Check for updates

OPEN ACCESS

EDITED BY Mona Nasrallah, American University of Beirut, Lebanon

REVIEWED BY

Igor Victorovich Lakhno, Kharkiv National Medical University, Ukraine Mehmet Hamdi Örüm, Elazığ Eğitim ve Araştırma Hastanesi, Türkiye Gözde Bacik Yaman, Süleyman Demirel University, Türkiye

CORRESPONDENCE Fengchun Wu ☑ 13580380071@163.com Jiebing Chen ☑ chenjieb@mail.sysu.edu.cn Ming Zhao ☑ 286091009@qq.com Chunqi Luo ☑ luochg@mail.sysu.edu.cn

[†]These authors have contributed equally to this work and share first authorship

RECEIVED 04 May 2023 ACCEPTED 07 August 2023 PUBLISHED 27 November 2023

CITATION

Zeng X, Yan X, Yang Y, Peng Z, Wei S, Chen J, Wu F, Chen J, Zhao M and Luo C (2023) A correlation analysis on the postpartum anxiety disorder and influencing factors in puerperae with gestational diabetes mellitus. *Front. Endocrinol.* 14:1202884. doi: 10.3389/fendo.2023.1202884

COPYRIGHT

© 2023 Zeng, Yan, Yang, Peng, Wei, Chen, Wu, Chen, Zhao and Luo. This is an openaccess article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

A correlation analysis on the postpartum anxiety disorder and influencing factors in puerperae with gestational diabetes mellitus

Xun Zeng^{1†}, Xiaofen Yan^{2†}, Yan Yang^{3†}, Zhangqing Peng^{4†}, Shiyao Wei⁵, Jinxia Chen⁴, Fengchun Wu^{6,7}*, Jiebing Chen^{4*}, Ming Zhao⁸* and Chunqi Luo⁴*

¹Out-Patient Department, The First Affiliated Hospital, Sun Yat sen University, Guangzhou, China, ²Deparment of Private Medical Center, The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China, ³Department of Internal Medicine, Zhongshan Hospital of Traditional Chinese Medicine, Zhongshan, China, ⁴Department of Obstetrics and Gynecology, The First Affiliated Hospital, Sun Yat-sen University, Guangzhou, China, ⁵Department of Oral Implantology, Hospital of Stomatology, Sun Yat-sen University, Guangzhou, China, ⁶Department of Psychiatry, the Affiliated Brain Hospital of Guangzhou Medical University, Guangzhou, China, ⁷Department of Psychiatry, Guangdong Engineering Technology Research Center for Translational Medicine of Mental Disorders, Guangzhou, China, ⁸Out-Patient Department of Nansha Division, The First Affiliated Hospital, SunYat-sen University, Guangzhou, China

Objective: The aim of this study is to discuss the postpartum anxiety disorder and influencing factors in puerperae with gestational diabetes mellitus (GDM) to provide a clinical basis for better early identification and intervention of adverse mood.

Methods: Convenient sampling method was adopted to investigate 205 pregnant women as the observation group and 201 normal healthy pregnant women in the same period as the control group. The self-rating anxiety scale (SAS) was used to investigate and observe the respondents, evaluate the postpartum anxiety status of patients with GDM, and analyze the related influencing factors. Statistical analysis of the data was performed using SAS 3.0 software. A proposed P < 0.05 was considered as statistically significant.

Results: Patients with GDM had a higher risk than normal maternal anxiety, related to years of education, triglycerides, 1-h postprandial blood glucose, and a history of induced abortion.

Conclusion: GDM can lead to the occurrence of postpartum anxiety, and the poor psychological state is not conducive to the maternal and infant health. Early identification and early intervention can reduce the harm caused by anxiety and promote the progress of maternal and infant health and clinical research.

KEYWORDS

gestational diabetes, postpartum, anxiety, influencing factors, correlation

1 Introduction

As one of the most common complications of pregnancy, gestational diabetes mellitus (GDM) (1) refers to an abnormal glucose metabolism that occurs during pregnancy, excluding the diabetes mellitus preexisting before pregnancy. GDM is associated with various factors like insulin resistance, genetics, changes in diet, and lifestyle during pregnancy (2). According to relevant literature, the prevalence rate of GDM is 14.0% globally (3). The puerperae with GDM are faced with many potential adverse pregnancy outcomes, such as macrosomia, neonatal hypoglycemia, progeny obesity, and type II diabetes, which may lead to an increased risk of mental disorders (4). According to current studies, about 10% to 15% of healthy women suffer from postpartum depression (PPD) after delivery in developed countries (5), whereas the rate was up to 24% in developing countries (6). PPD is often complicated with anxiety (7-12), which usually occurs within 6 months after delivery (13) with an incidence rate 14%-16% (14, 15). Maternal postpartum anxiety may cause some problems compromising the motor development of infant (16) as well as the breastfeeding behavior and breast milk composition (17). Therefore, for patients with GDM, who are at a high risk for mental disorders, early identification of postpartum anxiety is essential. Although current studies have proved that GDM is an important factor leading to postnatal anxiety (18, 19), most of the relevant studies merely focus on PPD, whereas postpartum anxiety and related influencing factors in puerperae with GDM are rarely reported. In this study, the relationship between GDM and postpartum anxiety was first established through a survey, and, also, relevant influencing factors were analyzed. The study results are helpful for early identification of the high-risk factors and early clinical intervention of patients with GDM with postpartum anxiety.

2 Materials and methods

2.1 Subjects

A total of 205 puerperae with GDM treated in the Obstetrics Clinic of The First Affiliated Hospital of Sun Yat-sen University between June 2021 and June 2022 were selected as the observation group, and, for statistical power, 201 healthy pregnant women in the same period were selected as the control group for postpartum anxiety investigation. Sampling method: convenience sampling. Inclusion criteria for the observation group: ① adult puerperae aged 18-49 years old and diagnosed as GDM; 2 re-examined 42 days after delivery with the ability to complete the questionnaire independently; 3 without past history of systemic complications like mental disease and nervous system disease; and ④ voluntarily received and cooperated with the survey. Exclusion criteria for the observation group: ^① with a history of mental illness before delivery; 2 with other pregnancy complications; 3 with endocrine disease, liver or kidney dysfunction, etc.; and \circledast with cognitive dysfunction. Inclusion criteria for the control group: 1) healthy maternal aged 18-49 years and 2 those who voluntarily received and cooperated with the survey. Exclusion criteria for the control group: ① with a history of mental illness before pregnancy; ② with other pregnancy complications; ③ with endocrine disease, liver or kidney dysfunction, etc.; and ④ with cognitive dysfunction.

2.2 Methods

Questionnaire of general information: A self-designed questionnaire of general information (including age, education years, monthly family income, number of children, intervention mode, and etc.) was adopted.

Clinical data: The patients were investigated for weeks of labor, gestational age, number of pregnancies, number of deliveries, history of adverse pregnancy, history of abortion, GDM, body mass index (BMI), Glycosylated hemoglobin (HBA1c), 1-h plasma glucose (1h-PG), triglyceride, and history of diabetes.

Anxiety scale: Self-rating anxiety scale (SAS) (20) formulated by Zung was used for relevant assessment. SAS consists of 20 items, for which Likert 4-grade scoring method was adopted: Scores 1 to 4 represent "never or seldom," "a small amount of time," "considerable time," and "most of or all of the time," respectively, and the total score multiplied by 1.25 was the scale standard score, which was positively correlated with anxiety. If the standard score is \geq 50, then there was anxiety disorder. According to relevant literature, the reliability of this scale was 0.82 (20).

2.3 Statistical analysis

Excel 2003 software was used for double entry of questionnaire and SAS 3.0 for statistical analysis of data. Continuous variables were expressed as $x \pm s$, and, Mann-Whitney U-test, a non-parametric test, was used for relevant statistical inference. Categorical variables were described by rate or percentage, and chi-square test was used for relevant analysis. The influencing factors of anxiety were discussed by binary logistic regression analysis and generalized linear mixed model, inspection level $\alpha = 0.05$.

2.4 Ethical statement

This study was approved by the Ethics Committee of The First Affiliated Hospital of Sun Yat-sen University (approval number: Lunshen (2021)566-1), and all of the patients signed the informed consent form.

3 Results

3.1 General information of puerperae in the observation group and control group

Mann-Whitney U-test was used for continuous variables, and chi-square test was used for categorical variables (see Table 1). There

were 205 subjects in the GDM group and 201 subjects in the healthy control group. There was statistical significance for differences in age, gestational age, 1h-PG, gestational HBA1c, gestational triglyceride, SAS, history of induced abortion, history of diabetes, and blood glucose control. For the differences in age, gestational age, 1h-PG, gestational HBA1c, gestational triglyceride, SAS, and history of induced abortion between the two groups, P = 0.020, and, for the difference in history of diabetes between the two groups, P = 0.010. The mean age, 1h-PG, gestational HBA1c, gestational triglyceride, and SAS of GDM group were higher than that of the control group, whereas the mean gestational age of GDM group was lower than that of the control group. The proportion of induced abortion history and diabetes history of GDM group was higher than that of the control group. As for BMI, education years, employment status, number of pregnancies, number of deliveries, number of children, payment method, monthly family income, and history of spontaneous abortion, there were no differences between the two groups.

