	0.031	6.317	0.012	0.926	0.872	0.983
Education level							
Pre-high school					1.000		
High school	−0.376	0.475	0.625	0.429	0.687	0.270	1.743
Junior college	−0.141	0.450	0.098	0.754	0.868	0.360	2.096
Bachelor's or higher	−0.077	0.458	0.028	0.866	0.926	0.377	2.273
Per capita monthly household income (RMB, yuan)							
<5,000					1.000		
5,000–8,000	0.193	0.346	0.310	0.578	1.213	0.615	2.391
8,000–15,000	1.371	0.403	11.552	0.001	3.939	1.787	8.683
>15,000	2.541	0.610	17.359	<0.001	12.691	3.841	41.940
History of adverse pregnancy							
With					1.000		
Without	0.193	0.273	0.501	0.479	1.213	0.711	2.070
Pregnancy complications							
With					1.000		
Without	0.659	0.279	5.593	0.018	1.934	1.120	3.340

Abbreviations: SE, standard error; OR, odds ratio; 95% CI, 95% confidence interval; L, lower limit; U, upper limit.

Discussion

This study aimed to explore the trajectories of blood glucose management protection motivation in pregnant women with GDM and identify factors associated with these trajectories. Two distinct trajectories were identified. Age, per capita monthly household income, and pregnancy complications significantly influenced the protection motivation trajectory for blood glucose management in this population.

Our identification of two distinct trajectories confirms the heterogeneity of blood glucose management protection motivation within this population. Both trajectories showed that blood glucose management protection motivation needed further intervention and improvement at T1 and T3. This finding aligns with a previous longitudinal qualitative study.[18]

Our study contributes to the existing knowledge base by identifying sub-groups of trajectories of blood glucose management protection motivation among pregnant women with GDM. This provides information for designing more precise interventions[35] to improve blood glucose management protection motivation for this population. Furthermore, our results revealed that different sub-groups showed different trends of change: one exhibited slowly increasing then rapidly declining motivation, and the other showed rapidly increasing then slowly declining motivation. This suggests a need to develop different interventions to improve blood glucose management protection motivation for different sub-groups of pregnant women with GDM. Given the limitations of resources such as funding and time in coping with rapidly changing healthcare systems,[36] our findings can be used to stratify populations for targeted interventions. This approach can help design more effective interventions tailored to resource-constrained settings.

Our study found that in trajectory 1 (low motivation), the blood glucose management protection motivation score in T3 was lower than in T1. This finding is consistent with a trajectory analysis study focused on blood glucose management protection behavior.[19] However, in trajectory 2 (high motivation), the score in T3 was higher than in T1. According to the health action process approach,[37] a complex process (such as action planning, coping planning, and action and maintenance) underlies an individual's motivation transferring to behavior. Our study may indicate that different sub-groups of pregnant women with GDM might exhibit different blood glucose management protection behaviors. Further research, including qualitative studies, can be conducted to explore how motivation translates into behavior among different sub-groups of pregnant women with GDM. This will help to understand the mechanism linking motivation to behavior and offer valuable insights for applying the health action process approach to this population.

Age. Older pregnant women were more likely to be categorized in trajectory 1 (low motivation). Studies have found that the older diabetic patients are, the less knowledge they have about the disease, particularly regarding diabetes severity and susceptibility.[38] The health belief model highlights that an individual's perceived disease severity and susceptibility are key determinants of protection motivation.[39] This may explain how age influences blood glucose management protection motivation. Our finding contributes to the existing evidence by confirming age as a predictor of blood glucose management protection motivation among this specific population. A 2024 systematic review and meta-analysis identified age as an important factor influencing the relationship between motivation and behavior, especially among women.[40] Considering the significance of age, which influences not only motivation but also the transition from motivation to behavior, we propose that older women should be a target population for improving blood glucose management protection motivation in GDM.

Per capita monthly household income. Women from households with a per capita monthly income below 5,000 were more likely to belong to trajectory 1 (low motivation) compared to those with a monthly income above 8,000. This may be due to lower health literacy,[41] which limits their understanding of disease management and the risks of poor blood glucose control for both maternal and fetal health.[42,43] Additionally, limited access to healthcare and resources,[44] such as regular check-ups and medications, may hinder their confidence and motivation in managing blood glucose levels.[42,45] Given the economic impact of the COVID-19 pandemic,[46] this factor is particularly important, and future research should explore how income and healthcare access interact in influencing the blood glucose management protection motivation of pregnant women with GDM.

