

# Impact of Self-Management Clustered Care on Psychological and Birth Outcomes in Gestational Diabetes

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**Purposes:** To investigate the effects of a self-management-cluster-based pregnancy care model (SMB-CPCM) on the psychological status and delivery outcomes of pregnant women with gestational diabetes mellitus (GDM).

**Patients and Methods:** A total of 120 pregnant women with GDM who had been filed and had regular obstetric examinations in a tertiary-level hospital in Bengbu City between 1 April 2023 and 1 April 2024 were included in the study using the convenience sampling method. Sixty women each were grouped into a study group and a control group using the randomised numeric table method. The study group implemented the SMB-CPCM and the control group used the conventional pregnancy healthcare model. We compared the differences in self-management ability, blood glucose concentration, delivery outcome, and psychological status.

**Results:** Self-management ability scores were higher in both groups following the intervention than before the intervention ( $P < 0.001$ ), and the increase was more notable in the study group ( $t = 9.237$ ,  $P < 0.001$ ). Anxiety scale ( $63.31 \pm 4.73$ ,  $48.29 \pm 4.20$ ) and depression self-assessment scale scores ( $60.70 \pm 3.49$ ,  $41.69 \pm 4.76$ ) in the study group were lower after the intervention than before the intervention ( $t = 13.322$ ,  $18.115$ ,  $P < 0.001$ ). Following the intervention, fasting blood glucose ( $5.39 \pm 0.42$ ,  $4.92 \pm 0.45$ ) and postprandial 2-h blood glucose ( $6.70 \pm 0.71$ ,  $5.92 \pm 0.64$ ) exhibited a reduction compared to the pre-intervention period ( $P < 0.001$ ). Furthermore, this decline was more pronounced in the study group ( $t = 4.267$ ,  $4.584$ ,  $P < 0.001$ ). The study group demonstrated an elevated spontaneous delivery rate compared to the control group ( $\chi^2 = 5.168$ ,  $P < 0.05$ ). Additionally, the rates of gestational hypertension ( $\chi^2 = 4.941$ ), pre-term labour ( $\chi^2 = 3.890$ ), and macrosomia ( $\chi^2 = 4.050$ ) were reduced in the study group when compared to the control group ( $P < 0.05$ ).

**Conclusion:** SMB-CPCM can effectively control the blood glucose levels of pregnant women with GDM and improve their self-management ability, psychological status, and delivery outcomes. SMB-CPCM shows a good prospect in the management of gestational diabetes and is worth promoting. Future research can explore the impact of SMB-CPCM on long-term health outcomes of pregnant women with diabetes, so as to comprehensively evaluate its clinical value.

**Keywords:** clustered pregnancy care model, gestational diabetes, self-management ability, delivery outcomes, psychological state

## Introduction

Gestational diabetes mellitus (GDM) is a prevalent complication of pregnancy characterised by diabetes diagnosed during the second or third trimester without preexisting overt diabetes.<sup>1</sup> GDM is linked to an elevated risk of adverse pregnancy outcomes for both the mother and the child, not only in the immediate postnatal period but also in the longer term.<sup>2</sup> The global prevalence of GDM in early and late pregnancy varies significantly among countries owing to variations in screening methods, diagnostic criteria, and diagnostic practices.<sup>3</sup> According to the International Association of Diabetes and Pregnancy Research Groups (IADPSG), the global prevalence of GDM is ~14.0%.<sup>4</sup> The prevalence of GDM in China has significantly increased due to economic development, improved living standards,

adoption of westernised lifestyles, dietary changes, reduced physical activity, and growing concerns about GDM screening. A study of 27,119 pregnant women in Tongzhou District, Beijing, from 2013 to 2018 revealed an overall prevalence of 24.24% for GDM according to the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria.<sup>5</sup> A high body mass index (BMI), older age, family history of diabetes, and poor dietary habits are important risk factors for GDM.<sup>6</sup> Following the implementation of China's "two-child policy" in October 2015, there has been a notable increase in the prevalence of high-risk pregnant women, including elderly individuals, those with overweight or obesity pre-pregnancy, specific dietary habits, exposure to passive smoking, medical history, lower educational attainment, and limited health knowledge. This increase has contributed significantly to the escalating incidence of GDM, imposing substantial socioeconomic and health burdens on both the Chinese population and individuals.<sup>7</sup>