3.2 Binary logistic regression analysis on influencing factors of anxiety in puerperae

The binary logistic regression analysis was conducted with whether anxious or not as the dependent variable and general information as the independent variable, and, for categorical variables, the last was taken as the reference category. The results of univariate analysis for anxiety showed that education years, 1h-PG, and GDM were related to anxiety, with education years as a protective factor and with 1h-PG and GDM as risk factors. The Odds Ratio (OR) value for education years was 0.846 (95% CI, 0.732 to 0.977; P = 0.023), that is, with the increase of education years, the risk of anxiety decreased. For 1h-PG, the OR value was 1.227 (95% CI, 1.057 to 1.424; P = 0.007), that is, the risk of anxiety increased with 1h-PG. The OR value for GDM was 15.093 (95% CI, 3.539 to 64.373; P < 0.001), i.e., patients with GDM had an increased risk of anxiety as compared with those without GDM (see Table 2 for details).

3.3 Multiple linear regression analysis on influencing factors of anxiety in puerperae

After adjustment for age, gender, history of diabetes, employment status, number of pregnancies, history of spontaneous abortion or induced abortion, blood glucose control, HBA1c, triglyceride, GDM, normal delivery or not, and newborn weight, the generalized linear mixed model (Figure 1) showed that there was a correlation between educational age and SAS: For every 1 year increase, SAS decreased by 0.487 (95% CI, -0.823 to -0.151; P = 0.005), the risk of anxiety grade (mild *vs.* normal) decreased by 0.243 (95% CI, -0.459 to -0.026; P = 0.028), and the risk of anxiety disorder decreased by 0.252 (95% CI, -0.468 to -0.037; P = 0.022), and, so, it was a protective factor for anxiety.

After adjustment for age, gender, history of diabetes, education years, employment status, number of pregnancies, history of spontaneous abortion or induced abortion, blood glucose controlled or not, HBA1c, triglyceride, normal delivery or not, and neonatal weight, the generalized linear mixed model (Figure 2) showed that GDM was correlated with SAS, and, compared with patients without GDM, patients with GDM had SAS increased by

Variables	GDM group (n = 205)	Control group (n = 201)	z	Р
	Mean ± SD	Mean ± SD		
Age (years)	33.93 ± 3.86	32.42 ± 4.14	-3.692	<0.001
Gestational age (weeks)	37.79 ± 2.74	38.69 ± 1.31	-4.503	<0.001
Educational age	15.78 ± 2.62	15.98 ± 2.35	-0.659	0.510
1h-PG	9.19 ± 2.11	7.43 ± 1.05	-9.188	<0.001
Glycosylated hemoglobin	5.05 ± 0.47	4.83 ± 0.34	-5.967	<0.001
Triglyceride	2.32 ± 0.94	2.04 ± 1.22	-3.673	<0.001
SAS	40.05 ± 7.74	35.93 ± 7.20	-5.205	<0.001
	GDM group	Control group		р
	N (%)	N (%)		P
1	59 (28.8)	38 (18.9)	5.443	0.020
2	146 (71.2)	163 (81.1)		
History of spontaneous abortion				
1	28 (13.7)	28 (13.9)	0.006	0.937
2	177 (86.3)	173 (86.1)		

 TABLE 1 Comparison of basic data between the two groups.

GDM, gestational diabetes mellitus; 1h-PG, 1-h plasma glucose; SAS, self-rating anxiety scale; P, positive subscore. Bold values implies statistical significance.

Factors	В	S.E.	Wald	Sig.	OR (95% CI)
Age (years)	0.037	0.047	0.627	0.428	1.038 (0.947, 1.137)
Gestational age (weeks)	-0.083	0.058	2.013	0.156	0.921 (0.821, 1.032)
Educational age	-0.167	0.074	5.157	0.023	0.846 (0.732, 0.977)
1h-PG	0.205	0.076	7.246	0.007	1.227 (1.057, 1.424)
Triglyceride	-0.184	0.265	0.481	0.488	0.832 (0.495, 1.399)
History of Abnormal pregnancy	0.218	0.637	0.117	0.732	1.244 (0.357, 4.337)
History of induced abortion	0.726	0.402	3.268	0.071	2.068 (0.941, 4.546)
History of spontaneous abortion	-0.814	0.747	1.186	0.276	0.443 (0.102, 1.917)
History of diabetes	0.562	0.409	1.886	0.170	1.754 (0.786, 3.914)
GDM	2.714	0.740	13.451	<0.001	15.093 (3.539, 64.373)

TABLE 2 Univariate logistic regression analysis of anxiety disorder in the two groups.

GDM, gestational diabetes mellitus; 1h-PG, 1-h plasma glucose; Sig., significance test. Bold values implies statistical significance.

4.275 (95% CI, 1.167 to 7.382; P = 0.007), risk of anxiety grade (mild *vs.* normal) increased by 2.434 (95% CI, 0.044 to 4.823; P = 0.046), and risk of anxiety disorder increased by 2.537 (95% CI, 0.146 to 4.928; P = 0.038), which is a risk factor for anxiety.

After adjustment for age, gender, history of diabetes, education years, employment status, number of pregnancies, history of spontaneous abortion, blood glucose controlled or not, HBA1c, triglyceride, GDM, normal delivery or not, and neonatal weight, there was no correlation between history of induced abortion and SAS (Figure 3), whereas there was a correlation between history of induced abortion and anxiety grade (mild *vs.* normal), and, compared with patients without history of induced abortion, those with history of induced abortion had risk of anxiety grade (mild *vs.* normal) increased by 2.003 (95% CI, 0.043 to 3.963; P = 0.045) and risk of anxiety disorder increased by 2.026 (95% CI, 0.065 to 3.988; P = 0.043), and, so, it was a risk factor for anxiety.

After adjustment for age, gender, history of diabetes, education years, employment status, number of pregnancies, history of

