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TMSS Medical College, Bogura, Bangladesh



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## Address of Correspondence

Editor-in-Chief, TMSS Medical College Journal, TMSS Medical College  
 Rangpur Road, Thengamara, Bogura, Bangladesh. Phone: 01775-316617  
 e-mail: editortmcjournal@gmail.com, Web: www.tmcjournal.org, www.tmssmedicalcollege.com

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*Original Article*

# Body Mass Index at Third Trimester and Pregnancy Outcome in the Bangladeshi Population Attending a Tertiary Care Hospital

Begum A<sup>1\*</sup>, Montasir AA<sup>2</sup>, Nazim R<sup>3</sup>, Neeger MN<sup>4</sup>, Ghosh UK<sup>5</sup>, SoniaAA<sup>6</sup>

1. Dr. Aeysha Begum, Assistant Professor, Department of Obstetrics & Gynaecology, Khawja Yunus Ali Medical College, Sirajganj.
2. Dr. Ahmed Al Montasir, Assistant professor, Department of Medicine, TMSS Medical College, Bogura.
3. Dr. Roksana Nazim, Assistant Professor, Department of Obstetrics & Gynaecology, Khawja Yunus Ali Medical College, Sirajganj.
4. Dr. Most. Nasrin Neeger, Associate Professor, Department of Obstetrics & Gynaecology, Khawja Yunus Ali Medical College, Sirajganj.
5. Dr. Uzzal Kumar Ghosh, Associate Professor, Department of Pediatrics, Khawja Yunus Ali Medical College, Sirajganj.
6. Dr. Asma Akter Sonia, Assistant Professor, Department of Obstetrics & Gynaecology, Khawja Yunus Ali Medical College, Sirajganj.

## \*Corresponding Author

### Abstract

**Background:** Maternal body mass index (BMI) is an important predictor of pregnancy outcomes; however, evidence regarding the prognostic value of third-trimester BMI in Bangladesh remains limited. This study evaluated the association between maternal BMI measured during the third trimester and maternal, obstetric, neonatal and postpartum outcomes.

**Materials and Methods:** A prospective observational cohort study was conducted among 250 singleton pregnant women attending the Department of Obstetrics and Gynaecology, Khawja Yunus Ali Medical College Hospital (KYAMCH), Bangladesh, between January 2024 and December 2025. Participants were classified using WHO Asian BMI criteria into underweight, normal weight, overweight, and obese groups. Maternal complications, mode of delivery, neonatal outcomes, and one-year postpartum maternal and infant outcomes were compared across BMI categories using appropriate statistical tests, with  $p \leq 0.05$  considered statistically significant.

**Results:** Underweight women constituted 28.4% of the cohort, whereas 22.4% were overweight or obese. Underweight mothers had significantly higher rates of anemia, preterm birth, low birth weight, and NICU admission. Conversely, overweight and obese women experienced significantly increased frequencies of gestational diabetes mellitus, pre-eclampsia, Caesarean delivery, meconium-stained amniotic fluid, fetal macrosomia, postpartum weight retention, and persistent glucose intolerance. Infants born to mothers at both BMI extremes demonstrated increased neonatal morbidity and greater NICU utilization.

**Conclusion:** Third-trimester maternal BMI is a simple, inexpensive, and clinically valuable predictor of adverse maternal and neonatal outcomes. Routine BMI assessment during late pregnancy may facilitate risk stratification, targeted nutritional intervention, individualized obstetric management, and improved maternal and neonatal outcomes in resource-limited settings such as Bangladesh.

**Keywords:** Third trimester BMI, Pregnancy outcome, Maternal complications, Gestational diabetes mellitus, Neonatal outcomes.

## Introduction

Maternal nutritional status is a major determinant of maternal, fetal, and neonatal health. Among available anthropometric measures, body mass index (BMI) remains a practical, inexpensive, reproducible, and widely applicable tool for assessing nutritional status and stratifying obstetric risk. Both low and high maternal BMI are associated with increased maternal morbidity, adverse pregnancy outcomes, and neonatal complications.<sup>1,2</sup> The coexistence of undernutrition and overweight/obesity-the “double burden of

malnutrition”-is particularly important in low- and middle-income countries (LMICs).<sup>3</sup> A large systematic review has demonstrated that abnormal maternal BMI is associated with preterm birth, hypertensive disorders, operative delivery, abnormal birth weight, and neonatal intensive care unit (NICU) admission.<sup>4</sup>