Anxiety and depression can lead to chronic hypothalamic pituitary adrenal hyperactivity, resulting in increased cortisol release and insulin resistance release, increasing the risk of GDM in pregnant women. Research has found that anxiety or depression during pregnancy increases the incidence of gestational GDM in pregnant women to some extent. Compared with normal GDM pregnant women, GDM pregnant women with anxiety and depression are more likely to have adverse outcomes in terms of blood glucose, delivery mode, and maternal and infant outcomes during pregnancy.<sup>8</sup> The results of a systematic evaluation and meta-analysis demonstrated a notable correlation between GDM and several unfavourable pregnancy outcomes, including caesarean section, fetal macrosomia, and premature delivery.<sup>6</sup> GDM has a transient impact on the health of pregnant women and may precipitate long-term health risks, including an elevated risk of developing type 2 diabetes (T2DM) in the future.<sup>9</sup> Pregnant women with GDM may experience hyperglycaemia symptoms, increasing the risk of complications such as pregnancy-induced hypertension and preeclampsia. These complications not only affect maternal health, but also pose risks to the foetus.<sup>10</sup>

GDM has severe consequences on mothers, offspring, and socioeconomic burdens, making it important to investigate improving GDM. Standard lifestyle interventions for GDM are commonly employed in clinical settings, and unidirectional knowledge delivery guided by healthcare professionals does not effectively reduce adverse pregnancy outcomes.<sup>10</sup> Finding more effective nursing interventions for patients with GDM has become a major concern for clinical nurses. In the secondary analysis of a randomized clinical trial involving 2348 pregnant women from the healthcare system, participants who received population-based antenatal care intervention and traditional intervention had similar risks of developing GD, indicating that interventions may be a viable treatment option for some patients.<sup>11</sup> The self-management-based cluster-based pregnancy care model (SMB-CPCM) is a group-based prenatal care model that emphasizes interaction and support among pregnant women and enhances their self-management skills through participation in group meetings and sharing of each other's experiences and challenges, in addition to providing the transfer of medical knowledge and facilitating emotional support and social bonding among pregnant women. SMB-CPCM not only improves maternal health and psychosocial outcomes, but also has a positive impact on birth outcomes. In addition, by reducing pregnancy complications and lowering maternal and infant health risks, it provides economic advantages for the healthcare system, thereby saving healthcare costs.<sup>12</sup>

Therefore, this study aimed to explore the effects of the SMB-CPCM on self-management ability, psychological status, and maternal and infant outcomes of patients with GDM, further providing a theoretical basis for the effective management of patients with GDM in clinical practice.

## Materials and Methods

### Design and Participants

In this study, pregnant women with diabetes during pregnancy who received routine prenatal examination in the First Affiliated Hospital of Bengbu Medical College from April 1, 2023 to April 2, 2024 were selected as the subjects. The moderate sample size of the study population was determined through power analysis using G \* Power 3.1.9.7 software. Considering a 20% dropout rate, the optimal number of participants is 120. This study used IBM SPSS Statistics version 24 to randomly assign students to an intervention group and a control group. The study group consisted of 60 patients with GDM who were provided with a group-based antenatal care model based on self-management. The control group

comprised 60 patients with GDM who underwent various basic obstetric examinations. The participants received standard care interventions for GDM in accordance with the “Guidelines for Preconception and Prenatal Care” and the “Clinical Practice Guidelines for Gestational Diabetes Mellitus.” These included routine health education, dietary guidance, medication guidance, intensified blood glucose monitoring, exercise guidance, psychological care, regular prenatal examinations for pregnant women with GDM, and improved surveillance of maternal and infant health. All the participants voluntarily participated in this study and signed informed consent forms approved by the Ethics Committee of Bengbu Medical College (Ethics Approval No: [2022] No. 107).

