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# Analysis of the Effects of Maternal Body Mass Index and Gestational Weight Gain on Maternal and Neonatal Outcomes in Twin Pregnancy

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**Abstract:** *Objective:* To investigate the effects of maternal body mass index (BMI) and gestational weight gain on maternal and neonatal outcomes in twin pregnancies. *Methods:* Five hundred cases of twin pregnancies were divided into a low body weight group (68 cases), a normal weight group (355 cases), an overweight group (65 cases), and an obesity group (12 cases) according to the World Health Organization (WHO) Body Mass Index (BMI) classification guidelines *Results:* Comparison of weight gain during different pregnancies revealed that pregnant women were mainly of low weight and average weight. The higher the BMI before pregnancy, the higher the incidence of excessive weight gain during pregnancy. The incidences of gestational diabetes mellitus (GDM) and premature rupture of membranes in women with low weight gain were significantly higher than those in women with average weight gain and high weight gain ($P < 0.05$). The incidences of gestational hypertension, preeclampsia, and anemia in women with high weight gain were significantly higher than those in women with low weight gain and average weight gain ($P < 0.05$). The incidence of neonatal birth weight, fetal distress, and macrosomia in the high weight gain group was significantly higher than those in the low weight gain and average weight gain groups ($P < 0.05$). The birth weight of newborns in low-weight gain mothers was significantly lower than that of normal-weight gain mothers ($P < 0.05$). *Conclusion:* Poor maternal and infant outcomes were common in women with insufficient or excessive weight gain during pregnancy. Therefore, for women with twin pregnancies, weight management is crucial to ensure maternal and infant health.

**Keywords:** Body mass index; Weight gain; Pregnancy outcome

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## I. Introduction

Globally, twin pregnancies account for approximately 2%–4% of all births, with a significant increase in incidences reported over the past few decades [1–4]. Compared with singleton pregnancies, women with twin pregnancies are more likely to suffer from pregnancy complications such as anemia, hypertensive disorders, gestational diabetes, and postpartum hemorrhage [5,6]. The risk of potentially life-threatening conditions, severe maternal outcomes, and maternal death is 2–4 times higher in twin pregnancies than in singleton pregnancies

[7]. Preterm birth and its associated complications are the leading cause of mortality in children < 5 years of age [8]. Previous studies have shown that for twin pregnancies, the preterm birth rates at < 37 and < 32 weeks were 5.7 times and 7.1 times higher respectively than in singleton pregnancies, and the preterm birth rates in twin pregnancies ranged from 31%–63% [9]. Proper identification of patients with an increased risk of preterm birth will enable optimization of available interventions to reduce adverse perinatal outcomes. At the same time, the availability of risk stratification systems can reduce unnecessary interventions in low-risk patients and improve treatment outcomes. Methods of predicting preterm birth and risk factors in twin pregnancies have long been studied. A history of premature birth, maternal clinical characteristics [10], such as age and height [11,12], gestational weight gain (GWG) [13,14], maternal complications such as preeclampsia [15], and biophysical and biochemical testing [16], have been proposed to help identify and optimize the management of preterm birth in twin pregnancies. However, studies involving twin pregnancies have been mainly conducted in Western countries, and data on perinatal outcomes of twin pregnancies in Chinese women are limited. Few studies have evaluated risk factors for preterm birth in this large population. Our goal is to determine the characteristics of weight gain during pregnancy, analyze its influencing factors, and provide scientific and standardized guidance reference materials for weight management during pregnancy health care for women with twin pregnancies, thereby improving the outcome of twin pregnancies and ensuring maternal and fetal safety.

## 2. Methods

### 2.1. Selection and grouping of research objects

This retrospective study recorded 500 cases of twin pregnancies in the hospital between January 2017 and December 2022. All obstetric records of eligible subjects were systematically reviewed and relevant data were extracted through a pre-designed standardized form. This study was approved by the hospital ethics committee. Inclusion criteria: (1) Pregnant women aged 18–45 years who had their first antenatal visit during pregnancy; (2) delivered viable twins at ≥ 26 weeks gestation. Exclusion criteria: (1) Patients with congenital anomalies and intrauterine death (2) women with missing data regarding height, pre-pregnancy weight, pre-delivery weight, and other confounding factors, including maternal age, pregnancy status, parity, historical cesarean section, education level, use of assisted reproductive technology (ART), twin type, previous diabetes/hypertension, gestational diabetes mellitus (GDM), gestational hypertension, and family history of diabetes or hypertension.

