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ARTICLE

Gestational weight gain trajectories in patients with gestational diabetes mellitus: a retrospective cohort study

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Abstract

Aims/Background Gestational diabetes mellitus is a common pregnancy complication that affects approximately 14% of pregnancies worldwide and can lead to adverse maternal and neonatal outcomes. This study aimed to investigate the trajectories of gestational weight gain among gestational diabetes mellitus patients and to inform the development of effective weight management strategies.

Methods Demographic and antenatal examination data from 1421 pregnant women diagnosed with gestational diabetes mellitus were retrospectively analysed. Quantitative data comparisons were performed using Chi-square tests, Fisher's exact test, *t*-tests, and one-way analysis of variance. Group-based trajectory modelling was employed to identify the trajectories of gestational weight gain among patients with gestational diabetes mellitus.

Results This study revealed that pre-pregnancy body mass index and types of gestational diabetes mellitus significantly influence gestational weight gain ($p < 0.05$). Group-based trajectory modelling identified three distinct gestational weight gain trajectories. Patients with gestational diabetes mellitus demonstrated a continuous weight gain throughout pregnancy, while women who were overweight or obese before pregnancy were more likely to follow a low-speed growth trajectory. Women in the rapid growth trajectory group were more inclined to deliver by caesarean section and were more likely to give birth to macrosomic infants.

Conclusion Our research underscores the importance of identifying and distinguishing between different gestational weight gain trajectories in pregnant women, thereby identifying high-risk groups, which is crucial for improving the health conditions of both mothers and newborns.

Key words: Gestational diabetes mellitus; Latent class; Pregnancy; Trajectory; Trajectory model; Weight gain

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Introduction

Gestational diabetes mellitus (GDM) is one of the most common complications during pregnancy, which can have serious adverse effects on both maternal and fetal health (Huang et al, 2021). According to the latest statistics, the global prevalence of GDM is 14% (Wang et al, 2022), and in Asia, it is standing at 11.5% (Lee et al, 2018). Recent years have seen a rising prevalence rate of GDM in China on an annual basis, with the overall prevalence approximately at 12.8%–16.7%, making it likely the country with the highest number of GDM cases in the world (Gao et al, 2019; Fu et al, 2021). Although the growth rate of GDM has slowed down after the implementation of the universal two-child policy in China, the rate of increase is still expected to remain high (Zhu et al, 2022).

The association of GDM with severe adverse outcomes during pregnancy, such as macrosomia, premature rupture of membranes, intrauterine infections, and pregnancy-induced hypertension, has been extensively studied (Mustafa et al, 2021). Weight gain during pregnancy is an independent risk factor for adverse pregnancy outcomes in women with GDM and has been identified as a strong predictor of multiple adverse maternal-fetal outcomes (Lautredou et al, 2022; Manera et al, 2022; Monteiro et al, 2022). Due to the

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changing dietary habits and nutritional status of modern people, gestational weight gain (GWG) is not significantly controlled in pregnant women (Liu et al, 2023). It is particularly noteworthy that GWG in pregnant women with GDM is closely related to the occurrence of adverse pregnancy outcomes, and a higher GWG would lead to a greater likelihood of adverse outcomes (Zheng et al, 2021; Li et al, 2022). GWG is closely related to nutritional intake, exercise and other metabolic conditions during pregnancy, so it is regarded as a crucial health monitoring indicator in pregnancy care (Capital Institute of Pediatrics, Children's Physical Development Survey Cooperation Group in nine cities, 2020; Aoyama et al, 2022). In view of the significant effect of GWG on pregnancy outcomes, GWG control in pregnant women with GDM has become one of the strategies to reduce the incidence of adverse pregnancy outcomes and has attracted extensive attention from scholars (Qian, 2021; He et al, 2023).

The U.S. Institute of Medicine has proposed GWG guidelines based on pre-pregnancy body mass index (ppBMI) (Institute of Medicine – IOM, National Research Council – NRC, 2009), but the same set of guidelines are not fully applicable in Asian countries such as China given the cultural and geographical differences. The 'Monitoring and Evaluation of Weight Gain during Pregnancy for Chinese Women' (National Health Commission of the People's Republic of China, 2022), a guide published by the Chinese Nutrition Society in 2021, provides recommendations on weight gain control based on a ppBMI classification tailored for Chinese pregnant women. In this study, a retrospective analysis of weight gain patterns among pregnant women with GDM was conducted in reference to the guideline, to explore the correlations between ppBMI and types of diabetes with GWG trajectories in GDM patients. The objective of this study is to lay a solid reference foundation for establishing personalised weight management strategies for pregnant women with GDM, with the aim of reducing the risk of adverse pregnancy outcomes.

