Intrapartum and early postpartum glycemic profiles in women with gestational diabetes mellitus: an observational study

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Abstract

Background: Data on the glycemic profile of pregnant women with gestational diabetes mellitus (GDM) during the perinatal period are sparse. This study described the intrapartum and early postpartum glucose profiles among pregnant women with GDM, and analyzed factors potentially affecting glycemic parameters during the period.

Methods: This was a prospective observational study conducted from March 2020 to November 2021. Pregnant women with GDM receiving lifestyle interventions alone during pregnancy and matched women with non-diabetic pregnancies (NDPs) were enrolled from among patients admitted to the obstetrics department for childbirth. Glucose monitoring was performed via a flash glucose monitoring (FGM) system on admission, and glucose readings during labor and early postpartum were analyzed. The clinical characteristics and FGM-based parameters of participants in the two groups were compared.

Results: A total of 124 participants (mean age: 29.5 ± 3.5 years, 92 [74.2%] primipara) were included in the final analysis. A total of 17,571 glucose readings were retrieved. There were no significant differences in clinical characteristics between the GDM (n = 60) and NDP (n = 64) groups. The average glucose level was 92.2 mg/dL, and the level was higher in the GDM group (95.5 ± 12.1 mg/dL *vs.* 89.1 ± 13.4 mg/dL, P = 0.008) during the intrapartum and early postpartum periods. The data were split into the intrapartum period (from the start of labor to delivery of the placenta) and the early postpartum period (within 24 h after placental delivery) for analysis. During intrapartum, women with GDM exhibited glycemic profiles and fluctuations similar to those in the NDP group. However, women with GDM had higher postpartum glucose levels (97.7 ± 13.4 mg/dL *vs.* 90.8 ± 15.3 mg/dL, P = 0.009), a longer time spent >140 mg/dL (8.7 ± 9.3% *vs.* 5.9 ± 10.3%, P = 0.011), and greater glycemic fluctuations than those with NDP. Postpartum hyperglycemia in GDM might be associated with high parity and postprandial glucose abnormalities in GDM screening tests.

Conclusion: Compared to those with normoglycemia, pregnant women with GDM receiving lifestyle interventions alone had similar intrapartum glucose profiles but higher early postpartum glucose levels and greater glucose variability, providing evidence for modification of the current perinatal glucose monitoring strategy for GDM.

Trial Registration: ChiCTR.org.cn, ChiCTR2000030972

Keywords: Blood glucose; Flash glucose monitoring; Gestational diabetes mellitus; Glycemic profiles

Introduction

Gestational diabetes mellitus (GDM) affects approximately 10% to 25% of pregnancies worldwide.[1-3] and is associated with many adverse obstetric and neonatal outcomes.[4] Previous studies have found potential relationships between intrapartum hyperglycemia and short-term adverse pregnancy outcomes such as neonatal hypoglycemia and neonatal admission to the neonatal intensive care unit (NICU) among neonates born to mothers with GDM.[5] Therefore, current guidelines suggest tight intrapartum glycemic control among women with GDM, which constantly requires glucose monitoring.[6-9] However, since the intrapartum glucose

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profile in pregnant women with GDM is less well described, the optimal strategy of intrapartum glucose monitoring for these women has not been established.

Moreover, women with GDM and their children are also at significantly higher risk for diabetes, metabolic syndrome, and cardiovascular diseases than those without diabetes during their pregnancies (non-diabetic pregnancy [NDP]).[10] As such, most guidelines and clinical pathways suggest that women with GDM should be screened for glucose tolerance as early as 4 to 6 weeks after delivery.[7,8,11] However, glucose monitoring strategies during the early postpartum period are rarely discussed. Data are sparse on the glucose profiles among women with GDM after delivery, and thus, evidence is lacking for the current recommendations of postpartum glucose monitoring for women with GDM.

