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A pathway study of factors influencing anxiety in patients with gestational diabetes mellitus

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Abstract

Background This study aims to assess anxiety severity among patients with and to elucidate the predominant psychological factors, informing the development of targeted anxiety management strategies.

Methods The cross-sectional study recruited 421 GDM patients via convenience sampling from Guangdong Province, China. Self-administered questionnaires, including the Pregnancy-related Anxiety Scale, Simplified Coping Style Questionnaire, Type D Personality Scale, Perceived Social Support Scale, and General Self-Efficacy Scale, were utilized to gather data. Data analysis was performed using Structural Equation Modeling (SEM) in AMOS 25.0 and SPSS 25.0.

Results Among patients with GDM, anxiety was significantly and positively associated with negative coping styles (β = 0.190, $P < 0.01$) and Type D personality (β = 0.167, $P < 0.01$), indicating their roles in exacerbating anxiety. In contrast, positive coping (β=-0.136, $P < 0.01$), perceived social support (β=-0.206, $P < 0.01$) and general self efficacy (β=-0.49, $P < 0.01$) had direct negative impacts on anxiety, suggesting their protective influence. Mediation analysis revealed that negative coping and Type D personality exerted significant mediating effects on anxiety, with the pathway from negative coping through Type D personality explaining 16% of the indirect effect (β = 2.302, 95% CI: 1.411 ~ 3.350) and the pathway from Type D personality through perceived social support explaining 32% of the indirect effect (β = 4.528, 95% CI: 3.231 ~ 5.913).

Conclusion The study identifies key psychological modifiers of anxiety in GDM, suggesting that targeted psychological support could mitigate anxiety and improve pregnancy outcomes.

Keywords Gestational diabetes Mellitus, Anxiety, Influencing factors, Pathway analysis

Introduction

Pregnancy and the postpartum period present a significant risk for women experiencing mental health challenges, particularly those related to anxiety and depression. The global academic community has conducted extensive research into the psychological state of patients with GDM, a transient form of diabetes induced by insulin resistance and pancreatic β-cell dysfunction during pregnancy. GDM is recognized as one of the major factors affecting maternal and child health [1]. The global prevalence of GDM ranges from approximately 9%–25% among pregnant women [2]. Pregnant women with GDM

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are more susceptible to complications during pregnancy and the postpartum period, including metabolic disorders [3], postpartum diabetes [4], and cardiovascular diseases [5]. Anxiety during pregnancy is intricately linked to the development and progression of GDM. Research has highlighted that pregnant women with heightened levels of Pregnancy-related anxiety (PRA) face a significantly elevated risk of GDM [6]. Moreover, compared to their healthy counterparts, women with GDM exhibit markedly increased anxiety levels at 30 weeks of gestation, likely attributable to concerns over fetal well-being [7].Anxiety not only heightens the risk of GDM but also exacerbates the severity of GDM-related complications, such as increased risks of preterm birth and preeclampsia [8]. Additionally, GDM has been identified as a significant contributor to postpartum anxiety [9]. In addition, while monitoring the physiological indicators of GDM is crucial, psychological factors are equally important. Effective self-management can significantly reduce anxiety and improve blood glucose levels [10].

PRA is defined as excessive worry and tension about various issues during pregnancy, including concerns about fetal health, the delivery process, and maternal health. Studies have demonstrated that prolonged anxiety, depression, and psychological stress during pregnancy can increase the risks of postpartum depression [11], preterm birth [12], and miscarriage [13].

An increasing number of studies have identified a correlation between elevated anxiety levels and GDM [14]. GDM is associated with an increased incidence of anxiety and depression in pregnant women [15], which may be related to a lack of knowledge about the disease and concerns about the impact of treatment on fetal health. Additionally, when pregnant women with GDM become aware that uncontrolled diabetes can lead to pregnancy-related complications and adverse neonatal outcomes, they are more likely to experience prenatal depression, anxiety, and stress [16, 17]. A cross-sectional study in Malaysia reported that 40% of women with GDM exhibited symptoms of anxiety and stress [18]. Prenatal psychological disorders, such as stress, anxiety, and depression, are not only associated with adverse obstetric and fetal outcomes, including fetal anomalies, low birth weight, preterm birth, stillbirth, and obstetric complications [19], but may also have lasting direct or indirect effects on children's growth and development. These effects include an increased risk of attention deficit hyperactivity disorder(ADHD) [20], autism [21], and adolescent depression [22]. Therefore, it is essential to conduct mental health screening and interventions for pregnant women [23]. These research findings further suggest that psychological disorders not only affect the occurrence and development of GDM but may also interact through multiple mechanisms.

