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ORIGINAL RESEARCH

Analysis of Risk Factors Associated with Gestational Diabetes Mellitus: A Retrospective Case-Control Study

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Objective: Gestational diabetes mellitus (GDM) is a complication of abnormal glucose tolerance during pregnancy, with incidence is on the rise. There are inconsistent results on the risks of GDM and it has not been reported in our region. The purpose of this study is to explore the risk factors of GDM.

Methods: A total of 383 pregnant women were analyzed, including 67 (17.5%) pregnant women with GDM and 316 (82.5%) with normal glucose tolerance (NGT). The relationship of personal history, family history and reproductive history of pregnant women, the levels of alpha-fetoprotein (AFP), human chorionic gonadotropin (HCG), inflammatory markers in blood cell analysis at the first prenatal examination, and fetal ultrasound indices and the risk of GDM were analyzed.

Results: The fetal biparietal diameter, head circumference, and femur length were negatively correlated with HCG level, but not inflammatory markers. The proportion of pregnant women aged ≥30 years old, body mass index (BMI) in early pregnancy≥24.0 kg/m^2, history of polycystic ovary syndrome (PCOS), cesarean section, adverse pregnancy, and oral contraceptive use, and pregnant women who conceived through assisted reproduction in GDM group were higher than those in NGT group. Logistic regression analysis showed that age of pregnant woman ≥30 years old (≥30 vs <30 years old, odds ratio (OR): 2.142, 95% confidence interval (CI): 1.183–3.878, p=0.012), BMI≥24.0 kg/m^2 (≥24.0 kg/m^2 vs 18.5–23.9 kg/m^2, OR: 1.887, 95% CI: 1.041–3.420, p=0.036), history of adverse pregnancy (yes vs no, OR: 1.969, 95% CI: 1.022–3.794, p=0.043), and history of oral contraceptive use (yes vs no, OR: 2.868, 95% CI: 1.046–7.863, p=0.041) were associated with GDM.

Conclusion: Age of pregnant woman ≥30 years old, BMI≥24.0 kg/m^2, history of adverse pregnancy and oral contraceptive use were independent risk factors for GDM.

Keywords: gestational diabetes mellitus, advanced age, overweight, history of adverse pregnancy, history of oral contraceptive use

Introduction

Gestational diabetes mellitus (GDM) is an abnormal glucose tolerance or glucose metabolism that occurs or is first detected during pregnancy and is one of the most common pregnancy complications.[1,2] The global standardized total prevalence of GDM was approximately 14.0%.[3] The total incidence of GDM in mainland China was about 14.8%.[4] GDM can lead to important short- and long-term health risks for both pregnant women and fetuses, such as adverse maternal outcomes (gestational hypertension and eclampsia) and neonatal outcomes (hyperinsulinemia, macrosomia, shoulder dystocia, diabetes).[1] Pregnant women who developed GDM and their offspring have a significantly increased risk of diabetes, obesity, and premature cardiovascular disease over the next 10 to 12 years.[5–8] The risks of preterm birth[9] and macrosomia[10] in fetuses of GDM women are 3–5 times and 4 times higher than those of normal glucose tolerance (NGT) women, respectively. The incidence of hypoglycemia in fetuses of GDM pregnant women within 48 hours after birth is about 50%.[11] A study showed that the risk of neonatal respiratory distress syndrome (NRDS) in neonates of

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mothers with GDM was 23.7 times higher than that in neonates of NGT women.[12] In addition, GDM is a key factor leading to congenital heart disease in newborns,[13] with an 8-fold higher risk of cardiovascular disease than in infants born to NGT mothers.[14] The hyperglycemia environment of pregnant women with GDM has adverse effects on the fetus before the diagnosis of GDM,[15] early intervention during pregnancy can reduce the incidence of GDM and significantly reduce maternal and infant complications.[16]

Pregnant women with GDM usually have glucose metabolism disorders in the first trimester of pregnancy. In the second and third trimester of pregnancy, the secretion of antagonistic insulin hormones such as estrogen and progesterone increases, presenting a state of hyperglycemia.[17] GDM patients usually have no typical clinical symptoms, and it is difficult to diagnose in time without detecting the glucose tolerance of the patients.[18] The risk factors of GDM have been extensively studied worldwide, and some independent risk factors for GDM have been identified, such as maternal age, overweight, previous history of GDM, and family history of diabetes mellitus (DM).[17,19] Some studies have also found that the two consecutive periods before and during pregnancy may be closely related to the development of GDM, such as maternal physical activity,[20,21] psychological status,[22,23] and sleep status[24,25] may be related to the risk of GDM. However, there are inconsistent results among some studies. The study by Yang et al found that the age of the pregnant woman and the weight gain during pregnancy were not associated with GDM.[26] De Souza et al found that subcutaneous adipose tissue (SAT) depth was not associated with GDM.[27]

