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Impact of maternal obesity on maternal and neonatal outcomes: A case-control study at a tertiary care centre in South Bihar.

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Abstract

Background
Maternal obesity has emerged as a significant public health concern, particularly in low- and middle-income countries, due to its association with increased maternal and neonatal complications. Both prepregnancy Body Mass Index (BMI) and gestational weight gain (GWG) are linked to adverse pregnancy outcomes.
Aim: To evaluate the impact of prepregnancy Body Mass Index (BMI) and gestational weight gain (GWG) on maternal and neonatal outcomes among term pregnancies.

Methods
This case-control observational study was conducted at the Department of Obstetrics and Gynaecology, Narayan Medical College, Sasaram, Bihar, from Dec 2022 to Dec 2023. A total of 400 singleton pregnant women attending their first antenatal visit before 16 weeks of gestation were enrolled and categorized into two groups: BMI <25 kg/m² (n=200) and BMI ≥25 kg/m² (n=200). Participants were followed through pregnancy, labor, and postpartum. Statistical analysis was conducted using SPSS version 26.0.

Results
Obesity was more prevalent among women aged ≥30 years and those from lower socioeconomic classes. Women with BMI ≥25 kg/m² had significantly higher incidences of gestational hypertension (31.3% vs. 6.3%), gestational diabetes mellitus (22.9% vs. 4.5%), preeclampsia/eclampsia (7.8% vs. 1.1%), prolonged labor (9.6% vs. 2.3%), and emergency cesarean delivery (53.0% vs. 11.4%) compared to women with BMI <25 kg/m² ($p<0.01$ for all). No significant differences were noted in fetal growth restriction, gestational age at delivery, congenital anomalies, or newborn birth weight.

Conclusion
Maternal obesity is significantly associated with increased risks of hypertensive disorders, gestational diabetes, labor complications, and cesarean deliveries.

Recommendation
Early BMI screening, preconception counseling, and tailored antenatal care strategies are essential for mitigating obesity-related pregnancy complications in resource-constrained settings.

Keywords: *Maternal obesity, Prepregnancy Body Mass Index, Gestational weight gain, Pregnancy outcomes, Gestational hypertension*
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Background

Obesity has become one of the most pressing public health challenges globally, with its prevalence steadily increasing across both high-income and low- to middle-income countries. According to the World Health Organization (WHO), obesity is defined as an abnormal or excessive accumulation of body fat that poses a health risk.[1] Body Mass Index (BMI), the most widely used tool to assess obesity, classifies individuals with a BMI ≥30 kg/m² as obese. However, BMI has notable limitations—it does not differentiate between fat and lean mass or reflect fat distribution, which can influence the risk of metabolic and cardiovascular complications.[2]

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In pregnant women, obesity presents unique clinical concerns. It is not only defined by BMI ≥30 kg/m² but may also include absolute weight thresholds or excess weight relative to ideal body weight. The rising prevalence of obesity among women of reproductive age is particularly alarming due to its well-established associations with adverse maternal and neonatal outcomes.[3] These include increased risks of gestational hypertension, gestational diabetes mellitus (GDM), preeclampsia, cesarean delivery, preterm birth, macrosomia, low Apgar scores, neonatal hypoglycemia, and higher neonatal intensive care unit (NICU) admissions. Postpartum complications such as hemorrhage, wound infections, thromboembolic events, and delayed recovery are also more common among obese mothers.[4]

Maternal obesity is a multifactorial condition influenced by genetic predisposition, sedentary lifestyle, poor dietary habits, hormonal imbalances, psychosocial stressors, and socioeconomic factors. Women from lower socioeconomic backgrounds often face greater challenges due to limited access to healthcare, inadequate nutritional education, and reduced opportunities for physical activity.[5]

Two key indicators for assessing maternal nutritional status are prepregnancy BMI (PPBMI) and gestational weight gain (GWG). PPBMI reflects a woman's health status at conception, while GWG accounts for physiological changes throughout pregnancy. Abnormalities in either parameter are independently associated with negative pregnancy outcomes. However, limited research has examined the combined influence of PPBMI and GWG, particularly in low-resource settings.[6]

This study aims to address this gap by evaluating the impact of both PPBMI and GWG on maternal and neonatal outcomes in a cohort of term pregnancies in South Bihar. By integrating clinical and sociodemographic data, the study seeks to identify high-risk maternal weight profiles and generate evidence to inform context-specific prenatal care strategies, ultimately improving pregnancy outcomes and guiding public health interventions in similar populations.