Anxiety and depression have been shown to trigger chronic hyperactivity of the hypothalamic-pituitary-adrenal (HPA) axis, leading to elevated cortisol levels and insulin resistance, which in turn increases the risk of GDM [24]. Conversely, a diagnosis of GDM may also increase the risk of antenatal or postnatal depression through a reverse mechanism [24, 25]. Additionally, anxiety has been found to accelerate the progression of GDM [26]. Women with GDM are more likely to experience pregnancy complications, including preterm delivery, assisted delivery, and morbidities in both mother and baby [27]. Furthermore, there is growing evidence that hyperglycemia during pregnancy can have long-term adverse effects on the metabolic health of offspring, increasing their risk of developing Type 2 Diabetes (T2DM) in the future [28]. Given these complex interrelationships, the primary objective of this study is to accurately assess anxiety levels in GDM patients to identify effective interventions that can improve pregnancy outcomes and promote long-term health for both mothers and their children [29].

PRA provides a more accurate reflection of the anxiety experienced by pregnant women in specific pregnancy contexts compared to general anxiety measures. Currently, there is a paucity of systematic research on PRA in the GDM population. Furthermore, existing studies predominantly explore coping mechanisms and intervention strategies for anxiety in the general pregnant population, with relatively limited research focusing specifically on GDM patients.

This study is based on the theory of psychological stress processes, which encompasses the main concepts of stressors, mediating variables, and stress responses [30]. The objective of this research is to examine the influence of Type D personality, coping styles, general self-efficacy, and social support on anxiety in GDM patients. Despite the limitations of previous cross-sectional studies [31], which often relied on samples from specific regions or hospitals and provided preliminary insights into the interactions among factors influencing anxiety [32], we conducted a survey on the anxiety levels of GDM patients in the developed Chinese city of Shenzhen. By employing the Structural Equation Model (SEM) for the first time, we can better understand the complex relationships between variables compared to traditional methods."

The objective of the study is to construct a SEM to analyze the psychological stress processes activated by anxiety in GDM patients and to identify the key factors determining the level of anxiety in this population with greater precision. It is of great importance to investigate the relationships between factors influencing anxiety in GDM patients, as this will facilitate the development of effective intervention strategies to enhance their mental health and provide novel insights into psychological

interventions. The objective of this study is to: (1) assess anxiety levels in GDM; (2) explore the characteristics of the sample to anxiety; (3) employ SEM to analyze the correlations between anxiety and mediating variables in GDM patients; and (4) determine the direct and indirect relationships between these variables through path analysis.

Methods

Study population

Between October 2023 and February 2024, pregnant women diagnosed with GDM and seeking treatment at the obstetrics outpatient clinic of Longgang District Maternity and Child Healthcare Hospital of Shenzhen City were recruited for this study. Inclusion criteria: (1)A standard 75-gram oral glucose tolerance test was administered between the 24th and 28th weeks of pregnancy. Diagnosis of GDM was in line with the criteria outlined in the Guidelines for the Diagnosis and Treatment of Diabetes Complicating Pregnancy (2014) [33], specifically with a fasting blood glucose level of ≥ 5.1mmol/L, a 1- hour post -glucose blood glucose level of ≥ 10.0 mmol/L, and a 2 - hour post - glucose blood glucose level of ≥ 8.5mmol/L. (2) Participants were aged 20 years and above. (3) they had good language expression and communication skills; (4) they consented to participate in this study. Exclusion Criteria: (1) Pregnant women with comorbidities such as hypertension, pre-eclampsia, hyperthyroidism, or hypothyroidism. (2) Pregnant women with a pre-pregnancy diagnosis of diabetes.; (3) multiple gestations; (4) Pregnant women with cognitive impairment or intellectual disability.

Standard protocol approvals, registrations, and patient consent

Before answering the questionnaire, all pregnant women were required to sign an informed consent form. This study was approved by the Ethics Committee of the Longgang District Maternity and Child Healthcare Hospital of Shenzhen (ethics number: KYXM-2023-040) and was conducted in accordance with the principles outlined in the 2013 Declaration of Helsinki.