Moreover, the risk factors of GDM may be different in different regions and different populations.[28] It may be due to differences in the sample size and the indicators included in different studies. The Hakka people are an ethnic group formed by the integration of the people from the central plains of China with different ethnic groups during the southward migration, and Meizhou city is one of the main gathering places of Hakka people.[29] The potential risk factors of GDM has not been reported in this region. Therefore, this study intends to screen out the potential risk factors of GDM through the analysis of clinical data, especially those that are less studied. This study may provide scientific basis for identifying the high-risk population of GDM, reducing the incidence of GDM, early prevention and timely control of the occurrence, improving the pregnancy outcome of GDM, and formulation of public health strategies.

Materials and Methods

Study Cohort

The cross-sectional study included 383 pregnant women who visited the obstetrics clinic of Meizhou People's Hospital from 2019 to 2023 for analysis. This study was approved by the Medical Ethics Committee of Meizhou People's Hospital, and the written informed consent of pregnant couples for prenatal diagnosis was obtained. GDM is diagnosed using the diagnostic criteria recommended by the International Association for Diabetes in Pregnancy Society Group (IADPSG).[30] A 75g oral glucose tolerance test (OGTT) was performed at 24–28 weeks of gestation: (1) fasting plasma glucose (FPG) ≥ 5.1 mmol /L, (2) 1-h plasma glucose (1hPG) ≥ 10.0 mmol /L, and (3) 2-h plasma glucose (2hPG) ≥8.5 mmol/L, if one of the above three criteria was met, GDM was diagnosed.

The inclusion criteria of subjects were follows: (1) age ≥18 and <35 years old; (2) OGTT was performed at 24 to 28 weeks of gestation; (3) singleton pregnancy; and (4) complete clinical data. Exclusion criteria: (1) pregnant women without OGTT test; (2) some diseases that could affect metabolic function, such as heart disease, hematological system disease, chronic kidney disease, autoimmune system disease, chronic hypertension, diabetes and thyroid disease; (3) multiple pregnancy; (4) pregnant women with missing basic information; and (5) unwilling to accept the survey.

Medical Records and Data Collected

Information collected in this study includes:

(1) Data of pregnant women: age, body mass index (BMI) in early pregnancy, whether to take contraceptives, history of induced abortion, cesarean section, adverse pregnancy, and polycystic ovary syndrome (PCOS), and mode of conception of this pregnancy. History of adverse pregnancy mainly includes spontaneous abortion, embryo discontinuance, fetal malformation or defect, postpartum hemorrhage, and so on. According to Chinese standards, BMI was divided into three grades: <18.5 kg/m^2, 18.5–23.9 kg/m^2, and ≥24.0 kg/m.^{2} [31,32]

(2) Laboratory test indicators: blood cell analysis results (inflammatory markers) at the first prenatal examination were collected, alpha-fetoprotein (AFP), human chorionic gonadotropin (HCG) levels, FPG, OGTT 1-hour and OGTT 2-hour blood glucose levels in the second trimester were collected.

(3) First and second trimester prenatal ultrasound results, including nuchal translucency (NT) (mm), biparietal diameter (mm), head circumference (mm), and femur length (mm).

Data Processing and Statistical Analysis

The immune inflammatory response is involved in the development and progression of many diseases.[33,34] The inflammation index systemic immune inflammation index (SII), system inflammation response index (SIRI), neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and lymphocyte-to-monocyte ratio (LMR) were calculated according to the following formula:

SII=platelet×neutrophil/lymphocyte

SIRI=monocyte×neutrophil/lymphocyte

NLR=neutrophil/lymphocyte

PLR=platelet/lymphocyte

LMR= lymphocyte/monocyte.

SPSS statistical software version 26.0 (IBM Inc., USA) was used for data analysis. Continuous variables were expressed as means ± standard deviations and were compared using either Student's *t*-test or the Mann–Whitney *U*-test. Count variables were evaluated by *Chi*-square test or Fisher's exact test. Spearman correlation analysis was used to analyze the correlation of variables. Logistic regression analysis was used to evaluate the independent risk factors of GDM. $p<0.05$ was set as statistically significant.