dt dt dt dt dt dt dt dt dt Educational age VS. SAS in two groups					
Educational age VS. SAS in two groups 404 -0.474(-0.7750.173 0.002 Model 1. Adjustel for age and gender 305 -0.478(-0.7830.174 0.002 Model 2. Model 1. Hatery of diabete 305 -0.478(-0.7830.174 0.002 Model 2. Model 1. Hatery of diabete 305 -0.478(-0.7830.174 0.002 Model 2. Model 1. Hatery of diabete 305 -0.58(-0.8810.224) 0.001 Model 2. Model 3. Oravidity + History of spontanous abortion and inducedabortion 302 -0.50(-0.830.186 0.003 Model 2. Model 5. Model 4. Contol mode 1. Glycosylatid hemoglatin - Trajyceride - CDM 302 -0.50(-0.830.186 0.003 Model 7. Model 6. Model 7. The undenhying diseases 305 -0.48(-0.8010.131) 0.007 Model 2. Model 3. Haternal combridities or complications 314 -0.42(-0.820.152) 0.005 Model 3. Model 3. Garavidity + History of gortianous abortion and inducedabortion 306 -0.162(-0.3080.010 0.000 Model 4. Model 3. Garavidity + History of gortianous abortion and inducedabortion 306 -0.162(-0.3080.010 0.000 Model 2. Model 3. Haternal combridities or complications 335 -0.28(-0.4380.017) 0.002 Model 3. Model 2. Eng				Point estimated	Р
Unadjusted 444 -0.474(-0.775,-0.173) 0.002 Modei 1: Adjusted for age and gender 367 -0.474(-0.775,-0.173) 0.002 Modei 2: Model 1: History of diabelie 367 -0.474(-0.775,-0.173) 0.002 Modei 2: Model 2: Hempioyment situation 368 -0.584(-0.788,-0.174) 0.002 Modei 3: Model 4: Control model - (Nocopsident Pernoglobin + Triglyceride + GDM) 362 -0.584(-0.884,-0.243) 0.001 Modei 6: Model 6: Control model - (Nocopsident Pernoglobin + Triglyceride + GDM) 362 -0.580(-0.833,-0.167) 0.003 Modei 7: Model 6: Body weight 385 -0.486(-0.804,-0.131) 0.007 Modei 8: Model 7: The underlying diseases 355 -0.486(-0.804,-0.131) 0.007 Modei 1: Adjusted for age and gender 403 -0.167(0.812,-0.022) 0.228 Modei 1: Adjusted for age and gender 368 -0.182(0.802,-0.010) 0.020 Modei 1: Adjusted for age and gender 368 -0.182(0.802,-0.010) 0.020 Modei 1: Adjusted for age and gender 368 -0.182(0.802,-0.021,-0.022,0.022) 0.021 Modei 2: Model 4: History of diabete 368 -0.182(0.802,-0.002,0.021 0.020 Mode			df	(95% CI)	Value
Model 1: Adjusted for age and gender 937 -0.478(-0.783, -0.174) 0.002 Model 2: Model 2: Model 2: Carpidyoment situation 936 -0.458(-0.783, -0.078) 0.001 Model 3: Model 2: Carpidyoment situation 936 -0.458(-0.783, -0.174) 0.001 Model 3: Model 2: Carpidyoment situation 936 -0.558(-0.881, -0.243) 0.001 Model 4: Model 3: Gravidty + History of spontanous abortion and inducedabortion 936 -0.558(-0.881, -0.243) 0.001 Model 6: Model 5: Control model + Opcosylated hemoglobin + Triglycaride + GDM 936 -0.458(-0.881, -0.13) 0.002 Model 7: Model 6: Body weight 936 -0.458(-0.881, -0.13) 0.001 Model 3: Model 7: The underlying diseases 936 -0.458(-0.881, -0.13) 0.002 Model 3: Model 6: Model 6: Model 7: The underlying diseases 936 -0.167(-0.314, -0.021) 0.026 Model 1: Adjusted for age and gender 936 -0.171(-0.320, -0.022) 0.026 Model 3: Model 4: History of spontanous abortion and inducedabortion 936 -0.171(-0.320, -0.022) 0.026 Model 3: Model 4: History of spontanous abortion and inducedabortion 936 -0.128(-0.480, -0.040) 0.017 Model 3: Model 6: Model 7: History of sp					
Model 2. Model 1 + History of diabete 936 -0.483(-0.788, -0.179) 0.002 Model 3. Model 2 + Employment situation 936 -0.548(-0.884, -0.23) 0.001 Model 5. Model 4 + Control model + Glycosylated hemoglobin + Triglycaride + GDM 332 -0.508(-0.881, -0.23) 0.001 Model 5. Model 5 + Whether natural delivery 949 -0.501(-0.835, -0.167) 0.003 Model 7. Model 6 + Body weight 338 -0.489(-0.801, -1.31) 0.071 Model 8. Model 7 + The underlying diseases 338 -0.489(-0.821, -1.52) 0.025 Model 9. Model 8 + Maternal comorbidities or complications 334 -0.487(-0.822, -0.157) 0.026 Model 9. Model 9 + Maternal comorbidities or complications 334 -0.487(-0.822, -0.157) 0.026 Model 1. Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 336 -0.487(-0.822, -0.157) 0.026 Model 1. History of diabete 936 -0.177(-0.314, -0.027) 0.026 0.026 Model 2. Model 1 + History of giontanus abortion and inducedabortion 334 -0.221(-0.038, -0.037) 0.020 Model 3. Model 2 + Employment situation 334 -0.221(-0.038, -0.037) 0.021 Model 4 + Control model + Glycosylated hemo					
Model 3. Model 2 + Employment situation 356 -0.564(-0.884, -0.243) 0.001 Model 4. Model 3 + Gravidy + History of spontanous abortion and inducedabortion 391 -0.558(-0.881, -0.234) 0.001 Model 5. Model 4 + Controt model + Glycosylated hemoglobin + Tigyoeride + GDM 392 -5050(-0.833, -0.168) 0.003 Model 5. Model 5 + Workher natural delivery 393 -0.488(-0.801, -0.131) 0.007 Model 5. Model 3 + Maternal comorbidities or complications 333 -0.488(-0.821, -0.131) 0.007 Model 5. Model 3 + Maternal comorbidities or complications 334 -0.488(-0.821, -0.131) 0.007 Model 5. Model 3 + Maternal comorbidities or complications 335 -0.488(-0.821, -0.131) 0.007 Model 5. Model 3 + Moternal comorbidities or complications 335 -0.488(-0.821, -0.131) 0.007 Model 3. Model 2 + Employment situation 403 -0.187(-0.332, -0.022) 0.028 Model 4. Model 3 + Employment situation 394 -0.223(-0.048, -0.037) 0.020 Model 5. Model 4 + Controt model + Glycosylated hemoglobin + Tigyceride + GDM 335 -0.228(-0.048, -0.037) 0.021 Model 5. Model 3 + Controt model + Glycosylated hemoglobin + Tigyceride + GDM 335 -0.238(-0.048, -0.037) <t< td=""><td></td><td></td><td></td><td></td><td></td></t<>					
Model 4: Model 3: Gravidity + History of sportanous abortion and inducedabortion 911 -0.558(-0.881,-0.224) 0.001 Model 6: Model 6: Model 4: Control model 4: Olycosylated hemoglobin + Triglyoride + GDM 322 -0.500(-0.833,-0.168) 0.003 Model 7: Model 6: Model 6: Body weight 335 -0.486(-0.833,-0.167) 0.003 Model 7: Model 8: Model 7: The underlying diseases 335 -0.486(-0.823,-0.152) 0.005 Model 1: Adjusted for age and gender 366 -0.487(-0.823,-0.152) 0.026 Model 1: Adjusted for age and gender 366 -0.17(-0.34,-0.021) 0.265 Model 2: Model 1: Haisory of sportanous abortion and inducedabortion 366 -0.17(-0.34,-0.021) 0.265 Model 2: Model 1: Haisory of sportanous abortion and inducedabortion 366 -0.17(-0.38,-0.021) 0.265 Model 2: Model 2: Employment stubion 368 -0.17(-0.38,-0.012) 0.225 Model 3: Gravidity + History of sportanous abortion and inducedabortion 369 -0.17(-0.38,-0.012) 0.225 Model 2: Model 3: Gravidity + History of sportanous abortion and inducedabortion 369 -0.224(-0.401,-0.012) 0.225 Model 3: Model 1: Model 3: Model 1: Model 3: Gravidity History of sportanous abortion and inducedabortion 366 -0.	Model 2: Model 1 + History of diabete		396		
Model 5: Model 4 + Control model = Glycosylated hemoglobin + Triglyceride + GDM 352 -0.500(-0.833-0.168) 0.003 Model 6: Model 6 + Whether natural delivery 336 -0.468(-0.801-0.131) 0.007 Model 8: Model 8 + Moterial comorbidities or complications 336 -0.468(-0.801-0.131) 0.007 Model 8: Model 8 + Material comorbidities or complications 336 -0.468(-0.801-0.131) 0.007 Model 1: Adjusted for age and gender 403 -0.468(-0.801-0.101) 0.005 Model 1: Adjusted for age and gender 336 -0.468(-0.801-0.101) 0.005 Model 2: Model 2 + Employment situation 336 -0.468(-0.801-0.101) 0.005 Model 3: Model 2 + Employment situation 336 -0.162(-0.380-0.016) 0.005 Model 3: Model 2 + Employment situation 336 -0.248(-0.401-0.044) 0.015 Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 337 -0.248(-0.400-0.044) 0.017 Model 5: Model 6 + Whether natural delivery 438 -0.224(-0.401-0.044) 0.017 Model 6: Model 7 - The underlying diseases 338 -0.248(-0.402-0.042) 0.018 Model 1: Adjusted for age and gender 338 -0.248(-0.402-0.042)<	Model 3: Model 2 + Employment situation	•	395	-0.564(-0.884,-0.243)	
Model 6: Model 5 + Whether natural delivery 349 -0.501(-0.835, 0.167) 0.033 Model 7: Model 6 + Eody weight 335 -0.468(-0.837, 0.151) 0.007 Model 8: Model 8 + Maternal combridities or complications 335 -0.468(-0.823, 0.152) 0.008 Model 9: Model 8 + Maternal combridities or complications 334 -0.477(-0.832, 0.152) 0.008 Educational age VS. Anxiety level (Mild vs. Normat) in two groups df df OR (95%, C1) Value Unadjusted -0.812(-0.383, 0.016) 0.033 -0.487(-0.832, 0.015) 0.028 Model 1: Adjusted for age and gender 403 -0.167(-0.314, -0.021) 0.228 Model 2: Model 1 - History of diabete 396 -0.167(-0.334, -0.021) 0.228 Model 3: Model 2 + Emptoyment situation -0.39 -0.223(-0.418, -0.021) 0.028 Model 3: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 395 -0.238(-0.436, -0.049) 0.017 Model 8: Model 4 + Control model + Biody weight 335 -0.248(-0.436, -0.049) 0.016 Model 7: Model 6 + Body weight 335 -0.248(-0.436, -0.049) 0.017 Model 8: Model 7 + The underlying diseases 335 -0.248(-0	Model 4: Model 3 + Gravidity + History of spontanous abortion and induced abortion	•	391	-0.558(-0.881,-0.234)	0.001
Model 7: Model 6 + Body weight 338 -0.48(-0.801,-0.131) 0.007 Model 8: Model 7 + The underlying diseases 335 -0.48(-0.823,-0.152) 0.005 Bodel 8: Model 7 + The underlying diseases 335 -0.48(-0.823,-0.152) 0.005 Educational age VS. Anxiety level (Mild vs. Normal) in two groups df dR (85% Cl) P Value Unadjusted -0.487,-032,-032,-032,-032,-032,-032,-032,-032	Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM		352	-0.500(-0.833,-0.168)	0.003
Model 8. Model 7 + The underlying diseases 335 -0.488(-0.823, -0.152) 0.005 Model 9: Model 8 + Maternal comorbidities or complications 334 -0.487(-0.823, -0.151) 0.005 Educational age VS. Anxiety level (Mild vs. Normal) in two groups df OR (95%, C) P Value Unadjusted 403 -0.167(-0.314, -0.021) 0.026 Model 1: Adjusted for age and gender 336 -0.17(-0.320, -0.022) 0.025 Model 3: Model 2 + Employment situation 334 -0.221(-0.389, -0.052) 0.010 Model 4: Model 3 + Gravidty + History of spontanous abortion and inducedabortion 336 -0.238(-0.047, -0.042) 0.025 Model 5: Model 4 - Control model + Glycosylated hemoglobin + Triglyceride + GDM 316 -0.238(-0.471, -0.048) 0.017 Model 5: Model 5 + Whether natural delivery 348 -0.248(-0.450, -0.045) 0.017 Model 6: Model 7 + The underlying diseases 334 -0.248(-0.450, -0.045) 0.017 Model 6: Model 7 + The underlying diseases 334 -0.248(-0.450, -0.026) 0.017 Model 7: Model 6 + Body weight 335 -0.248(-0.450, -0.026) 0.028 Model 7: Model 6 + Body weight 335 -0.248(-0.450, -0.026) 0	Model 6: Model 5 + Whether natural delivery		349	-0.501(-0.835,-0.167)	0.003
Model 9: Model 8 + Maternal comorbidities or complications 33 -0.487(-0.823, -0.157) 0.005 Educational age VS. Anxiety level (Mild vs. Normal) in two groups df OR (95%, Cl) P Value Unadjusted -0.487(-0.823, -0.157) 0.026 0.036 0.0162(-0.308, -0.002) 0.026 Model 1: Adjusted for age and gender -0.43 -0.167(-0.314, -0.02) 0.026 0.030 Model 2: Model 1 + History of diabete -0.43 -0.17(-0.308, -0.002) 0.025 0.031 Model 3: Model 2 + Employment situation -0.39 -0.223(-0.401, -0.044) 0.015 Model 6: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM -315 -0.238(-0.438, -0.037) 0.020 Model 7: Model 6 + Body weight -315 -0.238(-0.438, -0.037) 0.021 0.017 Model 8: Model 7 + The underlying diseases -335 -0.238(-0.443, -0.049) 0.016 Model 7: Model 8 + Maternal comorbidities or complications -335 -0.238(-0.473, -0.049) 0.017 Model 7: Model 8 + Maternal comorbidities or complications -335 -0.238(-0.473, -0.049) 0.017 Model 1: Adjusted for age and gender	Model 7: Model 6 + Body weight		336	-0.466(-0.801,-0.131)	0.007
Educational age VS. Anxiety level (Mild vs. Norma') in two groups df OR (95% CI) P Value Unadjusted	Model 8: Model 7 + The underlying diseases		335	-0.488(-0.823,-0.152)	0.005