All participants were weighed at 12 ± 1 weeks of gestation and divided into four subgroups according to body mass index (BMI) range according to the World Health Organization (WHO) classification: underweight (BMI < 18.5 kg/m$^2$), normal (BMI 18.5–25 kg/m$^2$), overweight (BMI 25–30 kg/m$^2$) and obese (BMI ≥ 30 kg/m$^2$) [17]. GWG is the difference between the mother's final prenatal and pre-pregnancy weight. According to the Institute of Medicine (IOM) [18] guidelines, the recommendations for weight gain according to different BMI categories were: underweight (12.5–18 kg), normal weight (11.5–16 kg), overweight (7–11.5 kg), and obese (5–9 kg). The BMI value gained during pregnancy was calculated by subtracting the BMI from pre-pregnancy with the BMI from pre-delivery. The women were divided into 3 groups based on this data. A BMI increase below 5 kg/m$^2$ was grouped as low weight gain; a BMI increase between 5 kg/m$^2$ and 7 kg/m$^2$ was grouped as normal weight gain; a BMI increase above 7 kg/m$^2$ was grouped as high weight gain.

### 2.2. Data collection

The data for this study was obtained through computer tracking systems or medical records, including (1) age (years) and BMI; (2) adverse maternal outcomes: maternal complications, including GMD, gestational hypertension, eclampsia, anemia, and premature membranes (3) adverse neonatal outcomes: premature birth, fetal distress, macrosomia, neonatal intensive care unit (NICU) stay for more than 48 hours, appearance, pulse, grimace, activity, and respiration (APGAR) score < 8, and other neonatal complications.

## 2.3. Statistical analysis

All statistical analyses of study data were performed using the SPSS 23.0 software and continuous variables with approximate Gaussian distribution were expressed as mean ± standard deviation, and analyzed by analysis of variance (ANOVA). Categorical variables were presented as frequencies and accompanying percentages and analyzed by the chi-squared ($\chi^2$) test or Fisher's exact test when appropriate. All *P* values are two-tailed and results were considered statistically significant at $P < 0.05$.

# 3. Results

## 3.1. Comparison of baseline data of pregnant women

As shown in **Table 1**, the mean age of the participants was 31.05 ± 3.57 years. Pregnant women with different pre-pregnancy BMI had different weight gain during pregnancy, and the differences were statistically significant ($P < 0.001$).

**Table 1.** Baseline data of pregnant women with different pre-pregnancy BMI

| Variable | Total cases (*n* = 500) | Underweight (*n* = 68) | Normal weight (*n* = 355) | Overweight (*n* = 65) | Obesity (*n* = 12) | F | *P* |
|---|---|---|---|---|---|---|---|
| Age (years) | 31.05 ± 3.57 | 31.47 ± 3.48 | 31.02 ± 3.78 | 31.29 ± 3.12 | 30.76 ± 3.65 | 34.653 | < 0.001 |
| GWG | 20.61 ± 0.93 | 20.06 ± 0.98 | 20.73 ± 0.95 | 20.89 ± 0.89 | 21.21 ± 0.88 | 5.283 | 0.001 |

## 3.2. Comparison of BMI weight gain in each group during pregnancy

As shown in **Table 2**, mothers were mainly underweight and had normal weight when comparing the differences in weight gain during different pregnancy periods. The higher the pre-pregnancy BMI, the higher the incidence of excessive weight gain during pregnancy.

**Table 2.** Comparison of BMI weight gain in different pregnancy periods [cases (%)]

| Group | Not enough weight gain | Appropriate weight gain | Gaining too much weight |
|---|---|---|---|
| Underweight group (*n* = 68) | 27 (39.71) | 29 (42.64) | 12 (17.65) |
| Normal weight group (*n* = 355) | 132 (37.18) | 173 (48.73) | 50 (14.09) |
| Overweight group (*n* = 65) | 20 (30.77) | 7 (10.77) | 38 (58.46) |
| Obese group (*n* = 12) | 2 (16.67) | 2 (16.67) | 8 (66.67) |
| $\chi^2$ | | 17.291 | |
| *P* | | 0.009 | |

## 3.3. Comparison of maternal complications and pregnancy outcomes under different weight gain conditions

As shown in **Table 3**, there were statistically significant differences in the incidence rates of GDM, gestational hypertension, preeclampsia, anemia, and premature rupture of membranes among mothers with different weight gain conditions ($P < 0.05$). Low body weight increases the risk of maternal GDM and fetal membranes. The incidence of premature rupture was significantly higher in low-weight gain mothers as compared to those with normal weight gain and high weight gain ($P$ < 0.05). The incidence rates of gestational hypertension, preeclampsia, and anemia in high-weight gain mothers were significantly higher than those of low-weight gain and normal weight-gain mothers ($P$ < 0.05).