Survey instruments

General demographic questionnaire

The primary contents included the respondents' age, occupation, marital status, pregnancy status, the method by which they were paying for their medical care, their per capita monthly family income, their level of education, the duration of their illness, the treatment modality they were undergoing, and the frequency with which they were engaging in physical exercise.

Pregnancy-related anxiety scale(PrAS)

The scale developed by Brunton [34] was translated and culturally adapted into Chinese for use among Chinese pregnant women by Wu Yang [35], a Chinese researcher. It consists of 32 items across 8 dimensions and employs a 4-point Likert scale. A score exceeding 75.5 indicates high pregnancy-related anxiety. The Cronbach's α coefficient for this scale is 0.943.

Simplified coping Style questionnaire(SCSQ)

The scale used to measure individual coping styles under stress was developed by Jie Yanning [36], a Chinese researcher, and was translated and culturally adapted for use among Chinese participants. It consists of 20 items divided into two dimensions: positive coping and negative coping, using a 4-point Likert scale. The Cronbach's α coefficient for the entire scale is 0.832, with 0.947 for positive coping and 0.913 for negative coping.

Perceived social support scale(PSSS)

The scale used to measure perceived support from family, friends, and others was developed by Zimet [37] and was translated and culturally adapted for use among Chinese participants by Jiang Qianjin [38], a Chinese researcher. It comprises 12 items distributed across three dimensions: family support, friend support, and other support. Participants are invited to indicate their level of agreement with each item on a 7-point Likert scale. Total scores range from 12 to 84, with higher scores indicating greater levels of social support. The Cronbach's α coefficient for the scale is 0.836.

Type D scale-14(DS-14)

The scale developed by Pedersen and Denollet [39] was translated and culturally adapted for use among Chinese participants by Xiao Nan and Zhang Jianxin [40], both Chinese researchers. It is employed to assess negative affectivity and social inhibition, with each dimension comprising seven items utilizing a five-point Likert scale. A score of ≥ 10 in both dimensions is indicative of a Type D personality. The Cronbach's α for the overall scale is 0.936, with 0.922 for negative affectivity and 0.916 for social inhibition.

General self-efficacy scale(GSES)

The scale developed by Schwarzer [41] was translated and culturally adapted for use among Chinese participants by Wang Caikang [42], a Chinese researcher. It comprises 10 items utilizing a 4-point Likert scale. A higher score indicates a greater sense of self-efficacy. The Cronbach's α coefficient for the scale is 0.938.

Statistical analyses

The data were subjected to analysis using the statistical software package SPSS 25.0. Categorical data were expressed as frequency and percentage. Continuous variables exhibiting approximately normal distribution were expressed as mean ± standard deviation and analyzed using independent samples t-test or one-way ANOVA. Pearson correlation analysis was employed to investigate the interrelationships between coping styles, Type D personality, perceived social support, general self-efficacy, and PRA. An SEM was constructed using AMOS 25.0 with parameter estimation conducted via the maximum likelihood method. The model was refined based on the modification index for path analysis, and a two-tailed p-value of less than 0.05 was regarded as statistically significant.

Results

Basic characteristic

A total of 421 GDM patients were recruited from wards and outpatient departments between May and October 2019, with a response rate of 95.13%. Of these, 277 (65.7%) were in the late stages of pregnancy, 216 (51.3%) were primiparas, and 344 (81.7%) had no previous history of GDM. The majority (84.5%) of patients adopted dietary and exercise regimes as their treatment method following a diagnosis of GDM.

Anxiety scores varied significantly by age, education, adverse pregnancy history, income, and exercise frequency ($P < 0.05$). The results are presented in Table 1.

Correlation analysis

The results of the Pearson correlation analysis indicated a significant positive correlation between social inhibition, negative affectivity, negative coping strategies, and PRA ($r = 0.479$, $r = 0.457$, $r = 0.487$, $P < 0.01$). Conversely, positive coping, family support, friend support, other support, and general self-efficacy were found to be significantly negatively correlated with PRA (r = -0.440, r = -0.548). Table 2 illustrates the results.

