Article

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The Correlation between Depression during Pregnancy and Metabolic Syndrome

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Abstract

Background: In recent years, the incidence of depression during pregnancy has gradually increased, and the disorder of lipid metabolism in patients with depression is an important research direction. Therefore, this study aimed to explore the correlation between depression during pregnancy and metabolic syndrome (MS).

Methods: A total of 113 pregnant women diagnosed as depression during pregnancy from November 2019 to January 2022 were selected as the observation group. After excluding 3 cases, 110 cases were finally included. And 102 pregnant women who were not diagnosed as depression during pregnancy in the same period were selected as the control group. After excluding 2 cases, 100 cases were finally included for comparative study. The levels of various parameters, including serum triglyceride (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C), fasting plasma glucose (FPG), C-reactive protein (CRP), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were compared between the two groups. Furthermore, the Edinburgh Postnatal Depression Scale (EPDS) was used to evaluate the depression scores of postpartum women. Additionally, the correlation between EPDS scores and clinical indexes was assessed in patients with depression during pregnancy.

Results: We observed that the body weight, EPDS score, the proportion of hyperglycemia, hypertension, and dyslipidemia were significantly higher in the observation group compared to the control group ($p < 0.001$). Furthermore, the observation group exhibited significantly higher levels of TG, TC, HDL-C, LDL-C, FPG, CRP, SBP, and DBP than the control group ($p < 0.001$). Pearson linear correlation analysis revealed that TG, TC, HDL-C, LDL-C, FPG, CRP, SBP, and DBP levels were positively correlated with EPDS scores ($p < 0.001$).

Conclusion: This study indicates a specific correlation between MS and depression during pregnancy, and MS-related indicators are positively correlated with EPDS scores among these individuals.

Keywords

metabolic syndrome; depression during pregnancy; pregnancy; correlation

Introduction

Perinatal depression (PND) is a common mental illness [1], affecting up to one-seventh of expectant mothers [2]. The American Psychiatric Association classifies PND as a form of major depressive disorder rather than a discrete condition. Women experiencing mental health issues during pregnancy and the postpartum period (perinatal period) are at higher risk for adverse outcomes affecting both mother and child [3]. Depression during pregnancy is often unrecognized due to its symptoms overlapping with gestational reactions. Its etiology remains unknown, but the typical symptoms can substantially disrupt the physiological functioning of pregnant women. Prenatal and postnatal depression is associated with adverse outcomes in mothers, fetuses and children [4], with severe cases potentially resulting in suicidal thoughts. To reduce the occurrence of prenatal depression and improve maternal and infant health, healthcare providers should know about the risk factors associated with depression during pregnancy and implement appropriate management measures.

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Metabolic syndrome (MS) is characterized by the coexistence of obesity, hypertension, dyslipidemia, and hyperglycemia in an individual [5]. This syndrome represents the clustering of different pathological conditions within the same patient. Patients with depression show a high incidence of dyslipidemia, particularly among women [6]. Negative psychological symptoms can affect cardiovascular risk factors, such as obesity and abnormal blood pressure [7]. This is because long-term depression increases vascular tone, resistance, and blood pressure. C-reactive protein (CRP) is also considered a candidate biomarker for major depression [8]. Women are more susceptible to these risks [9], and pregnant women face even a much higher risk of metabolic disorders due to physiological and hormonal changes. The study by Zhang *et al*. [10] has reported a bidirectional association between depression and MS and its components.

Currently, there is no research on the correlation between depression during pregnancy and MS. Therefore, this study aimed to explore the correlation between depression during pregnancy and MS, providing insights and a basis for the treatment and management of prenatal depression.

