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ORIGINAL RESEARCH

# Impact of Antepartum Case-Based Learning on Glycemic Control and Self-Management Skills in Women with Gestational Diabetes: A Patient-Centered Non-Parallel Quasi-Experimental Study

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**Introduction:** Gestational diabetes mellitus (GDM) is a growing global concern. GDM increases the risk of complications in both mothers and infants, including preeclampsia, macrosomia, and a higher likelihood of developing type 2 diabetes later in life. This study aimed to assess whether integrating case-based learning (CBL) with traditional education could improve glycemic control and patient outcomes in women with GDM.

**Methods:** This non-parallel quasi-experimental study compared CBL interventions with traditional education in GDM women. Pregnant women from September 2022 to March 2023 received only traditional education (control group), whereas those from April to September 2023 received both case-based and traditional education (intervention group). The primary outcomes included fasting and 2-hour postprandial blood glucose level changes after the intervention. The secondary outcomes included self-management behavior changes (Self-Management Scale for Women with GDM), self-efficacy (Pregnancy Exercise Self-Efficacy Scale), GDM understanding (self-developed questionnaire), satisfaction, pregnancy weight gain, and macrosomia incidence.

**Results:** A total of 140 GDM women were included, with the intervention and control groups containing 70 participants each. The intervention group showed significantly greater reductions in fasting and 2-hour postprandial blood glucose levels than the control group ($p<0.001$). In addition, the intervention group demonstrated notable improvements in self-management behaviors, GDM knowledge, and patient satisfaction. The incidence of macrosomia was also significantly lower in the intervention group (1.6% vs 10.8%, $p=0.034$), indicating better neonatal outcomes.

**Conclusion:** CBL could be incorporated into traditional education in GDM women to improve their self-management and self-efficacy for better glycemic control and pregnancy outcomes. Healthcare providers should be educated on the CBL and relevant policies should be developed to facilitate the implementation of CBL in the clinical practice.

**Keywords:** gestational diabetes mellitus, glycemic control, obstetric nursing, patient health education, case-based learning

## Introduction

The incidence of gestational diabetes mellitus (GDM) has been increasing annually in recent years, with a global prevalence of approximately 13.4% and a prevalence of 14.8% in China.[1] This is a significant health issue affecting pregnant women in China where antenatal healthcare had significant regional differences.[1–3] GDM significantly increases the risk of adverse maternal and neonatal outcomes, including macrosomia, cesarean delivery, preeclampsia, and type 2 diabetes. Adequate glycemic control for GDM patients can effectively improve their clinical outcomes. Approximately 70%-85% of GDM patients were on non-pharmacological management, including diet changes, exercise, and weight

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loss.[4] The evidence-based guidelines of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD) include recommendations on pharmacological management for GDM as well as advices on lifestyle changes, healthy diet, weight control, and physical activity.[5] Another important message from the guidelines is to develop personalized treatment goals and strategies in a patient-centered approach, taking into account each pregnant woman's needs, preferences, and tolerances to encourage self-management and self-efficacy.[5,6] Self-management and self-efficacy are important parts in diabetic control. Diabetes self-management refers to a patient who takes an active role in managing diabetes through lifestyle changes, medication adherence, and glucose monitoring. Diabetes self-efficacy refers to a patient's confidence in his/her ability to control the blood glucose. Studies have shown the benefits of self-management and self-efficacy on diabetic controls.[7,8] However, proper self-management and self-efficacy of GDM require adequate knowledge and skills that could be acquired from patient education and support.[9,10] The education methods for patients with GDM remain heterogeneous, which made learning experience and results varied significantly.

Traditional learning methods are lecture-based and centered on the instructor to disseminate the learning materials, which carries the limitations of passive participation of the students and lack of opportunity for critical thinking and problem-solving.[11,12] Case-based learning (CBL) is a type of interactive and participatory teaching model. It focuses on real-world scenarios as the core cases with the students as the main body. The students immerse themselves in the case scenario under the guidance and supervision of an instructor, who combines personal experience with cognition, abstract and visual thinking, and teaching to guide student' initiative and enthusiasm in the learning environment.[13] The students engage themselves in the scenarios, gain understanding of the knowledge, develop necessary problem-solving skills, and foster critical thinking. The standard five steps of CBL are assessment, diagnosis, planning, implementation, and evaluation, which has been proven to be a valuable tool in the fields of nursing and medical education.[13,14] For example, a cross-sectional study conducted among medical faculties found that CBL was more efficient than the traditional learning to deliver knowledge and cultivate critical thinking.[15] During the diabetic foot ulcer care training, CBL was more motivating than traditional learning and provided interactive approaches for nurses to learn foot care skills.[16] In teaching ectopic pregnancy, CBL combined with problem-based learning was effective to inspire medical students and let them better participate into the learning activities to acquire the desired knowledge and skills.[17] However, there was no previous study to investigate the efficacy of CBL in GDM women for better pregnancy outcomes.