Structural equation modeling and evaluation of anxiety in patients with gestational diabetes mellitus

This study is grounded in the theory of psychological stress processes and aims to explore the complex interactions among PRA, coping strategies, Type D personality, perceived social support, and general self-efficacy. To achieve this, an SEM was carefully developed, demonstrating a strong fit to the data: CMIN = 245.376, CMIN/DF = 2.53, P-value < 0.001, CFI = 0.942, AGFI = 0.912, NFI = 0.909, TLI = 0.928, and RMSEA = 0.06. The SEM analysis revealed significant factor loadings, highlighting robust associations among the key variables. In this study, an absolute value of factor loading greater than 0.5 was considered the threshold for acceptable construct validity, in line with established criteria [43]. Type D Personality showed substantial positive factor loadings with Social Inhibition (0.82) and Negative Emotions (0.75), and a significant negative factor loading with Perceived Social Support (-0.46). Furthermore, Perceived Social Support had substantial positive factor loadings from Family Support (0.77), Friends Support (0.66), and Significant Others Support (0.74), all of which were statistically significant at the $P < 0.01$ level. These findings underscore the importance of social support in mitigating the effects of Type D Personality. The results of these comparisons are shown in Table 3; Fig. 1.

Pathway analysis of anxiety in patients with gestational diabetes mellitus

The Type D personality has a considerable positive impact on anxiety (β = 0.304), exerting this influence through both direct (β = 0.167) and indirect pathways (β = 0.207). Additionally, negative coping strategies were found to have a significant positive effect on anxiety (β = 0.209), primarily through direct (β = 0.19) and indirect pathways (β = 0.046). The results indicate that positive coping has a significant negative effect on anxiety (β = -0.136), perceived social support has a significant negative effect on anxiety (β = -0.449), and general self-efficacy has a significant negative effect on anxiety (β = -0.206). The bootstrap method was employed to assess the mediating effects, with 5,000 resampling iterations. The findings indicated that negative coping played a mediating role in the relationship between Type D personality and anxiety, accounting for 16% of the total effect. Similarly, Type D personality acted as a mediator in the relationship between perceived social support and anxiety, accounting for 32% of the total effect. These results are presented in Tables 4 and 5.

Discussion

Influence of geography and healthcare resources on anxiety in patients with GDM

The study found that approximately 33% of GDM patients experienced PRA. This finding highlights the significant prevalence of anxiety among GDM patients and underscores the importance of understanding the factors contributing to this issue. When compared with the results of a study conducted by Feng Fu in Xinjiang, China, which was targeted at the same GDM patient group and reported an anxiety incidence rate of 59.07% [31], as well as the 27.9% anxiety rate among healthy pregnant women on the east coast of China [44], it is evident that the anxiety level of GDM patients is higher than that of healthy pregnant women. These discrepancies may be attributed to geographical and demographic differences, an uneven distribution of medical resources,

Table 1 Univariate analysis of general characteristics of Survey respondents ($n=421$)

Characteristics	*n*	%	PrAS (Score, $\bar{x}\pm s$)	t/F	*P*
Age					
≤ 30	217	51.5	70.75 ± 17.11	3.22	<0.001
>30	204	48.4	65.68 ± 15.07		
Gestational age at GDM diagnosis					
Mid Pregnancy	144	34.2	68.28 ± 15.63	-0.05	1.00
Late Pregnancy	277	65.7	68.29 ± 16.71		
Educational Level					
Junior High School	56	13.3	72.63 ± 14.80	5.77	<0.001
Senior High School/Technical Secondary School	95	22.5	72.08 ± 17.15		
Junior College	133	31.5	67.68 ± 16.58		
Undergraduate	137	32.5	64.47 ± 15.23		
Adverse Pregnancy History					
Yes	53	2.5	74.83 ± 19.47	3.15	0.02
No	368	87.4	67.35 ± 15.63		
Whether Primiparous					
Yes	216	51.3	69.68 ± 15.90	1.80	0.07
No	205	48.6	66.82 ± 16.69		
Bleeding During Pregnancy					
Yes	120	28.5	70.32 ± 18.07	1.61	0.11
No	301	71.4	67.48 ± 15.54		
History of GDM					
Yes	77	18.2	67.1 ± 15.07	0.66	0.48
No	344	81.7	68.56 ± 16.61		
Method of Payment for Medical Expenses					
Insurance	384	91.2	68.18 ± 16.58	-0.445	0.66
Out-of-Pocket	37	8.7	69.43 ± 13.63		
Monthly Per Capita Household Income					
<7000	115	27.3	72.94 ± 16.63	8.08	<0.001
7000 ~ 10,999	143	33.9	68.21 ± 16.12		
≥ 11,000	163	38.7	65.08 ± 15.60		
Frequency of Exercise					
< 3 times/week	196	46.5	70.98 ± 16.82	5.65	<0.001
3–4 times/week	111	26.3	67.08 ± 15.67		
> 4 times/week	114	27	64.83 ± 15.43		
the treatment method being used					
Diet + Exercise	356	84.5	67.9 ± 16.25	0.72	0.49
Insulin	24	5.7	69.58 ± 18.25		
uncontrolled	41	9.7	70.95 ± 15.99		