Methods

Research setting

This retrospective study was conducted at Huai'an Maternal and Child Health Hospital, Huai'an City, Jiangsu Province, China. It is a 700-bed, tertiary-level, municipal public healthcare facility equipped with an obstetrics department ranked among the top 20 in East China, providing high-quality, comprehensive healthcare services to women and children throughout their life cycle in the city and its surrounding areas. The hospital has more than 150,000 outpatient visits per year and receives more than 7000 pregnant and postpartum women annually.

Participants

Participants included pregnant women diagnosed with GDM between January 2021 and January 2022 at a tertiary hospital. The inclusion criteria of the present study are as follows: (i) full-term live births; (ii) single pregnancy; (iii) GDM diagnosis within 23–28 weeks of gestation; and (iv) availability of gestational weight data at 12, 16, 23, 28, and 37 weeks of gestation and before delivery in the maternal and child health information system. Individuals with the characteristics described in the following were excluded: (i) unnatural pregnancy; (ii) height <140 cm; (iii) body weight >125 kg; (iv) having endocrine diseases, including hypertension detected before pregnancy; and (v) inability to cooperate with medical staff owing to mental illness. A total of 1421 pregnant women were included in this study (Figure 1).

Measurements and calculation

GDM was diagnosed according to the diagnostic criteria defined by the International Association of Diabetes and Pregnancy Study Groups. The participants underwent a 75-gram oral glucose tolerance test at gestational weeks 24–28, and GDM was diagnosed if fasting venous plasma critical values were ≥5.1 mmol/L and/or ≥10 mmol/L at 1 h and ≥8.5 mmol/L at 2 h (Chinese Medical Association Diabetes Section, 2021; Sweeting et al, 2022). Based on the requirement of insulin intervention and dietary control response,

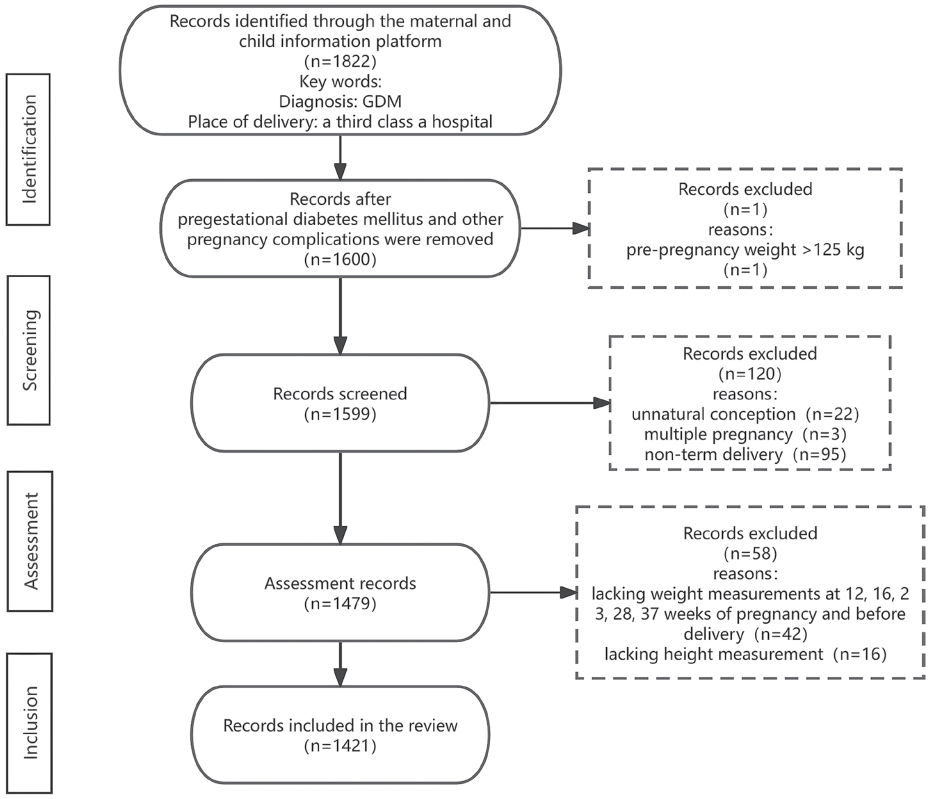

Figure 1. Flowchart depicting the participant selection process. GDM, gestational diabetes mellitus.

GDM is categorised as gestational diabetes diet-controlled (A1GDM), a category with which the patients (diagnosed with GDM) can maintain glycaemic targets through dietary modification and exercise alone. Contrary to A1GDM, individuals with gestational diabetes insulin-treated (A2GDM) are unable to achieve glycaemic control solely through diet and exercise and may necessitate insulin or other pharmacologic therapies to maintain glucose levels within desired ranges.