**Table 3.** Comparison of pregnancy complications among pregnant women with different weight gain conditions [$n$ (%)]

| Group | GDM | Hypertension during pregnancy | Preeclampsia | Anemia | Premature rupture of membranes |
|---|---|---|---|---|---|
| Low weight gain group ($n$ = 181) | 42 (25.97) | 31 (17.13) | 7 (3.87) | 7 (3.87) | 47 (25.97) |
| Normal weight gain group ($n$ = 211) | 31 (14.69) | 44 (20.85) | 21 (9.95) | 11 (5.21) | 33 (15.64) |
| High weight gain group ($n$ = 108) | 14 (12.96) | 39 (36.11) | 14 (12.96) | 14 (12.96) | 24 (20.37) |
| $\chi^2$ | 5.015 | 5.212 | 4.459 | 4.667 | 5.331 |
| $P$ | 0.028 | 0.024 | 0.036 | 0.033 | 0.021 |

## 3.4. Comparison of maternal and neonatal conditions with different weight gain conditions

As shown in Table 4, there were statistically significant differences in the birth weight, fetal distress, and incidence of macrosomia among mothers with different weight gain conditions ($P$ < 0.05). The birth weight, fetal distress, and incidence of macrosomia among mothers in the high weight gain group were all significantly higher than that of women with low weight gain and normal weight gain ($P$ < 0.05). The weight of newborns of women with low weight gain was significantly lower than that of women with normal weight gain ($P$ < 0.05).

**Table 4.** Comparison of maternal and neonatal conditions under different weight gain conditions

| Group | Birth weight (g) | APGAR rating (points) | Fetal distress [$n$ (%)] | Macrosomia [$n$ (%)] | NICU admission [$n$ (%)] |
|---|---|---|---|---|---|
| Low weight gain group ($n$ = 181) | 3,028.17 ± 312.27 | 9.83 ± 0.13 | 10 (5.52) | 13 (7.18) | 16 (8.84) |
| Normal weight gain group ($n$ = 211) | 3,316.25 ± 350.23 | 9.90 ± 0.11 | 19 (9.00) | 8 (3.79) | 20 (9.48) |
| High weight gain group ($n$ = 108) | 3,472.31 ± 328.59 | 9.93 ± 0.15 | 42 (38.89) | 45 (41.67) | 10 (9.26) |
| F/$\chi^2$ | 21.774 | 0.397 | 7.41 | 17.362 | 0.677 |
| $P$ | <0.001 | 0.676 | 0.025 | <0.001 | 0.423 |

Abbreviation: NICU, neonatal intensive care unit.

# 4. Discussion

Twin pregnancies account for approximately 1%–3% of all pregnancies. Due to advanced maternal age and the development of assisted reproductive technologies (ARTs), the incidence of twin pregnancies has been increasing [19]. Compared with singleton pregnancies, intrauterine mortality in twin pregnancies is nearly 2.5 times higher, and mortality in the first year is 4 times higher [20,21]. According to statistics, twins account for 3.2% of all births but account for more than 20% of burdens associated with preterm birth [22]. Twin pregnancy increases the risk of preeclampsia, GDM, rupture of membranes, premature birth, and cesarean section [23,24]. Adverse neonatal outcomes associated with twin pregnancy include premature birth, low birth weight, and fetal growth restriction. The resulting small-for-gestational-age neonates, perinatal deaths, and increased neonatal intensive care unit (NICU) requirements were mainly determined by the mother's GWG during pregnancy [25,26].

GWG is an important determinant of pregnancy outcome. Excessive GWG is related to preeclampsia and GDM [27]. In this study, the incidence rates of gestational hypertension, preeclampsia, and anemia in mothers with high weight gain were significantly higher than those with low and normal weight gain. Insufficient GWG is related to fetal growth restriction [28]. In addition, due to preeclampsia or fetal growth restriction, this study also found that the birth weight of newborns of low-weight gain mothers was significantly lower than that of normal-weight gain mothers, and excessive and insufficient GWG were all related to premature birth [29,30]. In twin pregnancies, insufficient GWG may have a greater negative impact on pregnancy outcomes due to the increased risk of the above pregnancy complications and nutritional requirements. Insufficient GWG is associated with an increased risk of pregnancy complications in the second trimester [31,32]. In the absence of effective preventive interventions for preterm birth in twin pregnancies, optimization of GWG is an attractive strategy to reduce the risk of preterm birth in twin pregnancies. However, there are two important obstacles to optimizing GWG in twin pregnancies. Firstly, the National Academy of Medicine (NAM) only provides interim guidance on total GWG, which does not allow care providers to reliably determine optimal GWG in the first trimester [33,34]. Therefore, weekly charts are needed to ensure optimal GWG throughout twin pregnancies. Secondly, insufficient GWG is common in twin pregnancies. We recently reported that more than half of patients with twin pregnancies had insufficient GWG [35]. This may be partially attributed to the lack of standardized protocols in the monitoring and management of GWG in twin pregnancies. Therefore, implementing a care pathway to monitor and optimize GWG in twin pregnancies is crucial to improve maternal and neonatal health.