and variations in survey samples [45]. Pregnant women in resource-poor regions face more significant economic and psychological challenges, which is consistent with previous studies [44]. The anxiety levels among GDM patients are significantly influenced by the stark contrast in medical resources and support systems between urban and rural areas. Systematic training and on-site guidance are crucial for clinical staff in under-resourced areas to effectively manage patient anxiety.

Educational level affects anxiety in GDM patients through direct and indirect pathways

The results indicated that higher educational levels were associated with lower levels of PRA in GDM patients, both directly and indirectly through enhanced coping strategies and social support. A review of the literature reveals a positive correlation between the age and educational level of patients with GDM and the prevalence of depression and anxiety disorders [46]. Those with higher education qualifications are better equipped to gather information and solve complex problems, which enables them to better handle pregnancy-related health issues, such as those about blood sugar management [47]. Patients proactively seek knowledge regarding accessible healthcare resources, consult with physicians, and utilize health resources to manage anxiety and stress [48]. Conversely, patients with GDM who have received less education are more likely to experience stress and

Table 2 The objective of this study is to analyze the correlation between anxiety, coping style, type D personality, social support, and self-efficacy in individuals with gestational diabetes mellitus ($n=421$)

Variables	PrAs	Social Inhibition	Negative Affect	Positive Coping	Negative Coping	Family Support	Friends Support	Others support	General Self-Efficacy
PrAs	1								
Social Inhibition	0.479**	1							
Negative Affect	0.457**	0.621**	1						
Positive Coping	−0.440**	−0.300**	−0.333**	1					
Negative Coping	0.487**	0.362**	0.287**	−0.317**	1				
Family Support	−0.548**	−0.413**	−0.407**	0.385**	−0.354**	1			
Friends Support	−0.485**	−0.308**	−0.344**	0.337**	−0.291**	0.530**	1		
Others support	−0.519**	−0.384**	−0.392**	0.331**	−0.302**	0.590**	0.517**	1	
General Self-Efficacy	−0.496**	−0.326**	−0.348**	0.308**	−0.290**	0.357**	0.267**	0.370**	1

**$P<0.01$

Table 3 Results of model fit test

SEM model	CMIN	CMIN/DF	*P*-value	CFI	AGFI	NFI	TLI	RMSEA
	245.376	2.53	<0.001	0.942	0.912	0.909	0.928	0.06

NOTE: CMIN Chi-square, CMIN/DF Cardinality of freedom ratio(CMIN/DF< 3 is acceptable), CFI comparative fit index, AGFI adjusted goodness-of-fit index, NFI normed fit index, TLI Tucker - Lewis Index(CFI、AGFI、NFI、TLI ≥ 0.90 is acceptable, ≥ 0.95 is good),RMSEA root mean square error of approximation (RMSEA ≤ 0.08 is recommended)