Unadjusted 403 -0.167(-0.314, -0.021) 0.026 Model 1: Adjusted for age and gender 306 -0.162(-0.308, -0.016) 0.300 Model 2: Model 1 + History of diabete 305 -0.171(-0.320, -0.022) 0.025 Model 3: Model 2 + Employment situation 306 -0.221(-0.389, -0.052) 0.010 Model 4: Model 3 + Gravidity + History of spontanous abortion and inducedabortion 304 -0.222(-0.430, -0.032) 0.020 Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 315 -0.238(-0.430, -0.037) 0.020 Model 6: Model 5: Whether natural delivery 348 -0.248(-0.450, -0.045) 0.017 Model 7: Model 6 + Body weight 335 -0.238(-0.417, -0.048) 0.017 Model 7: Model 6 + Maternal comorbidities or complications 333 -0.248(-0.450, -0.045) 0.017 Model 8: Model 7 + The underlying diseases 333 -0.248(-0.450, -0.045) 0.017 Model 8: Model 7 + The underlying diseases 333 -0.248(-0.450, -0.045) 0.017 Model 8: Model 7 + The underlying diseases 333 -0.248(-0.450, -0.045) 0.018 Model 8: Model 9 + Maternal comorbidities or complications 333 -0.248(-0.450, -0.051)	Model 9: Model 8 + Maternal comorbidities or complications		334	-0.487(-0.823,-0.151)	0.005
Model 1: Adjusted for age and gender 36 -0.162(-0.308, -0.016) 0.301 Model 2: Model 1: History of diabete 395 -0.171(-0.320, -0.022) 0.025 Model 3: Model 2: Employment situation 394 -0.221(-0.389, -0.052) 0.010 Model 4: Model 3: Gravidity + History of spontanous abortion and inducedabortion 396 -0.238(-0.438, -0.037) 0.020 Model 5: Model 4: Control model + Glycosylated hemoglobin + Tiglyceride + GDM 351 -0.238(-0.438, -0.037) 0.020 Model 6: Model 5: Model 4: Control model + Glycosylated hemoglobin + Tiglyceride + GDM 351 -0.238(-0.438, -0.037) 0.020 Model 6: Model 5: Model 4: Control model + Glycosylated hemoglobin + Tiglyceride + GDM 351 -0.238(-0.438, -0.037) 0.020 Model 7: Model 6 + Body weight 335 -0.208(-0.047) 0.016 Model 8: Model 7 + The underlying diseases 334 -0.21(-0.473, -0.49) 0.016 Model 8: Model 9 + Maternal comorbidities or complications 333 -0.248(-0.459, -0.022) 0.024 Unadjusted 404 -0.167(-0.312, -0.022) 0.027 0.021 Model 1: Adjusted for age and gender 396 -0.175(-0.322, -0.027) 0.021 Model 3: Model 2: Model 1 + Histor	Educational age VS. Anxiety level (Mild vs. Normal) in two groups		df	OR (95% CI)	P Value
Model 2. Model 1. History of diabete 395 -0.17(-0.320, -0.022) 0.025 Model 3. Model 2. Employment situation 394 -0.221(-0.389, -0.652) 0.010 Model 4. Model 3. Gravidity + History of spontanous abortion and inducedabortion 390 -0.222(-0.41), -0.044) 0.015 Model 5. Model 4. Control model + Glycosylated hemoglobin + Triglyceride + GDM 316 -0.238(-0.438, -0.037) 0.020 Model 6. Model 5. Whether natural delivery 348 -0.248(-0.460, -0.044) 0.017 Model 8. Model 7. The underlying diseases 334 -0.261(-0.473, -0.049) 0.017 Model 8. Model 7. The underlying diseases 333 -0.248(-0.451, -0.049) 0.017 Model 8. Model 7. The underlying diseases 333 -0.248(-0.451, -0.049) 0.017 Model 9. Model 8. Maternal comorbidities or complications 333 -0.248(-0.451, -0.049) 0.017 Unadgusted 404 -0.167(-0.312, -0.022) 0.022 0.022 Model 1. Adjusted for age and gender 397 -0.168(-0.308, -0.019) 0.027 Model 2. Model 1. History of diabete 396 -0.175(-0.322, -0.022) 0.021 Model 3. Model 2. Hoployment situation 396 -0.237(-0.442, -0.042)	Unadjusted		403	-0.167(-0.314,-0.021)	0.026
Model 3: Model 2 + Employment situation 394 -0.221(-0.39, -0.052) 0.010 Model 4: Model 3 + Gravidity + History of spontanous abortion and inducedabortion 390 -0.223(-0.401, -0.044) 0.015 Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 315 -0.238(-0.438, -0.037) 0.020 Model 6: Model 5 + Whether natural delivery 348 -0.248(-0.450, -0.045) 0.017 Model 7: Model 6 * Body weight 335 -0.238(-0.438, -0.037) 0.020 Model 7: Model 6 * Body weight 333 -0.248(-0.450, -0.045) 0.017 Model 8: Model 7 - The underlying diseases 333 -0.248(-0.450, -0.045) 0.017 Model 8: Model 7 - The underlying diseases 333 -0.248(-0.450, -0.045) 0.017 Model 9: Model 8 + Maternal comorbidities or complications 333 -0.248(-0.450, -0.045) 0.017 Unadjusted 404 -0.167(-0.312, -0.022) 0.024 Model 1: Aujusted for age and gender 397 -0.163(-0.308, -0.019) 0.027 Model 2: Model 1 + History of diabete 396 -0.27(-0.344, -0.059) 0.008 Model 3: Model 2 + Employment situation 395 -0.227(-0.344, -0.059) 0.018	Model 1: Adjusted for age and gender		396	-0.162(-0.308,-0.016)	0.030
Model 4: Model 3 + Gravidity + History of spontanous abortion and inducedabortion 900 -0.223(-0.401,-0.044) 0.015 Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 351 -0.238(-0.438,-0.037) 0.020 Model 6: Model 5 + Whether natural delivery 438 -0.248(-0.450,-0.045) 0.017 Model 7: Model 6 + Body weight -033 -0.238(-0.438,-0.037) 0.020 Model 7: Model 6 + Body weight -033 -0.248(-0.450,-0.045) 0.017 Model 7: Model 6 + Body weight -033 -0.28(-0.471,-0.048) 0.017 Model 8: Model 7 + The underlying diseases 333 -0.28(-0.459,-0.028) 0.018 Educational age VS. Anxiety disorder in two groups (reference: No anxiety group) df OR (95% CI) P Value Unadjusted -0167(-0.312,-0.022) 0.024 0.024 0.0167 0.021 0.021 Model 1: Adjusted for age and gender -0167(-0.512,-0.022) 0.024 0.0167 0.017 0.023 0.021 0.021 Model 2: Model 1 + History of diabete -0167(-0.512,-0.022) 0.021 0.021 0.021 0.021 0.021 0.021 0.021 0.021 0.022 0.021	Model 2: Model 1 + History of diabete		395	-0.171(-0.320,-0.022)	0.025
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 351 -0.28(-0.438,-0.037) 0.020 Model 6: Model 5 + Whether natural delivery 348 -0.248(-0.450,-0.045) 0.017 Model 6: Model 7 + The underlying diseases 333 -0.28(-0.437,-0.049) 0.016 Model 8: Model 7 + The underlying diseases 333 -0.28(-0.47,-0.049) 0.016 Model 8: Model 7 + The underlying diseases 333 -0.28(-0.47,-0.049) 0.016 Model 8: Model 7 + The underlying diseases 333 -0.28(-0.47,-0.049) 0.016 Model 8: Model 7 + The underlying diseases 333 -0.28(-0.47,-0.049) 0.016 Model 8: Model 7 + The underlying diseases 333 -0.28(-0.47,-0.049) 0.020 Educational age VS. Anxiety disordre in two groups (reference: No anxiety group) df OR (65%, CI) P Value Unadjusted - 404 -0.167(-0.312,-0.022) 0.021 Model 1: Adjusted for age and gender - 396 -0.175(-0.322,-0.027) 0.021 Model 2: Model 1 + History of diabete - 396 -0.227(-0.34,-0.059) 0.008 Model 4: Model 3 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 352	Model 3: Model 2 + Employment situation		394	-0.221(-0.389,-0.052)	0.010
Model 6: Model 5 + Whether natural delivery 348 -0.248(-0.450,-0.045) 0.017 Model 7: Model 6 + Body weight 335 -0.260(-0.471,-0.048) 0.017 Model 8: Model 7 + The underlying diseases 334 -0.281(-0.473,-0.049) 0.016 Model 8: Model 7 + The underlying diseases	Model 4: Model 3 + Gravidity + History of spontanous abortion and induced abortion		390	-0.223(-0.401,-0.044)	0.015
Model 7: Model 6 + Body weight 335 -0.260(-0.471,-0.048) 0.017 Model 8: Model 7: The underlying diseases 334 -0.261(-0.473,-0.049) 0.016 Model 8: Model 7: The underlying diseases 334 -0.261(-0.473,-0.049) 0.016 Model 9: Model 8: Maternal comorbidities or complications 333 -0.243(-0.459,-0.026) 0.028 Educational age VS. Anxiety disorder in two groups (reference: No anxiety group) df 0 R(95% CI) P Value Unadjusted 404 -0.167(-0.312,-0.022) 0.024 Model 1: Adjusted for age and gender 396 -0.175(-0.332,-0.027) 0.021 Model 2: Model 1: History of diabete 398 -0.227(-0.394,-0.059) 0.008 Model 3: Model 2 + Employment situation 398 -0.227(-0.394,-0.059) 0.001 Model 4: Model 3 + Gravidity + History of spontanous abortion and inducedabortion 391 -0.234(-0.442,-0.402) 0.016 Model 6: Model 4: Control model + Glycosylated hemoglobin + Triglyceride + GDM 352 -0.224(-0.442,-0.402) 0.016 Model 6: Model 7: Model 6 + Body weight 336 -0.268(-0.478,-0.055) 0.014 Model 7: Model 6 + Body weight 336 -0.268(-0.478,-0.055) 0.014	Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM		351	-0.238(-0.438,-0.037)	0.020
Model 8: Model 7 + The underlying diseases 334 -0.281(-0.473,-0.04) 0.016 Model 9: Model 8 + Maternal comorbidities or complications 333 -0.281(-0.473,-0.04) 0.028 Educational age VS. Anxiety disorder in two groups (reference: No anxiety group) df OR (95% CI) P Value Unadjusted	Model 6: Model 5 + Whether natural delivery		348	-0.248(-0.450,-0.045)	0.017
Nodel 9: Model 8: Maternal comorbidities or complications 33 -0.243(0.459, -0.26) 0.028 Educational age VS. Anxiety disorder in two groups (reference: No anxiety group) df OR (95% CI) P Value Unaigusted	Model 7: Model 6 + Body weight		335	-0.260(-0.471,-0.048)	0.017
Educational age VS. Anxiety disorder in two groups (reference: No anxiety group) df OR (95% CI) P Value Unadjusted	Model 8: Model 7 + The underlying diseases		334	-0.261(-0.473,-0.049)	0.016
Unadjusted	Model 9: Model 8 + Maternal comorbidities or complications		333	-0.243(-0.459,-0.026)	0.028
Model 1: Adjusted for age and gender 397 -0.163(-0.308, -0.019) 0.027 Model 2: Model 1 + History of diabete 396 -0.175(-0.322, -0.027) 0.021 Model 3: Model 2 + Employment situation 395 -0.227(-0.394, -0.059) 0.008 Model 4: Model 3 + Gravidty + History of spontanous abortion and inducedabortion 391 -0.230(-0.407, -0.052) 0.011 Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 352 -0.242(-0.442, -0.042) 0.018 Model 6: Model 5 + Whether natural delivery 336 -0.266(-0.478, -0.055) 0.014 Model 8: Model 7 + The underlying diseases 335 -0.269(-0.480, -0.057) 0.013	Educational age VS. Anxiety disorder in two groups (reference: No anxiety group)		df	OR (95% CI)	P Value
Model 2: Model 1 + History of diabete 396 -0.175(-0.322,-0.027) 0.021 Model 3: Model 2: Employment situation 395 -0.227(-0.394,-0.059) 0.008 Model 4: Model 3: Gravidity + History of spontanous abortion and inducedabortion 391 -0.230(-0.407,-0.052) 0.011 Model 5: Model 4: Control model - Glycosylated hemoglobin + Triglyceride + GDM 352 -0.224(-0.442,-0.042) 0.018 Model 6: Model 7: Model 6 + Body weight 349 -0.256(-0.478,-0.055) 0.014 Model 7: Model 7: The underlying diseases 335 -0.269(-0.478,-0.055) 0.014	Unadjusted		404	-0.167(-0.312,-0.022)	0.024
Model 3: Model 2 + Employment situation	Model 1: Adjusted for age and gender		397	-0.163(-0.308,-0.019)	0.027
Model 4: Model 3 + Gravidity + History of spontanous abortion and inducedabortion 391 -0.230(-0.407, -0.052) 0.011 Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 352 -0.242(-0.442, -0.042) 0.018 Model 6: Model 5 + Whether natural delivery 349 -0.233(-0.450, -0.051) 0.015 Model 7: Model 6 + Body weight 336 -0.268(-0.478, -0.055) 0.014 Model 8: Model 7 + The underlying diseases 335 -0.269(-0.480, -0.057) 0.013	Model 2: Model 1 + History of diabete		396	-0.175(-0.322,-0.027)	0.021
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM 352 -0.242(-0.442,-0.042) 0.018 Model 6: Model 5 + Whether natural delivery - 349 -0.253(-0.456,-0.051) 0.015 Model 7: Model 6 + Body weight - 336 -0.268(-0.478,-0.055) 0.014 Model 8: Model 7 + The underlying diseases - 335 -0.269(-0.480,-0.057) 0.013	Model 3: Model 2 + Employment situation		395	-0.227(-0.394,-0.059)	0.008
Model 6: Model 5 + Whether natural delivery	Model 4: Model 3 + Gravidity + History of spontanous abortion and inducedabortion		391	-0.230(-0.407,-0.052)	0.011
Model 7 + Model 6 + Body weight - 336 -0.266(-0.478,-0.055) 0.014 Model 8 : Model 7 + The underlying diseases - 335 -0.266(-0.478,-0.057) 0.013	Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM		352	-0.242(-0.442,-0.042)	0.018
Model 8: Model 7 + The underlying diseases	Model 6: Model 5 + Whether natural delivery		349	-0.253(-0.456,-0.051)	0.015
	Model 7: Model 6 + Body weight		336	-0.266(-0.478,-0.055)	0.014
Model 9: Model 8 + Maternal comorbidities or complications	Model 8: Model 7 + The underlying diseases		335	-0.269(-0.480,-0.057)	0.013
	Model 9: Model 8 + Maternal comorbidities or complications		334	-0.252(-0.468,-0.037)	0.022
	-1	-0.5 0			

