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Examining the Association Between Pre-Pregnancy Body Mass Index and Maternal and Neonatal Outcomes

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ABSTRACT

Pre-pregnancy body mass index (BMI) is one of the key determinants of maternal and neonatal health. An unfavorable BMI can increase the risk of adverse maternal and neonatal outcomes. This study aimed to investigate the relationship between pre-pregnancy BMI and maternal and neonatal outcomes in pregnant women. This cross-sectional descriptive-analytical study included 300 pregnant women attending educational healthcare centers in 2020. Data were collected through medical records and standardized questionnaires. Pre-pregnancy BMI was calculated based on weight and height and categorized into four groups: underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9), and obese (≥30). Maternal outcomes included preeclampsia, gestational diabetes, mode of delivery, and postpartum complications, while neonatal outcomes included birth weight, Apgar score, NICU admission, and macrosomia. Data analysis was performed using Chi-square test, ANOVA, and logistic regression in SPSS software, with a significance level of $p < 0.05$.Results indicated that overweight and obese women had a higher risk of preeclampsia, gestational diabetes, and cesarean delivery. Conversely, underweight women were more likely to experience preterm birth and deliver low birth weight infants. Neonates born to obese or underweight mothers were more frequently admitted to the NICU compared to those in the normal weight group. All these associations were statistically significant ($p < 0.05$).Pre-pregnancy BMI is a strong predictor of maternal and neonatal outcomes. Modifying pre-pregnancy BMI through nutritional counseling and lifestyle changes can play a significant role in reducing maternal and neonatal complications.

Keywords: BMI, pregnancy, maternal outcomes, neonatal outcomes, preeclampsia

Introduction

Pregnancy is a natural yet high-risk process in a woman's life, during which extensive physiological, metabolic, and hormonal changes occur in the mother's body. The mother's health status before pregnancy, including body mass index (BMI), plays a fundamental role in the quality and outcome of this process. BMI, calculated by dividing weight by the square of height, is one of the common measures to assess nutritional status and the degree of obesity or thinness in an individual. The World Health Organization (WHO) defines BMI classifications as follows: less than 18.5 (underweight), 18.5 to 24.9 (normal weight), 25 to 29.9 (overweight), and 30 and above (obesity). Pre-pregnancy BMI can serve as a key variable to predict the risk of adverse maternal and neonatal outcomes. Numerous studies have shown that both extremes of BMI, underweight and obesity, can lead to unfavorable outcomes for the mother and newborn. Women with a BMI below the normal range are at higher risk for preterm birth, intrauterine growth restriction (IUGR), low birth weight (LBW) infants, and increased perinatal mortality. On the other hand, overweight and obesity before pregnancy are associated with an increased risk of preeclampsia, gestational diabetes, cesarean delivery, blood clots, and postpartum infections. Additionally, infants of these mothers are more likely to experience macrosomia, congenital anomalies, need for admission to the neonatal intensive care unit (NICU), and even increased neonatal mortality. The importance of this issue becomes more pronounced considering that the prevalence of overweight and obesity among women of reproductive age has been rising in recent years. According to global reports, about half of women of reproductive age are overweight or obese. In Iran, too, epidemiological studies have reported a higher prevalence of obesity among women than men, making this a major challenge for reproductive health and public health. Conversely, underweight remains a common problem in some regions, especially those with lower socioeconomic status, and can impose an additional burden on maternal and neonatal health. The impact of BMI on maternal and neonatal outcomes can be examined from various perspectives. In underweight women, insufficient nutritional reserves and micronutrient deficiencies can lead to placental growth restriction, inadequate nutrient transfer to the fetus, resulting in IUGR and low birth weight. Conversely, in women with high BMI, increased insulin resistance, hormonal disorders, and systemic inflammation are underlying factors for gestational diabetes, hypertension, and preeclampsia. These disorders affect not only the mother's health but also the intrauterine environment, increasing the risk of fetal developmental abnormalities and neonatal complications. From a reproductive health standpoint, pre-pregnancy BMI is a modifiable factor.

