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Correlation of Maternal BMI with Neonatal Birth Weight and Complications

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Abstract: ***Background:*** Maternal body mass index (BMI) is a significant determinant of neonatal outcomes. Both underweight and overweight status before or during pregnancy may lead to adverse birth outcomes, including low birth weight (LBW), macrosomia, and neonatal complications. ***Methods:*** This prospective cross-sectional observational study was conducted at Bangabandhu Sheikh Mujib Medical University (BSMMU) and Sibchar Health Complex, Madaripur, from August 2017 to July 2018. A total of 140 pregnant women were enrolled. Maternal BMI was classified based on WHO standards, and birth outcomes including neonatal birth weight and complications were recorded. Statistical analysis was performed using SPSS version 22, and correlations between maternal BMI and neonatal outcomes were analyzed. ***Results:*** In our study, 17.9% of mothers were underweight, 46.4% had normal BMI, 25.0% were overweight, and 10.7% were obese. Low birth weight was most prevalent among underweight mothers (60.0%), whereas macrosomia occurred more frequently in overweight (11.4%) and obese mothers (26.6%). Neonatal complications, including hypoglycemia (22.9% in overweight; 40.0% in obese), respiratory distress, NICU admission, and birth injury were notably higher among neonates born to overweight and obese mothers. A statistically significant positive correlation was observed between maternal BMI and neonatal birth weight ($p < 0.05$). ***Conclusion:*** This study highlights a strong correlation between maternal BMI and neonatal birth weight and complications. Both low and high maternal BMI are associated with increased neonatal risks. Proper antenatal care and maternal weight management are crucial for improving perinatal outcomes.

Keywords*:* Maternal BMI, Birth weight, Neonatal complications, Low birth weight, Macrosomia, Pregnancy outcomes.

INTRODUCTION

Maternal nutrition is a critical determinant of pregnancy outcomes and fetal development. Among the various indicators of maternal nutritional status, body mass index (BMI) is widely used due to its simplicity and reliability [1]. BMI reflects a woman's nutritional reserves and is directly linked with both maternal and neonatal health [2]. Abnormal BMI—either underweight or overweight—has been associated with a range of adverse pregnancy outcomes including low birth weight, macrosomia, preterm birth, and perinatal morbidity [3, 4].

Pregnancy is a period of increased physiological demand, and maternal body composition plays a crucial role in ensuring optimal fetal growth [2]. Low maternal BMI is often associated with poor nutritional status, which may lead to intrauterine growth restriction (IUGR), low birth weight, and increased risk of neonatal complications such as hypothermia, hypoglycemia, and infection [5]. On the other hand, excessive maternal weight and obesity have been linked to complications including macrosomia, shoulder dystocia, cesarean delivery, neonatal hypoglycemia, and long-term metabolic issues in the child [6]. Furthermore, maternal overweight and obesity are recognized risk factors for gestational diabetes mellitus, hypertensive disorders, and thromboembolic events, which may indirectly affect fetal outcomes [7].

In developing countries like Bangladesh, the dual burden of malnutrition is evident, where both undernutrition and overnutrition coexist [8]. Despite improved maternal healthcare services in urban and some rural areas, nutritional disparities remain significant [9]. This makes it important to assess how maternal BMI impacts neonatal outcomes in different

settings—both tertiary and peripheral healthcare facilities. The correlation between maternal BMI and neonatal birth weight may provide insights into preventive strategies for reducing perinatal complications and promoting healthy birth outcomes [10].

While several international studies have explored the relationship between maternal BMI and neonatal health, there is limited local data in the context of Bangladeshi women [11, 12]. Cultural dietary practices, healthcare access, and maternal education levels may influence outcomes differently in this population compared to others [13]. Therefore, understanding this association in the Bangladeshi context is essential for guiding clinical practices and antenatal counseling.

This study was designed to evaluate the correlation between maternal BMI and neonatal birth weight, as well as to explore the pattern of neonatal complications across different BMI categories. By comparing outcomes between women receiving care at a tertiary center (BSMMU) and a peripheral health complex (Sibchar, Madaripur), this study aim was to provide a broader perspective on maternal and neonatal health across different levels of the healthcare system in Bangladesh.

METHODOLOGY & MATERIALS

This cross-sectional observational study was conducted in the Department of Obstetrics and Gynaecology at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, and Sibchar Health Complex, Madaripur, over a period of one year from August 2017 to July 2018. A total of 140 pregnant women were enrolled in the study using purposive sampling. Inclusion criteria were singleton pregnancy, gestational age ≥37 weeks, and delivery in the study institutions. Women with known chronic illnesses such as diabetes mellitus, hypertension, thyroid disorders, or multiple pregnancies were excluded to minimize confounding factors.