FIGURE 1

Generalized linear mixed model: Educational age and SAS.

			Point estimated	Р
		df	(95% CI)	Value
GDM VS. SAS in two groups	1			
Unadjusted		404	4.116(2.656,5.576)	<0.0001
Model 1: Adjusted for age and gender		397	4.130(2.622,5.638)	<0.0001
Model 2: Model 1 + History of diabete		396	4.103(2.584,5.621)	<0.0001
Model 3: Model 2 + Educational age + Employment situation		394	4.064(2.561,5.566)	<0.0001
Model 4: Model 3 + gravidity + History of spontanous abortion and induced abortion		390	4.097(2.588,5.606)	<0.0001
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride		352	4.228(1.132,7.324)	0.008
Model 6: Model 5 + Whether natural delivery		349	4.338(1.209,7.467)	0.007
Model 7: Model 6 + Body weight		336	4.152(1.046,7.258)	0.009
Model 8: Model 7 + The underlying diseases		335	4.177(1.076,7.278)	0.008
Model 9: Model 8 + Maternal comorbidities or complications		334	4.275(1.167,7.382)	0.007
GDM VS. Anxiety level (Mild vs. Normal) in two groups		df	OR (95% CI)	P Value
Unadjusted		403	2.677(1.220,4.133)	0.0003
Model 1: Adjusted for age and gender		396	2.639(1.173,4.106)	0.0004
Model 2: Model 1 + History of diabete		395	2.620(1.152,4.089)	0.001
Model 3: Model 2 + Educational age + Employment situation		393	2.641(1.166,4.115)	0.001
Model 4: Model 3 + gravidity + History of spontanous abortion and induced abortion		389	2.765(1.243,4.288)	0.0004
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride		351	1.797(-0.360,3.954)	0.102
Model 6: Model 5 + Whether natural delivery		348	1.875(-0.352,4.103)	0.099
Model 7: Model 6 + Body weight		335	1.833(-0.404,4.070)	0.108
Model 8: Model 7 + The underlying diseases		334	1.812(-0.425,4.048)	0.112
Model 9: Model 8 + Maternal comorbidities or complications		333	2.434(0.044,4.823)	0.046
GDM VS. Anxiety disorder in two groups (reference: No anxiety group)		df	OR (95% CI)	P Value
Unadjusted		404	2.714(1.259,4.169)	0.0003
Model 1: Adjusted for age and gender		397	2.702(1.237,4.167)	0.0003
Model 2: Model 1 + History of diabete		396	2.672(1.205,4.139)	0.0004
Model 3: Model 2 + Educational age + Employment situation		394	2.696(1.222,4.169)	0.0004
Model 4: Model 3 + gravidity + History of spontanous abortion and induced abortion		390	2.814(1.295,4.334)	0.0003
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride		352	1.894(-0.263,4.050)	0.085
Model 6: Model 5 + Whether natural delivery		349	1.995(-0.250,4.240)	0.081
Model 7: Model 6 + Body weight		336	1.970(-0.280,4.220)	0.086
Model 8: Model 7 + The underlying diseases		335	1.922(-0.326,4.169)	0.094
Model 9: Model 8 + Maternal comorbidities or complications		334	2.537(0.146,4.928)	0.038

FIGURE 2

Generalized linear mixed model: GDM and SAS.