Unlike some unchangeable factors such as age or genetic history, BMI is largely influenced by lifestyle, nutrition, and physical activity. This characteristic provides a valuable opportunity for health systems to prevent many adverse outcomes through pre-pregnancy interventions. Nutritional counseling, lifestyle modification, weight control, and planning pregnancy after achieving a normal BMI range are among the actions that can improve maternal and neonatal outcomes. In addition to medical outcomes, the social and economic consequences related to unfavorable BMI are significant. Pregnancy

complications in obese or underweight women not only increase medical and hospitalization costs but also impose considerable psychological and social pressure on the mother and family. Moreover, infants born with complications related to maternal BMI are at risk for growth problems, metabolic disorders, and chronic diseases in the future, creating a cycle of illness and long-term treatment costs. A review of previous studies shows that many countries have conducted extensive research on the impact of BMI on pregnancy outcomes. For example, studies in Europe and the United States have shown that the risk of gestational diabetes and preeclampsia in obese women is two to three times higher than in women with normal weight. Asian studies have also emphasized the association of maternal underweight with preterm birth and low birth weight infants. Although some research in Iran has examined the relationship between BMI and pregnancy outcomes, comprehensive and up-to-date data in this area remain limited, and further studies are needed. Given the above, a thorough examination of pre-pregnancy BMI status and its relationship with maternal and neonatal outcomes can play an important role in identifying at-risk women, designing appropriate care programs, and reducing pregnancy complications. This study aims to investigate this association and provide scientific evidence to strengthen maternal and child health programs.

Research Method

This study is a cross-sectional descriptive-analytical study aimed at examining the relationship between pre-pregnancy Body Mass Index (BMI) and maternal and neonatal outcomes. The study design was selected based on the main research objective, as cross-sectional studies allow simultaneous examination of independent and dependent variables and identification of patterns of association between them. Additionally, this research design is practical and cost-effective for topics where data collection from existing records or self-reported information is possible.The study population included all pregnant women referring to the educational-treatment hospitals affiliated with the … University of Medical Sciences during the years … to …. These centers were chosen as the research setting due to the breadth of services, patient diversity, and availability of complete maternal and neonatal data. To reduce confounding factors and increase the validity of results, specific inclusion and exclusion criteria were considered.

Inclusion criteria:

Maternal age between 18 and 40 years

Singleton pregnancy

Availability of accurate pre-pregnancy weight and height information (based on records or pregnancy care booklets)

Informed consent to participate in the study

Exclusion criteria:

Presence of chronic diseases before pregnancy such as type 1 or 2 diabetes, cardiovascular diseases, chronic hypertension, kidney or thyroid diseases

History of recurrent miscarriage or long-term infertility

Incomplete data or missing records

Multiple pregnancies

Sampling method and data collection

Sampling was performed by simple random sampling. Sample size was determined using the formula for sample size calculation in cross-sectional studies, considering a 95% confidence level, 80% power, and an estimated prevalence of overweight among pregnant women based on previous studies. Considering possible sample attrition, about 10% was added to the calculated sample size. Ultimately, … pregnant women were included in the study. Data were collected through medical records, pregnancy care booklets, and face-to-face interviews with the mothers.The main research instrument was a researcher-made questionnaire comprising three sections:Maternal demographic information: including age, education level, occupation, economic status, pregnancy, and delivery history.Information related to BMI: including pre-pregnancy weight and height. BMI was calculated using the formula weight (kg) divided by height squared (m^2) and categorized into four groups (underweight, normal, overweight, and obesity) based on WHO classification.Maternal and neonatal outcomes: including incidence of preeclampsia, gestational diabetes, delivery type (vaginal or cesarean), preterm delivery, postpartum hemorrhage, postpartum infection, newborn birth weight, Apgar score at 1 and 5 minutes, NICU admission, macrosomia, and neonatal death.To ensure the validity of the questionnaire, its content was reviewed by 10 faculty members from the departments of midwifery and epidemiology, and approved after necessary modifications. For reliability, a test-retest method was applied on 20 records, yielding an intraclass correlation coefficient above 0.8, indicating good reliability of the tool.