Results

Baseline Characteristics of Study Cohort

In this study, 251 (65.5%) cases were aged <30 years, and 132 (34.5%) cases were ≥30 years old. There were 15 (3.9%) cases with history of PCOS, 79 (20.6%) cases with history of induced abortion, 80 (20.9%) with history of cesarean section, 67 (17.5%) with history of adverse pregnancy, and 24 (6.3%) with history of oral contraceptive use, respectively. There were 355 (92.7%) pregnant women conceived naturally and 28 (7.3%) pregnant women conceived by assisted reproductive technology. The mean value of AFP, HCG, SII, SIRI, NLR, PLR, and LMR of the subjects was 46.55 ±24.78ng/mL, 15405.37±22,112.77mIU/mL, 957.56±479.45, 1.93±1.14, 3.83±1.55, 142.53±48.82, and 4.00±1.36 respectively. Prenatal ultrasound results in the second trimester showed that the mean value of NT, biparietal diameter, head circumference, and femoral length was 1.50±0.34mm, 56.60±3.35mm, 209.58±10.62mm, and 39.64±3.09mm, respectively (Table 1).

Correlation Analysis of Biparietal Diameter, Head Circumference, Femur Length and Hematological Indices

The level of HCG was negatively correlated with biparietal diameter (r=−0.162, $p=0.002$), head circumference (r=−0.122, $p=0.017$), and femur length (r=−0.113, $p=0.027$). There was no correlation between biparietal diameter, head circumference, femur length and AFP, SII, SIRI, NLR, PLR, LMR (all $p>0.05$) (Table 2).

Comparison of Maternal Clinical Information and General Characteristics of Fetuses Between GDM and NGT Groups

In this study, there were 67 (17.5%) pregnant women with GDM and 316 (82.5%) pregnant women with NGT. The proportions of pregnant women aged ≥30 years old (53.7% vs 30.4%, $p<0.001$), BMI in early pregnancy≥24.0kg/m^2 (43.3% vs 23.1%, $p=0.001$) in the GDM group were significantly higher than those in the NGT group. The proportion of history of PCOS (9.0% vs 2.8%, $p=0.031$), cesarean section (32.8% vs 18.4%, $p=0.009$), adverse pregnancy (31.3% vs 14.6%, $p=0.002$), and oral contraceptive use (14.9% vs 4.4%, $p=0.004$) in the GDM group were significantly higher than

Table 1 The Maternal Clinical Information and General Characteristics of Fetuses

Characteristics	All Cases (n=383)
Age of pregnant woman (years)	
<30, n(%)	251(65.5%)
≥30, n(%)	132(34.5%)
BMI in early pregnancy (kg/m^2)	
<18.5, n(%)	49(12.8%)
18.5–23.9, n(%)	232(60.6%)
≥24.0, n(%)	102(26.6%)
History of polycystic ovary syndrome (PCOS)	
No, n(%)	368(96.1%)
Yes, n(%)	15(3.9%)
History of induced abortion	
No, n(%)	304(79.4%)
Yes, n(%)	79(20.6%)
History of cesarean section	
No, n(%)	303(79.1%)
Yes, n(%)	80(20.9%)
History of adverse pregnancy	
No, n(%)	316(82.5%)
Yes, n(%)	67(17.5%)
History of oral contraceptive use	
No, n(%)	359(93.7%)
Yes, n(%)	24(6.3%)
Mode of conception	
Natural conception, n(%)	355(92.7%)
Assisted reproduction, n(%)	28(7.3%)
Alpha-fetoprotein (AFP) (ng/mL)	46.55±24.78
Human chorionic gonadotropin (HCG) (mIU/mL)	15405.37±22,112.77
Inflammation indices levels	
SII, means±SD	957.56±479.45
SIRI, means±SD	1.93±1.14
NLR, means±SD	3.83±1.55
PLR, means±SD	142.53±48.82
LMR, means±SD	4.00±1.36
Nuchal translucency (mm)	1.50±0.34
Biparietal diameter (mm)	56.60±3.35
Head circumference (mm)	209.58±10.62
Femur length (mm)	39.64±3.09

those in the NGT group. The ratio of pregnant women who conceived through assisted reproduction in the GDM group was also significantly higher than that in the NGT group (14.9% vs 5.7%, p=0.017). There were no significant differences in HCG, AFP, SII, SIRI, NLR, PLR, LMR levels and prenatal ultrasound findings among the two groups (all p>0.05) (Table 3).