Aim

To evaluate the impact of prepregnancy body mass index (PPBMI) and gestational weight gain (GWG) on maternal and neonatal outcomes among term pregnancies.

Objectives

- To determine the prevalence of different PPBMI categories (underweight, normal weight, overweight, obese) among pregnant women.
- To assess the distribution of gestational weight gain (inadequate, adequate, excessive) across different PPBMI groups.
- To analyze the association between PPBMI and adverse maternal outcomes

Material and methods

Study setting

Narayan Medical College & Hospital (NMCH), Sasaram, established in 2008, is a recognized private medical institution affiliated with Veer Kunwar Singh University. It offers MBBS and MD/MS programs, supported by a 1000+ bedded teaching hospital and modern facilities, serving the healthcare needs of Bihar and Jharkhand. The study was conducted over a period of 12 months from December 2022 to December 2023.

Study design

The study employed a case-control observational study.

Participants

Participants for this case-control study were recruited from the antenatal clinic of the Department of Obstetrics and Gynaecology, Narayan Medical College and Hospital, Sasaram, Bihar. Cases included pregnant women with a prepregnancy Body Mass Index (BMI) ≥25 kg/m², while controls were women with a BMI <25 kg/m², both enrolled before 16 weeks of gestation. The BMI cutoffs were based on WHO guidelines to differentiate between overweight/obese and normal weight categories. Both groups were selected from the same clinical setting during the same period to ensure comparability and minimize selection bias. Early recruitment ensured accurate BMI classification and reduced recall bias, while uniform antenatal care helped control for confounding factors related to healthcare access and quality.

Sampling technique and sample size calculation

For sample size calculation, hypertensive disorders in pregnancy were considered the primary outcome variable. Based on previous literature, the incidence of hypertensive disorders among women with normal BMI (<25 kg/m²) (p_0) was 8.8%, while the incidence among women with BMI ≥25 kg/m² (p_1) was 18.5%.

The following formula was applied for calculating the sample size for each group:

Considering each group, $n = (2 \times ((p0 + p1)/2) \times ((q0 + q1)/2) \times (Z\alpha/2 + Z1\text{-}\beta)$ ^2)/(p0 − p) ^2

Where:

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α = 0.05 (level of significance)
β = 0.20 (power 80%), 10% loss to follow-up was also considered.
Accordingly, the estimated sample size was calculated as 176 subjects per group, rounded off to 200 in each group. Thus, a total of 400 pregnant women were enrolled, divided into two groups based on their BMI at the first antenatal visit:

Inclusion criteria

- Singleton pregnancies.
- Pregnant women who are willing to give informed consent/assent for participation.

Exclusion criteria

- Women with multiple pregnancies (twins, triplets, or higher-order gestations).
- Women with pre-existing medical conditions,
- Women with a history of previous cesarean section or any uterine surgery.

Efforts to address potential sources of bias

To minimize bias, the study applied strict inclusion/exclusion criteria and consecutive sampling to reduce selection bias. A pretested proforma and standardized assessments limited information bias, while early BMI recording reduced recall bias. Objective outcome measures and validated diagnostic criteria minimized observer bias. Confounders were adjusted using multivariate regression, and a 10% sample size buffer accounted for minimal loss to follow-up, enhancing validity.