The body mass index (BMI) was classified according to Chinese guidelines as follows (Song and Long, 2021): low body weight, BMI <18.5 kg/m^2; normal body weight, 18.5 kg/m^2 ≤ BMI < 24 kg/m^2; overweight, 24 kg/m^2 ≤ BMI < 28 kg/m^2; and obese, BMI ≥28 kg/m^2. Considering the impact of early pregnancy symptoms such as loss of appetite and morning sickness on weight, as well as the uniformity of weight measurement timing, we regard the weight at 12 weeks of gestation as the pre-pregnancy weight, while pre-delivery weight was defined as the last measured weight in the week before delivery. Total GWG was calculated by subtracting pre-pregnancy weight (kg) from pre-delivery weight (kg). The range of weight gain during pregnancy was evaluated according to the ‘Monitoring and Evaluation of Weight during Pregnancy of Chinese Women’ guidelines released by the Chinese Nutrition Society in September 2021 (National Health Commission of the People's Republic of China, 2022). Pregnancy weight gain below the recommended range was considered insufficient weight gain during pregnancy; pregnancy weight gain within the recommended range was considered appropriate weight gain during pregnancy; and pregnancy weight gain above the recommended range was considered excessive weight gain during pregnancy (Table 1). Adverse maternal and neonatal outcomes include caesarean delivery, low birth weight (LBW), and macrosomia. Low birth weight is defined as a birth weight of less than 2500 grams, while macrosomia is defined as a birth weight of 4000 grams or more.

Data collection

Data were collected through a structured review of patient electronic clinical information obtained from the Jiangsu Province Maternal and Child Health Information System. The

Table 1. Criteria for classifying pregnant women based on pre-pregnancy body mass index

ppBMI	Weight gain (kg)		
	Insufficient	Appropriate	Excessive
Low (BMI <18.5 kg/m^2)	< 11.0	11.0–16.0	≥ 16.0
Normal (18.5 kg/m^2 ≤ BMI < 24.0 kg/ m^2)	< 8.0	8.0–14.0	≥ 14.0
Overweight (24.0 kg/m^2 ≤ BMI < 28.0 kg/m^2)	< 7.0	7.0–11.0	≥ 11.0
Obese (BMI ≥28.0 kg/m^2)	< 5.0	5.0–9.0	≥ 9.0

ppBMI: pre-pregnancy body mass index; BMI: body mass index.

collected participant data included: age, height, weight, educational background, gravidity, parity, number of prenatal visits, gestational age at delivery, delivery methods, and delivery outcomes. The following time points were selected for model fitting: 12, 16, 23, 28, and 37 weeks of gestation and before delivery.

Data analysis

SAS (version 9.4 for Windows, SAS Institute, Inc., Cary, NC, USA) was used for data management and statistical analysis. Qualitative data are expressed as count (percentage) and were compared across groups using Chi-square tests and Fisher's exact test. Data following a normal distribution are expressed as mean ± standard deviation and were compared between groups using *t*-tests and one-way analysis of variance. However, data not following a normal distribution are presented as median (P_{25}, P_{75}) and were compared using rank-sum tests.

Group-based trajectory modelling (GBTM) (Nagin, 2005; Lennon et al, 2018) was utilised to identify GWG trajectory patterns. We sequentially fitted trajectory models with 2 to 5 groups of different trajectory shapes (linear, quadratic, cubic) and selected the best model based on statistical evaluation criteria and professional interpretability. The chosen three-group trajectory model demonstrated a good fit, with average posterior probabilities above 0.9, close member probabilities and posterior member probabilities, odds of correct classification greater than 5, and entropy values above 0.8. Multinomial logistic regression was used to analyse the impact of ppBMI and disease diagnosis on trajectory group membership; binary logistic regression was employed to study the effect of trajectory groups on mode of delivery; and multinomial logistic regression was also used to evaluate the influence of trajectory groups on neonatal weight. A significance level of $p \leq 0.05$ was considered statistically significant.

Results

Patients' characteristics

In this study, we analysed data from 1421 pregnant women with GDM. The average age was 29.4 ± 4.3 years, and primiparas accounted for 57.1% of the cohort. Patients with A1GDM represented 88.95% and those with A2GDM comprised 11.05% of the sample. The proportions of women who were overweight and obese pre-pregnancy were 26% and 13%, respectively. The categories of GWG—insufficient, appropriate, and excessive—accounted for 24.84%, 41.66%, and 33.50%, respectively. The incidence rates of caesarean delivery, LBW, and macrosomia were 44%, 1.7%, and 10.8%, respectively.