Pregnancy complications. Women with pregnancy complications were more likely to fall into trajectory 1 (low motivation) compared to those without complications. Women who experience complications face numerous additional challenges in managing their conditions.[47] This complexity may diminish their confidence in effectively coping with their disease.[47] In recent years, the prevalence of pregnancy complications has shown a rising trend, with an increasing variety and complexity of conditions being reported.[48] Therefore, this factor identified by our study is important, and we propose that more focus should be placed on it.

Implications for Practice

Our study has several implications for practice. Firstly, healthcare professionals can leverage the identified trajectory factors to detect individuals at higher risk due to insufficient protection motivation for blood glucose management. Specifically, individuals with low protection motivation for blood glucose management should be focused on more in clinical practice. Secondly, healthcare professionals can develop more suitable interventions for pregnant women with GDM in different trajectories. For example, in trajectory 1, apply the same method to identify the trajectory category to which each pregnant woman belongs, determine the key time points and influencing factors for protection motivation within each category, and develop targeted interventions tailored to these characteristics. Such personalized support strategies are expected to promote active engagement in blood glucose management, thereby enhancing protection motivation and improving pregnancy outcomes for pregnant women with GDM.

Strengths and Limitations

This study offers several novel strengths. First, it is important to emphasize that our study is the first to conduct a longitudinal investigation of blood glucose management protection motivation in pregnant women with GDM, clearly revealing the dynamic patterns of this motivation. Furthermore, by applying a person-centered latent growth model, we identified two distinct trajectories of blood glucose management protection motivation in pregnant women with GDM, along with their influencing factors, and further classified the population into different subgroups. This innovative approach not only helps identify which groups require more targeted training and support, but also holds significant practical implications, particularly in resource-limited regions.[27]

This study has several limitations. First, it was conducted in a tertiary hospital in a single province in China, which may limit the generalizability of the findings to other regions. Future research could benefit from a multi-center, large-sample investigation to further validate and refine these results. Secondly, due to the applicability of the scale, this study focused solely on pregnant women with GDM who did not use medication to control their blood glucose levels. Future research should include pregnant

women with GDM who are undergoing medication treatment, to provide a more comprehensive understanding. Additionally, our study excluded participants who did not complete all three questionnaires, which may have impacted the reliability and generalizability of the findings. Third, the diagnostic criteria for GDM in this study followed the standards of the International Association of Diabetes and Pregnancy Study Groups.[23] However, since GDM criteria vary by country and region, due to differences in healthcare systems and diagnostic thresholds, the findings may only apply to populations using WHO criteria or similar standards, and may not be generalizable to areas with different criteria. Fourth, this study did not consider health education during pregnancy as a factor. While health education has been shown to influence lifestyle motivation in chronic kidney disease and weight management,[49,50] its impact on blood glucose management motivation in pregnant women remains unclear. Future research should include health education as a key factor to explore its role in shaping blood glucose management motivation. Fifth, we are unsure about the potential influence of the data collector's identity (whether the fact that the collector was an intern nursing student at the hospital might affect the participants' responses). However, the data collector reminded the participants about the anonymity of the questionnaire responses before data collection, which to some extent ensured the reliability of the participants' answers. Sixth, this study relied on self-reported questionnaires, which may introduce bias as participants could provide socially acceptable answers.[51] To minimize this, we ensured anonymity and emphasized honest reporting. Future research could enhance validity by using objective measures or triangulating self-reported data with medical records or behavioral observations.[52] Finally, this study focuses on short-term trajectories. Long-term follow-ups beyond the postpartum period could provide insights into the persistence of motivation and its impact on long-term health outcomes for mothers and infants, making it a valuable direction for future research.

Conclusions

Significant heterogeneity existed in the developmental trajectories of blood glucose management protection motivation among pregnant women with GDM. The majority exhibited a high-motivation (rapidly increasing then slowly declining) trajectory for blood glucose management. Future research should prioritize the development of targeted interventions that consider not only different developmental trajectories but also factors such as age, per capita monthly household income, and pregnancy complications. These strategies may foster blood glucose management protection motivation among pregnant women with GDM, addressing specific needs and enhancing the effectiveness of care.

Data Sharing Statement

The data that support the findings of this study are available on request from the corresponding author.

Author Contributions

All authors contributed significantly to the work reported, whether in the conception, study design, execution, data acquisition, analysis, and interpretation, or across all these areas. They participated in drafting, revising, or critically reviewing the article, provided final approval of the version to be published, agreed on the journal to which the article was submitted, and accepted responsibility for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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