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ORIGINAL RESEARCH

Impact of Pre-Pregnancy Body Mass Index and Gestational Weight Gain on Pregnancy Complications and Outcomes

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Objective: To assess impacts of pre-pregnancy BMI and gestational weight gain (GWG) on pregnancy complications and outcomes.
Methods: This retrospective study analyzed 2488 pregnant women from Zhuzhou Central Hospital (2022). Participants were categorized by pre-pregnancy BMI (underweight, normal, overweight, obese) and GWG (insufficient, appropriate, excessive). Multivariate logistic regression evaluated associations with outcomes, adjusting for confounders.
Results: Significant differences existed across BMI groups for age, parity, gestational diabetes (GDM), gestational hypertension (GHT), preterm birth, birth weight, cord entanglement, and delivery mode (all $p<0.05$). GWG significantly associated with age, parity, GDM, GHT, preterm birth, birth weight, and delivery mode (all $p<0.05$). After adjustment: *Pre-pregnancy BMI*: Underweight women had higher risks of preterm birth (OR=3.14, 95% CI:1.37–7.23) and GDM (OR=2.94, 95% CI:1.60–5.39). Overweight women had higher risks of GDM (OR=5.62, 95% CI:2.86–11.06) and GHT (OR=9.49, 95% CI:4.17–21.60). *GWG*: Insufficient gain increased risks of cesarean delivery (OR=1.48), low birth weight (LBW; OR=2.30), and macrosomia (OR=2.82). Excessive gain increased risks of preterm birth (OR=2.36), GDM (OR=1.52), GHT (OR=1.61), cesarean delivery (OR=1.57), LBW (OR=3.70), and macrosomia (OR=5.39) (all $p<0.05$ unless specified). Notably, obesity showed no significant associations. Maternal age ≥35 years independently increased preterm birth risk (OR=1.58), while high parity (≥3) was protective (OR=0.75).
Conclusion: Pre-pregnancy BMI and GWG significantly influence pregnancy complications and neonatal outcomes. Proper weight management may improve outcomes.

Keywords: pre-pregnancy body mass index, gestational weight gain, pregnancy complications, pregnancy outcomes

Introduction

Pregnancy complications encompass various health conditions affecting pregnant women, and pose significant risks to both maternal and fetal health.[1] In China, a survey of 18,045 pregnant women reported a 25.04% incidence of pregnancy complications.[2] The most common complications include gestational diabetes mellitus (GDM), gestational hypertension (GHT), heart disease, and gestational anemia (GAN),[3] with prevalence rates of 14%,[4] 7% −12%,[5] 1%,[6] and 38.2%,[7] respectively. These complications can lead to adverse pregnancy outcomes, jeopardizing maternal and neonatal health and, in severe cases, threatening their survival.[8] Pregnancy complications significantly contribute to risks such as preterm birth, cesarean delivery, macrosomia, and congenital anomalies.[1,9]

Maternal weight is crucial to metabolic function and fetal development during pregnancy. Both insufficient and excessive gestational weight gain (GWG) are associated with complications such as cesarean delivery, GDM, GHT, GAN, stillbirth, and macrosomia.[10,11] Moreover, excessive maternal weight may hinder prenatal diagnostics, complicating the detection of

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congenital heart disease, neural tube defects, chronic inflammation, and metabolic disorders in newborns.[12,13] The GWG is a key monitoring parameter for maternal fat accumulation, fetal growth, and placental and uterine function.[14]

Although GWG is associated with pregnancy complications and outcomes, limited research has examined pre-pregnancy body mass index (BMI) alongside weight gain throughout pregnancy, considering their combined effects. This study retrospectively analyzed the impact of pre-pregnancy BMI and GWG on pregnancy complications and outcomes.