Materials and Methods

Study Participants

A total of 113 pregnant women diagnosed as depression during pregnancy from November 2019 to January 2022 were selected as the observation group. Two cases using antidepressants during pregnancy and 1 case with severe hyperthyroidism were excluded, and 110 cases were finally included in this group. A total of 102 pregnant women who were not diagnosed as depression during pregnancy in the same period were selected as the control group. After excluding 1 case with hearing impairment and 1 case with polyembryony, 100 cases were finally included. The study design followed the Declaration of Helsinki [11], and approval was obtained from the Medical Ethics Committee of Taizhou Hospital of Zhejiang Province, China (approval no.: KL20240608).

The inclusion criteria for study participants were set as follows: (1) The pregnant women in the observation group met the diagnostic criteria for depression during pregnancy in the Diagnostic and Statistical Manual of Mental Disorders [12], and were diagnosed by psychiatric examination. (2) Pregnant women aged 20–35 years. (3) Pregnant women with good communication skills and cognitive ability. (4) Those provided informed consent.

The exclusion criteria for study participants were set as follows. (1) Pregnant women who have taken antidepressants or hormonal drugs during pregnancy. (2) Pregnant women with a family history of mental illness. (3) Pregnant women with severe pregnancy disorders, such as heart disease, kidney disease, hepatitis and hyperthyroidism. (4) Pregnant women who experienced 2 or more multiple births. (5) Pregnant women with hearing, speech and cognitive impairment.

Baseline and Clinical Characteristics of the Study Participants

Baseline data collected from study participants included age, gestational age, parity, weight, educational level, ethnicity, hyperglycemia, hypertension, and dyslipidemia. Hyperglycemia was defined as fasting blood glucose higher than 6.1 mmol/L or 2-hour postprandial blood glucose higher than 7.8 mmol/L. Moreover, hypertension was determined by systolic blood pressure (SBP) $\geq$130 mmHg and diastolic blood pressure (DBP) $\geq$80 mmHg.

Furthermore, we assessed the levels of serum triglyceride (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C), fasting plasma glucose (FPG), CRP, SBP, and DBP during pregnancy (within 13 weeks of gestation). The incidence of dyslipidemia (a lipid metabolic disorder that TC, LDL-C, TG exceeded normal levels or HDL-C was below the normal levels) in two groups was counted.

The experimental data were collected during the prenatal examination of pregnant women. We obtained 2–5 mL of fasting venous blood from postpartum women. The levels of fasting TG (normal range: 0.56–1.70 mmol/L), TC (normal range: 3.11–5.48 mmol/L), HDL-C (normal range: 1.04–1.55 mmol/L), LDL-C (normal range: 2.07–3.37 mmol/L), FPG (normal range: 3.9–6.1 mmol/L), CRP (normal range: 4.4–46.8 mg/L) were assessed using enzyme-linked immunosorbent assay (ELISA). An Omron automatic electronic blood pressure monitor (model: HBP-9021J; batch No.: 201705014; Shanghai Hanfei Medical Devices Co., Ltd.; origin: Shanghai, China) was used to measure SBP (normal range: 90–120 mmHg) and DBP (normal range: 60–80 mmHg).

The Edinburgh Postnatal Depression Scale (EPDS) [13] included 10 items: pessimism, lack of interest, self-blame, worry, fear, declined ability, sleep disorders, sadness, the tendency to cry, and self-injury/suicidal attitudes. Each item is scored on a scale from 0 to 3 points, with the total score ranging from 0–30. A score of $\geq$13 indicates the

Table 1. Comparison of baseline data between the two groups.