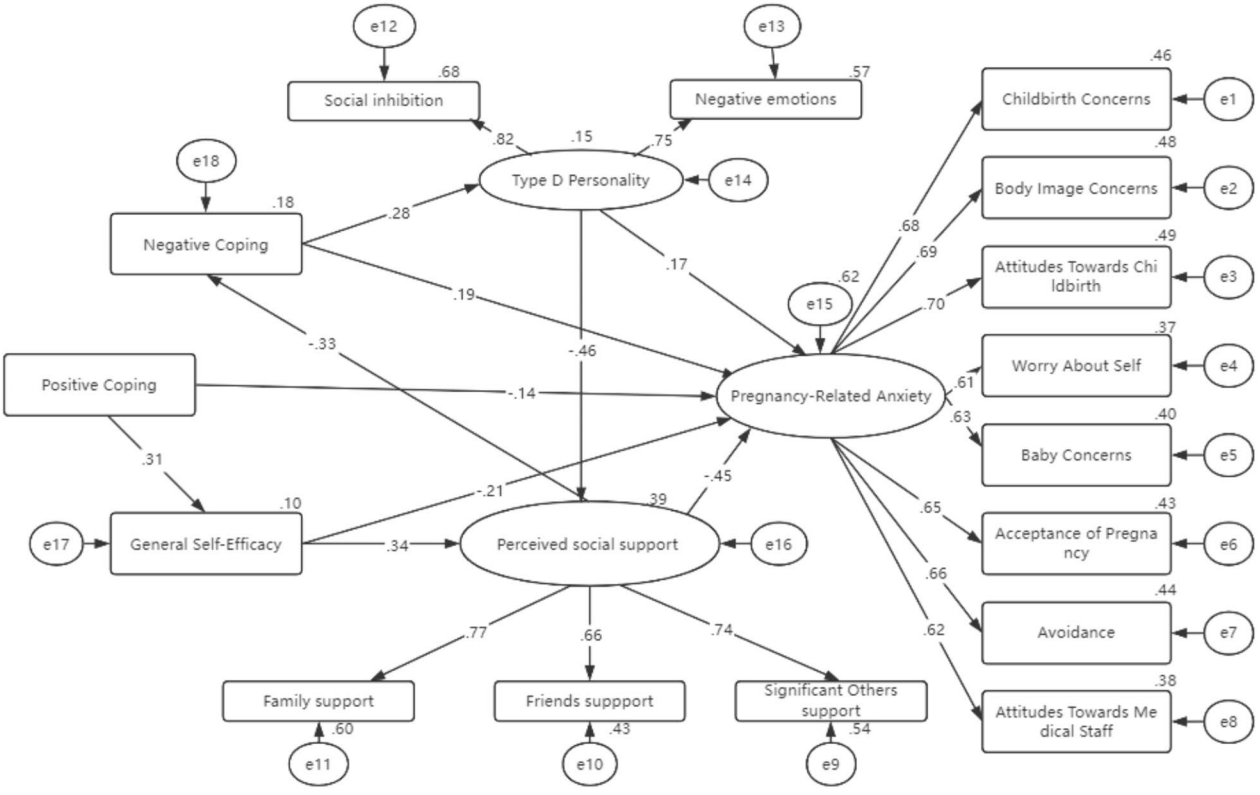

Fig. 1 Path Analysis of Influencing Factors of Anxiety in Patients with GDM (Standardized)

distress during pregnancy. Limited access to information, a reduced capacity to comprehend and utilize health-related data, and the challenge of effectively leveraging available support resources are frequently encountered by these individuals [31]. Research has demonstrated that diabetes education can positively influence patients' behaviors and health [49]. It helps patients better understand their conditions and make more informed self-care decisions. To optimize the mental health of pregnant GDM patients, regular health education classes tailored

Table 4 Results of path analysis of the effects of anxiety in gestational diabetes mellitus

Path	*P*	95%CI	Direct effect β	Indirect effect β	Total effect β
D-type personality	0.009	0.304∼0.541	0.167	0.207	0.374
Negative Affect	<0.001	0.209∼0.405	0.19	0.046	0.236
Positive Coping	0.002	-0.345∼-0.162	-0.136	-	-
Perceived Social Support	<0.001	-0.664∼-0.422	-0.449	-	-
General Self-Efficacy	<0.001	-0.481∼-0.295	-0.206	-	-

Table 5 Direct and Indirect effects of path diagrams

Path	Efficacy value β	SE	95%CI	*P*	Relative mediation effect
Total effect	14.106	1.235	11.679∼16.532	<0.001	-
Direct effect	7.276	1.114	5.087∼9.465	<0.001	-
Indirect effect	6.83	0.839	5.262∼8.56	<0.001	-
NA→DS-14→PrAS	2.302	0.497	1.4109∼3.3499	-	16%
DS-14→PSSS→PrAS	4.528	0.682	3.2306∼5.9128	-	32%

to GDM can be conducted by clinical staff within both community and hospital settings. This may include the use of props for dietary guidance demonstrations and the establishment of online consultation platforms to cater to their needs.