Therefore, we performed this project with the aim to explore the use of CBL for diabetes education in GDM patients and to investigate whether integrating CBL with traditional education could improve glycemic control and pregnant outcomes in women with GDM.

# Methods

## Study Design and Ethical Considerations

We perform a single-center, non-blinded, non-parallel, quasi-experimental study. The method of convenience sampling was used to select patients based on their readily available accessibility. Patients collected from September 2022 to March 2023 were enrolled in the control group, and those collected from April 2023 to September 2023 were assigned to the intervention group. The patients in the intervention group participated in both CBL and traditional GDM patient education, whereas the control group only received traditional health education.

Before the study, the researchers reached out to eligible participants, explained the purpose of the study, and informed them that participation was completely voluntary and that they could withdraw at any time without affecting their future care and management. All participants signed an informed consent form and received a link to the electronic baseline questionnaire. The questionnaire could also be completed on paper. The study was approved by the ethics committee board of Shenzhen Luohu District Maternal and Child Health Hospital, China, with the approval number of LL20230626058. This study was conducted in accordance with the principles of the Declaration of Helsinki.

## Participants

The study participants were recruited from the general obstetric clinic of a tertiary women's and children's hospital in Shenzhen, China. The inclusion criteria were as follows: (1) diagnosis of GDM based on the diagnostic criteria proposed

by the Guidelines for the Diagnosis and Treatment of Pregnancy Complicated with Diabetes Mellitus;[18] (2) gestational age between 24 and 28 weeks; and (3) routine prenatal care and return visits with delivery plans at the hospital. The exclusion criteria were: (1) age less than 18 years, (2) currently enrolled in other clinical trials, (3) demonstrated evidence that limits group activity, and (4) preterm delivery.

### Study Sample Estimation

The sample size was calculated using G-power 3.1.9.7 software with a two-sided test. The significance level was set at $\alpha = 0.05$, and power (1-β) was set at 0.9. The primary outcome measure was the fasting blood glucose (FBG) level of pregnant women with gestational diabetes at the time of delivery. Based on literature, the effect size was determined to be 0.55.[19] The calculated sample size was 116 participants. Considering a 20% attrition rate, 140 participants were included in the study, with 70 patients each in the intervention group and 70 in the control group.

### Gestational Diabetes Mellitus Health Education Team

The GDM Health Education Team consisted of nine members. (1) There were three members in the Expert Group (EG), all of whom had more than 15 years of experience in their respective specialties. This group included a chief obstetric nurse (CON), a psychiatrist, and a specialized nutrition nurse (SNN). The CON was responsible for guiding the implementation of the CBL and training the members. Mental health monitoring and counseling were supported by a psychiatrist, and information and guidance on nutrition and exercise were provided by the SNN. (2) Six members performed the intervention, including three midwives, two obstetricians, and a nutrition nurse. Prior to the implementation of case-based health education, members underwent training in CBL, which included the theoretical foundations of the teaching method and communication skills. Each team member participated in three supervised pilot consultation projects that were evaluated based on their communication skills and theoretical knowledge. They were also comprehensively evaluated based on both theoretical and practical knowledge before the intervention.

### Development of Case-Based Learning Patient Education

Based on previous case-based educational models,[13,20,21] the intervention in this study was based on nurse-driven protocols, integrated with traditional education models. The CBL syllabus was drafted based on the Guidelines for the Diagnosis and Treatment of Pregnancy Complicated with Diabetes Mellitus 9, 10 and Guidelines for Preconception and Prenatal Care.[22] It was reviewed by our expert teams and experienced educators, including experts in perinatal medicine, psychiatry, midwifery, and nutrition; ultimately, the plan was finalized when consensus was reached (Table 1).

## Steps in Case-Based Learning Patient Education

### Assessment

During the assessment phase, the EPHET collected comprehensive data on pregnant women, including general information, family background, diagnosis, medical history, and previous health education experience. These data were obtained from outpatient electronic medical records (EMR), patient interviews, and laboratory results. Additionally, the team used a 24-hour Dietary Recall Survey to evaluate the dietary habits of the participants.