Variables	Observation group (n = 110)	Control group (n = 100)	z/χ^2	*p*-value
Age [years old, M (P_{25}, P_{75})]	27.50 (24.00, 31.00)	27.00 (24.00, 31.00)	–0.932	0.351
Gestational age [week, M (P_{25}, P_{75})]	30.00 (27.00, 33.00)	30.00 (27.00, 34.00)	–0.157	0.875
Parity [times, M (P_{25}, P_{75})]	1.00 (0.00, 2.00)	1.00 (0.00, 2.00)	–1.070	0.285
Height [cm, M (P_{25}, P_{75})]	162.00 (155.00, 167.00)	161.00 (155.00, 165.00)	–1.306	0.192
Weight [kg, M (P_{25}, P_{75})]	68.00 (64.00, 71.00)	62.50 (56.50, 66.00)	–7.235	<0.001
Educational level [case, n (%)]			0.043	0.979
High school diploma and below	26 (23.64)	24 (24.00)		
Associate diploma	44 (40.00)	41 (41.00)		
Undergraduate or above	40 (36.36)	35 (35.00)		
Marital status [case, n (%)]			0.136	0.712
Married	88 (80.00)	82 (82.00)		
Divorced/unmarried	22 (20.00)	18 (18.00)		
Smoking history [case, n (%)]			0.199	0.655
Yes	19 (17.27)	15 (15.00)		
No	91 (82.73)	85 (85.00)		
Pregnancy mode [case, n (%)]			0.081	0.776
Natural pregnancy	75 (68.18)	70 (70.00)		
Assisted conception	35 (31.82)	30 (30.00)		
EPDS score [points, M (P_{25}, P_{75})]	20.00 (16.00, 24.00)	8.00 (7.00, 10.00)	–12.522	<0.001
Hyperglycemia [case, n (%)]	91 (82.73)	16 (16.00)	93.325	<0.001
Hypertension [case, n (%)]	77 (70.00)	19 (19.00)	54.900	<0.001
Dyslipidemia [case, n (%)]	79 (71.81)	15 (15.00)	68.391	<0.001

Notes: EPDS, Edinburgh Postnatal Depression Scale.

Table 2. Linear regression analysis.

Factors	B	Standard error (SE)	Standardized coefficient (beta)	t	*p*-value	95% Confidence interval (CI)	Variance inflation factor (VIF)
Constants	4.305	4.098	-	1.050	0.295	–3.775–12.385	-
Body weight	0.071	0.065	0.058	1.085	0.279	–0.058–0.200	1.059
Hyperglycemia	5.386	0.821	0.387	6.557	<0.001	3.767–7.006	1.311
Hypertension	2.573	0.805	0.184	3.198	0.002	0.987–4.160	1.249
Dyslipidemia	3.999	0.827	0.286	4.838	<0.001	2.369–5.629	1.313

presence of depression. Additionally, the scale has an internal consistency reliability of 0.76 and a content validity of 0.93.

Statistical Analysis

The data were statistically analyzed using IBM SPSS 26.0 software (International Business Machines Corporation; Armonk, NY, USA). Continuous variables not conforming to a normal distribution were analyzed utilizing the Mann-Whitney U test. The measurement data were analyzed using the Pearson chi-square test or Fisher exact test. A linear regression equation was employed to assess the causal relationship. Additionally, Pearson correlation analysis was performed to examine the correlation between EPDS and clinical indicators such as TG, TC, and HDL-C. A p-value < 0.05 was considered statistically significant.

Results

Comparison of Baseline Data between the Observation and Control Groups

There was no significant difference in baseline characteristics, such as age, gestational age, and parity between the two groups ($p > 0.05$). However, the body weight, EPDS score, hyperglycemia, hypertension, and dyslipidemia were substantially higher in the observation group compared to the control group ($p < 0.001$, Table 1).

Table 3. Comparison of clinical indexes between the two groups [M (P_{25}, P_{75})].