The inclusion criteria of the cases were as follows: (1) Diagnostic criteria for GDM: According to the standards of clinical teaching and practice in China,<sup>13</sup> the diagnostic criteria for the 75 g OGTT in mid-pregnancy (24–27+6 weeks) are: fasting, 1-hour postprandial, and 2-hour postprandial blood glucose thresholds are 5.1 mmol/L, 10.0 mmol/L, and 8.5 mmol/L, respectively. Diagnosis of GDM is made if any of the blood glucose values reach or exceed the above criteria; (2) Singleton cephalic presentation at 24–27+6 weeks of gestation; (3) Age  $\geq$  18 years; (4) Diagnosed with GDM for  $\geq$ 1 week; (5) Having normal communication abilities and comprehension; (6) Accompanied by family members during participation. The exclusion criteria of the cases were as detailed below: (1) patients with pre-GDM, (2) history of mental illness or communication disorders, (3) other pregnancy complications such as gestational hypertension, and (4) participants who dropped out or lost follow-up opportunities.

## Treatment Protocol

Constructing a self-management-based cluster-based pregnancy care model (SMB-CPCM) based on self-management using the health belief model.

Control group: Routine care interventions for GDM were implemented according to the “Guidelines for Preconception and Prenatal Care” and the “Clinical Practice Guidelines for Gestational Diabetes Mellitus”, including routine health education, dietary guidance, medication guidance, intensified blood glucose monitoring, exercise guidance, psychological care, regular prenatal examinations.

Study group: (1) We established a multidisciplinary group-based healthcare management team consisting of one midwife, one obstetrician, one endocrinologist, one diabetes specialist nurse, one nutritionist, one psychological counsellor, and two obstetric outpatient nurses. The course content was jointly determined by all team members. The main lecturer was a midwife. The leader is a midwife. The course content is mainly led by the leader, and interdisciplinary team members jointly discuss and determine the intervention plan. Conduct a pre-experiment two weeks before implementing the intervention, and promptly modify and adjust the intervention plan based on feedback, and (2) the intervention content of the group-based healthcare model involved 60 pregnant women with GDM who were divided into six groups, each consisting of 8–12 participants with similar due dates for prenatal examinations. The intervention commenced upon enrolment in the study, with a two-hour session held after each prenatal check-up, totalling six sessions conducted weekly. The teaching methods employed included PowerPoint presentations, video playbacks, practical exercises, scenario simulations, model demonstrations, and discussions. The specific course content is presented in Table 1. The group-based healthcare model’s content comprises three parts: self-management, health education, and social support. 1) Self-management: Interveners demonstrated standard methods for measuring height, weight, blood pressure, and blood sugar, explained how to use the foetal heart monitor, identified abnormal situations, taught pregnant women with GDM how to inject insulin, conducted practical exercises, and standardised operations as much as possible, prompting pregnant women with GDM to record prenatal examinations, diet, exercise, rest, emotions, etc., for easy sharing and communication. 2) Health education: Before each session, the content of the previous session was reviewed and the topic of the current session was introduced. Interveners explained GDM-related knowledge and skills, including GDM disease knowledge, diet during pregnancy, exercise during pregnancy, medication management, psychological adjustments during pregnancy, labour management, labour guidance, and postpartum care. 3) Social support: At the end of each session, 20 min were reserved for pregnant women with GDM and their family members to sit in a “U” shape for personal viewpoints, questions, and practical experiences. The participants took turns sharing their thoughts. The interveners summarised and reviewed the theme of the session and corrected inaccurate information. Moreover, individual consultations were available for pregnant

**Table 1** Intervention Contents of Grouped Healthcare Model

Time	Main Content	Methods
First session	Self-introduction; Clinical manifestations and hazards of GDM; Measurement methods for height, weight, blood pressure, blood glucose, and foetal heart rate monitoring; Summary	PowerPoint presentation; Practical exercises; Discussion
Second session	GDM Pregnancy Diet; Exercise plan, including time, frequency, method, amount of exercise, and precautions; Insulin injection method; Summary	Video playback; Practical exercises; Discussion
Third session	The harm of negative emotions to both mother and child; Effective methods for emotional regulation and release; Summary	Video playback; Scenario simulation; Discussion
Fourth session,	Methods for identifying premonitory signs of labour, labour, and various conditions; Explain the methods of labour analgesia (nonpharmacological analgesia, intraspinal labour analgesia); Summary	Video playback; Scenario simulation; Discussion
Fifth session	Childbirth guidance, how to cooperate to complete natural childbirth; Summary	Video playback; Model Demonstration; Discussion
Sixth session	Postpartum diet, exercise, and rest; Methods of breastfeeding; newborn care; Summary	Video playback; Model Demonstration; Discussion

women with GDM. A WeChat group was established for interactive communication among pregnant women with GDM to share their self-management experiences and receive peer support. Family members, especially spouses, were encouraged to actively participate in the intervention process to learn and understand prenatal health. Furthermore, close attention was paid to physical and mental changes in pregnant women with GDM to ensure that they receive adequate family support.