Data collection tools and methods

Purposive sampling was used to enroll eligible women into the study groups. Participants were followed at regular antenatal visits, during labor, and in the postpartum period until discharge from the hospital. During the follow-up, 4 women were lost to follow-up in the BMI <25 kg/m² group, and 10 women were lost to follow-up in the BMI ≥25 kg/m² group.
Group 1: BMI <25 kg/m²
Group 2: BMI ≥25 kg/m²

Data for the study were collected using a predesigned, pretested, and structured proforma. Detailed information was obtained on participants' demographic characteristics, including age, parity, and socioeconomic status, along with their obstetric history and previous pregnancy outcomes. The number of antenatal visits attended and any referral details were also documented. Upon enrollment, each participant underwent a thorough general physical examination, including assessment of vital signs and obstetric examination, along with relevant laboratory investigations. Participants were monitored prospectively throughout the course of pregnancy, during labor and delivery, and into the postnatal period until discharge. Deliveries were conducted either vaginally or by lower segment cesarean section (LSCS), depending on obstetric indications. All maternal and perinatal outcomes were meticulously recorded in the structured proforma to ensure comprehensive data capture for subsequent analysis.

Statistical analysis

Data were entered in Microsoft Excel 2019 and analyzed using SPSS version 26.0 (IBM Corp., Chicago, IL, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The Chi-square test was used for categorical data analysis. Univariate and multivariate logistic regression analyses assessed associations between BMI and maternal and perinatal outcomes. A p-value <0.05 was considered statistically significant, with all tests conducted at a 95% confidence interval.

Ethical consideration

The study was conducted after obtaining ethical clearance from the Institutional Ethics Committee of Narayan Medical College and Hospital, Jamuhar, Rohtas, Bihar. Informed written consent was obtained from all participants before enrollment. Confidentiality of patient information was maintained throughout the study, and all procedures were performed by the ethical standards of the institution and the Declaration of Helsinki.

RESULTS

Participant flow

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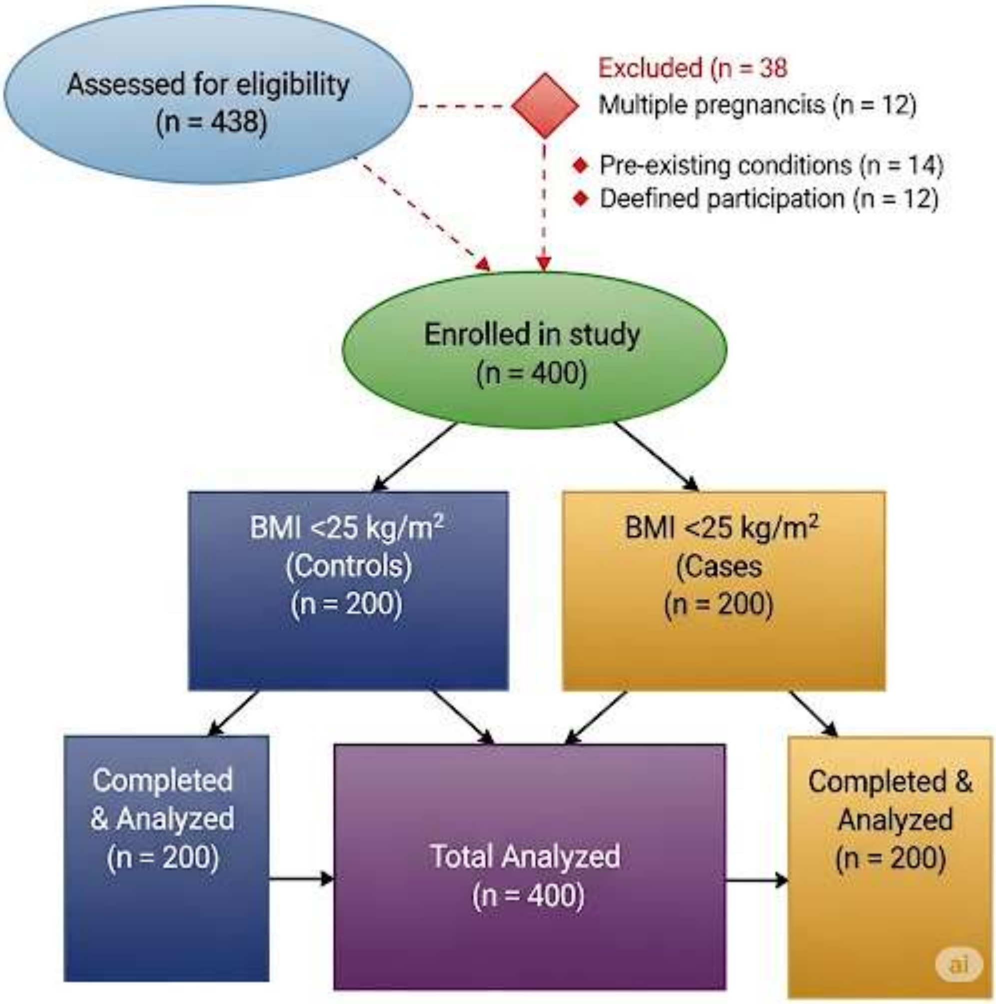