Recently, continuous glucose monitoring (CGM) has emerged as a new method for glucose monitoring, and flash glucose monitoring (FGM) is a widely used CGM type. Compared with capillary glucose monitoring, FGM allows the collection of richer information on glycemic profiles with automated glucose testing every 15 min.[12] Therefore, we conducted this observational study using the FGM system to describe the intrapartum and early postpartum glucose profiles among pregnant women with GDM in comparison with matched pregnant women with normoglycemia and to analyze factors potentially affecting glycemic parameters during the period.

Methods

Ethical approval

This study has been approved by the Ethics Committee of the First Affiliated Hospital of University of Science and Technology of China (No. 2020KY-16). And the procedures followed were in accordance with the *Declaration of Helsinki* 1975, as revised in 2000. Each participant provided written informed consent.

Study population

The study was a prospective observational study conducted from March 2020 to November 2021.

We consecutively enrolled pregnant women with GDM who were admitted to the obstetrics department for childbirth. The inclusion criteria were as follows: (1) age between 18 and 40 years; (2) underwent a 75 g-oral glucose tolerance test (OGTT) between 24 and 28 weeks of gestation and met the International Association of Diabetes and Pregnancy Study Groups diagnostic criteria of GDM.[13] (3) at term, i.e., between 37 weeks + 0 days and 40 weeks + 6 days of gestation on admission; (4) single intrauterine pregnancy confirmed by ultrasonic examination on admission; (5) not using anti-hyperglycemic medication, including but not limited to insulin and metformin, during pregnancy, labor and postpartum; (6) transvaginal delivery; and (7) agreement to participate in the study. We excluded women who (1) received scheduled or unscheduled cesarean section; (2) had pregestational diabetes or overt diabetes diagnosed during pregnancy; (3) had a known history of heart, renal, pulmonary, or hematologic diseases; (4) had multifetal gestation, (5) had entered the active phase of labor before the FGM sensor was implemented; (6) had intolerance/loss of the FGM device or inability to retrieve glucose readings from the FGM device; and (7) voluntarily withdrew from the study. These women with GDM received standardized lifestyle interventions provided by obstetricians or endocrinologists following the Chinese guidelines,[9] including glycemic target education, glucose monitoring guidance, gestational-week specific nutrition advice, physical exercise advice, and monitoring of maternal and fetal complications.

To compare the glucose profile of pregnant women with GDM, we enrolled pregnant women with normoglycemia (NDP) during the same study period. These women were matched in age and parity to those with GDM and had normal glucose tolerance in the 75-g OGTT results between 24 and 28 weeks of gestation; otherwise, they were enrolled using the same inclusion and exclusion criteria described above. The women in the NDP group received routine antenatal care.

Data collection

We collected data from pregnancy notes, electronic hospital records, and face-to-face interviews. Briefly, information was collected on maternal demographics, pregnancy history, history of chronic diseases, current and past medication, recent ultrasonic examinations, OGTT results used to diagnose GDM (fasting plasma glucose [FPG], 1-h postprandial plasma glucose [1-h PPG], and 2-h PPG), and other laboratory results. Due to the potential impact of pain on glycemic fluctuations, data on receiving neuraxial analgesia during delivery were also collected. We asked the participants to record their food intake (name and quality), starting from the date of admission, on a prespecified form. During admission, the diet for women with GDM was provided according to the guideline recommendation,[9] and women in the NDP group ate freely. The dietary record was confirmed by an investigator before the participants were discharged. Breastfeeding was recommended soon after the baby was born. Maternal and neonatal outcomes were also collected after discharge of the participants.

To monitor their blood glucose, we implemented an FGM sensor on each participant before the start of their labor. This sensor (FreeStyle® Libre Pro Flash Continuous Glucose Monitoring System, Abbott Laboratories, IL, USA) recorded glucose levels every 15 min. The accuracy, safety, and user acceptability of such an FGM system for women with diabetes during pregnancy have been previously demonstrated.[14] We removed the sensor 24 h after the placenta was delivered or before the participant was discharged from the hospital. We retrieved the glucose readings through the software provided by the manufacturer after the removal of the sensors.