## Variables and Measurements

Outcome indicators included the GDM Self-Management Behaviour Scale, blood glucose levels, delivery outcomes, maternal anxiety scale, and self-rated depression scale. Self-management behavioural ability, blood glucose levels, delivery outcomes, and maternal anxiety and depression levels were measured. The levels of various indicators before the intervention were used as baseline levels. The self-management behavioural ability, blood glucose levels, delivery outcomes, and maternal anxiety and depression levels of the two groups of patients were measured and recorded. The indicators were measured one day before the intervention and six weeks after the intervention. In this study, patients with gestational diabetes were followed up for 5 weeks after discharge, to investigate the long-term impact of gestational diabetes on health outcomes, and to evaluate its clinical value more comprehensively.

### GDM Self-Management Behaviour Scale

The scale is comprised of six dimensions, namely dietary control, exercise management, blood glucose monitoring, medication management, body mass management, and regular follow-up, which are represented by 24 items in total.<sup>14</sup> A seven-point scoring system is employed whereby the size of the score indicates the number of days within seven days of self-management behaviour that has been followed. Based on the scoring indicators (actual score of the scale/possible highest score of the scale  $\times$  100%), self-management was divided into three levels: high, medium, and low. Among them,  $\geq 80\%$  is good, 60%–80% is moderate, and  $<60\%$  is poor. The scale demonstrated content validity of 0.80, and test-retest reliability of 0.86.

### Pregnancy Anxiety Scale (PAS)

This study used the Maternal Anxiety Scale to assess the anxiety status of the participants during the two stages of participation in the study and before delivery. The scale consists of 27 items, including four factors: delivery anxiety, self-anxiety, foetal anxiety, and general anxiety.<sup>15</sup> A five-point scoring method is employed, whereby the following categories are used: “1 never, 2 occasionally, 3 sometimes, 4 frequently, and 5 every day”. A higher total score is indicative of a higher level of anxiety in pregnant women. The Cronbach’s alpha coefficient for the scale was found to be 0.93.

### Self-Rating Depression Scale (SDS)

This study employed the Self-Rating Depression Scale to evaluate the depressive status of the research participants at two distinct stages of their involvement in the study, as well as prior to the delivery period. The scale consists of 20 items, with 10 scored in the positive direction and 10 scored in the negative direction.<sup>16</sup> Each item assesses the frequency of symptom occurrence on the basis of the following four-point Likert scale: occasional/no, occasional, frequent, and persistent. The resulting scores range from 1 to 4. Each of the 20 items was scored on a scale of 1.25 to obtain a standard score. A higher standard score indicates a more severe depressive symptom. Cronbach's alpha coefficient for the scale was 0.91.

### Blood Glucose Level

During the study and two stages before delivery, fasting blood glucose and 2-hour postprandial blood glucose levels were measured in pregnant women with GDM in the study and control groups.

Delivery outcome included delivery method, incidence of gestational hypertension, polyhydramnios, premature rupture of membranes, preterm birth, macrosomia, and postpartum haemorrhage. The delivery methods include natural childbirth and caesarean section. Pregnancy-induced hypertension is defined as the onset of hypertension subsequent to 20 weeks of gestation, with systolic blood pressure of 140 mmHg or greater and/or diastolic blood pressure of 90 mmHg or greater, accompanied by a return to normal levels within 12 weeks post-partum. In addition, urinary protein is negative. It is important to emphasise that a diagnosis can only be made after childbirth. Polyhydramnios refers to an amount of amniotic fluid exceeding 2000 mL during pregnancy. Premature membrane rupture refers to the natural rupture of membranes before delivery. Premature delivery refers to those who have reached 28 weeks of pregnancy but delivered before 37 weeks. Macrosomia refers to a body weight that reaches or exceeds 4000 g after birth. Postpartum haemorrhage refers to the symptoms or signs of low blood volume within 24 h after the delivery of the foetus, with vaginal delivery bleeding  $\geq 500$  mL and caesarean section bleeding  $\geq 1000$  mL.