Table 1: Distribution of study subjects as per age in both the study groups

Parameter	Normal weight: BMI <25 kg/m² (n=200)	Obesity: BMI ≥25 kg/m² (n=200)	Total (n=400)
<20	51(25.5%)	17(8.5%)	68 (17.0%)
20–29	134(67.0%)	149(74.5%)	283 (70.8%)
≥30	15(7.5%)	34(17%)	49 (12.2%)
Total	200(100%)	200(100%)	400(100%)

In the present study, the majority of participants across both BMI groups were in the 20–29 years age group, comprising 67.0% of the normal weight group and 74.5% of the obesity group. A notable difference was observed in the <20 years age group, where a significantly higher proportion belonged to the normal weight group (25.5%) compared to the obesity group (8.5%). Conversely, individuals aged ≥30 years were more prevalent in the obesity group (17.0%) than in the normal weight group (7.5%). This suggests a trend of increasing obesity prevalence with advancing age.

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Figure 1: Distribution of study subjects as per socioeconomic status

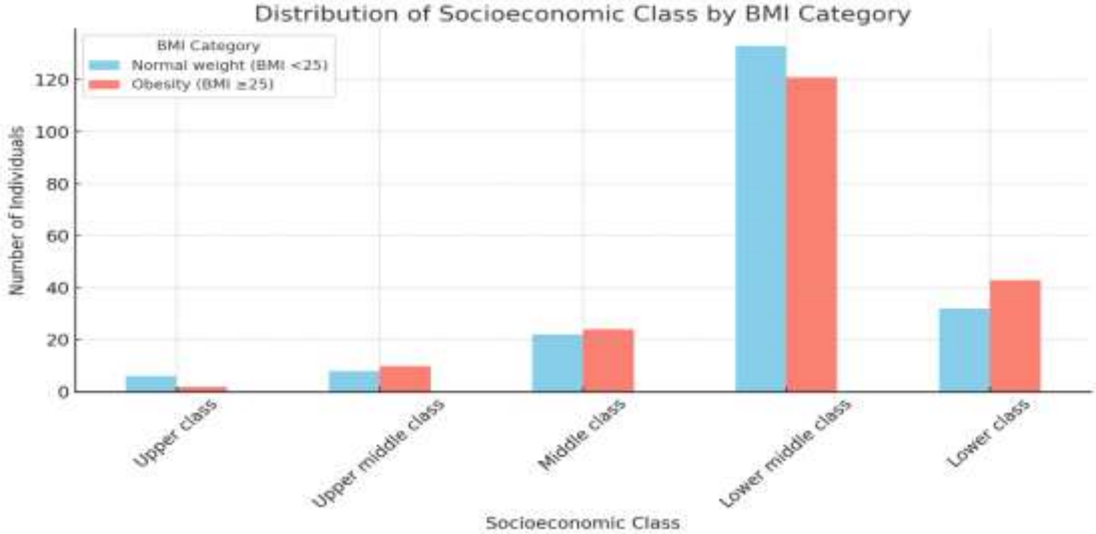

Figure 1 illustrates that the majority of study subjects in both BMI groups belonged to the lower middle class—66.5% among those with normal weight and 60.3% among those with obesity. A higher proportion of individuals from the lower class were found in the obesity group (21.7%) compared to the normal weight group (15.9%), suggesting a possible association between lower socioeconomic status and increased obesity risk. Upper and upper-middle classes constituted a smaller proportion across both groups, indicating that obesity was more prevalent among lower socioeconomic strata in the study population.