Clinical parameters	Observation group (n = 110)	Control group (n = 100)	z	*p*-value
TG (mmol/L)	1.89 (1.76, 2.04)	1.11 (0.81, 1.41)	–12.268	<0.001
TC (mmol/L)	5.69 (5.46, 5.92)	4.42 (3.845.04)	–11.999	<0.001
HDL-C (mmol/L)	2.53 (2.24, 2.80)	1.52 (1.25, 1.71)	–12.507	<0.001
LDL-C (mmol/L)	3.62 (3.47, 3.75)	2.85 (2.51, 3.17)	–11.883	<0.001
FPG (mmol/L)	7.20 (6.50, 7.70)	5.50 (4.90, 6.00)	–12.489	<0.001
CRP (mg/L)	74.95 (61.20, 92.80)	26.70 (16.80, 39.55)	–11.119	<0.001
SBP (mmHg)	154.50 (131.00, 171.00)	107.50 (100.00, 120.00)	–11.356	<0.001
DBP (mmHg)	94.50 (84.00, 104.00)	72.00 (65.00, 78.00)	–11.297	<0.001

Notes: TG, triglyceride; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; FPG, fasting plasma glucose; CRP, C-reactive protein; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 4. Pearson correlation analysis.

Indicators		TG	TC	HDL-C	LDL-C	FPG	CRP	SBP	DBP
EPDS	r	0.720**	0.687**	0.760**	0.642**	0.617**	0.734**	0.671**	0.659**
	p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Notes: ** At the 0.01 level (double tail), there is a significant correlation. TG, triglyceride; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; FPG, fasting plasma glucose; CRP, C-reactive protein; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Linear Regression Analysis

Linear regression analysis was performed using EPDS as the dependent variable and body weight, hyperglycemia, hypertension, and dyslipidemia as independent variables. The analysis indicated that hyperglycemia, hypertension, and dyslipidemia were the influencing factors of EPDS ($p < 0.05$, Table 2).

Comparison of Laboratory Indicators

We observed that TG, TC, HDL-C, LDL-C, FPG, CRP, SBP, and DBP levels were significantly higher in the observation group compared to the control group ($p < 0.001$, Table 3).

Pearson Correlation Analysis

Pearson linear correlation analysis revealed a positive correlation between EPDS and clinical indexes, such as TG, TC, HDL-C, LDL-C, FPG, CRP, SBP, and DBP ($p < 0.001$, Table 4 and Fig. 1).

Discussion

PND substantially impacts the health of mothers, infants, and their families [14]. Antenatal depression affects approximately one in seven pregnancies, with an increasing morbidity throughout gestation [15]. In China, the prevalence of PND is 16.3%, and it has been increasing over the past decade [16]. During childbirth, maternal mental health and productivity are interrelated. Maternal depression during pregnancy increases the risk of adverse neurodevelopmental outcomes in offspring [17]. MS, a pathological state characterized by metabolic disorders, is more common among pregnant women. Substantial evidence associates mental illness with an increased risk of MS [18]. This study explores the correlation between depression during pregnancy and MS to provide a reference for treatment strategies.

Our findings revealed that body weight, EPDS score, and the prevalence of hyperglycemia, hypertension, and dyslipidemia were significantly higher in the observation group compared to the control group. Obesity is a known risk factor for cardiovascular disease, and individuals with depression and a high body mass index (BMI) are more prone to insulin resistance, with the risk increasing with the severity of depression [19]. Elevated blood lipids and blood glucose levels lead to a higher incidence of MS. Furthermore, a study by Sominsky L *et al.* [20] reported that pre-pregnancy obesity increases the risk of depressive symptoms before delivery. Specifically, the level of brain-derived neurotrophic factor (BDNF) in the plasma of obese patients is decreased, and there is an inverse relationship between BDNF protein levels and BMI. This suggests that the