Trajectories of gestational weight gain

This study identified three GWG trajectories (Figure 2), namely low GWG (Trajectory 1), moderate GWG (Trajectory 2), and rapid GWG (Trajectory 3), with distribution percentages in the sample of 29.63%, 54.55%, and 15.82%, respectively. The average weight gains for pregnant women in Trajectories 1 to 3 were 6.5 kg, 11.6 kg, and 13.16 kg, respectively. Obese pregnant women constituted the lowest percentage in Trajectory 3,

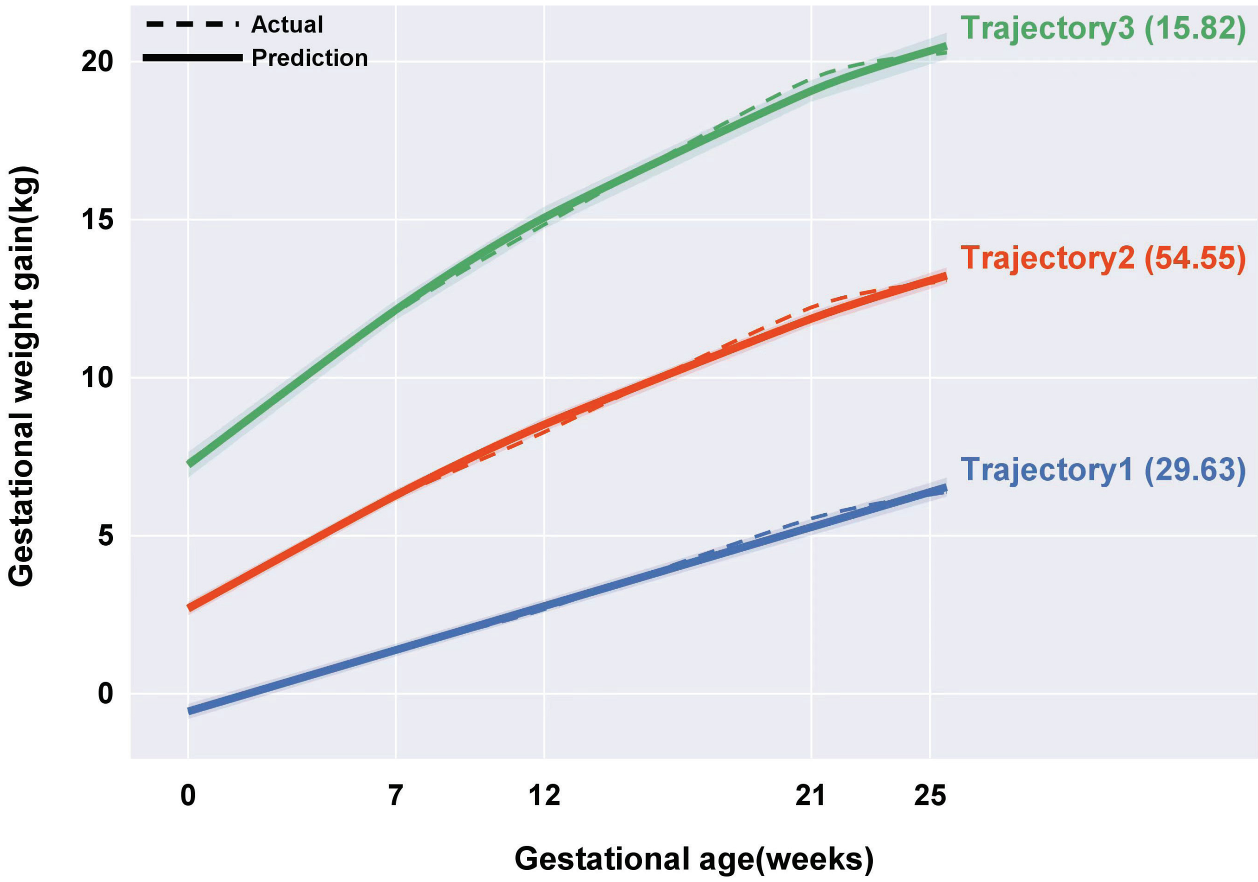

Figure 2. Gestational weight gain trajectories in pregnant women with gestational diabetes mellitus. Trajectory 1: Low GWG; Trajectory 2: Moderate GWG; Trajectory 3: Rapid GWG; GWG: Gestational weight gain.

but the highest in Trajectory 1 (Figure 3). All trajectory group model parameters were statistically significant (Table 2).

Association of gestational weight gain trajectories with pre-pregnancy body mass index and gestational diabetes mellitus type

A multinomial logistic regression model with unordered categories was performed using the trajectory group as the dependent variable, with Trajectory 1 serving as the reference category. In the model where ppBMI was the independent variable, the adjustment factors were age, parity, and educational level. In the model where GDM type was the independent variable, the adjustment factors included ppBMI, age, parity, and educational level. The study findings revealed that compared to women with low pre-pregnancy weight, those who were overweight or obese pre-pregnancy were more likely to fall into Trajectory 1. Similarly, women with A2GDM were more likely to be in Trajectory 1 compared to those with A1GDM, and these results remained robust after adjusting for confounding factors (Table 3).

Association of gestational weight gain trajectory groups with pregnancy outcomes

Binary logistic regression analysis indicated that after adjusting for confounding factors such as ppBMI, age, parity, and educational level, pregnant women in Trajectory 3 were 1.716 times more likely to deliver via caesarean section compared to those in Trajectory 1. Relative to women in Trajectory 1, the risk of giving birth to a macrosomic infant was increased 3.261 times for women in Trajectory 3 and 1.520 times for those in Trajectory 2, with these results remaining stable even after adjustment for confounding factors (Table 4).