Figure 2: Distribution of study subjects as per the gravida of the study subjects

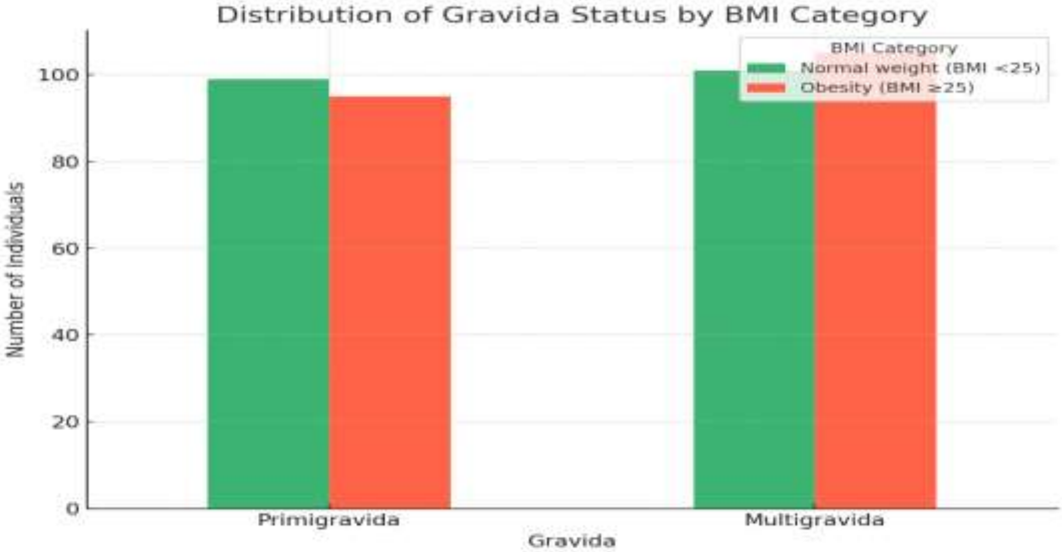

Figure 2 shows the distribution of study subjects based on gravida status across BMI categories. Among the normal weight group, 49.4% were primigravida and 50.6% were multigravida. Similarly, in the obesity group, 47.6% were primigravida and 52.4% were multigravida. The distribution is relatively balanced in both groups, with a slight predominance of multigravida subjects in the obesity group. This indicates that gravida status is comparably distributed among women with normal and

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elevated BMI, with no marked difference between the groups.

Table 2: Maternal outcome in both the group of study subject

Outcome	BMI <25 kg/m² (n=200)	BMI ≥25 kg/m² (n=200)	Total (n=400)	P
Gestational hypertension	13 (6.5%)	63 (31.5%)	76 (19%)	0.000
GDM	9 (4.5%)	46 (23.0%)	55 (13.75%)	0.003
Preeclampsia/eclampsia	2 (1.0%)	16 (8.0%)	18 (4.5%)	0.006
Prolonged labor	5 (2.5%)	19 (9.5%)	24 (6%)	0.008
Normal	171(85.5%)	56(28.0%)	173(43.25%)	<0.001
Total	200(100%)	200(100%)	400(100%)	

Table 2 demonstrates a significantly higher incidence of adverse maternal outcomes among women with BMI ≥25 kg/m² compared to those with BMI <25 kg/m². Gestational hypertension was markedly more common in the obesity group (31.3%) than in the normal weight group (6.3%), with a highly significant p-value of 0.000. Similarly, the prevalence of gestational diabetes mellitus (GDM) was significantly higher in the obesity group (22.9%) versus the normal group (4.5%) (p=0.003). Preeclampsia/eclampsia (7.8% vs. 1.1%, p=0.006) and prolonged labor (9.6% vs. 2.3%, p=0.008) were also notably more frequent in the obese group. These findings suggest a strong association between maternal obesity and increased risk of pregnancy-related complications.