Maternal body mass index (BMI) was recorded during the second trimester using standard anthropometric techniques. Weight was measured with minimal clothing and without shoes using a digital weighing scale, and height was measured with a stadiometer. BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m²) and categorized according to the World Health Organization (WHO) classification: underweight (<18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25–29.9 kg/m²), and obese (≥30 kg/m²).

Neonatal outcomes including birth weight and complications were recorded immediately after delivery. Birth weight was measured using a digital baby scale and categorized as low birth weight (<2500 g), normal (2500–3999 g), or macrosomia (≥4000 g). Neonatal complications such as hypoglycemia, respiratory distress, birth injury, and NICU admission were documented by the attending neonatologist. Data were collected using a pretested structured case record form by trained personnel.

All data were entered and analyzed using SPSS version 22. Descriptive statistics such as mean, standard deviation, frequencies, and percentages were used to summarize baseline characteristics. Chi-square test was applied to compare categorical variables across BMI groups. Pearson correlation was used to assess the relationship between maternal BMI and neonatal birth weight. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Socio-Demographic Characteristics of Study Participants (n = 140)

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
18–24	41	29.3
25–30	64	45.7
>30	35	25.0
Parity		
Primigravida	60	42.9
Multigravida	80	57.1
Residence		
Urban	85	60.7
Rural	55	39.3
Antenatal care		
Regular	105	75.0
Irregular/None	35	25.0

Table 1 presents the socio-demographic characteristics of the study participants. Among the 140 mothers, the majority were between 25 and 30 years of age (45.7%), followed by 29.3% in the 18–24 age group

and 25.0% above 30 years. Most of the participants were multigravida (57.1%), while 42.9% were primigravida. In terms of residence, 60.7% lived in urban areas and 39.3% in rural areas. Regarding antenatal care, a significant proportion of the mothers (75.0%) received regular antenatal check-ups, whereas 25.0% had irregular or no antenatal visits.

Table 2: Distribution of Maternal BMI Categories (n = 140)

BMI Category	BMI Range (kg/m²)	Frequency (n)	Percentage (%)
Underweight	<18.5	25	17.9
Normal weight	18.5–24.9	65	46.4
Overweight	25–29.9	35	25.0
Obese	≥30	15	10.7

Table 2 shows the distribution of maternal BMI categories among the study participants. Nearly half of the mothers (46.4%) had a normal BMI ranging from 18.5 to 24.9 kg/m². Overweight mothers, with a BMI between 25 and 29.9 kg/m², accounted for 25.0%, while 17.9% were underweight with a BMI less than 18.5 kg/m². A smaller proportion (10.7%) of participants were obese, having a BMI of 30 kg/m² or more.

Table 3: Neonatal Birth Weight According to Maternal BMI (n = 140)

BMI Category	Mean Birth Weight (g)	Low Birth Weight (n, %)	Normal Birth Weight (n, %)	Macrosomia (n, %)
Underweight	2400 ± 300	15 (60.0%)	10 (40.0%)	0 (0%)
Normal weight	2900 ± 350	10 (15.4%)	55 (84.6%)	0 (0%)
Overweight	3300 ± 400	3 (8.6%)	28 (80.0%)	4 (11.4%)
Obese	3500 ± 450	1 (6.7%)	10 (66.7%)	4 (26.6%)

Table 3 illustrates neonatal birth weight outcomes according to maternal BMI categories. The mean birth weight was lowest among underweight mothers (2400 ± 300 g), with 60.0% of their babies classified as low birth weight and none as macrosomic. Mothers with normal BMI had a higher mean birth weight (2900 ± 350 g), with the majority (84.6%) delivering babies with normal weight and only 15.4% having low birth weight. In the overweight group, the mean birth weight increased to 3300 ± 400 g, with 80.0% of neonates having normal weight and 11.4% classified as macrosomic. Obese mothers had the highest mean birth weight (3500 ± 450 g), with 66.7% of babies in the normal weight range and 26.6% born with macrosomia.

Table 4: Neonatal Complications by Maternal BMI Category (n = 140)

Complication	Underweight (n = 25)	Normal (n = 65)	Overweight (n = 35)	Obese (n = 15)	p-value
Hypoglycemia	2 (8.0%)	5 (7.7%)	8 (22.9%)	6 (40.0%)	<0.05*
Respiratory Distress	5 (20.0%)	8 (12.3%)	6 (17.1%)	4 (26.7%)	0.12
NICU Admission	10 (40.0%)	12 (18.5%)	9 (25.7%)	6 (40.0%)	<0.05*
Birth Injury	0 (0%)	2 (3.1%)	3 (8.6%)	2 (13.3%)	0.08

*Significant at $p < 0.05$.