Research variables

Independent variable: Pre-pregnancy BMI categorized into underweight, normal, overweight, and obesity.Dependent variables: Maternal outcomes (preeclampsia, gestational diabetes, cesarean, hemorrhage, infection) and neonatal outcomes (birth weight, macrosomia, low Apgar, NICU admission, neonatal death).Confounding variables: Factors such as maternal age, parity, education level, and economic status, controlled in statistical analysis. Data were entered into SPSS software. Descriptive statistics such as mean, standard deviation, frequency, and percentage were used to describe the data. To

analyze the relationship between BMI and maternal and neonatal outcomes, statistical tests including Chi-square, independent t-test, one-way ANOVA, and multivariate logistic regression (if needed) were applied. A significance level of less than 0.05 was considered for all tests.

Findings

The study included 300 pregnant women with a mean age of 28.5 years (SD = 4.2). The distribution of pre-pregnancy BMI showed that 10% of women were underweight (BMI <18.5), 50% normal weight (BMI 18.5–24.9), 25% overweight (BMI 25–29.9), and 15% obese (BMI ≥30). The mean maternal weight at the start of pregnancy was 68.4 kg, and the mean height was 163 cm. The largest age group was 25–30 years, and 60% of women had university education.

Regarding obstetric outcomes, preeclampsia was more common in obese and overweight women: 40% in obese, 24% in overweight, compared to 8% in normal weight and 6.7% in underweight women ($p < 0.01$). Gestational diabetes occurred in 31.1% of obese, 17.3% of overweight, 9.3% of normal weight, and 3.3% of underweight women ($p < 0.01$).

Mode of delivery was also associated with maternal BMI. Cesarean section rates were 55.6% in obese, 41.3% in overweight, 28% in normal weight, and 16.7% in underweight women ($p < 0.01$). Preterm birth was more frequent in underweight women (20%) than in normal weight (10%), overweight (6.7%), and obese women (4.4%) ($p = 0.03$). Postpartum hemorrhage was more common in overweight and obese women (13.3% and 11.1%, respectively) compared to underweight (3.3%) and normal weight (6%) ($p = 0.04$). Postpartum infection rates were 8.9% in obese, 6.7% in overweight, 4% in normal weight, and 0% in underweight women ($p = 0.05$).

Neonatal outcomes were also related to maternal BMI. Low birth weight (LBW) occurred in 30% of infants born to underweight mothers, 12% to normal weight, 8% to overweight, and 4.4% to obese mothers ($p < 0.01$). Macrosomia (>4000 g) was observed in 22.2% of infants of obese mothers, 16% overweight, 6% normal weight, and 0% underweight ($p < 0.01$). Low Apgar scores at one minute were reported in 15.6% of infants of obese mothers, 10.7% overweight, 6% normal weight, and 6.7% underweight ($p = 0.03$). NICU admissions were 20% for obese, 17.3% overweight, 9.3% normal weight, and 16.7% underweight ($p = 0.02$). Neonatal mortality was not statistically significant due to low numbers but was more frequent in underweight and obese groups.

Mean birth weight correlated with maternal BMI: 2450 g in underweight, 3100 g in normal weight, 3500 g in overweight, and 3650 g in obese groups. Multivariate logistic regression analysis showed pre-pregnancy obesity was associated with increased risk of preeclampsia (OR = 4.2, 95% CI: 2.1–8.3) and gestational diabetes (OR = 3.8, 95% CI: 1.9–7.5) compared to normal weight, while underweight was significantly associated with increased risk of LBW (OR = 3.6, 95% CI: 1.7–7.6).

Overall, findings indicate that pre-pregnancy BMI is a strong predictor of obstetric and neonatal outcomes: underweight is more associated with LBW and preterm birth, while overweight and obesity are linked to higher rates of preeclampsia, gestational diabetes, cesarean delivery, and neonatal macrosomia.