### Diagnosis

In the diagnosis phase, the EPHET analyzed the collected data to formulate nursing diagnoses for pregnant women in the intervention group. These diagnoses included assessments of the participants' knowledge, attitudes, and psychological goals.

### Planning

In the planning phase, the EPHET scheduled teaching sessions in appropriate facilities and prepared the educational materials. The midwives selected cases that closely represented the conditions of the participating pregnant women, with the information being de-identified. These cases were printed and distributed to the participants in advance. Additionally, midwives were trained and staged the teaching environment before the sessions to ensure optimal delivery of the contents.

**Table 1** Steps of Case-Based Learning in Pregnant Women with Gestational Diabetes in Intervention Group

| Steps | Contents | Comments |
|---|---|---|
| Assessment | Requirement and desire from pregnant women were assessed. Their general information, family background, diagnosis, medical history, and previous health education experience were evaluated. These data were obtained from outpatient electronic medical records, patient interviews, and laboratory test results. In addition, a 24-hour Dietary Recall Survey was conducted in the participants. | Completed by health education team. |
| Diagnosis | Formulation of nursing diagnoses, including assessments of the participant knowledge, attitudes, and psychological goals, as well as self-management scale evaluation. | Completed by health education team. |
| Planning | 1), Schedule the teaching location, time, and date, prepare educational materials, water, and snacks;<br>2), Midwives select cases that closely represented the conditions of the participating pregnant women. Each case has several questions relevant to the gestational diabetic control to encourage thinking and discussion in pregnant women. These are printed and distributed to the participants in advance;<br>3), Midwives receive training in advance to ensure they have adequate professional competence, communication, guidance, and organizational skills, and strong emotional intelligence. Diverse teaching methods are employed, including case analysis, role-playing, discussions, problem-solving, classroom demonstrations, and feedback evaluation, to encourage learning and reflection among pregnant women;<br>4), The classroom and teaching are tested in advance. To create an optimal environment for two-way communication and participation, the pregnant women are seated in a U-shape, with the midwife positioned in the open space to maintain eye contact with everyone. All participants can have a clear view of the whiteboard or multiple posters. All pregnant women are encouraged to speak. Equal chance for participation is ensured for everyone. | Completed by health education team. |
| Implementation | 1), Midwife introduces the purpose of case-based learning;<br>2), Each pregnant woman is provided with a printed case and a semi-structured form;<br>3), Midwife asks participants to read the first page aloud and then encourages them to start discussions based on the structured questions. When the discussion slows down (after 2–3 minutes), the midwife stimulates further discussion by posing questions, eliciting opinions, and guiding the thought process through clinical decision-making;<br>4), Midwife summarizes the discussion outcomes and supplements the participants with relevant health education knowledge about pregnancy-related conditions. | Guided by midwives, completed by pregnant women |
| Evaluation | 1), After the case-based learning, pregnant women are invited to participate in a survey to assess the effectiveness of the teaching and their satisfaction;<br>2), Pregnant women are invited to complete a questionnaire to assess their knowledge of gestational diabetes. | Invited by midwives, completed by pregnant women. |

## Implementation

During the implementation phase, CBL sessions were held, following traditional lectures. The midwife started by explaining the objectives of the CBL approach and provided each participant with printed cases and a semi-structured questionnaire. The participants were instructed to read the initial page aloud, introducing a case scenario that closely resembled the conditions of the intervention group. This approach was designed to capture participants' attention effectively. Subsequently, the women were divided into small groups to discuss key topics, including the definition of GDM, normal blood glucose levels, and strategies for managing and preventing GDM. After the initial discussion among participants, the midwife facilitated a more focused discussion based on the case, with one member from each group presenting their conclusions. Another group member completed a semi-structured questionnaire based on the discussion. Following the group discussions, the midwife guided the participants through a step-by-step analysis of the case, helping them understand the risks of GDM in both the mother and fetus, the three aspects of blood glucose control, diet and

exercise principles, and demonstration of glucose monitoring and insulin injections. The session concluded with the midwife summarizing the key points of the discussion and supplementing the participants' knowledge with additional health education on GDM. Teaching was arranged for 1 credit hour.

## Evaluation

The midwife conducted a post-session assessment inviting participants to complete a survey evaluating the effectiveness of the teaching, their satisfaction with the session, and their understanding of GDM.