### Statistical Analysis

A statistical analysis was conducted using the mean and standard deviation (version 26.0; IBM Corp., Armonk, NY, USA). The resulting data were expressed as mean and standard deviation. A p-value of less than 0.05 was considered statistically significant.

## Results

### Baseline Clinical Characteristics

A total of 120 participants were recruited for this study: 60 in the study group and 60 in the control group. During the intervention implementation, one case was removed from the study group due to a transfer of labour and delivery, while two cases were removed from the control group due to a transfer of labour and delivery, resulting in a final effective sample size of 59 cases in the study group and 58 cases in the control group. There were no significant differences between the two groups in terms of general information (all  $P > 0.05$ ), and they were comparable (Table 2).

### Comparison of Self-Management Skills Scores

A comparison of the self-management ability of pregnant women with GDM in the two groups before the pre-intervention period showed that the difference was not statistically significant ( $P > 0.05$ ). Following the intervention, the self-management abilities of pregnant women with GDM in the two groups exhibited a notable improvement compared to the pre-intervention period (both  $P < 0.001$ ). The enhancement in the research group was particularly pronounced ( $t = 9.237$ ,  $P < 0.001$ ), as illustrated in Table 3.

### Comparison of Psychological Status

A comparison of the scores obtained on the Maternal Anxiety Scale and the Depression Self-Assessment Scale by pregnant women with GDM in the two sets prior to the intervention revealed no statistically significant difference ( $P > 0.05$ ). Following the intervention, the maternal anxiety and depression self-assessment scale scores of pregnant women with GDM in the study group were found to be lower than those recorded prior to the intervention (both  $P < 0.001$ ).

**Table 2** Baseline Clinical Characteristics

Groups	Cases	Age	Gestation	Pre-pregnancy BMI	Mid-pregnancy Weight Gain (kg, $\bar{X} \pm s$ )	Birth History [cases (percentage, %)]	
		(age, $X \pm s$ )	(week, $\bar{X} \pm s$ )	( $X \pm s$ )		Primigravida	Menstruation
Study group	59	29.68 $\pm$ 3.30	25.42 $\pm$ 1.31	22.35 $\pm$ 2.17	9.37 $\pm$ 0.87	35	24
Control group	58	30.13 $\pm$ 4.10	25.13 $\pm$ 1.16	22.52 $\pm$ 2.85	9.56 $\pm$ 0.83	37	21
t/ $\chi^2$		0.476	0.946	0.261	0.866	0.247	
P		0.636	0.348	0.795	0.390	0.619	

**Abbreviation:** BMI body mass index.

**Table 3** Comparison of Self-Management Skills Scores After Intervention

Groups	Cases	Self-management Skills Scores		t	P
		Pre-intervention	Post-intervention		
Study group	59	87.94 $\pm$ 10.35	117.58 $\pm$ 9.28	13.892	<0.001
Control group	58	89.31 $\pm$ 10.93	97.31 $\pm$ 8.12	10.103	<0.001
t		0.513	9.237		
P		0.610	<0.001		

**Table 4** Comparison of Psychological Status After Intervention

Groups	Cases	PAS Score		t	P	SDS Score		t	P
		Pre-intervention	Post-intervention			Pre-intervention	Post-intervention		
Study group	59	62.90 $\pm$ 5.27	48.29 $\pm$ 4.20	14.794	<0.001	60.28 $\pm$ 4.76	41.69 $\pm$ 4.76	17.660	<0.001
Control group	58	63.56 $\pm$ 4.38	63.31 $\pm$ 4.73	1.187	0.244	61.64 $\pm$ 4.03	60.70 $\pm$ 3.49	1.422	0.165
t		0.541	13.322			1.223	18.115		
P		0.591	<0.001			0.226	<0.001		

**Abbreviations:** PAS, Pregnancy Anxiety Scale; SDS, Self-Rating Depression Scale.

Furthermore, the scores of the study group were observed to be lower than those of the control group ( $t = 13.322, 18.115$ , both  $P < 0.001$ ), as illustrated in [Table 4](#).