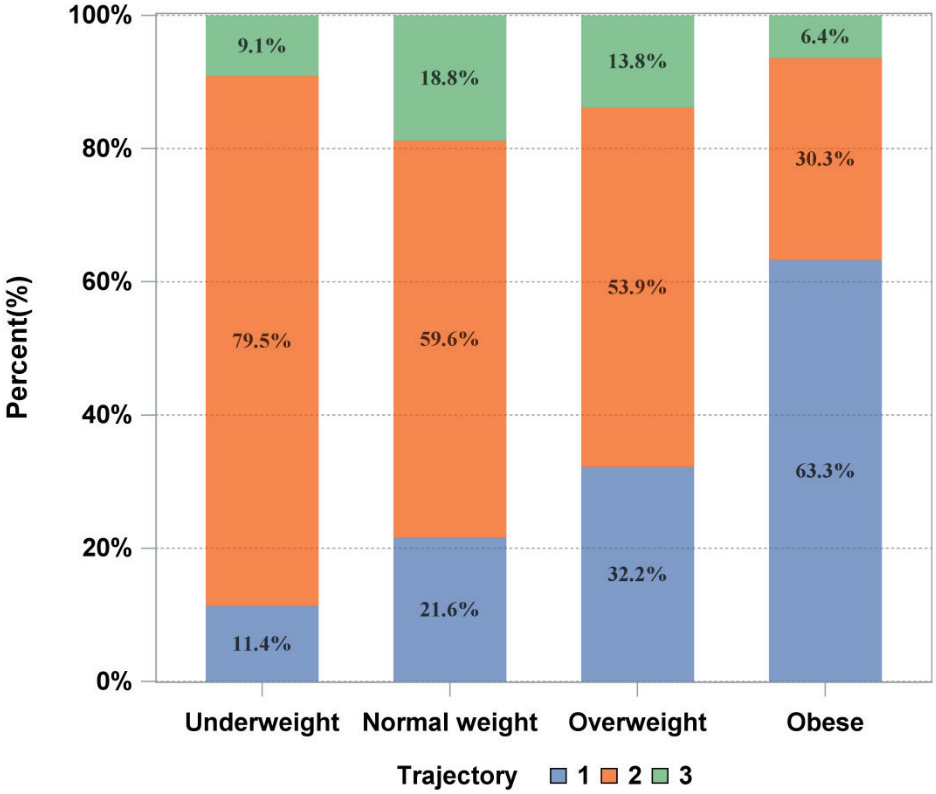

Figure 3. Distribution of gestational weight gain trajectories in pregnant women with gestational diabetes mellitus across different pre-pregnancy body mass index categories.

Table 2. Parameter estimates for the three trajectory models

Group	Parameter	Estimate	Standard error	*t*	*p*
Trajectory 1	Intercept	–0.557537	0.122620	–4.547	< 0.001
	Linear	0.277636	0.007141	38.878	< 0.001
Trajectory 2	Intercept	2.695380	0.110211	24.457	< 0.001
	Linear	0.549785	0.018022	30.506	< 0.001
	Quadratic	–0.005384	0.000646	–8.337	< 0.001
Trajectory 3	Intercept	7.240353	0.207144	34.953	< 0.001
	Linear	0.769896	0.033169	23.212	< 0.001
	Quadratic	–0.009829	0.001208	–8.139	< 0.001

Clinical characteristics by different pre-pregnancy body mass index categories

Among the four groups of pregnant women categorised by different ppBMI, significant differences were observed in age, GWG, GDM treatment during pregnancy, mode of delivery, and maternal and neonatal outcomes (Table 5).

Clinical characteristics of different gestational diabetes mellitus types

In pregnant women with A1GDM receiving non-pharmacological treatment and those with A2GDM receiving pharmacological treatment, the proportion of inadequate GWG was lower in the pharmacological treatment group, while the proportions of appropriate

Table 3. Impact of pre-pregnancy body mass index and disease diagnosis on trajectories

	Trajectory 2 vs Trajectory 1		Trajectory 3 vs Trajectory 1	
Variable	**OR (95%CI)**	***p***	**OR (95%CI)**	***p***
Unadjusted				
ppBMI				
Low	1.00 (ref)		1.00 (ref)	
Normal	2.533 (0.977–6.567)	0.056	0.919 (0.243–3.484)	0.901
Overweight	0.605 (0.455–0.805)	< 0.001	0.493 (0.333–0.730)	< 0.001
Obese	0.173 (0.121–0.248)	< 0.001	0.116 (0.062–0.218)	< 0.001
Type of diabetes				
A1GDM	1.00 (ref)		1.00 (ref)	
A2GDM	0.521 (0.363–0.750)	< 0.001	0.666 (0.404–1.097)	0.110
Adjusted				
ppBMI				
Low	1.00 (ref)		1.00 (ref)	
Normal	2.564 (0.987–6.661)	0.053	0.948 (0.248–3.622)	0.938
Overweight	0.580 (0.434–0.774)	< 0.001	0.421 (0.281–0.631)	< 0.001
Obese	0.165 (0.114–0.238)	< 0.001	0.096 (0.050–0.183)	< 0.001
Type of diabetes				
A1GDM	1.00 (ref)		1.00 (ref)	
A2GDM	0.647 (0.443–0.945)	0.024	0.840 (0.497–1.420)	0.515