## Control Group and Standard Care

The control group received standard care provided in the GDM follow-up clinic, which involved consultations with midwives, physicians, and dietitians. Both the control and intervention groups received standard care throughout the study period. However, participants in the intervention group were cared for by the EPHET who were trained in CBL patient education. On average, all participants, irrespective of their group assignment, attended six standard care sessions following the GDM diagnosis.

The first session of traditional lectures focused on fundamental information about GDM and self-management strategies, including blood glucose monitoring, target glucose levels, and maintaining a lifestyle diary. The subsequent five lessons covered topics such as safe medication use, self-monitoring techniques, coping with psychological stress during pregnancy, knowledge of natural childbirth, and postpartum care considerations. These sessions were conducted by midwives using PowerPoint presentations supplemented by the distribution of GDM-related health education booklets. Individualized education and monitoring guidance were provided to participants with poorly controlled blood glucose levels. These sessions were conducted biweekly, 40–60 minutes each session. Physicians also instructed women with GDM to record their weight weekly and monitor their blood glucose levels four times every three days —fasting, and two hours postprandial (after breakfast, lunch, and dinner). In addition, the frequency of prenatal visits increased after 28 weeks of gestation.

## Primary Outcome

The primary outcome of the study was the change in FBG and 2-hour postprandial blood glucose levels (2hPBG) at the time of enrollment and delivery.

## Secondary Outcomes

Changes in self-management behavior were evaluated using the Self-Management Scale for Women with Gestational Diabetes Mellitus (GDMS) before and after the intervention.[23] This scale encompasses four dimensions with a total of 32 items: self-management awareness, pregnancy management, blood glucose management, and resource utilization. Each item is scored on a 5-point Likert scale, ranging from 'strongly disagree/completely unable' to 'strongly agree/completely able' with total scores ranging from 32 to 160. The scale's standardized score was calculated as (actual score/maximum possible score) × 100, with scores of <60 indicating poor self-management, 60–80 indicating moderate self-management, and >80 indicating good self-management. The scale demonstrated strong reliability, with a Cronbach's α coefficient of 0.95, split-half reliability of 0.79, and test-retest reliability of 0.91.

The Chinese version of the Pregnancy Exercise Self-Efficacy Scale (P-ESES) was used by participants before and after the intervention. The P-ESES consists of 10 items covering three dimensions: overcoming emotional barriers, overcoming exercise barriers, and overcoming support barriers. Each item is rated on a 5-point Likert scale, ranging from 'strongly disagree' to "strongly agree" with total scores ranging from 10 to 50. Higher scores indicate greater exercise self-efficacy. The scale has a test-retest reliability of 0.531 and a Cronbach's α coefficient of 0.838.[24]

The individual level of GDM understanding was assessed using a self-developed questionnaire consisting of 12 questions. The content of the questionnaire covered basic knowledge of GDM, its risks, screening, and treatment methods, as well as self-monitoring and self-care practices. Scoring is based on three levels: correct answer (1 point), partially correct (0.5 points), and incorrect (0 points), with a maximum score of 12.

The satisfaction of participants with the health education provided was assessed using a custom-made satisfaction questionnaire, which includes six items, each rated on a binary scale of 'yes' or "no." After each session, the participants completed the questionnaire anonymously and the forms were collected immediately upon completion. A total of 127 valid questionnaires were collected with an effective response rate of 90.7%.

Neonatal birth weight and gestational weight gain data were also collected to evaluate the incidence of macrosomia and the appropriateness of weight gain during pregnancy. Macrosomia was defined as a birth weight of > 4 kg. The incidence of macrosomia was calculated as the number of macrosomia cases divided by the total number of newborns in the study multiplied by 100%. The body mass index (BMI) categories are as follows: underweight (BMI < 18.5 kg/m²), normal weight (18.5 kg/m² ≤ BMI < 24.0 kg/m²), overweight (24.0 kg/m² ≤ BMI < 28.0 kg/m²), and obesity (BMI ≥ 28 kg/m²). And the recommended weight gain during pregnancy is 11.0–16.0 kg for underweight women, 8.0–14.0 kg for normal weight, 7.0–11.0 kg for overweight women, and 5.0–9.0 kg for obese women. Gestational weight gain was categorized into three levels: insufficient, adequate, and excessive.

## Data Collection

The lead researcher and nursing master's students conducted the questionnaire distribution and data collection. Prior to randomization, baseline data were gathered, which included general demographic information such as maternal age, gestational age, pre-pregnancy body mass index (BMI), and the presence of any gestational complications or comorbidities. FBG and 2hPBG levels were measured and recorded. The GDMS and P-ESES (Chinese Version) were administered before and after the intervention. On the day of delivery, FBG and 2hPBG levels were measured. Additional data on maternal weight before delivery and neonatal birth weight were retrieved from the EMR.