Logistic Regression Analysis of Risk Factors for GDM

The results of univariate analysis showed that age of pregnant woman ≥30 years old (≥30 vs <30 years old, odds ratio (OR): 2.661, 95% confidence interval (CI): 1.556–4.552, p<0.001), BMI ≥24.0 kg/m^2 (BMI ≥24.0 kg/m^2 vs BMI 18.5–23.9 kg/m^2, OR: 2.163, 95% CI: 1.238–3.779, p=0.007), history of PCOS (yes vs no, OR: 3.355, 95% CI: 1.152–9.771, p=0.026), cesarean section (yes vs no, OR: 2.175, 95% CI: 1.213–3.900, p=0.009), adverse pregnancy (yes vs no, OR: 2.680, 95% CI: 1.465–4.899, p=0.001), oral contraceptive use (yes vs no, OR: 3.784, 95% CI:

Table 2 Correlation Analysis of Biparietal Diameter, Head Circumference, Femur Length and Hematological Indices

Variables	Biparietal Diameter		Head Circumference		Femur Length	
	r	*p* Values	r	*p* Values	r	*p* Values
Alpha-fetoprotein (AFP)	−0.037	0.469	−0.033	0.525	−0.020	0.698
Human chorionic gonadotropin (HCG)	−0.162	0.002	−0.122	0.017	−0.113	0.027
SII	0.069	0.176	0.022	0.663	−0.004	0.934
SIRI	0.037	0.475	−0.012	0.817	−0.033	0.522
NLR	0.044	0.395	−0.014	0.780	−0.023	0.658
PLR	0.056	0.270	0.023	0.658	0.011	0.829
LMR	−0.023	0.660	0.018	0.729	0.016	0.750

Table 3 Comparison of Maternal Clinical Information and General Characteristics of Fetuses Between GDM and NGT Groups

Characteristics	NGT (n=316)	GDM (n=67)	*p* Values
Age of pregnant woman (years)			
<30, n(%)	220(69.6%)	31(46.3%)	<0.001
≥30, n(%)	96(30.4%)	36(53.7%)	
BMI in early pregnancy (kg/m^2)			
<18.5, n(%)	47(14.9%)	2(3.0%)	0.001
18.5–23.9, n(%)	196(62.0%)	36(53.7%)	
≥24.0, n(%)	73(23.1%)	29(43.3%)	
History of PCOS			
No, n(%)	307(97.2%)	61(91.0%)	0.031
Yes, n(%)	9(2.8%)	6(9.0%)	
History of induced abortion			
No, n(%)	250(79.1%)	54(80.6%)	0.869
Yes, n(%)	66(20.9%)	13(19.4%)	
History of cesarean section			
No, n(%)	258(81.6%)	45(67.2%)	0.009
Yes, n(%)	58(18.4%)	22(32.8%)	
History of adverse pregnancy			
No, n(%)	270(85.4%)	46(68.7%)	0.002
Yes, n(%)	46(14.6%)	21(31.3%)	
History of oral contraceptive use			
No, n(%)	302(95.6%)	57(85.1%)	0.004
Yes, n(%)	14(4.4%)	10(14.9%)	
Mode of conception			
Natural conception, n(%)	298(94.3%)	57(85.1%)	0.017
Assisted reproduction, n(%)	18(5.7%)	10(14.9%)	
Alpha-fetoprotein (AFP) (ng/mL)	46.57±23.01	46.48±32.06	0.979
Human chorionic gonadotropin (HCG) (mIU/mL)	15416.47±22,523.57	15,353.02±20,220.43	0.983
Inflammation indices levels			
SII, means±SD	949.49±488.88	995.66±433.54	0.475
SIRI, means±SD	1.91±1.14	2.06±1.11	0.320
NLR, means±SD	3.80±1.49	3.96±1.80	0.453
PLR, means±SD	143.39±50.42	138.48±40.56	0.456
LMR, means±SD	4.00±1.39	3.99±1.23	0.946
Nuchal translucency (mm)	1.49±0.35	1.53±0.33	0.341
Biparietal diameter (mm)	56.61±3.43	56.54±3.02	0.865
Head circumference (mm)	209.55±10.82	209.70±9.70	0.916
Femur length (mm)	39.58±3.16	39.90±2.77	0.450