Low-income families influence psychological stress and anxiety in GDM patients through direct and indirect pathways

The study results highlight that low-income status is associated with increased psychological stress and anxiety in GDM patients, mediated both directly and indirectly by limited access to healthcare and social support. The economic level was identified as a significant predictor of anxiety in patients with GDM. As demonstrated by Fairburn [50], women with low socio-economic status must receive priority attention during pregnancy preparation, given their elevated risk of developing GDM. Low-income families frequently contend with heightened psychological distress due to constrained access to healthcare services and psychological support, which exacerbates mental health challenges among patients, leading to elevated levels of psychological stress and anxiety [51]. A study in Turkey showed that low-income pregnant women had high levels of anxiety and low scores on health-promoting lifestyles, indicating a need for targeted interventions to support these vulnerable populations [52].Clinicians must develop bespoke health education programs tailored to the needs of pregnant women, encompassing individuals from diverse educational backgrounds and economic statuses, with a particular focus on those belonging to low-income families and possessing relatively low educational levels. These programs aim to enhance their fundamental health knowledge. Implementing targeted interventions for low-income families, such as subsidized healthcare services and community support programs, could significantly reduce the psychological stress and anxiety experienced by GDM patients.

Type D personality affects anxiety in GDM patients through direct and indirect pathways

Results of the path analysis show that Type D personality (TDP) affects anxiety in GDM patients via both direct and indirect pathways. Extensive research has shown that TDP is associated with a variety of diseases, including cardiovascular disease, diabetes, and mental health issues [53–56]. Additionally, TDP has been linked to negative health behaviors in patients, such as smoking, alcohol consumption [57], poor medication adherence [58], and unhealthy dietary habits [59].Despite the extensive research on TDP across multiple domains, studies focusing on pregnant women, particularly those with GDM, are relatively limited. Concentrating on GDM patients, our study has found that TDP has a significant impact on their anxiety levels. GDM patients face multiple pressures during pregnancy, including blood glucose control, hormonal changes, physical discomfort, and concerns about childbirth and parenting. Individuals with TDP have limited capacity to cope with stressful life events [60], and such stressors are likely to trigger and exacerbate anxiety. Existing research has indicated that stress in pregnant women is closely related to GDM [61]. If stress is not effectively alleviated, it can increase the difficulty of managing GDM, worsen patient anxiety, and jeopardize the health of both mother and baby. Recent studies have discovered that, in addition to negative affectivity and social inhibition, inflammatory responses are also an important mechanism through which TDP affects anxiety in GDM patients, providing a new perspective for studying the relationship between the two. TDP may be associated with increased inflammation activation [62], and when an individual's mental health level declines, levels of TNF-α and sTNFr2 in those with TDP are significantly elevated [63]. GDM patients are physiologically sensitive

during pregnancy, and changes in inflammatory markers triggered by TDP can disrupt the body's internal balance, affecting both physiological and psychological states, and are highly likely to exacerbate anxiety from a physiological standpoint. Depression and anxiety symptom scores in pregnant women during mid-pregnancy are closely related to increased serum levels of Th2-related cytokines (IL-5, IL-9, IL-13) [64], further revealing the close link between anxiety and inflammatory markers. It is evident that TDP is likely to play a more complex role in the development of anxiety in GDM patients through its impact on inflammatory responses.

It is recommended that clinical professionals provide targeted psychological interventions for GDM pregnant women, such as cognitive-behavioral therapy [65], mindfulness meditation, or emotion regulation training. These interventions can enhance the psychological resilience of pregnant women, improve their stress resistance, and mitigate the impact of acute and chronic stress [66], helping them better manage anxiety during pregnancy and ensure the health of both mother and baby. Future research may focus on the differences in the impact of TDP on anxiety through inflammatory responses among GDM patients with varying disease severities, providing a basis for precise interventions.