Bangladesh is experiencing this nutritional transition. Maternal undernutrition, anemia, and micronutrient deficiencies remain prevalent, particularly among

socioeconomically disadvantaged women, while urbanization, dietary changes, and reduced physical activity have contributed to increasing overweight and obesity among women of reproductive age.<sup>5,6</sup> Maternal underweight is associated with inadequate nutritional reserves, impaired fetal growth, low birth weight (LBW), preterm birth, and neonatal morbidity.<sup>2,7,8</sup> Conversely, maternal overweight and obesity increase insulin resistance, systemic inflammation, and endothelial dysfunction, contributing to gestational diabetes mellitus (GDM), hypertensive disorders, pre-eclampsia, fetal macrosomia, operative delivery, and Caesarean section.<sup>9-14</sup>

Although BMI is ideally assessed before conception or during early pregnancy,<sup>15</sup> this information is frequently unavailable in Bangladesh because many women initiate antenatal care late or first present to tertiary hospitals during the third trimester.<sup>5,6</sup> In this context, third-trimester BMI may provide a pragmatic measure for late-pregnancy risk stratification. Despite physiological gestational weight gain, late-pregnancy BMI remains associated with hypertensive disorders, GDM, operative delivery, fetal growth abnormalities, and neonatal complications.<sup>16,17</sup>

Prospective evidence regarding the prognostic value of third-trimester BMI in Bangladesh remains limited, particularly regarding postpartum maternal health and infant outcomes.<sup>18-22</sup> Therefore, this prospective observational cohort study evaluated the association between third-trimester maternal BMI and maternal, obstetric, neonatal, and one-year postpartum outcomes among women attending Khawja Yunus Ali Medical College Hospital, Bangladesh. We hypothesized that both underweight and overweight/obesity would be independently associated with adverse pregnancy outcomes.

## Materials and Methods

This prospective observational cohort study was conducted in the Department of Obstetrics and Gynaecology, Khawja Yunus Ali Medical College Hospital, Bangladesh, from January 2024 to December 2025. Of 300 consecutively enrolled women, 250

completed the one-year follow-up and were included in the final analysis. Eligible participants were aged 18–40 years with singleton pregnancies at  $\geq 28$  weeks of gestation. Women with multiple gestation, hydramnios, pre-existing diabetes, chronic hypertension, severe renal or cardiac disease, or intrauterine fetal death at presentation were excluded.

Maternal height and weight were measured using standard equipment, and BMI was calculated as  $\text{kg/m}^2$ . According to WHO Asian criteria, participants were categorized as underweight ( $<18.5$ ), normal weight ( $18.5\text{--}22.9$ ), overweight ( $23.0\text{--}24.9$ ), or obese ( $\geq 25.0$   $\text{kg/m}^2$ ). Maternal, obstetric, and neonatal outcomes, including anemia, pre-eclampsia, gestational diabetes, mode of delivery, birth weight, Apgar scores, and NICU admission, were recorded. Maternal metabolic and weight outcomes, breastfeeding, and infant growth were assessed during one-year postpartum follow-up.

Data were analyzed using SPSS version 25.0. Appropriate parametric, non-parametric, and categorical tests were applied, with  $p \leq 0.05$  considered statistically significant. Institutional ethical approval and written informed consent were obtained.

Institutional ethical approval was obtained from KYAMC. All participants were counselled regarding the study, and written informed consent was obtained before enrollment.

## Results

Baseline Demographic Profiles of the 300 women enrolled at baseline, 250 (83.3%) completed the one-year postpartum follow-up and were included in the final analysis, while 50 (16.7%) were lost to follow-up.

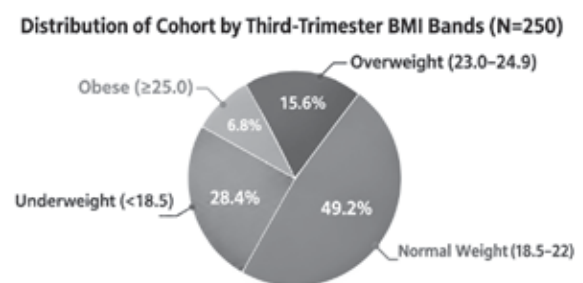


**Figure 1: Pie chart cohort distribution by BMI bands**

Among the 250 enrolled women, the cohort distribution across third-trimester BMI bands revealed a distinct presentation of the malnutrition: Underweight (28.4%), Normal Weight (49.2%), Overweight (15.6%), and Obese (6.8%, including morbid obesity) (Figure 1).