Measurements

Our primary outcome of interest was the intrapartum and early postpartum glucose profile, as represented by the

Table 1: Clinical characteristics of the study participants.

Clinical characteristics	All (n = 124)	GDM (n = 60)	NDP (n = 64)	P value
Age (years)	29.5 ± 3.5	29.8 ± 3.3	29.3 ± 3.6	0.501
Parity	0.3 ± 0.5	0.3 ± 0.5	0.3 ± 0.5	0.579
Primipara	92 (74.2)	43 (71.7)	49 (76.6)	0.546
Higher education	72 (58.1)	33 (55.0)	39 (60.9)	0.586
Gestational weeks (weeks)	39.4 ± 1.0	39.3 ± 0.9	39.4 ± 1.2	0.241
Weight gain in pregnancy (kg)	14.2 ± 5.6	13.2 ± 4.8	15.0 ± 6.1	0.265
BMI (kg/m^2)	27.1 ± 3.3	27.2 ± 3.5	27.0 ± 3.2	0.745
Systolic BP (mmHg)	119.8 ± 12.0	121.4 ± 11.4	118.2 ± 12.4	0.129
Diastolic BP (mmHg)	75.8 ± 9.5	76.0 ± 9.2	75.7 ± 10.0	0.886
Pulse rate (beats/min)	91.1 ± 10.3	91.7 ± 10.7	90.6 ± 10.1	0.555
Neuraxial analgesia	62 (50.0)	30 (50.0)	32 (50.0)	1.000

Data are mean ± standard deviation or n (%). Higher education refers to university experience or postgraduate experience. BMI: Body mass index; BP: Blood pressure; GDM: Gestational diabetes mellitus; NDP: Non-diabetic pregnancy.

FGM parameters derived from the FGM readings, of pregnant women with GDM in contrast to NDP pregnant women. FGM parameters were calculated in R software (version 4.1.1; R Foundation for Statistical Computing, Vienna, Austria) according to the recommendations from the international consensus.[15] Average glucose (AG) was defined as the arithmetical average of all the glucose readings during a certain period of time. Time in range (TIR) was defined as the percent time with glucose levels between 70 and 140 mg/dL. Time above range (TAR) was defined as the percent time with glucose levels >140/180 mg/dL, and time below range (TBR) was defined as the percent time with glucose levels <54/70 mg/dL. Metrics of glycemic fluctuation included the standard deviation (SD) and percentage coefficient of variation (CV), defined according to the aforesaid consensus.[15]

Statistics

To achieve 90% power at a two-sided 5% significance level, we assumed a difference of 9.0 mg/dL (0.50 mmol/L) in AG levels between the two groups with an SD of 13.9 mg/dL (0.77 mmol/L) based on the results of our pilot study, and we calculated that a minimum of 52 participants was required per group.

Data are presented as the mean ± SD. The Kolmogorov-Smirnov test was used to evaluate the normal distribution of data. Comparisons of covariates among different groups were performed using Student's t test or analysis of variance tests for continuous variables which obeyed normal distribution and the chi-squared test for categorical variables. Continuous variables with skewed distributions were analyzed using the Mann–Whitney rank test or Kruskal–Wallis H test. All statistical analyses were conducted using SPSS (version 26.0; IBM, Armonk, NY, USA). All tests were two-sided with a statistical significance set at $P < 0.05$.

Results

Clinical characteristics of study participants

Between March 2020 and November 2021, 125 participants were assessed for eligibility. One woman was excluded due to insulin use during labor, and remaining 124 participants were included in the final analysis (mean age: 29.5 years [SD = 3.5], 92 [74.2%, 92/124] primipara, 72 [58.1%, 92/124] higher education, and all married). The basic characteristics of participants in the GDM (n = 60) and NDP (n = 64) groups are shown in Table 1. There was no significant difference in the basic characteristics of the participants between the two groups. The proportions of patients who received neuraxial analgesia between the two groups were not significantly different. Neonatal characteristics and outcomes, including neonatal sex, birth weight, hypoglycemia, macrosomia, congenital malformation(s), and admission to the NICU, are shown in Supplementary Table 1, http://links.lww.com/CM9/B240. The abovementioned neonatal features also did not differ between the two groups.