## Statistical Analysis

All data were independently entered into the database by two researchers to ensure accuracy and consistency. All statistical analyses were performed using SPSS version 25.0 (IBM SPSS Inc., Chicago, IL, USA). Categorical variables were summarized using frequencies and percentages, and comparisons between groups were conducted using the chi-squared ($\chi^2$) test. Ordinal data were analyzed using the Wilcoxon rank-sum test. Continuous variables are expressed as means and standard deviations, and between-group comparisons were conducted using independent sample t-tests. A two-sided p-value of less than 0.05 was considered statistically significant.

# Results

## Study Flow-Chart and Baseline Characteristics

A total of 140 participants were enrolled in this study, with 70 assigned to the intervention group and 70 to the control group. In the intervention group, eight participants were excluded: six transferred to an outside hospital for delivery, one for not completing the full study, and one for preterm labor, leaving a total of 62 patients in the intervention group. In the control group, five participants were excluded due to a lack of complete clinical data, resulting in 65 participants included in the final analysis. The flowchart (Figure 1) illustrates these exclusions and the final sample size.

Table 2 presents a comparative analysis of the general characteristics of the intervention group (n=62) and the control group (n=65). The variables examined included age, gestational age, pre-pregnancy BMI, marital status, educational level, insurance status, weight gain during pregnancy, and the incidence of macrosomia. The mean age of the participants in the intervention group was 28.74 years, compared to 28.99 years in the control group, with no statistically significant difference observed (p=0.751). The mean gestational age at diagnosis was also similar between the two groups (26.03 vs 25.88, p=0.501). Pre-pregnancy BMI was also similar between the two groups, with the intervention group having a mean BMI of 23.36 kg/m² and the control group a mean BMI of 23.21 kg/m² (p=0.929). Regarding pregnancy outcomes, participants in both groups achieved adequate weight gain during pregnancy.