GDM: gestational diabetes mellitus; ppBMI: pre-pregnancy body mass index; A1GDM: gestational diabetes diet-controlled; A2GDM: gestational diabetes insulin-treated.

and excessive weight gain were higher in the non-pharmacological treatment group. These differences were statistically significant (Table 6).

Discussion

In this study, three trajectories of GWG in pregnant women with GDM were identified: low-speed growth (Trajectory 1), moderate growth (Trajectory 2), and rapid growth (Trajectory 3). Overall, the GWG trajectories in GDM women remained relatively stable throughout pregnancy, with no apparent inflexion points observed in weight gain. However, previous studies have shown that healthy pregnant women experience a significant inflexion point in weight gain between the 10th and 20th weeks of gestation, after which the rate of weight gain accelerates (Goldstein et al, 2017; Pugh et al, 2017; Min, 2019; Song et al, 2020). This discrepancy suggests that weight gain in pregnant women with GDM may follow unique trajectories due to metabolic or lifestyle changes.

Some reports have shown a significant correlation between ppBMI and GWG (Chen et al, 2020; Qu et al, 2021). In this study, we found that GDM pregnant women with higher ppBMI levels were more likely to fall into 'Trajectory 1'. This group of women typically had older age and were mostly multiparous, whereas GDM pregnant women with low pre-pregnancy weight were more likely to fall into 'Trajectory 2', characterised by younger age and a higher proportion of women with higher education levels. This may be related to different levels of education, dietary habits, and nutritional beliefs. However, due to the complexity and multifactorial nature of factors contributing to GWG, consensus on this phenomenon has not yet been reached (McDowell et al, 2019; Sun et al, 2020; Yong et al,

Table 4. Impact of trajectory groups on mode of delivery and birth weight

	Caesarean section		LBW vs Normal		Macrosomia vs Normal	
Variable	**OR (95%CI)**	***p***	**OR (95%CI)**	***p***	**OR (95%CI)**	***p***
Unadjusted						
Trajectory 1	1.00 (ref)		1.00 (ref)		1.00 (ref)	
Trajectory 2	1.035 (0.814–1.315)	0.779	0.559 (0.194–1.604)	0.279	1.520 (1.017–2.273)	0.041
Trajectory 3	1.264 (0.911–1.753)	0.161	0.645 (0.133–3.138)	0.587	3.261 (2.054–5.178)	< 0.001
Adjusted						
Trajectory 1	1.00 (ref)		1.00 (ref)		1.00 (ref)	
Trajectory 2	1.365 (1.050–1.776)	0.020	0.715 (0.234–2.189)	0.557	1.977 (1.287–3.036)	0.002
Trajectory 3	1.716 (1.204–2.445)	0.003	0.804 (0.152–4.242)	0.797	4.446 (2.693–7.339)	< 0.001

LBW: low birth weight.

2020; Catov et al, 2022). It is noteworthy that although obese mothers accounted for a higher proportion in ‘Trajectory 1,’ obesity itself may already increase the risk of adverse pregnancy outcomes, which should be further investigated in future studies.

In our analysis of the impact of GWG trajectories on pregnancy outcomes, initial findings showed no significant association between GWG trajectories and modes of delivery. However, upon incorporating key variables such as ppBMI, age, parity, and educational level into the statistical model, we observed a significantly higher likelihood of caesarean delivery among women with a rapid weight gain trajectory (Trajectory 3) compared to those with a slow growth trajectory (Trajectory 1). This indicates that these factors may mask the true relationship between GWG trajectories and the probability of caesarean delivery. Research by Borges et al (2024) also demonstrates that ppBMI, age and education significantly affect the mode of delivery in pregnant women (Pinheiro et al, 2019). Therefore, it is essential to consider these key factors when analysing the relationship between gestational weight management and pregnancy outcomes. The adjusted results suggested that women with a rapid weight gain trajectory (Trajectory 3) were more inclined to undergo caesarean section delivery, consistent with previous studies on healthy pregnant women (Li et al, 2021; Jin et al, 2021), reflecting that rapid weight gain may lead to more pregnancy complications. Additionally, the current study revealed a significantly increased risk of fetal macrosomia among pregnant women in Trajectory 3, especially those with A2GDM receiving medication therapy, which may have adverse effects on the long-term health of newborns and potentially increase the risk of childhood obesity (Xu et al, 2020; Liu and Yang, 2022). This emphasises the importance of controlling GWG in preventing macrosomia births. Therefore, for maternal and child health workers, being able to identify and differentiate pregnant women with different GWG trajectories to determine high-risk groups is crucial for improving the health status of both pregnant women and newborns.