Glycemic profiles and FGM parameters

A total of 261,720 min of glucose monitoring were performed throughout the study, and 17,571 glucose readings were retrieved. Maternal delivery and early postpartum glycemic metrics were compared between the GDM and NDP groups, as shown in Table 2. Overall, the AG level for all participants was 92.2 mg/dL, with a significant difference between the two groups. The AG level was higher in the GDM group than in the NDP group (95.5 ± 12.1 mg/dL *vs.* 89.1 ± 13.4 mg/dL, P = 0.008), suggesting impaired glucose in the GDM group. Additionally, the GDM group had a higher TAR >140 (7.6 ± 8.7% *vs.* 4.9 ± 8.1%, P = 0.019) and lower TBR <70 (13.6 ± 14.1% *vs.* 20.7 ± 18.3%, P = 0.018) than the NDP group. However, there were no significant differences in SD (23.6 ± 7.4 mg/dL *vs.* 21.6 ± 7.3 mg/dL, P = 0.118), CV (24.6 ± 6.2% *vs.* 24.1 ± 7.0%, P = 0.704), TIR 70–140 (78.8 ± 13.8% *vs.* 74.4 ± 17.5%, P = 0.121), TAR >180 (1.3 ± 2.8% *vs.* 0.9 ± 2.0%, P = 0.404), and TBR <54 (2.0 ± 5.6% *vs.* 4.0 ± 9.7%, P = 0.066) between the two groups.

Next, we split the whole monitoring period into two time periods for further analysis: the intrapartum period (the period between the beginning of labor and the delivery of

Table 2: Glycemic parameters of participates of the GDM and the NDP groups in the study.

Glycemic variability parameters	Overall			Intrapartum			Postpartum		
	GDM ($n = 60$)	NDP ($n = 64$)	*P* value	GDM ($n = 60$)	NDP ($n = 64$)	*P* value	GDM ($n = 60$)	NDP ($n = 64$)	*P* value
AG (mg/dL)	95.5 ± 12.1	89.1 ± 13.4	0.008	90.1 ± 19.0	86.0 ± 17.4	0.216	97.7 ± 13.4	90.8 ± 15.3	0.009
SD (mg/dL)	23.6 ± 7.4	21.6 ± 7.3	0.118	17.7 ± 8.7	17.8 ± 10.0	0.966	23.7 ± 7.5	21.4 ± 7.0	0.074
CV (%)	24.6 ± 6.2	24.1 ± 7.0	0.704	19.1 ± 7.1	20.1 ± 8.2	0.480	24.1 ± 6.4	23.6 ± 6.8	0.652
TAR >180 (%)	1.3 ± 2.8	0.9 ± 2.0	0.404	1.1 ± 4.2	1.1 ± 5.1	0.511	1.4 ± 3.2	1.0 ± 2.6	0.313
TAR >140 (%)	7.6 ± 8.7	4.9 ± 8.1	0.019	5.2 ± 12.2	3.8 ± 9.0	0.808	8.7 ± 9.3	5.9 ± 10.3	0.011
TIR 70–140 (%)	78.8 ± 13.8	74.4 ± 17.5	0.121	77.0 ± 24.2	69.7 ± 26.6	0.079	79.6 ± 13.1	75.2 ± 17.4	0.112
TBR <70 (%)	13.6 ± 14.1	20.7 ± 18.3	0.018	17.8 ± 24.0	26.5 ± 27.8	0.049	11.7 ± 13.1	18.9 ± 18.4	0.034
TBR <54 (%)	2.0 ± 5.6	4.0 ± 9.7	0.066	5.2 ± 17.4	5.5 ± 12.1	0.349	1.0 ± 2.6	3.5 ± 10.2	0.038

Data are mean ± standard deviation. AG: Average glucose; CV: Percentage coefficient of variation; GDM: Gestational diabetes mellitus; NDP: Non-diabetic pregnancy; SD: Standard deviation; TAR: Time above range; TBR: Time below range; TIR: Time in range.