			Point estimated	Р
		df	(95% CI)	Value
History of induced abortion VS. SAS in two groups				
Unadjusted	_	404	-0.028(-1.804,1.747)	0.975
Model 1: Adjusted for age and gender		397	-0.125(-1.968,1.718)	0.894
Model 2: Model 1 + History of diabete		396	-0.075(-1.922,1.772)	0.937
Model 3: Model 2 + Educational age + Employment situation		394	-0.359(-2.198,1.480)	0.702
Model 4: Model 3 + Gravidity + History of spontanous abortion		391	0.527(-1.826,2.881)	0.660
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM		352	-0.802(-3.209,1.604)	0.513
Model 6: Model 5 + Whether natural delivery		349	-0.796(-3.213,1.622)	0.518
Model 7: Model 6 + Body weight		336	-0.419(-2.833,1.996)	0.733
Model 8: Model 7 + The underlying diseases		335	-0.369(-2.780,2.043)	0.764
Model 9: Model 8 + Maternal comorbidities or complications		334	-0.322(-2.735,2.092)	0.793
History of induced abortion VS. Anxiety level (Mild vs. Normal) in two groups		df	OR (95% CI)	P Value
Unadjusted		403	0.784(-0.014,1.582)	0.054
Model 1: Adjusted for age and gender		396	0.718(-0.112,1.547)	0.090
Model 2: Model 1 + History of diabete		395	0.751(-0.082,1.585)	0.077
Model 3: Model 2 + Educational age + Employment situation		393	0.665(-0.180,1.511)	0.123
Model 4: Model 3 + Gravidity + History of spontanous abortion		390	1.440(0.037,2.843)	0.044
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM		351	1.453(-0.333,3.239)	0.110
Model 6: Model 5 + Whether natural delivery		348	1.493(-0.329,3.314)	0.108
Model 7: Model 6 + Body weight		335	1.605(-0.259,3.469)	0.091
Model 8: Model 7 + The underlying diseases		334	1.636(-0.236,3.508)	0.087
Model 9: Model 8 + Maternal comorbidities or complications		333	2.003(0.043,3.963)	0.045
History of induced abortion VS. Anxiety disorder in two groups (reference: No anxiety group)		df	OR (95% CI)	P Value
Unadjusted		404	0.727(-0.064,1.517)	0.071
Model 1: Adjusted for age and gender		397	0.679(-0.142,1.499)	0.105
Model 2: Model 1 + History of diabete		396	0.724(-0.102,1.550)	0.086
Model 3: Model 2 + Educational age + Employment situation		394	0.636(-0.203,1.474)	0.137
Model 4: Model 3 + Gravidity + History of spontanous abortion		391	1.429(0.026,2.832)	0.046
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride + GDM		352	1.449(-0.341,3.239)	0.112
Model 6: Model 5 + Whether natural delivery	+-•	349	1.494(-0.335,3.322)	0.109
Model 7: Model 6 + Body weight		336	1.611(-0.265,3.486)	0.092
Wodel 7: Model 6 + Body weight				
Model 7. Model 6 + Body Weign Model 8: Model 7 + The underlying diseases		335	1.669(-0.216,3.554)	0.083

FIGURE 3

Generalized linear mixed model: History of induced abortion and SAS.

spontaneous abortion or induced abortion, blood glucose controlled or not, HBA1c, triglyceride, normal delivery or not, and newborn weight, 1h-PG was correlated with SAS (Figure 4), for every 1-unit increase in 1h-PG, SAS increased by 0.384 (95% CI, 0.001 to 0.767; P = 0.049), risk of anxiety grade (mild *vs.* normal) increased by 0.210 (95% CI, 0.003 to 0.417; P = 0.047), and risk of anxiety disorder increased by 0.222 (95% CI, 0.017 to 0.426; P = 0.034), and, so, it was a risk factor for anxiety.

After adjustment for factors like age, gender, diabetes history, education years, employment status, number of pregnancies, history of spontaneous or induced abortion, blood glucose controlled or not, HBA1c, GDM, normal delivery or not, and newborn weight, the triglyceride had no correlation with SAS (Figure 5), and no correlation with anxiety grade (mild *vs.* normal) but had a correlation with anxiety disorder, and, for every 1-unit increase in triglyceride, the risk of anxiety was reduced by 0.832 (95% CI, -1.653 to -0.011; P = 0.034).

4 Discussion

To our knowledge, this is one of the first studies to find that the postpartum anxiety score of GDM puerperae was 40.05 ± 7.74 , which was much higher than that of healthy puerperae (35.93 ± 7.20). The patients' education years and triglyceride were protective

factors, whereas GDM, history of induced abortion, and 1h-PG were related to anxiety grade as the risk factors.

Education years were a protective factor for anxiety, and, for every 1-year increase in education years, SAS decreased by 0.487, the risk of anxiety grade (mild *vs.* normal) decreased by 0.243, and the risk of anxiety disorder decreased by 0.252.

Educational age was correlated with SAS as a protective factor for anxiety of puerpera (p < 0.05), which was consistent with the results reported by relevant studies from Japan and Nigeria (11, 21, 22). With many years of education and rich knowledge reserve, the patients can understand the process of pregnancy through various scientific ways and a variety of channels, learn the pressure generated during pregnancy, identify their own physical and psychological problems, deal with problems arising in life actively, and thus find a scientific solutions to their own problems (23). At the same time, for the patients, the more the education years, the higher the ability to accept GDM related knowledge, and their anxiety would be reduced with the understanding of GDM. On the contrary, the less the education years, the higher the anxiety grade and risk.

Triglyceride showed no correlation with SAS and anxiety grade, and triglyceride was related to anxiety. For every 1-unit increase in triglyceride, the risk of anxiety disorder decreased by 0.832.

Driven by the increased resistance of insulin, estrogen, progesterone, and placental prolactin, the physiological and basic levels of plasma total cholesterol and triglyceride during pregnancy

		Point estimated	Р
	df	(95% CI)	Value
1h-PG VS. SAS in two groups			
Unadjusted	 403	0.613(0.278,0.947)	0.0004
Model 1: Adjusted for age and gender	 396	0.607(0.261,0.953)	0.001
Model 2: Model 1 + History of diabete	 395	0.597(0.249,0.946)	0.001
Model 3: Model 2 + Educational age + Employment situation	 393	0.602(0.257,0.947)	0.001
Model 4: Model 3 + Gravidity + History of spontanous abortion and induced abortion	 389	0.596(0.250,0.942)	0.001
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride	 352	0.408(0.028,0.788)	0.035
Model 6: Model 5 + Whether natural delivery	 349	0.406(0.022,0.790)	0.038
Model 7: Model 6 + Body weight	 336	0.389(0.007,0.772)	0.046
Model 8: Model 7 + The underlying diseases	 335	0.388(0.006,0.770)	0.047
Model 9: Model 8 + Maternal comorbidities or complications	334	0.384(0.001,0.767)	0.049
1h-PG VS. Anxiety level (Mild vs. Normal) in two groups	df	OR (95% CI)	P Value
Unadjusted	 402	0.198(0.049,0.347)	0.009
Model 1: Adjusted for age and gender	 395	0.184(0.034,0.334)	0.017
Model 2: Model 1 + History of diabete	 394	0.180(0.030,0.329)	0.018
Model 3: Model 2 + Educational age + Employment situation	 392	0.206(0.052,0.360)	0.009
Model 4: Model 3 + Gravidity + History of spontanous abortion and induced abortion	 388	0.201(0.046,0.356)	0.011
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride	 351	0.237(0.045,0.429)	0.016
Model 6: Model 5 + Whether natural delivery -	 348	0.229(0.038,0.420)	0.019
Model 7: Model 6 + Body weight	 335	0.222(0.022,0.423)	0.030
Model 8: Model 7 + The underlying diseases	 334	0.223(0.020,0.425)	0.031
Model 9: Model 8 + Maternal comorbidities or complications	 333	0.210(0.003,0.417)	0.047
1h-PG VS. Anxiety disorder in two groups (reference: No anxiety group)	df	OR (95% CI)	P Value
Unadjusted	 403	0.205(0.055,0.354)	0.007
Model 1: Adjusted for age and gender	 396	0.194(0.043,0.346)	0.012
Model 2: Model 1 + History of diabete -	 395	0.188(0.039,0.338)	0.014
Model 3: Model 2 + Educational age + Employment situation	 393	0.216(0.062,0.370)	0.006
Model 4: Model 3 + Gravidity + History of spontanous abortion and induced abortion	 389	0.209(0.054,0.365)	0.009
Model 5: Model 4 + Control model + Glycosylated hemoglobin + Triglyceride	 352	0.244(0.054,0.435)	0.012
Model 6: Model 5 + Whether natural delivery	 349	0.236(0.047,0.425)	0.015
Model 7: Model 6 + Body weight -	 336	0.231(0.033,0.428)	0.022
Model 9: Model 7 + The underbing diseases	335	0.231(0.030,0.432)	0.024
Model 8: Model 7 + The underlying diseases -			

FIGURE 4

Generalized linear mixed model: 1h-PG and SAS.