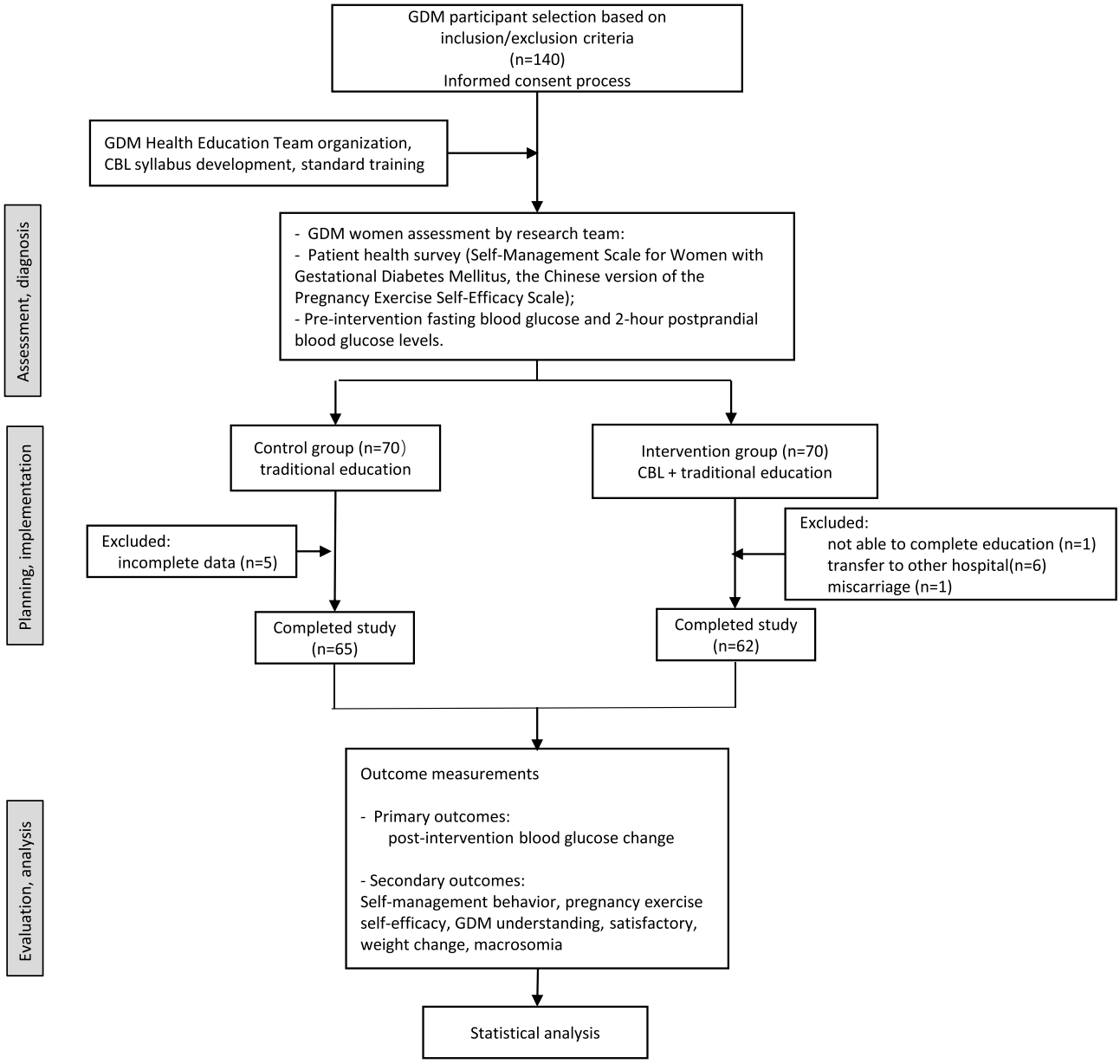


**Figure 1** Participant selection flowchart.
**Abbreviations**: CBL, case-based learning; GDM, gestational diabetes mellitus.

## Fasting and Two-Hour Post-Prandial Blood Glucose Level Changes

A comparison of FBG and 2hPBG scores between the intervention and control groups before and after the intervention is presented in Table 3. In the intervention group, FBG significantly decreased from 5.99 to 4.66 mmol/L, and 2hPBG decreased from 6.90 to 5.78 mmol/L (both $p<0.001$). Similarly, the control group showed a significant reduction in FBG from 6.90 to 5.78 mmol/L and in 2hPBG from 7.04 to 6.56 mmol/L (both $p<0.001$). The FBG and 2hPBG levels in the intervention group were both significantly lower after CBL than in the control group (both $p<0.001$).

## Participant Behavior Changes and Neonatal Outcome

In the intervention group, the average GDMS score significantly increased from 42.73 to 84.61 after combined CBL and traditional teaching ($p<0.001$). Similar results were also observed in the P-ESES, which demonstrated an increase from 24.58 to 41.55 after the intervention ($p<0.001$) (Table 3). Although GDMS also showed a significant increase in the


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**Table 2** Baseline Characteristic Comparisons Between Two Groups

| Characteristics | Intervention group (n=62) | Control group (n=65) | *p* |
|---|---|---|---|
| Age, years, M±SD | 28.74±4.41 | 28.99±4.17 | 0.751 |
| Gestational age, weeks, M±SD | 26.03±1.23 | 25.86±1.20 | 0.429 |
| Body mass index, kg/m$^2$, M±SD | 23.36±2.72 | 23.32±2.31 | 0.929 |
| Marriage status, n (%) | | | 1.000 |
| Married | 61(98.4) | 63(96.9) | |
| Single | 1(1.60) | 2(3.1) | |
| Education level, n (%) | | | 0.552 |
| Elementary and middle school | 11(17.8) | 11(16.9) | |
| High school | 18(29) | 18(27.7) | |
| College | 33(53.2) | 36(55.4) | |
| Insurance type, n (%) | | | 0.528 |
| Out-of-pocket | 11(17.8) | 7(10.8) | |
| Basic medical insurance | 50(80.6) | 57(87.7) | |
| Commercial medical insurance | 1(1.6) | 1(1.5) | |
| Appropriate gestational weight gain (%) | | | 0.634 |
| Yes | 58(93.5) | 53(81.5) | |
| Fasting glucose level, mmol/L, M±SD | 5.99±0.79 | 6.90±0.71 | 0.357 |
| 2-hour post-prandial glucose level, mmol/L, M±SD | 6.90±0.71 | 7.04±0.64 | 0.233 |
| GDMS, M±SD | 42.73±3.88 | 42.18±3.81 | 0.429 |
| P-ESES, M±SD | 24.58±3.74 | 25.54±2.80 | 0.104 |
| GDM knowledge score, M±SD | 4.19±0.65 | 4.16±0.61 | 0.274 |
| Macrosomia, n (%) | | | 0.784 |
| Yes | 1(1.6) | 7(10.8) | |

**Abbreviations**: GDM, gestational diabetes mellitus; GDMS, Self-Management Scale for Women with Gestational Diabetes Mellitus; M±SD, mean ± standard deviation; P-ESES, Pregnancy Exercise Self-Efficacy Scale.