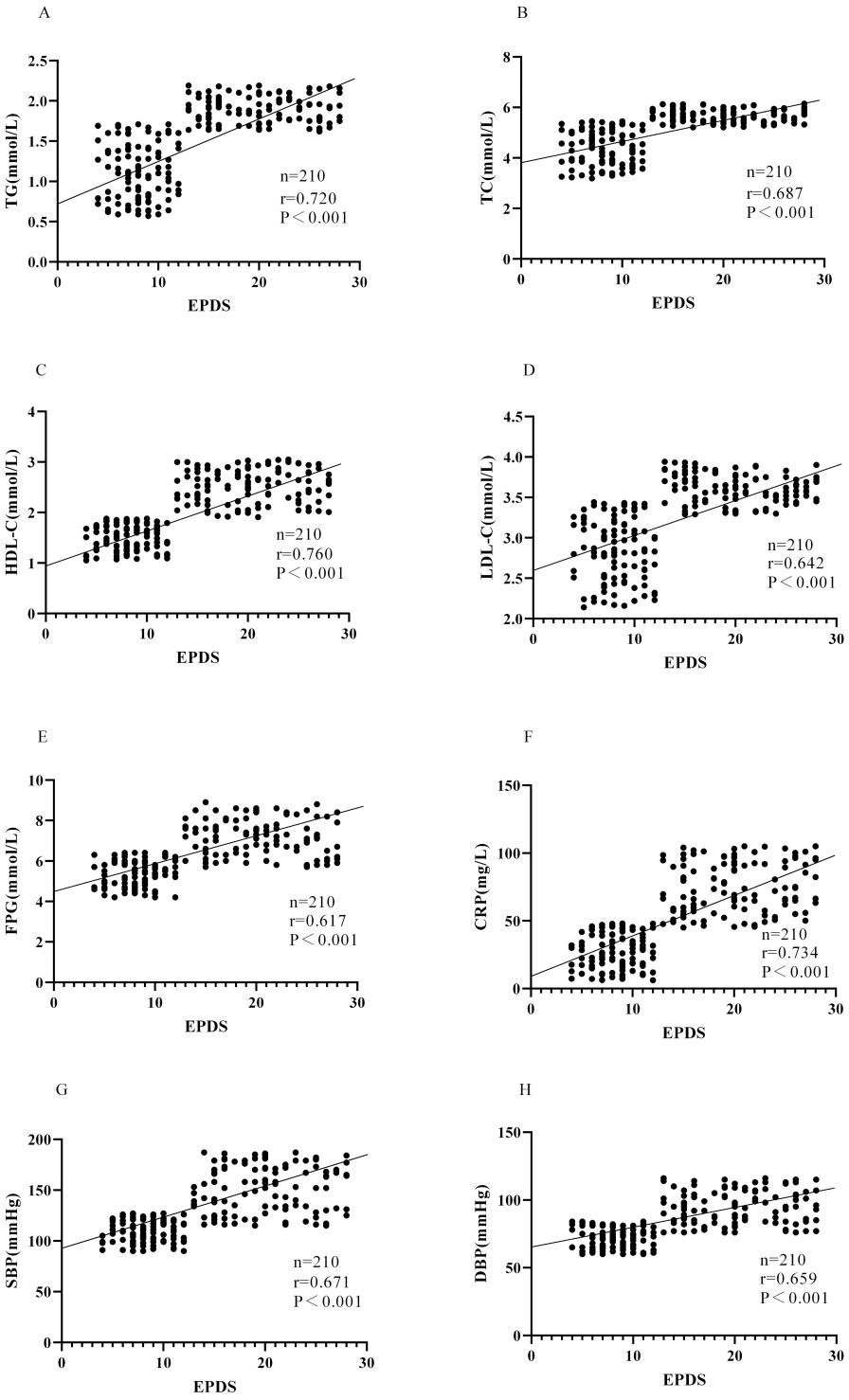

Fig. 1. Relationship between clinical indicators and EPDS using scatter plot method. Notes: (A) represents the scatter plot of TG and EPDS. (B) shows the scatter plot of TC and EPDS. (C) indicates the scatter plot of HDL-C and EPDS. (D) shows the scatter plot of LDL-C and EPDS. (E) shows the scatter plot of FPG and EPDS. (F) represents the scatter plot of CRP and EPDS. (G) indicates the scatter plot of SBP and EPDS. (H) shows the scatter plot of DBP and EPDS. EPDS, Edinburgh Postnatal Depression Scale; TG, triglyceride; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; FPG, fasting plasma glucose; CRP, C-reactive protein; SBP, systolic blood pressure; DBP, diastolic blood pressure.

low levels of serum neurotrophic factors in pregnant women due to pre-pregnancy overweight may be an essential mechanism for prenatal depression.