Appropriate weight management and nutritional guidance are important to prevent adverse pregnancy outcomes. Controlling weight gain and providing nutritional guidance can prevent complications caused by excessive weight gain during pregnancy while ensuring that the fetus receives adequate nutrition for normal growth and development. In addition, nutritional guidance can help pregnant women better understand how to meet their own and their fetus' energy needs and reduce unnecessary fat accumulation, reducing the risk of adverse pregnancy outcomes. Currently, there are research limitations on the relationship between maternal BMI, GWG, and adverse pregnancy outcomes, including a single data source and a small sample size. In this study, high trends in GDM, gestational hypertension, and premature rupture of membranes were observed. Appropriate lifestyle interventions, including diet and physical activity, should be strongly recommended to prevent these maternal complications. Further large-scale clinical trials and studies are needed to explore the exact relationship between these factors and adverse pregnancy outcomes to identify more accurate and reliable interventions to improve pregnancy safety and neonatal health.

## Disclosure statement

The authors declare no conflict of interest.

## References

[1] Ananth CV, Chauhan SP, 2012, Epidemiology of Twinning in Developed Countries. Semin Perinatol, 36: 156–61.

[2] Martin JA, Hamilton BE, Osterman MJ, 2012, Three Decades of Twin Births in the United States, 1980–2009. NCHS Data Brief, 80:1–8.

[3] Deng C, Dai L, Yi L, et al., 2019, Temporal Trends in the Birth Rates and Perinatal Mortality of Twins: A Population-Based Study in China. PLoS ONE, 14: e0209962.

[4] Chauhan SP, Scardo JA, Hayes E, et al., 2010, Twins: Prevalence, Problems, and Preterm Births. Am J Obstet