				Point estimated	Р
			df	(95% CI)	Value
Triglyceride VS. SAS in two groups					
Unadjusted			373	-0.108(-0.827,0.610)	0.767
Model 1: Adjusted for age and gender			366	-0.112(-0.839,0.615)	0.762
Model 2: Model 1 + History of diabete			365	-0.102(-0.829,0.624)	0.782
Model 3: Model 2 + Educational age + Emp	loyment situation		363	-0.104(-0.825,0.616)	0.776
Model 4: Model 3 + Gravidity + History of sp	contanous abortion and inducedabortion		359	-0.111(-0.834,0.613)	0.764
Model 5: Model 4 + Control model + Glycos	ylated hemoglobin + GDM		352	-0.347(-1.052,0.357)	0.333
Model 6: Model 5 + Whether natural deliver	у		349	-0.330(-1.040,0.379)	0.361
Model 7: Model 6 + Body weight			336	-0.397(-1.100,0.306)	0.267
Model 8: Model 7 + The underlying disease	s		335	-0.382(-1.083,0.320)	0.286
Model 9: Model 8 + Maternal comorbidities	or complications		334	-0.396(-1.098,0.307)	0.269
Triglyceride VS. Anxiety level (Mild vs. N	ormal) in two groups		df	OR (95% CI)	P Value
Unadjusted			372	-0.170(-0.692,0.352)	0.522
Model 1: Adjusted for age and gender			365	-0.197(-0.729,0.334)	0.466
Model 2: Model 1 + History of diabete			364	-0.202(-0.743,0.339)	0.464
Model 3: Model 2 + Educational age + Emp	loyment situation		362	-0.232(-0.802,0.338)	0.424
Model 4: Model 3 + Gravidity + History of sp	contanous abortion and inducedabortion		358	-0.212(-0.796,0.373)	0.477
Model 5: Model 4 + Control model + Glycos	ylated hemoglobin + GDM		351	-0.448(-1.093,0.197)	0.173
Model 6: Model 5 + Whether natural deliver	у		348	-0.505(-1.164,0.154)	0.133
Model 7: Model 6 + Body weight			335	-0.705(-1.467,0.057)	0.070
Model 8: Model 7 + The underlying disease	s		334	-0.705(-1.466,0.056)	0.069
Model 9: Model 8 + Maternal comorbidities	or complications		333	-0.808(-1.634,0.018)	0.055
Triglyceride VS. Anxiety disorder in two	groups (reference: No anxiety group)		df	OR (95% CI)	P Value
Unadjusted			373	-0.184(-0.705,0.338)	0.489
Model 1: Adjusted for age and gender			366	-0.203(-0.731,0.325)	0.450
Model 2: Model 1 + History of diabete			365	-0.209(-0.749,0.330)	0.446
Model 3: Model 2 + Educational age + Emp	loyment situation		363	-0.239(-0.807,0.329)	0.409
Model 4: Model 3 + Gravidity + History of sp	ontanous abortion and inducedabortion		359	-0.219(-0.803,0.366)	0.463
Model 5: Model 4 + Control model + Glycos	ylated hemoglobin + GDM		352	-0.463(-1.109,0.183)	0.160
Model 6: Model 5 + Whether natural deliver	ý		349	-0.531(-1.193,0.130)	0.115
Model 7: Model 6 + Body weight			336	-0.729(-1.491,0.032)	0.060
Model 8: Model 7 + The underlying disease	\$		335	-0.729(-1.488,0.029)	0.060
Model 9: Model 8 + Maternal comorbiditie	as or complications		334	-0.832(-1.653,-0.011)	0.047
		-2 0 1			
FIGURE 5					
Generalized linear mixed model: Triglyceride and SAS.					
acheralized ined mixed model. mggeende did 576.					

were increased to guarantee sufficient energy reserves (glucose, amino acids, and lipids) as well as full development and growth of the fetus (24). For the patients in the study group, the triglyceride level was 2.32 ± 0.94 , which was higher than the normal level of puerpera and was consistent with the previous study results (25–28), but still at a normal level (29). Although a high triglyceride level significantly increased the risk of GDM as a risk factor for drug-resistant subtype of GDM (30, 31), our study found that, for every 1-unit increase of triglyceride, the risk of anxiety disorder was reduced by 0.832 (95% CI, -1.653 to -0.011; P = 0.034), which was inconsistent with those in previous studies, suggesting that an appropriate increase in the blood lipid level had a protective effect on the anxiety for the patients.

GDM and 1h-PG were correlated with SAS as risk factors for anxiety. Compared with the patients without GDM, those with GDM had SAS increased by 4.275, risk of anxiety grade increased by 2.434, and risk of anxiety disorder increased by 2.537. For every 1unit increase in 1h-PG, SAS increased by 0.384, and 1h-PG was related to anxiety grade; for every 1-unit increase in 1h-PG, the risk of anxiety grade increased by 0.210, and the risk of anxiety grade increased by 0.222.

1h-PG and GDM were the risk factors for anxiety, and patients with GDM had an increased risk of anxiety disorder as compared with those without GDM. After inclusion of blood glucose-related indicators, including HBA1c, insulin, and Oral Glucose Tolerance Test (OGTT), 1h-PG showed a positive correlation with the anxiety of patients, and the OR value for 1h-PG was 1.227 (95% CI, 1.057 to 1.424; P = 0.007), that is, the risk of anxiety increased with 1h-PG, which was consistent with that in the study of Zhao et al. (32). An analysis of the International Association of Diabetes and Pregnancy Study Groups has clarified the importance of fasting blood glucose plus 1h-PG for the diagnosis of GDM (33). The above results have indicated that 1h-PG is critical for GDM. Therefore, the rise of 1h-PG may cause anxiety in relevant patients. In clinical nursing, we should pay more attention to the health of patients with elevated 1h-PG.

History of induced abortion showed no correlation with SAS. Compared with patient without history of induced abortion, those with history of induced abortion had risk of anxiety grade increased by 2.003, and the risk of anxiety disorder increased by 2.026, and, so, the history of induced abortion was a risk factor for anxiety. This is a significant finding and also the first report on the relationship between history of induced abortion and postpartum anxiety in patients with GDM globally. Induced abortion may lead to a series of problems, including secondary infertility, ectopic pregnancy, spontaneous abortion, premature delivery, low birth weight, and pregnancy or childbirth complications. Therefore, compared with GDM puerperae without history of induced abortion, those with history of induced abortion have a higher level of postpartum anxiety (34) and a higher incidence of anxiety and depression comorbidity. Specifically, 29% of the puerperae might suffer from severe or mild depression and anxiety comorbidity. In this study, 59

patients with GDM had history of induced abortion, accounting for 28.8%, which was 18.9% higher than that of normal puerperae. In future studies, the frequency and reasons of induced abortion may be considered to further explore the relationship between induced abortion and postpartum anxiety in patients with GDM.

There are several limitations to our study that should be considered. First, the study was conducted at one hospital, and the results may not be as widespread. Second, A self-rating scale was used in this study. Although it has passed the internal consistency test, the results are still not so objective. Third, The study results are limited by sample size. In the future, a multicenter study of large sample size will be carried out to include more pregnant women in the survey, so as to obtain more reliable conclusions.

5 Conclusion

For the first time, this study found the status of anxiety in GDM puerperae and the related influencing factors, which are helpful for early identification and early clinical intervention of postpartum anxiety in GDM puerperae, thus reducing relevant hazards and promoting the maternal and child health as well as the progress of relevant clinical studies.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

This study was approved by the Institutional Review Board (IRB) of the he First Affiliated Hospital of Sun Yat-sen University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

References

 Mack LR, Tomich PG. Gestational diabetes: diagnosis, classification, and clinical care. Obstet Gynecol Clin North Am (2017) 44(2):207–17. doi: 10.1016/j.ogc.2017.02.002
 Filardi T, Panimolle F, Crescioli C, Lenzi A, Morano S. Gestational diabetes mellitus: the

impact of carbohydrate quality in diet. Nutrients (2019) 11(7):1–9. doi: 10.3390/nu11071549 3. Wang H, Li N, Chivese T, Werfalli M, Sun H, Yuen L, et al. IDF diabetes atlas: estimation of global and regional gestational diabetes mellitus prevalence for 2021 by international association of diabetes in pregnancy study group's criteria. Diabetes Res Clin Pract (2022) 183:109050. doi: 10.1016/j.diabres.2021.109050

4. Paul IM, Downs DS, Schaefer EW, Beiler JS, Weisman CS. Postpartum anxiety and maternal-infant health outcomes. *Pediatrics* (2013) 131(4):e1218–24. doi: 10.1542/peds.2012-2147

5. Parfitt Y, Ayers S. Transition to parenthood and mental health in first-time parents. *Infant Ment Health J* (2014) 35(3):263–73. doi: 10.1002/imhj.21443

Author contributions

All authors contributed to the study design and data interpretation. FW and JieC were responsible for management and oversight of the study. YY, CL and XZ were responsible for general omnibus data analyses and were keys contributing authors to the manuscript. XY and ZP were responsible for all research interviews and clinical chart reviews associated with this study. SW and JinC provided guidance on the design of primary analyses. CL and MZ assisted with all data collection, analysis, and writing of the manuscript. All authors contributed to the article and approved the submitted version.