Methods and Materials

Patients

Based on predefined inclusion and exclusion criteria, this study retrospectively collected clinical data from all pregnant women at Zhuzhou Central Hospital between January 2022 and December 2022. Inclusion criteria: Pregnant women with no history of cardiovascular or cerebrovascular diseases, hematological disorders, benign or malignant tumors, those who underwent routine prenatal examinations, those with complete obstetric records, and those who provided informed consent. Exclusion criteria: Pregnant women with primary conditions affecting weight gain, such as congenital heart disease, severe anemia, or chronic nephritis, those lacking regular prenatal examinations or complete clinical records, and cases of stillbirth.

Observed Indicators

Collected clinical parameters included maternal age, height, pre-pregnancy BMI, gravidity, parity, delivery mode, pregnancy complications (diabetes, hypertension, anemia), GWG, neonatal birth weight (BW) and sex, congenital disabilities, and umbilical cord entanglement. Pregnant women were categorized into four groups based on pre-pregnancy BMI (underweight, normal, overweight, obese) and three groups based on GWG (insufficient, appropriate, excessive) for comparative analysis.

Pre-pregnancy BMI: Pre-pregnancy BMI was calculated as weight (kg) divided by height (m^2). According to the World Health Organization (WHO, 2009) BMI classification, participants were categorized as follows: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥30.0 kg/m^2).

Gestational weight gain (GWG) was defined as the difference between the maternal weight on the day before delivery and the lowest weight recorded in the year before pregnancy (kg). Based on the "Guidelines for Monitoring and Evaluating Weight Gain in Pregnant Women in China", GWG was classified as insufficient, normal, or excessive[15] (Table 1).

Pregnancy Complications and Outcomes

Pregnancy complications include GDM, GHT, and GAN, while pregnancy outcomes encompass congenital disabilities and BW.

GDM is diagnosed if any of the following blood glucose levels meet or exceed equal to: fasting blood glucose 5.1 mmol/L, 1h blood glucose 10.0 mmol/L, 2h blood glucose 8.5 mmol/L.[16]

GHT: According to the 2018 International Society for the Study of Hypertension in Pregnancy (ISSHP) guidelines, GHT is diagnosed when systolic blood pressure exceeds 140 mmHg or the diastolic blood pressure exceeds 90 mmHg or both conditions coexist after 20 weeks of gestation. Blood pressure should be measured using an electronic monitor with an appropriately sized cuff.[17]

Table 1 Weight Gain During Pregnancy and Recommended Weekly Weight Gain in the Middle and Late Stages of Pregnancy Based on Pre-Pregnancy BMI Classification

Pre-Pregnancy BMI Classification (kg/m^2)	Total Gain Range (kg)
Underweight (<18.5)	11.0–16.0
Normal (18.5–23.9)	8.0–14.0
Overweight (24.0–27.9)	7.0–11.0
Obese (≥28.0)	5.0–9.0

GAN: As per the WHO criteria,[18] GAN is diagnosed when hemoglobin (Hb) levels <110 g/L, with hematocrit levels <0.33. Severity is classified as mild (100–109 g/L), moderate (70–99 g/L), severe (40–69 g/L), or extremely severe (<40 g/L).

Congenital structural or genetic abnormalities can impact health and development. Common defects involve the circulatory, musculoskeletal, urinary, and digestive systems.

BW: Defined per the 10th edition of *Pediatrics* (People's Health Press).[19] BW is measured within 1 hour after birth. The classification includes low birth weight (LBW, <2500 g), normal birth weight (NBW, 2500–4000 g), and macrosomia (>4000 g).

Statistical Analysis

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) statistical software (version 25.0, International Business Machines Corporation, New York, USA). Categorical variables were expressed as frequencies and percentages. The chi-square or rank-sum test was used for between-group comparisons, with statistical significance at $p<0.05$. Logistic regression was conducted to examine associations between GWG and pregnancy outcomes.