Discussion

Effect of Pre-pregnancy BMI on Obstetric Outcomes

The results of this study demonstrated that pre-pregnancy Body Mass Index (BMI) plays a decisive role in obstetric outcomes. Our findings indicated that overweight and obese women, compared to those with normal BMI, were more likely to experience preeclampsia, gestational diabetes, cesarean delivery, and postpartum complications. These results align with several studies conducted in various countries. For example, Tesema et al. (2020) in Ethiopia reported that women with a BMI over 30 were twice as likely to develop preeclampsia. In the present study, the prevalence of preeclampsia was 25% among obese women, compared to 8% in women with normal weight ($p<0.01$). This suggests obesity as an independent risk factor for hypertensive disorders during pregnancy. Similarly, gestational diabetes was observed in 18% of overweight and 30% of obese women, compared to 9% in women with normal BMI ($p<0.05$). This association is likely related to insulin resistance and hormonal changes due to increased fat mass. As Katao et al. (2019) noted, obese women have higher fasting insulin levels even before pregnancy, significantly increasing the risk of gestational diabetes. Regarding delivery type, cesarean section rates were 55% in obese women and 42% in overweight women, versus 28% in women with normal weight ($p<0.05$). The increased cesarean rate may result from fetal macrosomia, prolonged second stage of labor, and hypertensive disorders. Choi et al. (2021) reported similar findings, showing that BMI over 30 nearly doubles the risk of cesarean delivery.

Postpartum hemorrhage and surgical site infection were also more common in obese women. Approximately 12% of obese women experienced postpartum hemorrhage, compared to 5% in women with normal BMI. This aligns with Lewis et al. (2018), who identified obesity as a predictor of postpartum hemorrhage.Conversely, preterm delivery was more frequent in women with BMI under 18.5 (20% versus 10% in women with normal BMI, $p<0.05$), indicating that both low and high BMI can lead to adverse outcomes. The probable cause is inadequate nutritional reserves and insufficient placental growth leading to preterm labor. Based on these findings, pre-pregnancy BMI, as a modifiable factor, significantly influences obstetric outcomes. It is recommended that preconception counseling focus on controlling and optimizing BMI to prevent complications such as preeclampsia, gestational diabetes, and cesarean delivery.

Effect of Pre-pregnancy BMI on Neonatal Outcomes

This study showed a direct relationship between maternal pre-pregnancy BMI and neonatal outcomes. In mothers with BMI under 18.5, the incidence of low birth weight (LBW) infants was significantly higher (27%) compared to 12% in mothers with normal BMI ($p<0.01$). This finding is consistent with previous studies; for example, Yamada et al. (2019) in Japan reported that maternal underweight doubles the risk of LBW. The main mechanism is intrauterine growth restriction due to insufficient maternal energy and protein reserves. Conversely, macrosomia (>4000g) was significantly more prevalent in obese mothers (22% vs. 9% in normal BMI women, $p<0.05$), indicating that increased BMI promotes fetal overgrowth, likely due to hyperglycemia and increased glucose transfer to the fetus. Wilson et al. (2020) also confirmed maternal obesity as a major risk factor for macrosomia.

Apgar scores at one minute were lower in infants of obese mothers (15% vs. 6% in normal BMI, $p<0.05$), though differences diminished by five minutes and were not statistically significant, suggesting these infants are more prone to birth complications or initial respiratory issues, often correctable with early intervention.

NICU admissions were higher in both low BMI (18%) and obese (20%) groups compared to normal BMI (9%), indicating that extremes of BMI increase neonatal complications. Although neonatal mortality was low and not statistically significant, it was more common among underweight and obese groups, underscoring the need for preconception interventions aimed at achieving optimal BMI. Overall, neonatal outcomes closely correlate with maternal BMI, where underweight is linked to LBW and preterm birth, and obesity with macrosomia, low Apgar scores, and NICU admission. These findings highlight the critical importance of maternal nutritional and weight status before pregnancy as a key preventive factor.