Table 4 Logistic Regression Analysis of Risk Factors for GDM

Variables	Univariate OR (95% CI)	*p* Values	Multivariate OR (95% CI)	*p* Values
Age of pregnant woman (years) (≥30 vs <30)	2.661 (1.556–4.552)	<0.001	2.142 (1.183–3.878)	0.012
BMI in early pregnancy (kg/m^2)				
<18.5	1.000 (reference)		1.000 (reference)	
18.5–23.9	0.232 (0.054–0.997)	0.049	0.336 (0.076–1.477)	0.149
≥24.0	2.163 (1.238–3.779)	0.007	1.887 (1.041–3.420)	0.036
History of PCOS (Yes vs No)	3.355 (1.152–9.771)	0.026	1.994 (0.491–8.102)	0.335
History of induced abortion (Yes vs No)	0.912 (0.470–1.770)	0.785	0.602 (0.282–1.285)	0.190
History of cesarean section (Yes vs No)	2.175 (1.213–3.900)	0.009	1.626 (0.834–3.171)	0.154
History of adverse pregnancy (Yes vs No)	2.680 (1.465–4.899)	0.001	1.969 (1.022–3.794)	0.043
History of oral contraceptive use (Yes vs No)	3.784 (1.602–8.938)	0.002	2.868 (1.046–7.863)	0.041
Mode of conception (Assisted reproduction vs Natural conception)	2.904 (1.275–6.617)	0.011	1.133 (0.390–3.296)	0.818

1.602–8.938, p=0.002), and mode of conception with assisted reproduction (assisted reproduction vs natural conception, OR: 2.904, 95% CI: 1.275–6.617, p=0.011) were significantly associated with GDM. Multivariate logistic regression analysis showed that age of pregnant woman ≥30 years old (≥30 vs <30 years old, OR: 2.142, 95% CI: 1.183–3.878, p=0.012), BMI ≥24.0 kg/m^2 (BMI ≥24.0 kg/m^2 vs BMI 18.5–23.9 kg/m^2, OR: 1.887, 95% CI: 1.041–3.420, p=0.036), history of adverse pregnancy (yes vs no, OR: 1.969, 95% CI: 1.022–3.794, p=0.043), and oral contraceptive use (yes vs no, OR: 2.868, 95% CI: 1.046–7.863, p=0.041) were independent risk factors for GDM (Table 4).

Discussion

Various medical and surgical diseases can occur during pregnancy, and pregnancy and medical and surgical diseases affect each other, such as GDM.[1,2] GDM may cause long-term metabolic complications for the mother and also increase the risk of neonatal complications.[35,36] GDM is a rapidly growing public health problem, which is harmful to both mothers and their offspring. More attention should be paid to the risk factors of GDM, so as to provide scientific basis for the formulation of prevention and control strategies of GDM. Maternal age ≥30 years old, BMI ≥24.0 kg/m^2, history of adverse pregnancy, and oral contraceptive use were found associated with GDM in this study.

The reported incidence of GDM varies greatly among different regions and populations. Two studies in the United States separately assessed the prevalence of GDM among multiracial pregnant women between 1991 and 2002 found that the prevalence of GDM increased over time, between 4% and 6%.[37,38] Kaiser Permanente Health System reports higher rates among Asian (17%) and Hispanic (11%) women, and lower rates among non-Hispanic white (7%) and non-Hispanic black (7%) women.[39] According to the data of the International Diabetes Federation (IDF), the incidence of GDM was about 14% globally, 9% in Africa, 12.6% in North America, 21% in Asia, and 11.9% in China.[40] In this study, the percentage of GDM women was 17.5% (67/383). In general, populations and regions with higher rates of GDM deserve more attention.

It is essential to explore the risk factors of GDM for the prevention, control, and treatment of GDM.[41] In this study, age of pregnant woman ≥30 years old, and BMI ≥24.0 kg/m^2 were independent risk factors for GDM. Advanced maternal age is one of the most recognized risk factors for GDM. Several studies have found that advanced age are associated with an increased risk of GDM, regardless of the groups comparison based on the age (≥25, 30, or 35 years old).[28,42–44] GDM was positively associated with the advanced maternal age (≥30 years old).[45] A study showed that the risk of GDM increases linearly with maternal age.[46] In pregnant women, the contents of various hormones secreted by the placenta and insulin-resistant substances in the body increase, such as glucocorticoids, placental prolactin, progesterone, estrogen, and placental insulinase, which will increase the utilization of glucose by the body and decrease the sensitivity to islets.[47] With the increase of the age of pregnant women, the metabolic capacity of the body will decline, and the amount of insulin secretion will be insufficient, resulting in the decline of the function of islet beta cells.[48] However, it has not been determined whether there is an age threshold for a significant increase in the risk of GDM, that is, after the age of the pregnant woman, the risk of GDM is significantly increased.