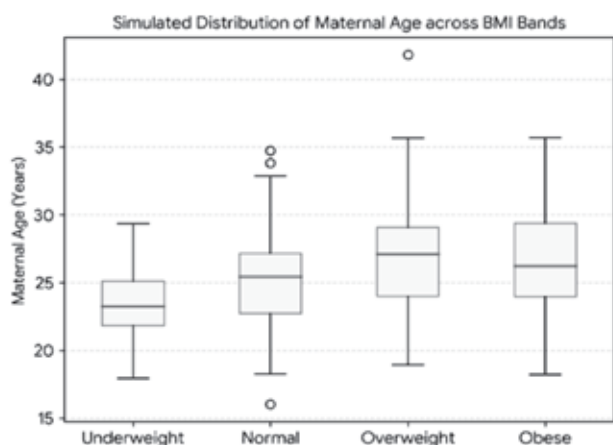


**Figure 2: Box plot showing distribution of maternal age across BMI categories Maternal Antepartum Complications**

The mean age of the participants were associated with weight tiers, spanning from 23.8 years in the underweight group to over 26.5 years within higher

weight ranges (Figure 2). Obese women demonstrated a higher likelihood of being multigravida (73.33%) compared to the underweight, who were mostly primigravida

**Table I: Maternal antenatal complications stratified by third-trimester BMI bands**

| Maternal Complication (%)  | Underweight (<18.5) | Normal Weight (18.5-22.9) | Overweight (23.0-24.9) | Obese ( $\geq 25.0$ ) | p-value |
|----------------------------|---------------------|---------------------------|------------------------|-----------------------|---------|
| Maternal Anemia            | 23.94%              | 5.69%                     | 7.69%                  | 6.67%                 | <0.05   |
| Pre-eclampsia              | 21.13%              | 22.76%                    | 38.46%                 | 40.00%                | <0.05   |
| Gestational Diabetes (GDM) | 2.82%               | 3.25%                     | 10.26%                 | 26.67%                | <0.01   |

The clinical outcomes of the pregnancy was heavily influenced by third-trimester weight statuses. Anemia was overwhelmingly clustered within the underweight group, affecting 23.94% of its members, compared to only 5.69% of normal-weight individuals ( $p < 0.05$ ). Conversely, hypertensive and glycemic complications were dominant within the overweight and obese groups. Pre-eclampsia risk ranged from 21.13% in the underweight group up to 40.00% within the obese category. Similarly, GDM rates rose sharply from a baseline of 3.25% in normal-weight women to 26.67% among obese patients ( $p < 0.01$ ) (Table I).

**Table II : Association of Third-Trimester Maternal Body Mass Index with Obstetric and Neonatal Outcomes.**

| Outcome                         | Underweight (n=71), n/N (%) | Normal weight (n=123), n/N (%) | Overweight (n=39), n/N (%) | Obese (n=17), n/N (%) | $\chi^2$ | p-value |
|---------------------------------|-----------------------------|--------------------------------|----------------------------|-----------------------|----------|---------|
| Spontaneous vaginal delivery    | 51/71 (71.8)                | 84/123 (68.3)                  | 23/39 (59.0)               | 8/17 (47.1)           | 4.95     | 0.175   |
| Caesarean delivery              | 20/71 (28.2)                | 39/123 (31.7)                  | 16/39 (41.0)               | 9/17 (52.9)           | 4.95     | 0.175   |
| Preterm birth                   | 23/71 (32.4)                | 15/123 (12.2)                  | 2/39 (5.1)                 | 3/17 (17.6)           | 17.67    | <0.001  |
| Low birth weight (<2.5 kg)      | 26/71 (36.6)                | 18/123 (14.6)                  | 4/39 (10.3)                | 2/17 (11.8)           | 17.51    | <0.001  |
| Macrosomia (>4.0 kg)            | 0/71 (0.0)                  | 1/123 (0.8)                    | 3/39 (7.7)                 | 3/17 (17.6)           | 21.03    | <0.001  |
| Meconium-stained amniotic fluid | 7/71 (9.9)                  | 15/123 (12.2)                  | 8/39 (20.5)                | 6/17 (35.3)           | 8.88     | 0.031   |
| NICU admission                  | 10/71 (14.1)                | 4/123 (3.3)                    | 8/39 (20.5)                | 5/17 (29.4)           | 18.00    | <0.001  |

(Values are presented as n/N (%). BMI was categorized according to WHO Asian BMI criteria: underweight (<18.5 kg/m<sup>2</sup>), normal weight (18.5–22.9 kg/m<sup>2</sup>), overweight (23.0–24.9 kg/m<sup>2</sup>), and obese ( $\geq 25.0$  kg/m<sup>2</sup>). Overall differences among BMI categories were assessed using Pearson's  $\chi^2$  test. A two-sided  $p < 0.05$  was considered statistically significant. BMI, body mass index; NICU, neonatal intensive care unit).