Positive coping, social support and general self-efficacy for anxiety in GDM patients

Results show that positive coping, social support, and general self-efficacy play significant roles in reducing anxiety levels in GDM patients. It is widely acknowledged that positive coping mechanisms, social support, and general self-efficacy play a pivotal role in alleviating anxiety during pregnancy. The pivotal function of positive coping in alleviating psychological distress is further substantiated by evidence indicating that efficacious emotion regulation is enabled by positive coping strategies [67]. Pregnant women with high self-efficacy are better equipped to cope with the challenges of pregnancy, and fostering feelings of social support can indirectly reduce anxiety. It has been demonstrated that the intensity of anxiety can be markedly reduced by the presence of good self-efficacy [68]. In addition to alleviating anxiety directly, social support also reduces the psychological burden of pregnant women by providing emotional and practical assistance [69]. Studies have shown that social support buffering mechanisms, such as social support potentially enhancing individual perceived capabilities [70] are crucial. Lacking social support, pregnant women are more likely to experience prenatal stress and anxiety symptoms [23]. It is worth noting that social support does not always mitigate the negative impact of stress and can sometimes exacerbate the negative psychological associations in individuals with low self-efficacy [71]. It is worth exploring whether positive coping and good social support can help GDM patients better control their blood sugar levels, which in turn might further reduce anxiety levels. At the community and family levels, there is a need to establish diverse social support systems and encourage family members and friends to provide increased care and support to patients with GDM, thereby effectively improving their quality of life [72, 73].

Analysis of the mediating effects of Type D personality negative coping and social support on anxiety in GDM patients

Results indicate that Type D personality and negative coping significantly influence anxiety levels in GDM patients, while social support has a protective effect. The indirect elevation of patient anxiety levels can be attributed to Type D personality traits, which are associated with higher levels of anxiety and health problems. The occurrence of recurrent negative emotions is a consequence of the utilization of negative coping behaviors, which serve to exacerbate anxiety [73] Conversely, social support plays a pivotal role in the alleviation of anxiety. The formation and sustenance of a social support network are frequently more arduous for individuals with Type D personality traits, which can indirectly precipitate the development of anxiety [74]. This finding highlights the pivotal role of social support in anxiety reduction. It is therefore essential to minimize negative coping behaviors, improve Type D personality traits, and enhance social support to effectively reduce anxiety. Pregnant women can be assisted by clinical workers in recognizing and changing negative coping styles and providing the necessary emotional and practical support to reduce psychological burden and anxiety. This can be achieved by establishing mutual support groups for pregnant women and robust family support systems.

Limitations

It is important to note that our research is not without limitations. Firstly, the cross-sectional design of the study restricts our capacity to establish causal relationships between variables. Secondly, the study was conducted in a single tertiary specialty hospital, which may limit the generalizability of the findings. It would therefore be beneficial for future research to consider including multiple hospitals to improve the scientific rigor and validity of the study. Finally, the use of self-reported questionnaires introduces a potential for recall bias, suggesting that future studies should incorporate observational data from multiple sources to provide a more objective perspective.

Conclusions

The results of this study demonstrate that anxiety in patients with GDM is influenced by several factors, as evidenced by path analysis. The results indicated that Type D personality is a significant factor, with negative affectivity and social inhibition contributing to heightened anxiety levels. Additionally, negative coping behaviors and a lack of social support systems were found to further exacerbate anxiety in these patients. Therefore, it is recommended that clinical interventions should target these influencing factors and their pathways of action, implementing timely and effective countermeasures to control and reduce anxiety. It would be beneficial for future studies to further validate the pathway model and develop multidisciplinary interventions to enhance the scope and theoretical foundation of this research.

Abbreviations

GDM	Gestational diabetes mellitus
PrAS	Pregnancy-related Anxiety Scale
NA	Negative Affect
DS-14	Type D NA Scale
PSSS	Perceived social support scale

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Author contributions

Jiale Li: Writing– original draft, Methodology, Data acquisition, Interpretation. Yiling Yang: Writing– review & editing. Weiqiang Chen: Writing– review & editing, Supervision, Project administration. Ziwei Yu: Writing– review & editing, Data curation. Jingjing Liang: Writing– review & editing, Statistical analysis. Qian Ye: Writing– review & editing. Yanxia Chen: Writing– review & editing, Conceptualization.Sijia Li: Writing– review & editing, Software.

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Data availability

Data will be available upon request of the corresponding author.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Longgang District Maternity and Child Healthcare Hospital of Shenzhen (ethics number: KYXM-2023-040). Before participation, all subjects provided informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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