**Table 3** Intra-Group Primary and Secondary Outcome Comparisons Before and After Education

| Outcome measurements, M±SD | | Before education | After education | *p* |
|---|---|---|---|---|
| Fasting glucose level, mmol/L | Intervention group | 5.99±0.79 | 4.66±0.41 | <0.001 |
| | Control group | 6.90±0.71 | 5.78±0.66 | <0.001 |
| 2-hour post-prandial glucose level, mmol/L | Intervention group | 6.90±0.71 | 5.78±0.66 | <0.001 |
| | Control group | 42.18±3.81 | 6.56±0.67 | <0.001 |
| GDMS | Intervention group | 42.73±3.88 | 84.61±4.23 | <0.001 |
| | Control group | 42.18±3.81 | 78.77±3.58 | <0.001 |
| P-ESES | Intervention group | 24.58±3.74 | 41.55±3.64 | <0.001 |
| | Control group | 25.54±2.80 | 40.40±2.06 | 0.15 |
| GDM knowledge score | Intervention group | 4.19±0.65 | 4.16±0.61 | <0.001 |
| | Control group | 4.16±0.61 | 7.84±0.94 | <0.001 |

**Abbreviations**: GDM, gestational diabetes mellitus; GDMS, Self-Management Scale for Women with Gestational Diabetes Mellitus; M±SD, mean ± standard deviation; P-ESES, Pregnancy Exercise Self-Efficacy Scale.

**Table 4** Patient Satisfaction Survey Results

| Items, n(%) | Intervention group (n=62) | Control group (n=65) | *p* |
|---|---|---|---|
| Teaching modality | 62 (100) | 58 (89.23) | 0.008 |
| Teaching attitude | 58 (93.55) | 62 (95.38) | 0.650 |
| Teaching skills | 61 (98.39) | 56 (86.15) | 0.011 |
| Session atmosphere | 61 (98.39) | 56 (86.15) | 0.011 |
| Communication | 59 (95.16) | 53 (81.53) | 0.017 |
| Schedules | 60 (96.78) | 56 (86.15) | 0.033 |

control group (p<0.001), P-ESES did not show a significant change (25.54 vs 40.40, p=0.15). Both post-intervention GDMS and P-ESES scores were higher in the intervention group than in the control group (p<0.001, p=0.032). GDM knowledge level after CBL and traditional education in the intervention group demonstrated a significant increase from baseline (4.19 vs 8.95, p<0.001). Compared to the control group, the intervention group had more GDM knowledge after CBL and traditional education (8.95 vs 7.84, p<0.001). Table 4 presents the results of the satisfaction survey. Except for the teaching attitude, the participants in the intervention group were more satisfied with different teaching aspects than those in the control group (p<0.05). Regarding neonatal outcomes, the intervention group had a lower incidence of macrosomia than the control group (1.6% vs 10.8%, p=0.034).

## Discussion

This study had several key findings. Baseline characteristics, such as age, gestational age, and pre-pregnancy BMI, were similar between the two groups, ensuring comparability. Importantly, the intervention group exhibited significantly greater reductions in FBG and 2hPBG following the intervention compared to the control group, suggesting the effectiveness of CBL along with traditional education in better managing blood glucose levels. Additionally, the intervention group showed significant improvements in the GDMS, P-ESES, and GDM knowledge, along with higher satisfaction rates in various teaching aspects. Neonatal outcomes also favored the intervention group, which had a lower incidence of macrosomia.

Traditional learning is passive and instructor-centered. CBL is active and student-centered and can cultivate critical thinking and teamwork through interactive discussions and a high level of engagement from the students. Previous studies have demonstrated clinical applications of CBL in diabetic care and abnormal pregnancy.[16,17] In the current study, we showed that the integration of CBL into traditional learning could also benefit GDM women more than the traditional learning alone. The CBL model allows pregnant women to gain a clear understanding of gestational diabetes symptoms by analyzing real-life cases. By progressively dissecting and discussing these cases, pregnant women can better understand the dangers associated with gestational diabetes. Research has shown that pregnant women's perception of the risks associated with the short- and long-term complications of gestational diabetes is a critical motivator for behavioral changes in blood glucose management.[25,26] In this study, the post-intervention GDM knowledge scores of the intervention group were significantly higher than those of the control group. Additionally, there was a marked decrease in both fasting blood glucose and 2-hour postprandial blood glucose levels in the intervention group compared to those in the control group, with statistically significant differences (p<0.001). This case-based health education approach shifts the traditional model, which primarily relies on didactic teaching, to one that encourages pregnant women to engage actively in learning. By using cases that closely resemble their own situations, participants can thoroughly analyze the basic knowledge, mechanisms, and principals involved, thereby deepening their understanding of the disease. This approach enhances their ability to apply learned knowledge to address their own health issues, reducing cognitive and behavioral biases.[27–29] It also underscores the necessity for clinical nursing staff to provide individualized health education and