### Intrapartum Profiles and Delivery Modes

Delivery modes varied widely based on third-trimester BMI status. Spontaneous vaginal deliveries were most frequent among underweight (71.8%) and normal-weight (68.3%) cohorts. Caesarian section were needed among over weight and obese cohorts: the Caesarean section rate reached 41.0% in overweight women and 53.3% in obese women ( $p < 0.05$ ). Primary clinical indications for caesarian section in high-BMI cohorts included labor dystocia, induction failures, and acute fetal distress signaled by meconium-stained liquor. Meconium-stained amniotic fluid was documented in 36% of obese mothers deliveries, contrasted against just 12% within the normal-weight control group.

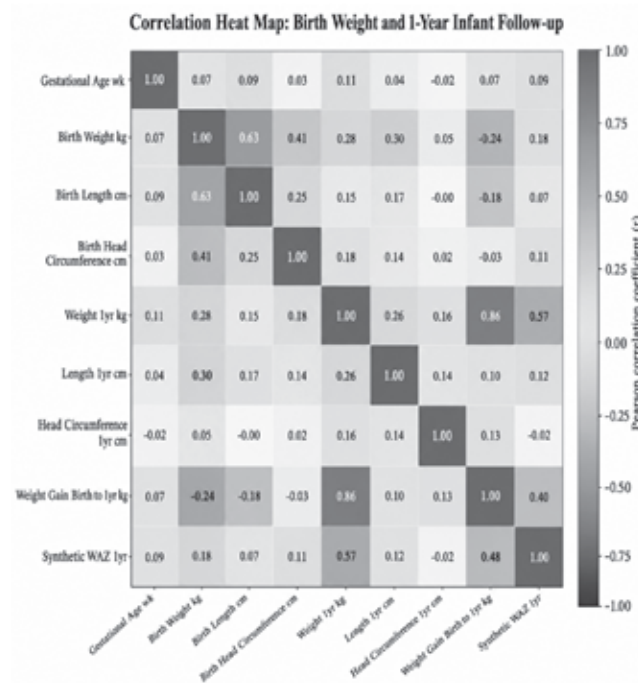


**Figure 3. Correlation heat map of birth anthropometric parameters and infant growth outcomes at 1-year follow-up.**

The heat map shows correlations between birth characteristics and infant growth at 1 year. The strongest correlation was between 1-year weight and weight gain ( $r = 0.86$ ), followed by birth weight and birth length ( $r = 0.63$ ). One-year weight was also moderately associated with WAZ ( $r = 0.57$ ). Most other relationships were weak to moderate.

### Neonatal Outcomes

Maternal third-trimester weight variations correlated strongly with neonatal birth profiles (Figure 3).

#### Neonatal Outcomes

Maternal third-trimester weight variations correlated strongly with neonatal birth profiles. Preterm labor pains were prominent in the underweight group (32%) relative to normal weight (12%) and overweight cohorts (4%) ( $p = 0.000$ ) (Table II).

**Birth Weight:** Mean birth weight showed a direct linear relationship with maternal BMI status. Underweight mothers frequently delivered Low Birth Weight infants ( $<2.5$  kg). In contrast, macrosomia ( $>4.0$  kg) was uniquely seen within the high-BMI categories, tracking at 15.38% in the obese subgroup.

**Apgar Scores and NICU Admissions:** While average 1-minute and 5-minute APGAR scores did not deviate much across the different groups ( $p > 0.05$ ), the total numbers of neonates requiring immediate care interventions did. NICU admissions peaked at the newborns of mothers with extreme groups of BMI: 14% of infants born to underweight mothers (primarily for low birth weight and prematurity) and 26.7% born to obese mothers (for birth asphyxia and respiratory distress) required intensive care.