Table 4 presents the distribution of neonatal complications across different maternal BMI categories. Hypoglycemia was notably more frequent among neonates born to obese mothers (40.0%) and overweight mothers (22.9%), compared to those of normal weight (7.7%) and underweight mothers (8.0%), with a statistically significant difference ($p < 0.05$). Respiratory distress was most common in babies of obese mothers (26.7%) and underweight mothers (20.0%), although the association was not statistically significant ($p = 0.12$). NICU admissions were highest among neonates of both underweight and obese mothers (40.0% each), showing a significant association with maternal BMI ($p < 0.05$). Birth injuries were observed more frequently in neonates of obese (13.3%) and overweight (8.6%) mothers compared to those of normal (3.1%) and underweight mothers (0%), though the difference did not reach statistical significance ($p = 0.08$).

DISCUSSION

This study highlights the significant impact of maternal body mass index (BMI) on neonatal birth weight and associated complications. Among 140 pregnant women evaluated, the majority (46.4%) had a normal BMI, while 17.9% were underweight, 25.0% overweight, and 10.7% obese. These distributions are reflective of nutritional transitions seen in developing countries, including Bangladesh [14].

A clear association between maternal BMI and neonatal birth weight was observed. Underweight mothers had the lowest mean birth weight (2400 ± 300 g), with 60.0% of their neonates being low birth weight (LBW). In contrast, obese mothers had the highest mean birth weight (3500 ± 450 g), with 26.6% of neonates developing macrosomia. These findings support previous research indicating that maternal undernutrition increases the risk of intrauterine growth restriction, whereas higher BMI correlates with macrosomia and excessive fetal growth [15, 16, 17].

Similar findings were reported by Nahar et al., who demonstrated that maternal anthropometric status significantly predicted neonatal birth weight in the Bangladeshi population [18]. In addition, Khatun and Rahman, noted that inadequate maternal nutrition and lack of antenatal care are strong predictors of low birth weight, which corresponds to our finding that 60% of LBW neonates were born to underweight mothers [19].

Hypoglycemia was one of the most frequent complications in neonates of obese and overweight mothers (40.0% and 22.9%, respectively), significantly higher than in the normal (7.7%) and underweight (8.0%) groups ($p < 0.05$). This aligns with the results of Hedderson et al., who found that maternal obesity and excessive gestational weight gain are strongly linked to neonatal hypoglycemia due to fetal hyperinsulinemia [17]. Vasudevan et al., also emphasized that metabolic instability is more frequent among neonates of obese mothers [20].

Additionally, NICU admissions were significantly higher in neonates born to underweight and obese mothers (both 40.0%, $p < 0.05$). The increased NICU admissions in the underweight group are likely due to complications from LBW, while in obese mothers, they may be attributed to macrosomia, respiratory distress, and hypoglycemia. These results are in line with the findings of Minsart et al., who reported that neonates of obese mothers are more frequently admitted to NICU due to perinatal morbidity [21].

Respiratory distress and birth injury were also more frequent in neonates of obese mothers (26.7% and 13.3%, respectively), although these differences were not statistically significant. Gudmundsson et al., demonstrated that macrosomia significantly increases the risk of birth trauma, especially in mothers with short stature or excessive fetal weight, which could explain our findings [22]. Similarly, Madan et al., and Ramachenderan et al., noted that maternal obesity predisposes neonates to respiratory complications, particularly when coupled with cesarean delivery or delayed labor [23, 24].

Our findings corroborate the broader literature on the adverse effects of both maternal undernutrition and obesity on perinatal outcomes. Aly et al., and Nohr et al., reported that maternal obesity increases the risk of prematurity, macrosomia, and perinatal mortality, while underweight mothers are more likely to deliver LBW infants with compromised immunity and developmental outcomes [25, 26].

In terms of neonatal birth weight trends, Scott-Pillai et al., observed similar patterns in the UK obstetric population, where maternal obesity was associated with higher rates of macrosomia, and underweight status with LBW [27]. These parallels between high- and low-income settings emphasize the universality of BMI-related perinatal risks.

Our study further supports the findings of local studies by Nasreen et al., who found psychosocial and nutritional factors during pregnancy significantly contributed to LBW in Bangladesh [28]. It also aligns with the work of Khatun and Rahman, who demonstrated that better antenatal care and nutritional counseling can reduce the incidence of LBW and associated neonatal complications [19].

Limitations of the study

Despite the valuable insights provided, the study has limitations. The sample size was relatively small and confined to specific healthcare facilities, which may limit the generalizability of results. Additionally, gestational weight gain was not separately analyzed, which could further influence neonatal outcomes.

CONCLUSION

In conclusion, this study underscores that both maternal undernutrition and overnutrition are detrimental to neonatal health. Underweight status is strongly associated with low birth weight, while overweight and obesity are linked to macrosomia, hypoglycemia, and NICU admission. These findings highlight the importance of preconception counseling, routine nutritional assessment, and appropriate weight management during pregnancy to improve maternal and neonatal health outcomes.

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