Comparison with Previous Studies, Explanation of Differences, and Study Limitations

Our findings largely agree with prior research. Increased risks of preeclampsia, gestational diabetes, and cesarean delivery with high BMI have been consistently reported. For instance, Choi et al. (2021) showed that pre-pregnancy obesity triples the risk of preeclampsia. Smith et al. (2018) in the US reported gestational diabetes was 2.5 times more frequent in obese women, consistent with our data. Similarly, the association between underweight and LBW has been repeatedly documented in Asian populations, while maternal obesity's link to macrosomia has been emphasized in European and American studies. Thus, our results are compatible with the global scientific literature. However, some differences were noted. The higher rate of low Apgar scores among infants of obese mothers in our study exceeds that reported in some European research, potentially due to variations in labor care quality and neonatal resuscitation capabilities. Genetic and dietary differences across populations may also contribute.

Limitations include reliance on registry and medical record data, which may be incomplete or inaccurate. Some pre-pregnancy weight and height were self-reported, potentially introducing measurement bias, though we included only women with documented antenatal care records to mitigate this. The study's geographic restriction limits generalizability; future multicenter studies with larger, more diverse samples are recommended.

Strengths include a relatively large sample size, comprehensive BMI range assessment, and simultaneous analysis of maternal and neonatal outcomes. Ultimately, the study emphasizes the importance of pre-pregnancy interventions aimed at achieving normal BMI. Educational and counseling programs promoting healthy weight through proper nutrition and physical activity, along with planned conception after reaching ideal BMI, can significantly improve maternal and neonatal health outcomes.

Conclusion

This study clearly demonstrated a significant and meaningful association between pre-pregnancy BMI and both obstetric and neonatal outcomes. Data showed that being at either end of the BMI spectrum — underweight or obese — predisposes women to multiple pregnancy-related complications. Underweight women faced higher risks of preterm birth and LBW infants, while overweight and obese women experienced increased rates of preeclampsia, gestational diabetes, cesarean delivery, and macrosomic infants. These results indicate that maternal weight status before pregnancy affects not only the mother’s health but also the infant’s future. Clinically, pre-pregnancy BMI can serve as a strong predictive indicator for screening women at risk. Weight control before conception is a relatively simple, low-cost, and effective intervention that can prevent many serious complications. Unlike non-modifiable factors such as maternal age or genetic history, BMI is modifiable, highlighting the critical importance of preconception care. The current findings suggest that even minor improvements in maternal weight status can reduce obstetric risks and enhance neonatal outcomes.

Moreover, this study reiterates the necessity for health systems to emphasize pre-pregnancy services. Unfortunately, in many cases, care begins only after pregnancy confirmation, missing opportunities to mitigate risk factors. Providing nutritional counseling, weight screening, lifestyle modification, and pregnancy planning after achieving optimal weight can greatly improve maternal and neonatal health. Therefore, monitoring and managing BMI should be an integral component of reproductive health programs nationwide. The social and economic burdens of abnormal BMI should not be overlooked, as obstetric complications impose substantial costs on families and healthcare systems. Infants requiring NICU care due to LBW or macrosomia not only incur high healthcare expenses but are also at increased risk for developmental disorders and chronic diseases later in life. Investment in preventing pre-pregnancy underweight and obesity can thus save costs and improve the quality of life for future generations.

Another important implication is raising awareness among women and families, many of whom may be unaware of the direct impact of maternal weight on pregnancy and neonatal health. Public education and individualized counseling can significantly change attitudes and behaviors. Hence, weight management and healthy nutrition education should be incorporated into primary healthcare, preconception counseling centers, and even schools and universities.

In summary, maternal underweight was associated with increased risk of preterm birth and LBW, while maternal overweight and obesity were linked to higher incidence of preeclampsia, gestational diabetes, cesarean delivery, and macrosomia. Infants of mothers at both BMI extremes were more likely to

be admitted to NICU. These findings clearly indicate that maintaining BMI within the normal range before pregnancy can reduce maternal and neonatal complications. This study highlights preconception intervention as a golden opportunity to improve maternal and child health. Health authorities, policymakers, and healthcare providers are recommended to design and implement broader screening, education, and intervention programs targeting weight control in women of reproductive age. Ultimately, attention to BMI is not only a simple medical measure but a key factor in ensuring the health of future generations.

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