This study confirmed that levels of TG, TC, HDL-C, and LDL-C were substantially elevated in pregnant women with depression compared to the control group. These lipid indicators were positively correlated with the EPDS score, suggesting that increased levels of TG and TC are associated with depression during pregnancy. Stress response and cortisol play a crucial role in this relationship. The hypothalamic-pituitary-adrenal axis (HPA) activity is increased through central and peripheral mechanisms [21], and cortisol increases, causing the mobilization of systemic fat, and resulting in high levels of TC and TG. Therefore, the hyperactivity of the HPA axis induces dyslipidemia in patients with depression, establishing a direct correlation between the two.

This study identified that FPG levels in pregnant women with depression were significantly higher compared to the control group and that FPG was positively correlated with EPDS scores. This association may be due to changes in the immune system that are thought to underlie cognitive symptoms in psychosis and emotional disorders [22]. Pregnant women with depression experience elevated stress, leading to increased cortisol secretion and reduced glucose utilization. This mechanism inhibits insulin secretion, increases sympathetic excitation, and elevates catecholamine secretion, resulting in elevated blood glucose and potentially leading to insulin resistance.

Our study demonstrated that elevated CRP levels were positively correlated with depression during pregnancy. An increase in CRP during pregnancy may indicate minor damage or infection of the endometrium, which can contribute to depression. As a main reactive protein in the body's inflammatory response, CRP can affect mood and behavior by disrupting the permeability of the blood-brain barrier and impacting the transport and metabolism of neurotransmitters such as 5-hydroxytryptamine and dopamine.

Furthermore, we observed that SBP and DBP were significantly higher in pregnant women with depression compared to the control group, and these indicators were positively correlated with EPDS scores. Depression during pregnancy can lead to hypothalamic vasoconstriction, sympathetic nervous system excitation, increased adrenal medulla secretion, enhanced cardiac output, and elevated blood pressure. This may also be related to hypothalamic dysfunction. The HPA axis, a neuroendocrine system [23], increases steroid hormone secretion, leading to the retention of water and sodium, and elevated blood pressure.

The limitations of this study are as follows. Firstly, as a retrospective study, the data are extracted from the hospital system, which may introduce data bias. Secondly, the study only includes the samples from one hospital, with a limited range and small sample size, which may affect the generalizability of the findings. Thirdly, the study does not explore the potential mechanism or track the disease progression in pregnant women with depression, leading to incomplete research results. In the future, more scientific and rigorous prospective studies with large sample size will be carried out to provide more powerful evidence for clinical practice.

Conclusion

In summary, there is a specific correlation between depression during pregnancy and MS. MS-related indicators, such as TG, TC, HDL-C, LDL-C, FPG, CRP, SBP, and DBP, are positively correlated with EPDS scores. Therefore, clinical measurement of metabolic indicators in pregnant women with depression during pregnancy should be strengthened to detect the potential risk of MS as soon as possible. This study has important guiding significance for clinical practice.

Availability of Data and Materials

Data to support the findings of this study are available on reasonable request from the corresponding author.

Author Contributions

QW and HH designed the research study; XW and XT performed the research; XT and QW collected and analyzed the data. QW drafted the manuscript. All authors have been involved in revising it critically for important intellectual content. All authors give final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

The study design followed the Declaration of Helsinki, and approval was obtained from the Medical Ethics Committee of Taizhou Hospital of Zhejiang Province, China (approval no.: KL20240608). All participants provided informed consent.

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Conflict of Interest

The authors declare no conflict of interest.

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