Results

Clinical Characteristics of Pregnant Women

This study included 2488 pregnant women with a mean age of 31.55 ± 4.33 years, an average height of 159.85 ± 5.14 cm, a pre-pregnancy BMI of 21.81 ± 3.14, GWG of 13.75 ± 4.51 kg, and an average BW of 3218.99 ± 468.61 g. Among them, 824 were primigravidae, 790 were experiencing their second pregnancy, and 874 had a history of multiple pregnancies. The number of first-time deliveries was 1297, while second deliveries accounted for 1043 cases, and 148 involved multiple deliveries. A total of 1373 women underwent cesarean sections, while 1115 had vaginal deliveries. Pregnancy complications included 646 cases of GDM, while 1842 women did not develop the condition. GHT was observed in 225 cases, whereas 2263 women remain unaffected. Anemia was categorized as moderate in 213 cases and mild in 422 cases, while 1853 women had normal Hb levels. Regarding pre-pregnancy BMI, 310 women were classified as underweight, 1802 had a normal BMI, 333 were overweight, and 43 were obese. GWG was insufficient in 656 cases, appropriate in 1135 cases, and excessive in 697 cases. The study also recorded 1311 male fetuses and 1177 female fetuses. Neonatal outcomes included 124 cases of LBW infants, 2283 cases of normal weight, and 81 cases of macrosomia. Congenital disabilities were identified in 55 newborns, while 2433 were unaffected. Moreover, 884 cases involved umbilical cord entanglement around the neck, whereas 1604 cases did not (Table 2).

Table 2 Clinical Characteristics of 2488 Pregnant Women

Characteristics	No. (%)
Parity	
1	824(33.1)
2	790(31.8)
≥3	874(35.1)
Births	
1	1297(52.2)
2	1043(41.9)
≥3	148(5.9)

(*Continued*)

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Table 2 (Continued).

Characteristics	No. (%)
Delivery mode	
Eutocia	1115(44.8)
Caesarean	1373(55.2)
GDM	
Yes	646(26.0)
No	1842(74.0)
GH	
Yes	225(9.0)
No	2263(91.0%)
GA	
Normal	1853(74.4)
Mild	422(17.0)
Moderate	213(8.6)
Pre-pregnancy weight	
Low weight	310(12.5)
Normal	1802(72.4)
Overweight	333(13.4)
Obesity	43(1.7)
GWG	
Insufficient	656(26.4)
Appropriate	1135(45.6)
Excessive	697(28.0)
Newborn gender	
Man	1311(52.7)
Female	1177(47.3)
BW	
LBW	124(5.0)
NBW	2283(91.7)
Fetal macrosomia	81(3.3)
Birth defect	
Yes	55(2.2)
No	2433(97.8)

(*Continued*)

Table 2 (Continued).

Characteristics	No. (%)
CAN	
Yes	884(35.5)
No	1604(64.5)

Abbreviations: GDM, Gestational diabetes mellitus; GH, Gestational hypertension; GA, Gestational anemia; GWG, Gestational weight gain; BW, birth weight; LBW, Low birth weight infant; NBW, Normal birth weight infant; CAN, Cord Around Neck.

Correlation Between Pre-Pregnancy BMI and Pregnancy Complications and Outcomes

Participants were categorized into four groups based on pre-pregnancy BMI: underweight, normal, overweight, and obese. A comparative analysis revealed significant differences among these groups regarding maternal age, number of pregnancies and deliveries, incidence of GDM and GHT, preterm birth rates, BW, CAN, and mode of delivery ($p<0.05$). However, no substantial associations were found between pre-pregnancy BMI and birth defect, GAN, and newborn gender ($p>0.05$) (Table 3).

Table 3 The Correlation Between Pre-Pregnancy BMI and Pregnancy Complications and Outcomes

Characteristics	Pre-Pregnancy BMI				p
	Low Weight	Normal	Overweight	Obesity	
Age					0.003
<35	55(17.7%)	434(24.1%)	87(26.1%)	15(34.9%)	
≥35	255(82.30%)	1368(75.9%)	246(73.9%)	28(65.1%)	
Parity					0.000
1	132(42.6%)	576(32.0%)	95(28.5%)	21(48.9%)	
2	105(33.9%)	584(32.4%)	92(27.6%)	9(20.9%)	
≥3	73(23.5%)	642(35.6%)	146(43.9%)	13(30.2%)	
Births					0.000
1	191(61.6%)	923(51.2%)	156(46.9%)	27(62.8%)	
2	111(35.8%)	773(42.9%)	147(44.1%)	12(27.9%)	
≥3	8(2.6%)	106(5.9%)	30(9.0%)	4(9.3%)	
Delivery mode					0.000
Eutocia	127(41.0%)	981(54.4%)	234(70.3%)	31(72.1%)	
Caesarean	183(59.0%)	821(45.6%)	99(29.7%)	12(27.9%)	
GDM					0.000
Yes	45(14.5%)	442(24.5%)	138(41.4%)	21(48.8%)	
No	265(85.5%)	1360(75.5%)	195(58.6%)	22(51.2%)	