#### NICU Admission Rates Trend Profile:

- Underweight ( $<18.5$  kg/m<sup>2</sup>): 14.0% requiring critical care intervention
- Normal Weight (18.5–22.9 kg/m<sup>2</sup>): 3.3% baseline operational care
- Overweight (23.0–24.9 kg/m<sup>2</sup>): 20.5% transitional observation
- Obese ( $\geq 25.0$  kg/m<sup>2</sup>): 26.7% intensive metabolic and respiratory support

### One-Year Postpartum Follow-Up Outcomes

The one-year longitudinal phase identified lingering effects from the third-trimester classifications:

**1. Maternal Metabolic Path:** Over 18% of the obese and overweight mothers who developed GDM exhibited persistent impaired fasting glucose or frank Type 2 diabetes mellitus at their 6-week and 1-year screening intervals.

**2. Postpartum Weight Trends:** Women entering the third trimester with an overweight and obese BMI profile retained a mean of 6.4 kg above their early pregnancy estimates at one year postpartum, aggravating baseline obesity levels.

**3. Infant Lactation and Development:** Underweight mothers experienced higher rates of subjective lactation insufficiency within the first six months. At the one-year followup milestone, infants born to the underweight cohort had higher rates of persistent mild-to-moderate wasting and failure to thrive compared to normal-weight controls.

### Multivariable Logistic Regression Analysis

After multivariable adjustment, both extremes of maternal BMI remained independently associated with adverse pregnancy outcomes. Compared with women with normal BMI, obese women had significantly higher adjusted odds of pre-eclampsia (AOR 8.06; 95% CI 2.35–27.68;  $p<0.001$ ), NICU admission (AOR 9.66; 95% CI 1.95–47.89;  $p=0.005$ ), and meconium-stained amniotic fluid (AOR 11.40; 95% CI 3.01–43.16;  $p<0.001$ ). Overweight women had increased odds of Caesarean delivery (AOR 2.78; 95% CI 1.19–6.51;  $p=0.019$ ). Maternal underweight was independently associated with preterm birth (AOR 2.74; 95% CI 1.16–6.46;  $p=0.021$ ), low birth weight (AOR 3.45; 95% CI 1.52–7.80;  $p=0.003$ ), and NICU admission (AOR 4.32; 95% CI 1.33–13.97;  $p=0.015$ ). Urban residence was associated with lower adjusted odds of Caesarean delivery and NICU admission. Other adjusted covariates did not demonstrate statistically significant independent associations in the respective models.

### Discussion

The present prospective observational cohort study demonstrates that maternal body mass index (BMI) measured during the third trimester is significantly associated with maternal, obstetric, neonatal, and postpartum outcomes among Bangladeshi women. Both ends of the BMI spectrum showed distinct patterns of risk: underweight was predominantly associated with nutritional deficiency, preterm birth, low birth weight (LBW), and neonatal morbidity,

whereas overweight and obesity were associated with metabolic, hypertensive, and operative complications. These findings support the clinical usefulness of late-pregnancy BMI for risk stratification, particularly in resource-limited settings where early antenatal BMI is frequently unavailable.

Nearly one-third of the study population was underweight, highlighting the persistent burden of maternal undernutrition in Bangladesh despite improvements in maternal healthcare. This finding is consistent with national evidence showing that undernutrition remains particularly important among rural and socioeconomically disadvantaged women. Maternal anemia was substantially more frequent among underweight women, plausibly reflecting reduced nutritional reserves and deficiencies of iron and other micronutrients. Previous Bangladeshi studies have similarly demonstrated associations between maternal undernutrition, anemia, and adverse neonatal outcomes.<sup>23</sup>

Underweight women also experienced significantly more preterm births and LBW infants.<sup>24,25</sup> Maternal nutritional deficiency may impair placental development and fetal nutrient supply, thereby restricting fetal growth and increasing susceptibility to premature delivery.<sup>26</sup> Comparable studies from Pakistan and India have demonstrated associations between low maternal BMI, fetal growth restriction, LBW, and neonatal morbidity.<sup>27-29</sup> In the present study, infants of underweight mothers also required NICU admission more frequently, predominantly because of prematurity, LBW, respiratory problems, and feeding difficulties. These observations emphasize the importance of nutritional assessment and intervention during pregnancy.<sup>30</sup>

Conversely, overweight and obese women experienced higher frequencies of gestational diabetes mellitus (GDM), pre-eclampsia, Caesarean delivery, meconium-stained amniotic fluid, and neonatal complications.<sup>31</sup> These findings are consistent with evidence identifying maternal obesity as an important modifiable risk factor for adverse pregnancy outcomes.<sup>32</sup> Increasing maternal adiposity promotes

insulin resistance, chronic inflammation, oxidative stress, endothelial dysfunction, and abnormal placental function, providing plausible mechanisms for these associations.<sup>33–36</sup>