comprehensive decision support, as the better a pregnant woman understands gestational diabetes, the more effectively she can manage her blood glucose.[30,31]

Teaching based on actual clinical cases allows participants to engage in learning through the integration of needs and contextual scenarios, thereby fostering connections and resonance. This approach enhances their ability to understand the material, solve clinical problems, and improve self-efficacy.[32] Huang's team reported that the perception of disease severity is a key motivator for behavior change.[33] Consistent with those findings, participants of the intervention group showed better comprehension of GDM, and also exhibited higher GDMS and P-ESES scores at the end of the intervention, compared to standard care. This reflects a better autonomy support and perceived self-efficacy. CBL involves more comprehensive assessments of pregnant women prior to classes, and immerses the learning process within the context of real gestational disease cases. Structured discussions of cases that closely mirror participants' own situations encouraged critical reflection on their adverse behaviors and provided tailored disease prevention strategies for the different risk factors they faced. This approach significantly motivates them to take meaningful action towards their health, effectively leading to behavioral change. These findings align with some existing evidence, which advocate for immediate diabetes-related education, including blood glucose self-management and consistent exercise, upon diagnosis of GDM.[10,34,35] Another significant finding of our study was the appropriate gestational weight gain and decrease in macrosomia rate. There was a positive correlation between neonatal birth weight and maternal gestational weight gain, which in turn is closely linked to diet, exercise, and blood glucose levels.[36] Our results revealed that post-intervention, the rate of adequate gestational weight gain was 93.5% in the intervention group, which was higher than the 81.5% observed in the control group, which was not statistically significant. However, the incidence of macrosomia was notably lower in the intervention group at 3.4%, compared to 16.7% in the control group, with a statistically significant difference between the two groups, consistent with the findings of Ural et al.[37] The CBL integrated GDM patient education focused on a patient-centered model, which necessitates that patients actively participate in health decision-making, rather than passively receiving care.[38] The intervention in our study encouraged pregnant participants to explore the pathogenesis, risks, and preventive strategies of GDM based on the reflection on their own health conditions.

In the current study, we showed the benefits of CBL in GDM women, which was consistent with previous reports. However, the barriers to the application of CBL were also reported previously, including time and effort consuming, instructor-dependence, unequal participations, and physical presence.[39] Future studies are required to explore the most appropriate approach to implement CBL in different settings.

To the best of our knowledge, this is the first study to investigate the effect of CBL on GDM patient education. However, this study has several limitations. First, this was a single-center study in the Chinese population, with a lack of other representatives and more diverse data. Second, while this CBL approach did provide appropriate staffing support, it might be difficult to implement in resource-limited medical facilities. Another limitation was that the study had a relatively short follow-up period, which might not have captured the long-term outcomes. We adopted a non-parallel quasi-experimental study design and collected control and intervention groups at the different time periods, which could certainly bring bias and potential unknown confounding factors to affect the result analyses. Finally, there is a potential for reporting bias, as participants may have over- or under-reported behaviors, which could affect the accuracy of the findings. Future research should focus on exploring the long-term effects of case-oriented health education on both maternal and child health outcomes while also investigating its integration with digital health tools for broader applications. Additionally, multicenter randomized trials and cost-effectiveness analyses are required to validate and optimize this approach across diverse populations and healthcare settings.

This study demonstrated that case-oriented health education significantly improves self-management behaviors, blood glucose control, and pregnancy outcomes in women with GDM. These findings suggest that incorporating real-life scenarios into educational interventions can effectively enhance patient understanding, engagement, and adherence to health recommendations, ultimately leading to better maternal and neonatal health outcomes. It is recommended that the relevant authorities could enhance the education and management of gestational diabetes in health care providers by developing policies to promote the implementation of CBL in pregnant women with GDM.

## Data Sharing Statement

All the data presented in this paper are freely available upon request from the corresponding authors.

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## Disclosure

The authors declare no conflicts of interest for this work.

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