Gynecol, 203: 305–15.
[5] Rao A, Sairam S, Shehata H, 2004, Obstetric Complications of Twin Pregnancies. Best Pract Res Clin Obstet Gynaecol, 18: 557–76.
[6] Committee on Practice Bulletins-Obstetrics, Society for Maternal-Fetal Medicine, 2016, Practice Bulletin No. 169: Multifetal Gestations: Twin, Triplet, and Higher-Order Multifetal Pregnancies. Obstet Gynecol, 128: e131–46.
[7] Santana DS, Cecatti JG, Surita FG, et al., Twin Pregnancy and Severe Maternal Outcomes: The World Health Organization Multicountry Survey on Maternal and Newborn Health. Obstet Gynecol, 127: 631–41.
[8] Liu L, Johnson HL, Cousens S, et al., 2012, Global, Regional, and National Causes of Child Mortality: An Updated Systematic Analysis for 2010 with Time Trends Since 2000. Lancet, 379: 2151–61.
[9] Martin JA, Hamilton BE, Ventura SJ, et al., 2013, Births: Final Data for 2011. Natl Vital Stat Rep, 62: 1–69 + 72.
[10] Kazemier BM, Buijs PE, Mignini L, et al., 2014, Impact of Obstetric History on the Risk of Spontaneous Preterm Birth in Singleton and Multiple Pregnancies: A Systematic Review. BJOG, 121:1197–208.
[11] Dickey RP, Xiong X, Gee RE, et al., 2012, Effect of Maternal Height and Weight on the Risk of Preterm Birth in Singleton and Twin Births Resulting from In Vitro Fertilization: A Retrospective Cohort Study Using the Society for Assisted Reproductive Technology Clinic Outcome Reporting System. Fertil Steril, 97: 349–54.
[12] Marleen S, Dias C, Nandasena R, et al., 2020, Association Between Chorionicity and Preterm Birth in Twin Pregnancies: A Systematic Review Involving 29864 Twin Pregnancies. BJOG, 128(5): 788–796.
[13] Bodnar LM, Himes KP, Abrams B, et al., 2019, Gestational Weight Gain and Adverse Birth Outcomes in Twin Pregnancies. Obstet Gynecol, 134(5): 1075–86.
[14] Lin D, Fan D, Wu S, et al., 2019, The Effect of Gestational Weight Gain on Perinatal Outcomes Among Chinese Twin Gestations Based on Institute of Medicine Guidelines. BMC Pregnancy Childbirth, 19: 262.
[15] Marleen S, Hettiarachchi J, Dandeniya R, et al., 2018, Maternal Clinical Predictors of Preterm Birth in Twin Pregnancies: A Systematic Review Involving 2,930,958 Twin Pregnancies. Eur J Obstet Gynecol Reprod Biol, 230:159–171.
[16] Conde-Agudelo A, Romero R, 2014, Prediction of Preterm Birth in Twin Gestations Using Biophysical and Biochemical Tests. Am J Obstet Gynecol, 211: 583–95.
[17] World Health Organization Technical Report Series, 2000, Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation, World Health Organization, Geneva, Switzerland, 894.
[18] Institution of Medicine (US) Committee on Nutritional Status During Pregnancy and Lactation, 1990, Nutrition During Pregnancy: Part I, Weight Gain: Part II, Nutrient Supplements, Natl Academy Pr, Washington (DC), 10.
[19] Monden C, Pison G, Smits J, 2021, Twin Peaks: More Twinning in Humans Than Ever. Hum Reprod, 36(6): 1666–1673.
[20] Santana DS, Silveira C, Costa ML, et al., 2018, Perinatal Outcomes in Twin Pregnancies Complicated by Maternal Morbidity: Evidence from the WHO Multicountry Survey on Maternal and Newborn Health. BMC Pregnancy Childbirth, 18: 449.
[21] The ESHRE Capri Workshop Group, 2000, Multiple Gestation Pregnancy. Hum Reprod, 15(8): 1856–1864.
[22] Roman A, Ramirez A, Fox NS, 2022, Screening for Preterm Birth in Twin Pregnancies. Am J Obstet Gynecol MFM, 4(2): 100531.
[23] Li S, Gao J, Liu J, et al., 2021, Perinatal Outcomes and Risk Factors for Preterm Birth in Twin Pregnancies in a Chinese Population: A Multi-center Retrospective Study. Front Med, 2021(8): e657862.
[24] Zhou S, Yang Y, Zhang X, et al., 2021, Perinatal Outcomes of Twin Pregnancies with Preterm Premature Rupture of the Membranes At 24–34 Weeks Gestation. Sci Rep, 11: 23419.
[25] Refuerzo JS, Momirova V, Peaceman AM, et al., 2010, Neonatal Outcomes in Twin Pregnancies Delivered

Moderately Preterm, Late Preterm, and Term. Am J Perinatol, 27(7): 537–542.
[26] Kominiarek MA, Peaceman AM, 2017, Gestational Weight Gain. Am J Obstet Gynecol. 217(6): 642–651.
[27] Crane JM, White J, Murphy P, et al., 2009, The Effect of Gestational Weight Gain by Body Mass Index on Maternal and Neonatal Outcomes. J Obstet Gynaecol Can, 31: 28–35.
[28] Strauss RS, Dietz WH, 1999, Low Maternal Weight Gain in the Second or Third Trimester Increases the Risk for Intrauterine Growth Retardation. J Nutr, 129: 988–93.
[29] Viswanathan M, Siega-Riz AM, Moos MK, et al., 2008, Outcomes of Maternal Weight Gain. Evid Rep Technol Assess (Full Rep), 2008(168): 1–223.
[30] Bodnar LM, Himes KP, Abrams B, et al., 2019, Gestational Weight Gain and Adverse Birth Outcomes in Twin Pregnancies. Obstet Gynecol, 134: 1075–86.
[31] Luke B, Gillespie B, Min SJ, et al., 1997, Critical Periods of Maternal Weight Gain: Effect on Twin Birth Weight. Am J Obstet Gynecol, 177: 1055–62.
[32] Luke B, Min SJ, Gillespie B, et al., 1998, The Importance of Early Weight Gain in Twins' Intrauterine Growth and Birth Weight. Am J Obstet Gynecol, 179: 1155–61.
[33] Rasmussen KM, Yaktine AL, (eds), 2009, Weight Gain During Pregnancy: Reexamining the Guidelines, National Academic Press, Washington, http://www.ncbi.nlm.nih.gov/books/NBK32813/
[34] Lipworth H, Barrett J, Murphy KE, et al., 2022, Gestational Weight Gain in Twin Gestations and Pregnancy Outcomes: A Systematic Review and Meta-Analysis. BJOG, 129: 868–79.
[35] Lipworth H, Melamed N, Berger H, et al., 2021, Maternal Weight Gain and Pregnancy Outcomes in Twin Gestations. Am J Obstet Gynecol, 225(2): 523.e1–532.e12.

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