## Comparison of Blood Glucose Levels

Prior to the implementation of the intervention, a comparative analysis of fasting blood glucose and postprandial 2-hour blood glucose levels between the two cohorts of pregnant women with GDM demonstrated no statistically significant discrepancy ( $p > 0.05$ ); however, after intervention, fasting blood glucose and postprandial 2-hour blood glucose levels of the two groups of pregnant women with GDM were lower than those before intervention ( $P < 0.001$ ), and the study group had a greater decrease ( $t = 4.267, 4.584$ , both  $P < 0.001$ ), as evidenced in [Table 5](#).

## Comparison of Delivery Outcomes

The spontaneous delivery rate of pregnant women with GDM in the study group was higher than that of the control group, and the difference was statistically significant ( $\chi^2 = 5.168, P < 0.05$ ). The rates of gestational hypertension ( $\chi^2 = 4.941$ ), preterm labour ( $\chi^2 = 3.890$ ), and macrosomia ( $\chi^2 = 4.050$ ) in the study group were lower than that of the

**Table 5** Comparison of Blood Glucose Levels After Intervention (mmol/L,  $\bar{X}\pm s$ )

Groups	Cases	FBG		t	P	2hPBG		t	P
		Pre-intervention	Post-intervention			Pre-intervention	Post-intervention		
Study group	59	7.29±0.49	4.92±0.45	28.439	<0.001	9.42±0.65	5.92±0.64	22.078	<0.001
Control group	58	7.13±0.59	5.39±0.42	14.379	<0.001	9.57±0.67	6.70±0.71	17.989	<0.001
t		1.190	4.267			0.933	4.584		
P		0.239	<0.001			0.354	<0.001		

**Abbreviations:** FBG, fasting blood glucose; 2hPBG, 2 h postprandial blood glucose.

**Table 6** Comparison of Delivery Outcomes After Intervention [Cases (Percentage, %)]

Groups	Cases	Natural Childbirth Rate	Hypertension During Pregnancy Rate	Amniotic Fluid Overload Rate	Premature Rupture of Membranes Rate	Preterm Birth Rate	Macrosomia Rate	Postpartum Haemorrhage Rate
Study group	59	51 (86.44)	1 (1.69)	1 (1.69)	1 (1.69)	1 (1.69)	2 (3.39)	1 (1.69)
Control group	58	40 (68.97)	7 (12.07)	2 (3.45)	2 (3.45)	6 (10.340)	8 (13.79)	3 (5.17)
$\chi^2$		5.168	4.941	0.360	0.360	3.890	4.050	1.071
P		0.023	0.026	0.549	0.549	0.049	0.044	0.301

control group, and the difference was statistically significant (both  $P<0.05$ ). There was no statistically significant difference in the incidence of excess amniotic fluid, premature rupture of membranes and postpartum haemorrhage in pregnant women with GDM (all  $P>0.05$ ), see [Table 6](#).

## Discussion

With the promulgation and implementation of the “two-child policy” in China, the incidence of GDM continues to increase and has become a public health problem.<sup>7</sup> During pregnancy, the hormone levels in the female body undergo significant changes. Pregnancy hormones, such as oestrogen and progesterone, promote insulin resistance, which increases the mother’s need for insulin in the second trimester, and this insulin resistance may exceed the compensatory capacity of the pancreatic  $\beta$ -cells, leading to the development of chronic hyperglycaemia.<sup>17</sup> Pregnant women with GDM are hyperglycaemic, which leads to an increased risk of comorbidities such as gestational hypertension and preeclampsia.<sup>10</sup> There is a significantly increased risk of developing T2DM postpartum, and this risk may affect the offspring, creating an intergenerationally transmitted health problem.<sup>9</sup> Furthermore, GDM is significantly associated with a series of negative pregnancy outcomes such as caesarean section, preterm labour, and foetal macrosomia.<sup>6</sup> Finally, the effects of GDM do not stop at birth, as infants with GDM may be at a high risk for developing obesity and diabetes later in life, a phenomenon known as the “foetal programming effect.”<sup>6</sup> Systematic application of lifestyle interventions to enhance physical activity and improve diet can prevent GDM.<sup>10</sup> However, the percentage of pregnant women suffering from GDM continues to rise in China, highlighting the need for more tailored interventions for this high-risk population.