Table 3: Mode of Delivery of study subjects in both the study groups

Mode of delivery	BMI <25 kg/m² (n=200)	BMI ≥25 kg/m² (n=200)	Total (n=400)	P
VD	177 (88.6%)	94 (47.0%)	271 (67.8%)	<0.001
Emergency LSCS	23 (11.4%)	106 (53.0%)	129 (32.2%)	

Table 3 highlights a significant difference in the mode of delivery between the two BMI groups. Among women with BMI <25 kg/m², the majority (88.6%) had a vaginal delivery (VD), while only 11.4% required an emergency lower segment cesarean section (LSCS). In contrast, in the BMI ≥25 kg/m² group, less than half (47.0%) delivered vaginally, and a much higher proportion (53.0%) underwent emergency LSCS. The p-value (<0.001) indicates that this difference is statistically significant, suggesting a strong association between higher maternal BMI and increased risk of cesarean delivery.

Table 4: Maternal outcomes of the study subjects in both the study groups

Outcome	BMI <25 kg/m² (n=200)	BMI ≥25 kg/m² (n=200)	Total (n=400)	P
Gestational age				
Preterm (<37)	42 (21.0%)	34 (16.9%)	76 (19%)	0.412
Term (37–40)	153 (76.7%)	152 (75.9%)	305 (76.3%)	
Postterm (>40)	5 (2.3%)	14 (7.2%)	19 (4.7%)	
Total	200(100%)	200(100%)	400(100%)	
IUFD	5 (2.3%)	7 (3.6%)	12 (3%)	
Congenital anomaly	5 (2.3%)	4 (1.8%)	9 (2.0%)	
FGR	2 (1.1%)	2 (1.2%)	4 (1%)	0.384

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Table 4 presents various maternal outcomes across the two BMI groups. The incidence of fetal growth restriction (FGR) was similar and very low in both groups (1.1% in BMI <25 kg/m² and 1.2% in BMI ≥25 kg/m²; p=0.384), indicating no significant association with BMI. Preterm delivery was slightly more common in the normal weight group (21.0%) compared to the obesity group (16.9%), while term deliveries were nearly equal (76.7% vs. 75.9%). Postterm deliveries were more frequent among obese women (7.2%) than in the normal BMI group (2.3%). The rates of intrauterine fetal demise (IUFD) and congenital anomalies were low and comparable between the groups. Overall, no statistically significant differences were observed in these outcomes, suggesting that BMI had minimal influence on these specific maternal outcomes in the study.

Table 5: Newborn birth weight of study subjects in both groups

Outcome	BMI <25 kg/m² (n=200)	BMI ≥25 kg/m² (n=200)	Total (n=400)	P
Weight of newborn				
<2.5 kg	43 (21.5%)	36 (18.0%)	79 (19.8%)	0.124
2.5–4 kg	157 (78.5%)	162 (81.0%)	319 (79.8%)	
>4 kg	0	2 (1.0%)	2 (0.5%)	
Total	200(100%)	200(100%)	400(100%)	

Table 5 presents the distribution of newborn birth weights across the two BMI groups. The majority of newborns in both groups had a birth weight between 2.5–4 kg, 78.4% in the normal weight group and 81.3% in the obesity group. Low birth weight (<2.5 kg) was slightly more common among mothers with BMI <25 kg/m² (21.6%) compared to those with BMI ≥25 kg/m² (18.1%). Only one case of macrosomia (>4 kg) was observed, and it occurred in the obesity group (1.0%). The p-value of 0.124 indicates that these differences are not statistically significant, suggesting no strong association between maternal BMI and newborn birth weight in this study.

Discussion

The present study found a higher prevalence of obesity among women aged ≥30 years, which was significantly associated with adverse maternal outcomes such as gestational hypertension, gestational diabetes mellitus (GDM), and cesarean section rates. These findings are in agreement with those of Lovely Kumari et al. (2024)[7], who also reported a higher incidence of these complications in obese pregnant women, particularly in those of advanced maternal age. This consistency across studies highlights the compounded risk posed by both increasing age and elevated BMI.