(*Continued*)

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Table 3 (Continued).

Characteristics	Pre-Pregnancy BMI				p
	Low Weight	Normal	Overweight	Obesity	
GH					0.000
Yes	15(4.8%)	128(7.1%)	68(20.4%)	14(32.6%)	
No	295(95.2%)	1674(92.9%)	265(79.6%)	29(67.4%)	
GA					0.053
Normal	26(8.4%)	161(8.9%)	22(6.6%)	4(9.3%)	
Mild	58(18.7%)	316(17.6%)	43(12.9%)	5(11.6%)	
Moderate	226(72.9%)	1325(73.5%)	268(80.5%)	34(79.1%)	
Newborn gender					0.976
Man	164(52.9%)	949(52.7%)	175(52.6%)	23(53.5%)	
Female	146(47.1%)	853(47.3%)	158(47.4%)	20(46.5%)	
BW					0.177
LBW	13(4.2%)	81(4.5%)	25(7.5%)	5(11.6%)	
NBW	294(94.8%)	1658(92.0%)	295(88.6%)	36(83.7%)	
Fetal macrosomia	3(1.0%)	63(3.5%)	13(3.9%)	2(4.7%)	
Birth defect					0.922
Yes	7(2.3%)	41(2.3%)	5(1.5%)	2(4.7%)	
No	303(97.7%)	1761(97.7%)	328(98.5%)	41(95.3%)	
CAN					0.810
Yes	110(35.5%)	630(35.0%)	136(40.8%)	8(18.6%)	
No	200(64.5%)	1172(65.0%)	197(59.2%)	35(81.4%)	
Preterm birth					0.000
Yes	13(4.2%)	105(5.8%)	31(9.3%)	7(16.3%)	
No	297(95.8%)	1697(94.2%)	302(90.7%)	36(83.7%)	

Abbreviations: GDM, Gestational diabetes mellitus; GH, Gestational hypertension; GA, Gestational anemia; GWG, Gestational weight gain; BW, birth weight; LBW, Low birth weight infant; NBW, Normal birth weight infant; CAN, Cord Around Neck.

Correlation Between GWG and Pregnancy Complications and Outcomes

Pregnancy complications and outcomes were analyzed across GWG categories. Significant differences were observed among the groups in maternal age, parity, GDM, GH, premature infants, BW, and mode of delivery ($p<0.05$). However, no substantial differences were found in neonatal sex distribution, GA, congenital disabilities, umbilical cord entanglement, or newborn outcomes ($p>0.05$) (Table 4).

Associations Between Pre-Pregnancy BMI, GWG, and Pregnancy Outcomes

Analysis of the impact of pre-pregnancy BMI and GWG on pregnancy outcomes revealed significant associations (Table 5 and Supplementary Table S1). Compared to women with normal pre-pregnancy BMI, underweight women