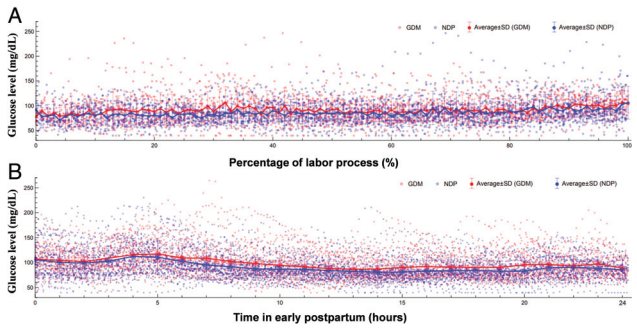

Figure 1: Comparison of glycemic profiles between the GDM and NDP groups. (A) During labor; (B) Early postpartum. GDM: Gestational diabetes mellitus; NDP: Non-diabetic pregnancy; SD: Standard deviation.

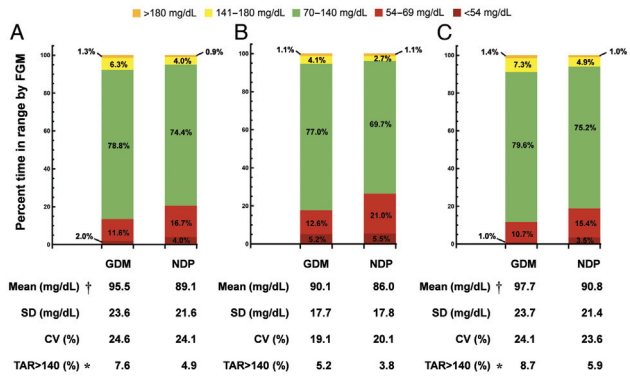

Figure 2: FGM parameters of glycemic variability between the GDM and NDP groups. (A) During labor period and early postpartum; (B) During labor; (C) Early postpartum. $^{*}P < 0.05$ and $^{\dagger}P < 0.01$. CV: Percentage coefficient of variation; FGM: Flash glucose monitoring; GDM: Gestational diabetes mellitus; NDP: Non-diabetic pregnancy; SD: Standard deviation; TAR: Time above range.

the placenta) and the early postpartum period (the 24-h period after the delivery of the placenta). We found that there were different glucose profiles in these two time periods between the two participant groups [Figures 1 and 2 and Table 2].

During labor, the glucose levels were similar between the two groups as labor progressed [Figure 1A]. There was no difference between-group in AG level (90.1 ± 19.0 mg/dL *vs.* 86.0 ± 17.4 mg/dL, $P = 0.216$), SD (17.7 ± 8.7 mg/dL *vs.* 17.8 ± 10.0 mg/dL, $P = 0.966$), CV (19.1 ± 7.1% *vs.* 20.1 ± 8.2%, $P = 0.480$), TIR 70–140 (77.0 ± 24.2% *vs.* 69.7 ± 26.6%, $P = 0.079$), TAR >180 (1.1 ± 4.2% *vs.* 1.1 ± 5.1%, $P = 0.511$), and TBR <54 (5.2 ± 17.4% *vs.* 5.5 ± 12.1%, $P = 0.349$; Figure 2B and Table 2). However, the GDM group had a significantly lower TBR <70 (17.8 ± 24.0% *vs.* 26.5 ± 27.8%, $P = 0.049$) than the NDP group intrapartum, which was consistent with the overall results.