The study on the relationship between GDM types and GWG found that compared to those with A1GDM, pregnant women with A2GDM constituted a higher proportion of women with inadequate weight gain during pregnancy and were more inclined towards a low-speed growth trajectory, consistent with the results of previous studies (Chaves et al, 2021; Che et al, 2022). This could be attributed to metabolic changes induced by medication therapy or adjustments in diet and activity levels, partially offsetting the increased risk of weight gain associated with GDM. This finding suggests the impact of medication therapy on GWG and underscores the potential significance of medication therapy in controlling GWG. Such a finding also prompts us to exercise greater caution in providing GWG guidance for this group. A higher proportion of pregnant women with A1GDM who

Table 5. Univariate analysis by pre-pregnancy body mass index

Variable	Total	ppBMI				Statistic	*p*
		Low (n=44)	Normal (n=823)	Overweight (n=369)	Obese (n=185)		
Age (years)	29.4 ± 4.3	27.7 ± 3.4	29.2 ± 4.3	29.8 ± 4.3	29.8 ± 4.1	*F*=4.68	0.002
Type of diabetes							
A1GDM	1264 (88.95)	41 (93.18)	770 (93.56)	320 (86.72)	133 (71.89)	χ^2=75.24	< 0.001
A2GDM	157 (11.05)	3 (6.82)	53 (6.44)	49 (13.28)	52 (28.11)		
Parity							
Primipara	581 (40.89)	26 (59.09)	362 (43.99)	135 (36.59)	58 (31.35)	χ^2=19.09	< 0.001
Multipara	840 (59.11)	18 (40.91)	461 (56.01)	234 (63.41)	127 (68.65)		
Educational level							
High school or below	254 (17.87)	5 (11.36)	115 (13.97)	76 (20.60)	58 (31.35)	χ^2=84.94	< 0.001
Technical secondary school	176 (12.39)	5 (11.36)	80 (9.72)	75 (20.33)	16 (8.65)		
Associate degree	355 (24.98)	7 (15.91)	209 (25.39)	84 (22.76)	55 (29.73)		
Bachelor's degree	572 (40.25)	23 (52.27)	375 (45.57)	120 (32.52)	54 (29.19)		
Graduate degree	64 (4.50)	4 (9.09)	44 (5.35)	14 (3.79)	2 (1.08)		
Height	162.0 (159.0, 165.0)	161.5 (159.5, 164.5)	162.0 (159.0, 165.0)	161.0 (158.0, 165.0)	162.0 (159.0, 165.0)	*H*=2.04	0.564#
Gestational age at delivery (years)	39.0 ± 0.9	39.0 ± 0.8	39.0 ± 0.9	39.0 ± 1.0	38.7 ± 0.9	*F*=6.93	< 0.001
Mode of delivery							
Vaginal delivery	796 (56.02)	28 (63.64)	513 (62.33)	187 (50.68)	68 (36.76)	χ^2=46.49	< 0.001
Caesarean section	625 (43.98)	16 (36.36)	310 (37.67)	182 (49.32)	117 (63.24)		
Infant weight							
LBW	24 (1.69)	0 (0.00)	10 (1.22)	6 (1.63)	8 (4.32)	—	< 0.001*
Normal-birth-weight child	1244 (87.54)	41 (93.18)	740 (89.91)	320 (86.72)	143 (77.30)		
Macrosomic infant	153 (10.77)	3 (6.82)	73 (8.87)	43 (11.65)	34 (18.38)		
GWG							
Insufficient	221 (15.55)	9 (20.45)	107 (13.00)	61 (16.53)	44 (23.78)	χ^2=45.30	< 0.001
Appropriate	595 (41.87)	27 (61.36)	382 (46.42)	117 (31.71)	69 (37.30)		
Excessive	605 (42.58)	8 (18.18)	334 (40.58)	191 (51.76)	72 (38.92)		

** Indicates Fisher's exact test; # indicates rank-sum test. GWG: gestational weight gain; GDM: gestational diabetes mellitus; ppBMI: pre-pregnancy body mass index; A1GDM: gestational diabetes diet-controlled; A2GDM: gestational diabetes insulin-treated; LBW: low birth weight.*