Table 4 The Correlation Between GWG and Pregnancy Complications and Outcomes

Characteristics	GWG			p
	Insufficient	Appropriate	Excessive	
Age				0.003
<35	183(27.9%)	274(24.1%)	134(19.2%)	
≥35	473(72.1%)	861(75.9%)	563((80.8%)	
Parity				0.452
1	205(31.3%)	380(33.5%)	239(34.3%)	
2	210(32.0%)	368(32.4%)	212(30.4%)	
≥3	241(36.7%)	387(34.1%)	246(35.3%)	
Births				0.002
1	320(48.8%)	574(50.6%)	403(57.8%)	
2	291(44.3%)	497(43.8%)	255(36.6%)	
≥3	45(6.9%)	64(5.6%)	39(5.6%)	
Delivery mode				0.000
Eutocia	337(51.4%)	601(53.0%)	435(62.4%)	
Caesarean	319(48.6%)	534(47.0%)	262(37.6%)	
GDM				0.001
Yes	212(32.3%)	267(23.5%)	167(24.0%)	
No	444(67.7%)	868(76.5%)	530(76.0%)	
GH				0.013
Yes	47(7.2%)	101(8.9%)	77(11.0%)	
No	609(92.8%)	1034(91.1%)	620(89.0%)	
GA				0.400
Normal	60(9.1%)	102(9.0%)	51(7.3%)	
Mild	120(18.3%)	182(16.0%)	120(17.2%)	
Moderate	476(72.6%)	851(75.0%)	526(75.5%)	
Newborn gender				0.244
Man	339(51.7%)	590((52.0%)	382(54.8%)	
Female	317(48.3%)	545(48.0%)	315(45.2%)	
BW				0.000
LBW	52(7.9%)	57(5.0%)	15(2.2%)	
NBW	596(90.9%)	1051(92.6%)	636(91.2%)	
Fetal macrosomia	8(1.2%)	27(2.4%)	46(6.6%)	

(*Continued*)

Table 4 (Continued).

Characteristics	GWG			p
	Insufficient	Appropriate	Excessive	
Birth defect				0.840
Yes	15(2.3%)	23(2.0%)	17(2.4%)	
No	641(97.7%)	1112(98.0%)	680(97.6%)	
CAN				0.884
Yes	237(36.1%)	398(35.1%)	249(35.7%)	
No	419(63.9%)	737(64.9%)	448(64.3%)	
Preterm birth				0.000
Yes	63(9.6%)	63(5.6%)	30(4.3%)	
No	593(90.4%)	1072(94.4%)	667(95.7%)	

Abbreviations: GDM, Gestational diabetes mellitus; GH, Gestational hypertension; GA, Gestational anemia; GWG, Gestational weight gain; BW, birth weight; LBW, Low birth weight infant; NBW, Normal birth weight infant; CAN, Cord Around Neck.

Table 5 The Correlation Between Pre-Pregnancy BMI and GWG with Pregnancy Complications and Outcomes

	Preterm Birth [a]	GDM [b]	GH [c]	Caesarean [d]	LBW [e]	Macrosomia [f]	P	OR (95% CI)
Pre-pregnancy BMI								
Normal	105(67.31%)	442(68.42%)	128(56.89%)	981(71.45%)	81(65.32%)	63(77.78%)		
Low weight	13(8.33%)	45(6.97%)	15(6.67%)	127(9.25%)	13(10.48%)	3(3.70%)	0.007[a]	3.14(1.37–7.23) [a]
							0.001[b]	2.94(1.60–5.39) [b]
							0.025[c]	6.31(1.10–4.24) [c]
							0.025[d]	2.16(1.10–4.24) [d]
							0.033[e]	2.84(1.097.44) [e]
							0.607[f]	1.46(0.34–6.21) [f]
Overweight	31(19.87%)	138(21.36%)	68(30.22%)	234(17.04%)	25(20.17%)	13(16.05%)	0.003[a]	4.44(1.66–11.86) [a]
							0.000[b]	5.62(2.86–11.06) [b]
							0.000[c]	9.49(4.17–21.60) [c]
							0.000[d]	3.72(1.84–7.52) [d]
							0.039[e]	3.14(1.06–9.32) [e]
							0.068[f]	5.44(0.88–33.68) [f]
Obesity	7(4.49%)	21(3.25%)	14(6.22%)	31(2.26%)	5(4.03%)	2(2.47%)	0.159[a]	1.89(0.78–4.61) [a]
							0.357[b]	1.35(0.71–2.55) [b]
							0.73[c]	1.88(0.94–3.76) [c]
							0.805[d]	1.09(0.54–2.21) [d]
							0.343[e]	1.64(0.59–4.55) [e]
							0.766[f]	1.26(027–5.81) [f]
GWG								
Appropriate	63(40.38%)	267(41.33%)	101(44.89%)	601(43.77%)	57(45.96%)	27(33.33%)		
Insufficient	63(40.38%)	212(32.82%)	47(20.89%)	337(24.55%)	52(41.94%)	8(9.88%)	0.000[a]	1.48(1.22–1.79) [a]
							0.831[b]	0.97(0.78–1.22) [b]
							0.13[c]	1.27(0.93–1.74) [c]
							0.000[d]	1.48(1.22–179) [d]
							0.005[e]	2.30(1.29–4.10) [e]
							0.000[f]	2.821.73–4.57) [f]
Excessive	30(19.24%)	167(25.85%)	7734.22%)	43(31.68%)	15(12.10%)	46(56.79%)	0.000[a]	2.36(1.51–3.70) [a]
							0.001[b]	152(1.19–1.92) [b]
							0.014[c]	1.61(1.102.35) [c]
							0.000[d]	1.57(1.27–1.95) [d]
							0.000[e]	3.70(2.06–6.64) [e]
							0.000[f]	5.39(2.52–11.51) [f]