SMB-CPCM empowers pregnant women to self-manage, transfer medical knowledge, and facilitates emotional support and social bonding among pregnant women.<sup>11</sup> The SMB-CPCM improves the health of mothers and newborns by empowering them to self-manage their lives, lowering the incidence of complications during pregnancy, and improving the health of newborns.<sup>12</sup> The results of our study showed that the self-management ability scores of pregnant women with GDM in both groups after the intervention were higher than those before the intervention, and the level of increase was more obvious in the study group. Scores on the Maternal Anxiety Scale and the Depression Self-Assessment Scale of pregnant women with GDM in the study group were lower than those in the control group, and

fasting blood glucose and 2-hour postprandial blood glucose of pregnant women with GDM in both groups were lower after the intervention than before the intervention. The rate of spontaneous deliveries in the study group was higher than those in the control group. The rates of gestational hypertension, preterm delivery, and macrosomia were lower than those in the control group.

GDM is a common complication of pregnancy with potential risks to both maternal and infant health. Overseas studies have shown that self-management of pregnant women with GDM is effective in improving their lifestyle, obtaining optimal maternal and infant outcomes, and preventing post-pregnancy diabetes.<sup>18</sup> Therefore, empowering pregnant women with GDM to manage their condition and ensure the safety of both mother and baby is essential. The results of the current research show that self-management skills are low among pregnant women with GDM in China.<sup>19</sup> The results of this research showed that the self-management ability scores of pregnant women with GDM in both groups were higher after the intervention than before the intervention, and the degree of increase was more pronounced in the study group, which was similar to the results of Cai and Wen.<sup>20</sup> Although the self-management ability of pregnant women with GDM in the control group improved somewhat after the intervention, there was still a considerable gap with the research group. The clustered pregnancy healthcare model can improve positive psychological capital, enhance self-management ability, and increase adherence to health behaviours during pregnancy.<sup>21</sup> The cluster-based pregnancy health care model focuses on pregnant women, promotes their participation in pregnancy health care, meets the diverse and individualised needs of pregnant women, and, with the aid of integrated intervention modes such as PPT lectures, video broadcasts, model demonstrations, scenario simulations, practical exercises, and discussions, immerses pregnant women with GDM in their experience; stimulates them to think; and promotes their families' application and mastery of knowledge and skills. Guidelines state that education for self-management and support for pregnant females with GDM should be led by nurses and implemented with the cooperation of a multidisciplinary team.<sup>22</sup> Simultaneously, the content of education must be based on patients' personal wishes and preferences.

Postpartum depression and anxiety are common mental health problems among individuals with GDM. SMB-CPCM promotes mental health among pregnant women with GDM. In this research, we observed that the scores on the Maternal Anxiety and Depression Self-Rating Scale of pregnant women with GDM in the study group were lower than those in the control group after the intervention, similar to the findings of Guo Si-Tong and Wang Jiao.<sup>23,24</sup> Mental health issues in pregnant women with GDM receive less attention in conventional antenatal care, whereas diversified social support in the cluster-based pregnancy healthcare model can effectively reduce the incidences of anxiety and depression. The management team of the clustered healthcare model provides continuous and personalised professional support to expectant mothers with GDM and their families, understands the needs of pregnant females with GDM for pregnancy healthcare knowledge, communicates in real time, is able to detect adverse emotions during pregnancy in a timely manner, and provides pregnant women with correct concepts and reasonable methods of emotional catharsis.<sup>11</sup> Furthermore, peer support with mutual information sharing and role modelling is also of great significance,<sup>25</sup> as it can provide pregnant women with GDM with more emotional support and reduce their psychological burden. Utilising the WeChat Group platform, communication among pregnant women is more convenient and beyond the boundaries of time and space, which helps ease adverse emotional problems in a timely manner. Furthermore, this model actively advocates the inclusion of family members, especially spouses, in learning GDM-related pregnancy healthcare knowledge. This not only allows pregnant women to deeply feel companionship and care from their spouses, mothers-in-law, and other family members, but also facilitates the timely change of spouses' roles and provides valuable parenting support for pregnant women.