Furthermore, the association between maternal obesity and poor neonatal outcomes is also reflected in the findings of Yilmaz AD et al., [8], who noted that higher pre-pregnancy BMI and excessive gestational weight gain correlated with increased rates of NICU admission and low Apgar scores. In our study, similar neonatal complications were more frequent among obese mothers, suggesting that maternal obesity independently contributes to adverse perinatal outcomes.

Together, these observations not only reinforce existing evidence but also emphasize the need for early identification and management of obesity in pregnant women, particularly those aged 30 years and above. The interplay between maternal age and obesity warrants closer monitoring to mitigate both maternal and neonatal risks during pregnancy.

The current study demonstrates a significantly higher prevalence of maternal obesity among women belonging to lower socioeconomic strata, particularly within the lower middle and lower classes. This finding directly addresses one of the study's core objectives—to assess the association between socioeconomic status and maternal obesity. Our analysis revealed that women from economically disadvantaged backgrounds not only had higher BMI but were also more likely to experience adverse maternal outcomes such as gestational hypertension, preeclampsia, and increased rates of cesarean deliveries. This suggests a potential link between economic vulnerability and both the development and complications of maternal obesity.

These results are consistent with findings reported by Lovely Kumari et al. (2024)[7], who conducted a prospective observational study in Jamshedpur and found a similar pattern of obesity being more prevalent among women of lower socioeconomic status. They also reported a significantly higher incidence of pregnancy complications—including hypertensive disorders and operative deliveries—in this population, thereby corroborating our observations from South Bihar.

In a multicentric cross-sectional study, McAuliffe FM et al(2020).[9] also identified a higher risk of obesity in pregnant women from economically disadvantaged regions in India. Their analysis attributed this to factors such as low nutritional literacy, limited access to quality antenatal care, and sedentary lifestyles. Our findings similarly underscore the role of inadequate health education and suboptimal antenatal care utilization among lower-income groups, indicating that socioeconomic

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disadvantage acts as both a direct and indirect contributor to adverse maternal outcomes.

Furthermore, the population-based study by Balarajan and Villamor (2009)[10] supports our data by highlighting that lower income and educational attainment were significantly associated with elevated maternal BMI, poor dietary practices, and reduced prenatal engagement. In our cohort, lower socioeconomic status also correlated with fewer antenatal visits and substandard dietary practices, reinforcing their conclusion that maternal health inequities are deeply rooted in social determinants.

Thus, the study findings not only confirm the role of socioeconomic status in the etiology and outcomes of maternal obesity but also emphasize the urgent need for targeted public health interventions. Tailored strategies aimed at improving antenatal care coverage, nutritional education, and lifestyle modifications in economically weaker sections may be key to reducing the burden of maternal obesity and its associated complications.

One of the principal objectives of the current study was to evaluate the impact of maternal obesity on both maternal and neonatal outcomes, independent of gravida status. The results demonstrate that maternal obesity is significantly associated with a higher incidence of adverse outcomes—including gestational hypertension, gestational diabetes mellitus (GDM), prolonged labor, and increased rates of cesarean deliveries—as well as poor neonatal outcomes such as low Apgar scores and NICU admissions.

In the study cohort, the rate of gestational hypertension among obese women was 31.3%, compared to 6.3% in women with normal BMI—a finding that mirrors the results of Sudha Menon and Sivaprasad (2019)[11], who reported increased odds of hypertensive disorders (OR 3.5) in obese pregnant women. Similarly, the incidence of GDM in our study was 22.9% in the obese group versus 4.5% in non-obese women, closely paralleling their reported odds (OR 5.2). The significantly elevated rates of emergency cesarean deliveries (53% vs. 11.4%) and labor complications among our obese participants align with the increased cesarean risk (OR 4.0) and prolonged labor noted in their study. These findings affirm that maternal obesity markedly elevates the risk of pregnancy-related complications even when the gravida distribution is similar across groups.