Notes: [a-f], represent Preterm birth, GDM, GH, caesarean, LBW, macrosomia, respectively.

Abbreviations: GDM, Gestational diabetes mellitus; GH, Gestational hypertension; GA, Gestational anemia; GWG, Gestational weight gain; BW, birth weight; LBW, Low birth weight infant; NBW, Normal birth weight infant; CAN, Cord Around Neck.

demonstrated significantly higher risks of preterm birth (OR=3.14, 95% CI: 1.37–7.23; p=0.007) and gestational diabetes mellitus (GDM) (OR=2.94, 95% CI: 1.60–5.39; p=0.001) in multivariate analysis adjusted for maternal age and parity. Overweight women exhibited substantially elevated risks of GDM (OR=5.62, 95% CI: 2.86–11.06; p<0.001) and gestational hypertension (GHT) (OR=9.49, 95% CI: 4.17–21.60; p<0.001). No significant associations were observed for obese women across outcomes (p>0.05), and notably, pre-pregnancy BMI showed no correlation with macrosomia. Regarding GWG, insufficient weight gain significantly increased risks of cesarean delivery (OR=1.48, 95% CI: 1.22–1.79; p<0.001), low birth weight (LBW) (OR=2.30, 95% CI: 1.29–4.10; p=0.005), and macrosomia (OR=2.82, 95% CI: 1.73–4.57; p<0.001). Excessive weight gain was associated with significantly higher risks for preterm birth (OR=2.36, 95% CI: 1.51–3.70; p<0.001), GDM (OR=1.52, 95% CI: 1.19–1.92; p=0.001), GHT (OR=1.61, 95% CI: 1.10–2.35; p=0.014), cesarean delivery (OR=1.57, 95% CI: 1.27–1.95; p<0.001), LBW (OR=3.70, 95% CI: 2.06–6.64; p<0.001), and macrosomia (OR=5.39, 95% CI: 2.52–11.51; p<0.001). Additionally, advanced maternal age (≥35 years) independently increased preterm birth risk (OR=1.58, 95% CI: 1.17–2.13; p=0.003), while high parity (≥3 births) reduced this risk by 25% (OR=0.75, 95% CI: 0.58–0.97; p=0.028).

Discussion

Ensuring maternal health and safety during pregnancy and postpartum remains a critical economic and population development priority. Comprehensive prenatal and perinatal care plays a key role in minimizing pregnancy complications and adverse outcomes.