On the other hand, in the early postpartum period, on the contrary, there was a significant difference in AG levels: A higher AG level was observed in the GDM group than in the NDP group (97.7 ± 13.4 mg/dL *vs.* 90.8 ± 15.3 mg/dL, $P = 0.009$, Figure 1B). Additionally, as shown in Figure 2C, the TAR >140 (8.7 ± 9.3% *vs.* 5.9 ± 10.3%, $P = 0.011$) was significantly higher in the postpartum GDM group, in addition to a lower TBR <70 (11.7 ± 13.1% *vs.* 18.9 ± 18.4%, $P = 0.034$) and lower TBR <54 (1.0 ± 2.6% *vs.* 3.5 ± 10.2%, $P = 0.038$) in the GDM group during the early postpartum period. In terms of the degree of glycemic fluctuation [Figure 2C], the SD of the GDM group was higher than that of the NDP group (23.7 ± 7.5 mg/dL *vs.* 21.4 ± 7.0 mg/dL, $P = 0.074$), although it did not reach statistical significance.

Together, these findings demonstrated that during labor, the glucose profiles were similar between the GDM and NDP groups, but the GDM group did not recover to normoglycemia during the early postpartum period and remained slightly hyperglycemic, with more fluctuations than those in the NDP group.

Subgroup analysis of early postpartum glucose characteristics among the GDM group

To understand factors potentially affecting the early postpartum glucose profile among participants with GDM, subgroup analysis was performed, with age, parity, and glucose status in the 75-g OGTT test for GDM [Table 3].

Table 3: Subgroup analysis of early postpartum glucose characteristics among the GDM group.

Characteristics	AG (mg/dL)	*P* value	TAR >140 (%)	*P* value	SD (mg/dL)	*P* value	CV (%)	*P* value	TIR 70–140 (%)	*P* value
Age (years)		0.747		0.552		0.304		0.213		0.314
<30	98.2 ± 13.3		8.3 ± 9.5		22.7 ± 5.7		23.0 ± 4.7		81.3 ± 12.2	
≥30	97.1 ± 13.7		9.1 ± 9.3		24.7 ± 9.0		25.1 ± 7.7		77.9 ± 13.9	
Primipara		0.621		0.148		0.066		0.056		0.087
Yes	97.1 ± 13.5		7.9 ± 9.2		22.4 ± 6.4		22.8 ± 5.0		81.4 ± 12.0	
No	99.0 ± 13.5		10.7 ± 9.6		27.1 ± 9.2		27.3 ± 8.6		75.0 ± 14.8	
75-g OGTT		0.712		0.241		0.067		0.032		0.084
hFPG-only	93.6 ± 13.1		4.6 ± 6.8		19.4 ± 6.8		20.4 ± 5.0		85.5 ± 11.1	
hPPG-only	97.8 ± 14.0		9.3 ± 9.6		25.5 ± 7.8		25.9 ± 6.7		75.8 ± 12.9	
hFPG and hPPG	96.6 ± 20.2		7.3 ± 14.9		21.1 ± 8.2		21.6 ± 5.9		77.8 ± 14.5	

Data are mean ± standard deviation. AG: Average glucose; CV: Percentage coefficient of variation; hFPG: High fasting plasma glucose; GDM: Gestational diabetes mellitus; OGTT: Oral glucose tolerance test; hPPG: High postprandial plasma glucose; TAR: Time above range; TIR: Time in range; SD: Standard deviation.

We did not find significant differences in early postpartum AG, TAR >140, SD, CV, or TIR 70 to 140 in different age groups. Multiparous women with GDM tended to have lower TIR 70 to 140 (81.4 ± 12.0% *vs.* 75.0 ± 14.8%, $P = 0.087$) and more severe glucose fluctuations represented by SD (22.4 ± 6.4 mg/dL *vs.* 27.1 ± 9.2 mg/dL, $P = 0.066$) and CV (22.8 ± 5.0% *vs.* 27.3 ± 8.6%, $P = 0.056$), although the difference was not statistically significant.