The frequency of GDM increased markedly with increasing BMI. Excess adiposity aggravates the physiological insulin resistance of pregnancy, increasing maternal hyperglycaemia and fetal glucose exposure and subsequently contributing to macrosomia and neonatal metabolic complications.<sup>33</sup> Similarly, pre-eclampsia increased progressively among overweight and obese women, consistent with the established relationship between obesity, endothelial dysfunction, systemic inflammation, and impaired placental vascular adaptation.<sup>34–36</sup> These findings support intensified metabolic and blood-pressure surveillance in pregnant women with increased BMI. Caesarean delivery was also more frequent with increasing BMI. Maternal obesity may increase operative delivery through fetal macrosomia, dysfunctional labour, prolonged labour, failed induction, and concern regarding fetal compromise.<sup>32,37,38</sup> Meconium-stained amniotic fluid was likewise more common among obese mothers, potentially reflecting placental dysfunction and increased fetal susceptibility to intrapartum stress.<sup>39</sup> These observations indicate that women with elevated BMI may require more intensive intrapartum surveillance and preparedness for operative delivery.

NICU admission showed a U-shaped relationship with maternal BMI, with increased admission among infants of both underweight and obese mothers. Underweight-related admissions were mainly associated with prematurity and LBW, whereas infants of obese mothers more frequently required intensive care for respiratory compromise, hypoglycaemia, birth asphyxia, and complications associated with macrosomia. Similar patterns of neonatal morbidity associated with abnormal maternal BMI have been reported previously.<sup>40</sup>

The one-year follow-up adds an important longitudinal dimension to this study. Women with elevated BMI demonstrated greater postpartum weight retention and persistent glucose abnormalities, supporting the

concept that pregnancy may identify women at future metabolic risk.<sup>33,41</sup> In contrast, underweight mothers experienced more perceived lactation insufficiency, while their infants showed greater growth impairment. Maternal nutritional status may therefore have consequences extending beyond delivery, affecting both maternal metabolic health and early childhood growth.<sup>42</sup>

These findings have practical implications for Bangladesh, where delayed antenatal presentation remains common. Third-trimester BMI is inexpensive, non-invasive, and readily available and may help identify women requiring enhanced antenatal surveillance, nutritional intervention, delivery planning, and neonatal preparedness. Although pre-pregnancy or early-pregnancy BMI remains preferable, late-pregnancy BMI may provide useful supplementary risk information when earlier measurements are unavailable. The study's prospective design, Asian-specific BMI classification, and one-year follow-up strengthen its clinical relevance; however, its single-centre design, use of third-trimester BMI, loss to follow-up, and absence of detailed information on gestational weight gain, dietary intake, physical activity, and nutritional biomarkers should be considered when interpreting the findings. Future multicentre studies incorporating serial anthropometric and metabolic assessments are warranted.

Overall, the study demonstrates a clinically important U-shaped relationship between maternal BMI and adverse pregnancy outcomes. Maternal underweight primarily increases nutritional, fetal-growth, and prematurity-related risks, whereas overweight and obesity increase metabolic, hypertensive, operative, and neonatal complications. Routine BMI assessment, combined with targeted nutritional and obstetric management, may therefore represent a practical approach to improving maternal and neonatal outcomes in Bangladesh.

## Conclusion

Maternal body mass index (BMI) measured during the third trimester is a significant predictor of adverse maternal, obstetric, neonatal, and postpartum

outcomes. Underweight mothers were more likely to experience anemia, preterm birth, low birth weight, and increased NICU admissions, whereas overweight and obese mothers had higher risks of gestational diabetes, pre-eclampsia, Caesarean delivery, and postpartum metabolic complications. In resource-limited settings where early antenatal booking is often delayed, third-trimester BMI provides a simple and cost-effective tool for risk stratification. Routine BMI assessment, nutritional interventions, and structured postpartum follow-up may improve maternal and neonatal outcomes and strengthen obstetric care in Bangladesh.

### Limitations

This study has several limitations. Its single-centre design may limit generalizability, and third-trimester BMI cannot fully represent pre-pregnancy nutritional status because of physiological gestational weight gain. Dietary intake and gestational weight gain were not formally assessed, while 16.7% loss to follow-up may have introduced attrition bias. Finally, the observational design precludes causal inference, and residual confounding from unmeasured factors cannot be excluded.

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