Overweight or obese women before pregnancy are 2.16 times more likely to develop GDM and 4.02 times more likely to develop GHT,[20] which is consistent with the results of this study. This association may be attributed to elevated blood lipid levels in overweight and obese women, which contribute to insulin resistance and atherosclerosis, thereby increasing the risk of GDM and GHT.[21] Moreover, this study found that pre-pregnancy overweight and obesity significantly increased the risk of premature birth and cesarean delivery. Excessive adiposity in obese pregnant women has been linked to a higher incidence of pregnancy complications and prolonged labor. These factors, along with increased psychological stress, may impair uterine contractions, leading to elevated rates of preterm birth and cesarean section.[22,23] However, a study from the United States reported that both low pre-pregnancy weight and obesity were associated with a higher risk of preterm birth. Conversely, this study found that pregnant women with insufficient weight gain had a lower incidence of preterm birth than other groups.[24] Similarly, a meta-analysis of Chinese pregnant women reported no substantial correlation between low pre-pregnancy BMI and preterm birth, suggesting that variations in sample size and ethnic differences may account for the discrepancies in findings.[25] A retrospective cohort study by Nowak et al[26] demonstrated a positive correlation between pre-pregnancy BMI and neonatal BW, with obese women facing a higher risk of macrosomia. In this study, we found that low weight and overweight of pre-pregnancy BMI affected BW. However, obesity did not identify a considerable association, highlighting the need for further investigation with larger sample sizes in obesity of pre-pregnancy BMI.

The GWG is a crucial indicator of maternal nutritional status during pregnancy. The Institute of Medicine (IOM) classifies appropriate GWG based on pre-pregnancy BMI, providing a reliable measure of nutritional reserves before and during pregnancy. Excessive GWG is associated with GHT, cesarean delivery, and macrosomia, whereas inadequate GWG has been linked to GDM.[27] Our findings reinforce this association. Excessive GWG may induce insulin resistance, leading to metabolic abnormalities in the mother, fetal hyperinsulinemia, and accelerated fetal growth. These factors contribute to an increased risk of GHT, macrosomia, and cesarean delivery.[28] Rapid weight gain during the first trimester has been strongly associated with an increased risk of GDM, whereas weight gain in the second trimester does not appear to have a similar effect.[29] Since this study does not distinguish between weight gain across trimesters, it observed a higher incidence of GDM in the underweight group than those with normal or excessive weight gain. Furthermore, findings indicate variations in weight gain across pregnancy stages based on maternal age and neonatal BW distribution, suggesting the need for heightened attention to weight management in older primiparous women. While these results highlight a robust relationship between GWG and adverse pregnancy outcomes, further research is necessary to establish definitive evidence.

Multivariate logistic regression controlling for confounders including maternal age and parity confirmed the independent impact of prepregnancy BMI and GWG on pregnancy outcomes. Notably: 1) The robust association between overweight status and GDM/GHT (adjusted OR=5.62 for GDM; OR=9.49 for GHT) was amplified after adjustment, suggesting previous studies may have underestimated the independent effect of weight abnormalities - consistent with lipid metabolism disorders inducing insulin resistance and vascular endothelial damage;[21,28] 2) The counterintuitive association between insufficient GWG and macrosomia (OR=2.82) may relate to compensatory fetal metabolic programming triggered by energy deficit,[27] though requires validation with third-trimester glucose monitoring; 3) Non-significant findings in the obese group likely reflect statistical power limitations (n=43), warranting larger validation studies. Collectively, these regression analyses demonstrate that prepregnancy BMI and GWG remain independent predictors of complications even after accounting for age/parity, strongly supporting the necessity of prepregnancy weight screening and personalized GWG guidance.[15,27]

Given its retrospective design and relatively small sample size, this study may have inherent biases and limitations in establishing a causal relationship between pre-pregnancy weight management and pregnancy outcomes. However, it underscores the potential benefits of optimizing pre-pregnancy BMI and GWG to reduce complications such as LBW, macrosomia, and cesarean delivery. These findings provide a valuable reference for local maternal and child healthcare providers in perinatal care; they serve as a foundation for future research by our team on the mechanisms through which weight management can mitigate adverse pregnancy outcomes.

Ethics Approval

This study was approved by the Ethics Committee of Zhuzhou Central Hospital (No. 2020190-01) and was conducted in accordance with the Declaration of Helsinki.

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Disclosure

The authors declare no conflicts of interest in this work.

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