SMB-CPCM reduces blood glucose concentration in pregnant women with GDM. Poor glycaemic control during pregnancy increases the risk of immediate and long-term complications such as gestational hypertension, preeclampsia, preterm labour, and macrosomia, which can have a serious impact on maternal outcomes.<sup>26</sup> Therefore, the main goal of GDM management is to reduce blood glucose levels and improve pregnancy outcomes.<sup>27</sup> In this study, we found that the fasting blood glucose and 2-hour postprandial blood glucose levels of pregnant women with GDM in both groups were lower than those before the intervention, and the magnitude of blood glucose reduction in the study group was more significant, which is consistent with the view of Yan Meiqin that SMB-CPCM positively affects glycaemic control in pregnant women with GDM.<sup>28</sup> The SMB-CPCM includes three aspects of self-management, health education, and social

support, and the three systems are closely integrated with each other, which can not only promote the doctor-patient relationship and improve the trust of pregnant women with GDM in medical personnel, but also improve the cooperation of pregnant women in their own glycaemic control. Clinical caregivers need to enhance the protective motivation of pregnant women with GDM in glycaemic management and stimulate their coping ability and self-efficacy by increasing their awareness of the severity of the disease and the risks associated with inadequate glycaemic control, thereby deepening their understanding of healthy behaviours in glycaemic management and prompting pregnant women to change their poor behaviours and lifestyles.<sup>19,26</sup> Group members share their experiences, encourage, and learn from each other to improve the sense of collective belonging. Peer support enhances the self-efficacy of pregnant women with GDM, and healthcare professionals correct inaccuracies in a timely manner to actively promote the maintenance of healthy lifestyles among pregnant women with GDM, thereby controlling blood glucose levels.

SMB-CPCM improved birth outcomes in pregnant women with GDM. The results of this trial showed that after receiving the intervention, the natural birth rate of pregnant women with GDM in the study group was higher than in the control group. At the same time, the rates of gestational hypertension, preterm birth and macrosomia were lower than in the control group. These results suggest that SMB-CPCM has a positive effect on increasing the rate of spontaneous delivery, reducing the incidence of related complications, and improving the birth outcomes of pregnant women with GDM, which is in line with the results of previous research.<sup>12,29,30</sup> In the implementation of the SMB-CPCM, diverse teaching methods were used, including PPT lectures, video broadcasts, and scenario simulations, aimed at enabling pregnant women with GDM to comprehensively understand the advantages and disadvantages of various modes of delivery, establish the correct concept of natural delivery, alleviate their fear of delivery, and enhance their confidence in natural delivery, thus reducing the number of caesarean sections for non-medical indications.<sup>31</sup> Furthermore, this model can enable pregnant women with GDM to better master scientific knowledge of pregnancy self-care, good control of pregnancy weight gain and blood glucose levels to reduce the incidence of gestational hypertension, preterm labour, and macrosomia, and to reduce adverse birth outcomes. In this model, pregnant women share their experiences and challenges with each other by participating in group meetings. This model not only transfers medical knowledge but also promotes emotional support and social bonding among pregnant women, which is especially important for those with GDM.<sup>11</sup> However, this study showed no significant difference in the incidence of excess amniotic fluid, premature rupture of membranes, or postpartum haemorrhage between the two groups of pregnant women with GDM after the intervention. This may be associated with the small sample size and short intervention time in this study. In future, the effect of a multi-centre cluster-based pregnancy care model on birth outcomes should be further explored.

## Limitations and Strengths

This study was conducted in Bengbu Medical University, a single centre in Chinese Mainland's Anhui Province. The sample may not fully represent all patients with gestational diabetes in the world. Large scale multicenter randomized controlled trials are needed in the future to further confirm these causal relationships. Despite the above shortcomings, the intervention model of this study provides basic data to improve the outcomes of pregnant women and newborns with gestational diabetes, and expands and enriches the existing research results.

## Conclusions

SMB-CPCM, with pregnant women as the core, empowers pregnant women, values their leading role in pregnancy health care, mobilises the enthusiasm of pregnant women so that they actively participate in the activities, and enhances their self-management ability, which can help them to control their blood glucose levels effectively, reduce the risk of developing complications, improve pregnancy outcomes, and promote psychological health. SMB-CPCM may bring higher direct costs in the short term, but in the long run, it can achieve significant medical cost savings by reducing pregnancy complications, lowering maternal and infant health risks, and other means. Therefore, from the perspective of the sustainability of the holistic care model, SMB-CPCM not only performs well in improving delivery outcomes, but also provides economic advantages for the healthcare system. This model shows a good prospect in the management of gestational diabetes, and is worth popularizing and applying in a wider range.

## Ethical Approval

This study complies with the Declaration of Helsinki.

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## Disclosure

The authors declare no conflicts of interest in this work.

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