However, the glycemic status at 75-g OGTT seemed to have an impact. We divided GDM participants into three groups, denoted as high FPG (hFPG)-only, high PPG (hPPG)-only, and hFPG and hPPG. Participants in the hFPG-only group had only high FPG at the 75-g OGTT, namely, FPG ≥92 mg/dL, 1-h PPG <180, and 2-h PPG <153 mg/dL. Similarly, participants in the hPPG-only group had only high PPG in the OGTT, namely, FPG< 92 mg/dL, and 1-h PPG ≥ 180 and/or 2-h PPG ≥ 153 mg/dL. Participants in the hFPG and hPPG group were characterized by both elevated FPG and PPG. We found that the participants in the hFPG-only group were younger (28.7 ± 3.1 *vs.* 28.9 ± 2.7 *vs.* 32.7 ± 3.7 years, $P = 0.023$) and had a higher BMI (29.1 ± 4.1 *vs.* 25.8 ± 3.4 *vs.* 27.5 ± 3.1 kg/m^2, $P = 0.042$) than the other two groups [Supplement Table 3, http://links.lww.com/CM9/B240]. We observed that the participants in the hPPG-only group had a higher early postpartum AG (93.6 ± 13.1 *vs.* 97.8 ± 14.0 *vs.* 96.6 ± 20.2 mg/dL, $P = 0.712$), SD (19.4 ± 6.8 *vs.* 25.5 ± 7.8 *vs.* 21.1 ± 8.2 mg/dL, $P = 0.067$), CV (20.4 ± 5.0% *vs.* 25.9 ± 6.7% *vs.* 21.6 ± 5.9%, $P = 0.032$), and TAR >140 (4.6 ± 6.8% *vs.* 9.3 ± 9.6% *vs.* 7.3 ± 14.9%, $P = 0.241$) than the other two groups [Table 3].

Discussion

In this prospective observational study, the glycemic profiles and fluctuations in pregnant women with GDM and NDP during labor and the early postpartum period were described and compared based on FGM data. We found that compared with pregnant women in the NDP group, pregnant women with GDM who received lifestyle intervention alone exhibited similar glycemic profiles during labor but higher early postpartum glucose levels and variability. The multiparous women in the GDM group appeared to have higher levels of postpartum glycemia and more glycemic fluctuations than primipara. Additionally, participants with GDM who only elevated PPG at the 75-g OGTT at weeks 24 to 28 tended to have more severe early postpartum hyperglycemia and glycemic variability.

Intrapartum glucose profile and clinical implications

During delivery, the goal of glucose management is to maintain maternal glucose levels within the normal range as much as possible because elevated blood glucose 4 to 6 h before delivery is associated with an increased risk of neonatal hypoglycemia.[16] To achieve such glycemic control targets, extra glucose monitoring is necessary. It is recommended that strict fingertip glucose testing during delivery be performed for women with GDM regardless of the use of anti-diabetic therapy during pregnancy by the National Institute for Health and Care Excellence in the United Kingdom and the Chinese Society of Perinatal Medicine.[6,9] However, a recent study indicated that strict hourly intrapartum maternal glucose management fails to reduce the incidence of neonatal hypoglycemia during delivery compared with that after a liberalized regimen for women with GDM.[17] There is no consensus on the frequency of blood glucose monitoring during labor in pregnant women with GDM.[18] In clinical practice, care providers may measure glucose more frequently to prevent hyperglycemia in pregnant women with GDM.[19] More clinical studies are needed to clarify the intrapartum glycemic profile data in GDM.

Our findings in this study suggested that intrapartum glucose levels and variability were similar among pregnant women with GDM who received lifestyle interventions only and women in the NDP group. Over 70% of the whole labor time, the glucose level of the studied women with GDM and NDP fell in the recommended range of 72 to 126 mg/dL.[6] No significant difference was observed in adverse outcomes, such as neonatal hypoglycemia. These findings provide evidence that for women with GDM, a more relaxed strategy of glucose monitoring could be applicable, which similar to that for normoglycemic pregnant women. Moreover, hourly close monitoring of blood glucose of the laboring women as the current guidelines requirement could pose a challenge in terms of both resources and expertise in the obstetrics wards. The

application of a relatively looser monitoring strategy may be safe and feasible.