Table 6. Univariate analysis by gestational diabetes mellitus type

Variable	Total	Type of diabetes A1GDM (n=1264)	Type of diabetes A2GDM (n=157)	Statistic	*p*
Age (years)	29.4 ± 4.3	29.2 ± 4.3	30.6 ± 4.3	t=3.80	< 0.001
Parity					
Primipara	581 (40.89)	534 (42.25)	47 (29.94)	χ^2=8.76	0.003
Multipara	840 (59.11)	730 (57.75)	110 (70.06)		
Educational level					
High school or below	254 (17.87)	205 (16.22)	49 (31.21)	χ^2=23.66	< 0.001
Technical secondary school	176 (12.39)	156 (12.34)	20 (12.74)		
Associate degree	355 (24.98)	318 (25.16)	37 (23.57)		
Bachelor's degree	572 (40.25)	526 (41.61)	46 (29.30)		
Graduate degree	64 (4.50)	59 (4.67)	5 (3.18)		
Height	162.0 (159.0, 165.0)	162.0 (159.0, 165.0)	160.0 (158.0, 165.0)	Z=–2.03	0.042#
Gestational age at delivery (years)	39.0 ± 0.9	39.0 ± 0.9	38.7 ± 0.9	t=4.32	< 0.001
Mode of delivery					
Vaginal delivery	796 (56.02)	735 (58.15)	61 (38.85)	χ^2=21.10	< 0.001
Caesarean section	625 (43.98)	529 (41.85)	96 (61.15)		
Infant weight					
LBW	24 (1.69)	19 (1.50)	5 (3.18)	χ^2=12.00	0.002
Normal-birth-weight child	1244 (87.54)	1120 (88.61)	124 (78.98)		
Macrosomic infant	153 (10.77)	125 (9.89)	28 (17.83)		
GWG					
Insufficient	221 (15.55)	185 (14.64)	36 (22.93)	χ^2=7.35	0.025
Appropriate	595 (41.87)	536 (42.41)	59 (37.58)		
Excessive	605 (42.58)	543 (42.96)	62 (39.49)		

 # indicates rank-sum test. GWG: gestational weight gain; GDM: gestational diabetes mellitus; A1GDM: gestational diabetes diet-controlled; A2GDM: gestational diabetes insulin-treated; LBW: low birth weight.

received non-medication treatment underwent excessive weight gain, which may indicate that non-medication interventions are less effective in controlling GWG. This may also reflect that pregnant women in the non-medication treatment group are more focused on blood sugar control rather than weight management.

This study was the first using GBTM in the analysis of weight gain trajectories throughout the entire gestational period among women with GDM in the East China region. It explores the relationship of GDM women's GWG trajectory with ppBMI, GDM types, and adverse pregnancy outcomes, shedding light on the current status of gestational weight management in the GDM population. Furthermore, this study provides scientific evidence for personalised management strategies.

This study has several limitations. Firstly, the retrospective design of this study may lead to selection and recall biases. Secondly, the sample of this study was solely drawn from a single tertiary hospital, not fully representing the GDM population. Thirdly, the small sample size of GDM patients requiring pharmacological treatment may limit the generalizability of the study findings. Future studies should assess the effects of different regions, ethnicities, and interventions on the trajectory of weight gain during pregnancy in GDM patients, using a prospective or multicenter approach to enhance the generalizability and external validity of the results, and long-term follow-up should be considered to assess the long-term effects of weight management strategies on maternal and infant health, laying the foundation for guiding the comprehensive health management strategies for patients with GDM.

Conclusion

This study utilised GBTM to analyse the trajectory of weight gain during the entire gestational period among women with GDM and investigated its relationship with ppBMI, GDM types, and adverse pregnancy outcomes. We found that the weight gain trajectory of GDM women exhibited diversity, underscoring the necessity to implement personalised management strategies. The pattern of weight gain Is closely associated with factors such as ppBMI and GDM types. In clinical practice, personalised gestational weight management strategies should be developed based on individual circumstances to improve pregnancy outcomes and maternal-infant health in GDM patients.

Key points

- GWG trajectories in women with GDM can be categorised into three types: slow, moderate, and rapid growth.
- Pregnant women who are overweight or obese before pregnancy are more likely to follow a slow growth trajectory.
- Women on a rapid growth trajectory are more likely to undergo caesarean delivery and face increased risks of giving birth to macrosomic infants.
- Identifying and distinguishing pregnant women with different GWG trajectories to determine high-risk groups is crucial for improving the health outcomes of both mothers and newborns.

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Availability of data and materials

All data included in this study are available upon request by contact with the corresponding author.

Author contributions

YL and XW designed the research study. YL and XXF performed the acquisition, analysis and interpretation of the data. XW provided help and advice throughout the study. YL is responsible for drafting and revising articles, and XW critically revises important intellectual content. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics approval and consent to participate

This study was approved by the ethics committee of Huai'an Maternal and Child Health Hospital (14 July 2022; approval no. 2022032) and was conducted according to the tenets of the Declaration of Helsinki. All data were de-identified and anonymized throughout the analysis. The requirement for informed consent was waived.

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Conflict of interest

The authors and contributor declare no conflict of interest.

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