Funding

This work was supported by the grant of Natural Science Foundation of Tibet Autonomic Region (XZ 2019 ZR G-152).

Acknowledgments

The authors thank all participants who shared their experiences for this survey.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

6. Shankar R, Badker R, Brain U, Oberlander TF, Misri S. Predictors of recovery from depression and anxiety in women: A longitudinal study from childbirth to 6 years. *Can J Psychiatry* (2017) 62(5):318–26. doi: 10.1177/0706743716677725

7. Vengadavaradan A, Bharadwaj B, Sathyanarayanan G, Durairaj J. Frequency and correlates of mother-infant bonding disorders among postpartum women in India. *Asian J Psychiatr* (2019) 44:72–9. doi: 10.1016/j.ajp.2019.07.004

8. Miller ES, Hoxha D, Wisner KL, Gossett DR. The impact of perinatal depression on the evolution of anxiety and obsessive-compulsive symptoms. *Arch Womens Ment Health* (2015) 18(3):457–61. doi: 10.1007/s00737-014-0476-x

9. Lara-Cinisomo S, McKenney K, Di Florio A, Meltzer-Brody S. Associations between postpartum depression, breastfeeding, and oxytocin levels in latina mothers. *Breastfeed Med* (2017) 12(7):436-42. doi: 10.1089/bfm.2016.0213 10. Luo Z, Xue L, Ma L, Liu Z. Comorbid anxiety and depression and related factors among pregnant and postpartum chinese women during the coronavirus disease 2019 pandemic. *Front Psychol* (2021) 12:701629. doi: 10.3389/fpsyg.2021.701629

11. Nakic RS, Tadinac M, Herman R. Anxiety during pregnancy and postpartum: course, predictors and comorbidity with postpartum depression. *Acta Clin Croat* (2018) 57(1):39–51. doi: 10.20471/acc.2018.57.01.05

12. van der Zee-van den Berg AI, Boere-Boonekamp MM, Groothuis-Oudshoorn CGM, Reijneveld SA. Postpartum depression and anxiety: a community-based study on risk factors before, during and after pregnancy. *J Affect Disord* (2021) 286:158–65. doi: 10.1016/j.jad.2021.02.062

13. Sawyer A, Ayers S, Smith H. Pre- and postnatal psychological wellbeing in Africa: a systematic review. J Affect Disord (2010) 123(1-3):17-29. doi: 10.1016/j.jad.2009.06.027

14. Reck C, Struben K, Backenstrass M, Stefenelli U, Reinig K, Fuchs T, et al. Prevalence, onset and comorbidity of postpartum anxiety and depressive disorders. *Acta Psychiatr Scand* (2008) 118(6):459–68. doi: 10.1111/j.1600-0447.2008.01264.x

15. Marchesi C, Ossola P, Amerio A, Daniel BD, Tonna M, De Panfilis C. Clinical management of perinatal anxiety disorders: A systematic review. *J Affect Disord* (2016) 190:543–50. doi: 10.1016/j.jad.2015.11.004

16. Oyetunji A, Chandra P. Postpartum stress and infant outcome: A review of current literature. *Psychiatry Res* (2020) 284:112769. doi: 10.1016/j.psychres.2020.112769

17. Fallon V, Groves R, Halford JC, Bennett KM, Harrold JA. Postpartum anxiety and infant-feeding outcomes. J Hum Lact (2016) 32(4):740–58. doi: 10.1177/0890334416662241

18. Daniells S, Grenyer BF, Davis WS, Coleman KJ, Burgess JA, Moses RG. Gestational diabetes mellitus: is a diagnosis associated with an increase in maternal anxiety and stress in the short and intermediate term? *Diabetes Care* (2003) 26(2):385–9. doi: 10.2337/diacare.26.2.385

19. Bogaerts AF, Devlieger R, Nuyts E, Witters I, Gyselaers W, Van den Bergh BR. Effects of lifestyle intervention in obese pregnant women on gestational weight gain and mental health: a randomized controlled trial. *Int J Obes (Lond)* (2013) 37(6):814–21. doi: 10.1038/ijo.2012.162

20. Dunstan DA, Scott N, Todd AK. Screening for anxiety and depression: reassessing the utility of the Zung scales. *BMC Psychiatry* (2017) 17(1):329. doi: 10.1186/s12888-017-1489-6

21. Matsumura K, Hamazaki K, Tsuchida A, Kasamatsu H, Inadera H, Japan Environment and Children's Study (JECS) Group. Education level and risk of postpartum depression: results from the Japan Environment and Children's Study (JECS). *BMC Psychiatry* (2019) 19(1):419. doi: 10.1186/s12888-019-2401-3

22. Agbaje OS, Anyanwu JI, Umoke PIC, Iwuagwu TE, Iweama CN, Ozoemena EL, et al. Depressive and anxiety symptoms and associated factors among postnatal women in Enugu-North Senatorial District, South-East Nigeria: a cross-sectional study. *Arch Public Health* (2019) 77:1. doi: 10.1186/s13690-018-0329-6

23. Naicker K, Johnson JA, Skogen JC, Manuel D, Øverland S, Sivertsen B, et al. Type 2 diabetes and comorbid symptoms of depression and anxiety: longitudinal associations with mortality risk. *Diabetes Care* (2017) 40(3):352–8. doi: 10.2337/dc16-2018

24. Mauri M, Calmarza P, Ibarretxe D. Dyslipemias and pregnancy, an update. *Clin Investig Arterioscler* (2021) 33(1):41-52. doi: 10.1016/j.artere.2020.12.005

25. Schaefer-Graf UM, Meitzner K, Ortega-Senovilla H, Graf K, Vetter K, Abou-Dakn M, et al. Differences in the implications of maternal lipids on fetal metabolism and growth between gestational diabetes mellitus and control pregnancies. *Diabetes Med* (2011) 28(9):1053–9. doi: 10.1111/j.1464-5491.2011.03346.x

26. Danielsen I, Granström C, Haldorsson T, Rytter D, Hammer Bech B, Henriksen TB, et al. Dietary glycemic index during pregnancy is associated with biomarkers of the metabolic syndrome in offspring at age 20 years. *PloS One* (2013) 8(5):e64887. doi: 10.1371/journal.pone.0064887

27. Ryckman KK, Spracklen CN, Smith CJ, Robinson JG, Saftlas AF. Maternal lipid levels during pregnancy and gestational diabetes: a systematic review and metaanalysis. *BJOG* (2015) 122(5):643–51. doi: 10.1111/1471-0528.13261

28. Han L, Ma J, Wang S, Li Z. Evaluation of bone mineral density in patients with gestational diabetes mellitus by ultrasonic bone mineral density measurement combined with Vitamin-D deficiency and analysis of influencing factors. *Pak J Med Sci* (2022) 38(4Part-II):933–8. doi: 10.12669/pjms.38.4.5090

29. Larsson A, Palm M, Hansson LO, Axelsson O. Reference values for clinical chemistry tests during normal pregnancy. *BJOG* (2008) 115(7):874–81. doi: 10.1111/j.1471-0528.2008.01709.x

30. Wang Y, Lu S, Xu X, Zhang L, Yang J, Hu W. The interactive effects of prepregnancy body mass index, thyroid function, and blood lipid levels on the risk of gestational diabetes mellitus: a crossover analysis. *BMC Pregnancy Childbirth* (2022) 22 (1):580. doi: 10.1186/s12884-022-04908-4

31. Zhang C, Bai L, Sun K, Ding G, Liu X, Wu Y, et al. Association of maternal triglyceride responses to thyroid function in early pregnancy with gestational diabetes mellitus. *Front Endocrinol (Lausanne)* (2022) 13:1032705. doi: 10.3389/ fendo.2022.1032705

32. Zhao MZ, Wei J, Duan YP, Hong X, Jiang J, Ma LK, et al. [Association between gestational diabetes mellitus and postpartum depressive episode]. *Zhongguo Yi Xue Ke Xue Yuan Xue Bao* (2022) 44(3):422–7. doi: 10.3881/j.issn.1000-503X.14742

33. Weinert LS. International Association of Diabetes and Pregnancy Study Groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy: comment to the International Association of Diabetes and Pregnancy Study Groups Consensus Panel. *Diabetes Care* (2010) 33(7):e97. doi: 10.2337/dc10-0544

34. Giannandrea SA, Cerulli C, Anson E, Chaudron LH. Increased risk for postpartum psychiatric disorders among women with past pregnancy loss. J Womens Health (Larchmt) (2013) 22(9):760–8. doi: 10.1089/jwh.2012.4011