Early postpartum glucose profile and clinical implications

Usually, following the delivery of the placenta, which is the main source of diabetogenic hormones, insulin sensitivity is restored, and glucose intolerance is resolved.[20] Emerging evidence suggests that women who develop GDM already have β-cell dysfunction and chronic insulin resistance long before pregnancy, which indicates that these metabolic disturbances are likely to persist after childbirth.[20] Evidence-based guidelines recommend postpartum care for GDM patients to reduce the incident type 2 diabetes risk, including a retest of the 75-g OGTT at 4 to 12 weeks after delivery. However, the rates of postpartum diabetes screening were unexpectedly low.[21] From screening to postpartum follow-up, there are multiple barriers to GDM management for women with this condition.[22]

Nevertheless, few investigations have described glycemic profiles in the early postpartum period. In this study, we found that after the delivery of the placenta, although the glucose of studied mothers with GDM had been well-controlled during late pregnancy with a fair mean HbA1c of 5.56%, they were still subjected to significantly higher glucose levels and slightly greater variability than those of the NDP group. Our study provided detailed information on ambulatory glycemic profiles and parameters related to glycemic fluctuations in GDM women in the early postpartum period. High parity and elevated PPG at GDM screening may be associated with worse early postpartum glycemic status among pregnant women with GDM.

Previous studies have identified risk factors for the development of postpartum diabetes in GDM.[23,24] Both elevated FBG and PPG were associated with the incident of diabetes postpartum.[25] In our study, we found that patterns of abnormality in the 75-g OGTT screening during pregnancy may be associated with early postpartum glycemic level and variability. GDM patients with high FPG were younger and had lower postpartum AG levels and minor glycemic fluctuations. Interestingly, pregnant women with GDM with high PPG only were more likely to present with worse postpartum glycemia, suggesting that more attention should be given to this subgroup during follow-up.[26] Evidence in the form of randomized controlled trials and cohort studies supports the precise management of postpregnancy GDM to improve maternal glucose levels and reduce adverse long-term maternal outcomes. Based on the findings above, postpartum triage management needs to move beyond the traditional "one-size-fits-all" approach to GDM management. Additionally, earlier and more intensive glucose monitoring plans should be suggested among women with GDM to enable timely interventions, especially in those with elevated PPG found by 75-g OGTT screening during pregnancy.

Strengths and limitations

This study focused on the glucose levels and fluctuations intrapartum and early postpartum in GDM patients receiving lifestyle interventions alone, which may be helpful for perinatal glucose management in pregnant women with GDM. We achieved this aim based on an FGM system and the inclusion of glucose variability analysis. However, there are several limitations to this study. First, this conclusion could not be generalized to GDM patients who required pharmacologic hypoglycemic therapy during pregnancy. Second, we collected data on food intake during labor and neuraxial analgesia for labor. However, due to the irregularity of eating, the diversity of food types and quantities, and the variance in plans for neuraxial analgesia, we were not able to present the impact of diet and analgesia on glucose variability. Finally, due to the nature of the observational design, we could not rule out the possibility of residual confounding from unmeasured and unknown factors. Future research in larger populations is needed to further investigate factors associated with postpartum hyperglycemia in women with GDM for the implementation of personalized treatment.

In conclusion, we found that pregnant women with GDM receiving lifestyle interventions alone demonstrated similar glucose profiles during labor but higher glucose levels and greater glucose variability at early postpartum than those with normoglycemia. These findings suggested that similar strategies as normoglycemic pregnant women for intrapartum monitoring and glucose management should be applied to women with GDM characterized by mild glucose intolerance. However, more intensive postpartum monitoring and early intervention are recommended for women with GDM.

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Conflicts of interest

None.

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