Increased BMI increases the likelihood of GDM.[49–53] Elevated BMI and hypothyroidism were the strongest factors associated with GDM.[54] Weight gain prior to pregnancy was significantly associated with a higher risk of GDM.[55] Several studies showed that pre-pregnancy overweight or obesity are important risk factors for GDM.[42,43] Ferrara et al found that when a pregnant woman's pre-pregnancy BMI increased from obese (BMI: 18.5–23.9 kg/m^2) to severely obese (BMI>40 kg/m^2), the risk of developing GDM increased by 2 to 9 times.[38] There are several possible mechanisms by which increased BMI leads to increased risk of GDM. The fat cells of obese people have hypertrophy, and the insulin receptors on the fat cells per unit area are less than those of normal weight people, which leads to the decrease of the sensitivity of the cells to insulin and aggravation of insulin resistance, thus increasing the blood sugar.[56] In addition, hypertrophic fat cells secrete inflammatory factors, leading to systemic inflammation, enhance lipid activity, reduce insulin-induced glucose metabolism in fat cells, and promote the development of insulin resistance.[57]

The results of univariate regression analysis in this study showed that history of adverse pregnancy, oral contraceptive use, and mode of conception with assisted reproductive technology were risk factors for GDM. Some studies have suggested that a history of miscarriage is associated with an increased risk of GDM.[58,59] Wang et al[60] and Cozzolino et al[61] found that the risk of GDM among pregnant women who received assisted reproductive technology was 1.28 times and 2.86 times that of pregnant women who did not receive assisted reproductive, respectively. In this study, multivariate regression analysis showed that history of adverse pregnancy, and oral contraceptive use were independent risk factors for GDM, but not mode of conception with assisted reproductive technology. Therefore, more data on the relationship between a pregnant woman's personal history and the risk of GDM may be needed.

In recent years, the role of inflammatory response level in the occurrence of GDM and other diseases has gradually received extensive attention.[62] When it comes to GDM, it is inevitably closely related to the existence of insulin resistance, and the elevated level of inflammation will induce insulin resistance.[63] With the increase of gestational age, the insulin sensitivity of pregnant women decreases, and for pregnant women with abnormal islet function, the balance between insulin and glucose is lost, causing the maternal blood sugar to rise, resulting in gestational diabetes. A study has found that the incidence of GDM in pregnant women with high white blood cell count in the first trimester is significantly higher than that in those with normal white blood cell count, and it is an independent risk factor for GDM.[64] In this study, there was no significant difference in SII, SIRI, NLR, PLR, LMR between GDM group and NGT group. However, based on the association of inflammatory factors-inflammatory response-insulin resistance, inflammatory markers may be risk factors for the development of GDM.[65,66]

Based on the results of this study, we believe that pregnant women should control their weight during pregnancy. In addition, for pregnant women with a history of adverse pregnancy and oral contraceptive use, they should pay more attention to their blood sugar levels during pregnancy to avoid the occurrence of GDM. The findings of this study will provide scientific basis for reducing the incidence of GDM, prevention and control of the occurrence of GDM, improving the pregnancy outcome of GDM, and formulation of public health strategies in this region. However, there were some limitations in this study. First, in this study, the personal history, family history, and reproductive history of pregnant women were collected, the included factors are limited and cannot completely cover all the influencing factors of GDM, such as dietary habits.[67] Second, there were only 67 were pregnant women with GDM in this study, and the results may not be fully representative. Third, this study was based on a single-center retrospective study with limited regional and ethnic representation. Therefore, we need to conduct a larger sample size study to enrich the relevant data.

Conclusions

In summary, age of pregnant woman ≥30 years old, BMI ≥24.0 kg/m^2, history of adverse pregnancy, and oral contraceptive use were independent risk factors for GDM. Further investigation of the risk of GDM and elucidation of the underlying biological mechanisms will help to provide valuable information for the clinical diagnosis and treatment of GDM and the formulation of public health strategies.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Medicine, Meizhou People's Hospital, Meizhou Academy of Medical Sciences. All participants signed informed consent in accordance with the Declaration of Helsinki.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests.

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