Furthermore, the study by Gandhi et al. (2023)[12] substantiates our observations of higher rates of fetal macrosomia, NICU admissions (26%), and maternal complications in obese women. Our data (Tabs 2 and 3) similarly reflect increased neonatal ICU admissions and adverse intrapartum events in obese mothers, emphasizing the consistent negative impact of obesity across diverse geographic regions.

In addition, the study by Mansi Kumar and Kimaya Mali (2022)[13] found a 15% incidence of gestational hypertension, 18% GDM, and a 44% cesarean rate in obese women—outcomes strikingly close to our recorded values. Their findings of increased NICU admissions and neonatal hypoglycemia further reinforce our results presented in Tables 4 and 5, which show that elevated maternal BMI correlates with significantly poorer immediate neonatal outcomes.

Taken together, our study confirms that maternal obesity is an independent and significant risk factor for a wide spectrum of maternal and neonatal complications, consistent with patterns reported in recent Indian literature. Importantly, these associations remain robust even when gravida status is controlled, highlighting that parity alone does not mitigate the risks associated with elevated BMI. This underscores the urgent need for targeted preventive strategies, including early BMI screening, nutritional counseling, and lifestyle interventions within antenatal programs—particularly in tertiary care settings serving vulnerable populations.

Generalizability

The study findings are generalisable to similar low- and middle-income settings with comparable sociodemographic and healthcare characteristics. While purposive sampling limits wider applicability, the large sample and real-world clinical data enhance relevance for regional maternal health planning.

Conclusion

This prospective observational study conducted at a tertiary care centre in South Bihar highlights a significant association between elevated maternal BMI (≥25 kg/m²) and adverse maternal and neonatal outcomes. While gravida distribution was relatively balanced across BMI groups, women with obesity exhibited markedly higher incidences of gestational hypertension, gestational diabetes mellitus, preeclampsia/eclampsia, prolonged labor, and emergency cesarean deliveries. Although no statistically significant differences were observed in rates of fetal growth restriction, gestational age at delivery, congenital anomalies, or birth weight, the trend toward increased complications in the obese group underscores the impact of maternal obesity on pregnancy outcomes.

Limitations

Single-center design and purposive sampling are important limitations. Prepregnancy BMI was estimated, not directly measured. The lack of long-term follow-up also constrains the findings.

Recommendations

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These findings emphasize the importance of preconception counseling, early BMI monitoring, and targeted antenatal interventions to mitigate risks associated with maternal obesity and improve maternal and neonatal health in similar resource-constrained settings.

Acknowledgement

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List of abbreviations

BMI – Body Mass Index
PPBMI – Prepregnancy Body Mass Index
GWG – Gestational Weight Gain
GDM – Gestational Diabetes Mellitus
LSCS – Lower Segment Cesarean Section
FGR – Fetal Growth Restriction
IUFD – Intrauterine Fetal Demise
NICU – Neonatal Intensive Care Unit
OBGY – Obstetrics and Gynaecology
NMCH – Nalanda Medical College and Hospital
MBBS – Bachelor of Medicine and Bachelor of Surgery
MS – Master of Surgery
MD – Doctor of Medicine

Funding

The study received no funding.

Conflict of interest

The author declares no conflict of interest.

Author biography

Dr. Poojita is an Associate Professor in the Department of Obstetrics and Gynaecology at Narayan Medical College and Hospital, Jamuhar, with expertise in antenatal care.

Dr. Renuka Keshari is a Professor in the same department, with extensive experience in obstetrics, endocrinology in pregnancy, and women's health research.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. All data were collected and managed per institutional ethical guidelines, ensuring participant confidentiality.

Authors' contributions

Dr. Poojita was responsible for the study conception, design, data collection, and statistical analysis. She also contributed to the interpretation of results and drafting of the manuscript.

Dr. Renuka Keshari provided critical guidance in study design, supervised the research process, and contributed to the interpretation of findings and manuscript revision. Both authors read and approved the final manuscript.

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