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Association of Maternal BMI with Obstetric and Perinatal Outcomes

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ABSTRACT

The increasing prevalence of obesity among women of childbearing age is linked to a higher risk of pregnancy complications. Maternal obesity affects both obstetric and perinatal outcomes, posing risks for mother and child. **Objective:** To investigate the relationship between maternal BMI and obstetric and perinatal outcomes. **Methods:** A cross-sectional study was conducted at the Department of Obstetrics and Gynecology, Tertiary Care Hospital Bahawalpur, from January to July, 2022. A total of 254 pregnant women were categorized into underweight, normal, overweight, and obese groups based on BMI. Data on Gestational Diabetes Mellitus (GDM), Pregnancy-Induced Hypertension (PIH), and mode of delivery, labor complications, postpartum hemorrhage, preterm labor, and NICU admissions were analyzed using SPSS version 25.0. **Results:** Higher incidences of GDM (31.9% in obese vs. 10.6% in underweight) and PIH (23.1% in obese vs. 7.7% in underweight) were observed, though not statistically significant ($p = 0.088$ and $p = 0.463$, respectively). Obese mothers had more cesarean sections (24.6% vs. 13.8% in underweight, $p = 0.178$) and increased NICU admissions (18.9% vs. 8.1%, $p = 0.788$). **Conclusions:** This study observed clinically relevant trends suggesting that higher maternal BMI may be associated with adverse obstetric and perinatal outcomes, including increased rates of gestational diabetes, hypertension, cesarean sections, and NICU admissions. Although statistical significance was not reached, findings emphasize the importance of maternal weight management in prenatal care.

INTRODUCTION

Maternal Body Mass Index (BMI) is a critical determinant of both obstetric and perinatal outcomes. The increasing prevalence of maternal obesity globally has raised significant concerns due to its association with adverse pregnancy outcomes, including gestational hypertension, Gestational Diabetes Mellitus (GDM), cesarean delivery, and neonatal complications [1]. On the other end of the spectrum, low maternal BMI is linked with risks such as Intrauterine Growth Restriction (IUGR) and preterm birth, which contribute to neonatal morbidity and mortality [2]. Understanding the association between maternal BMI and pregnancy outcomes is essential to implementing strategies for optimizing maternal and fetal health. Obesity, defined as a BMI of 30 kg/m^2 or higher, has been strongly associated with hypertensive disorders in pregnancy, including preeclampsia and eclampsia [3]. A study analyzing data from over 497,000 women in Europe and North America found that increased maternal BMI significantly raised the likelihood of gestational hypertension and preeclampsia, emphasizing the need for preventive measures before conception [4]. Additionally, obesity contributes to metabolic complications such as insulin resistance, which predisposes pregnant women to GDM. Research suggests that women with higher BMI have an increased risk of developing GDM, which can lead to macrosomia, birth injuries, and neonatal hypoglycemia [5]. Maternal obesity also influences delivery outcomes. Higher BMI is correlated with an increased incidence of cesarean

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section due to complications such as cephalopelvic disproportion, fetal distress, and prolonged labor [6]. A study conducted in Ireland found that obese mothers had significantly higher rates of induction of labor and emergency cesarean sections, further reinforcing the negative impact of excessive maternal weight on labor progress [7]. Furthermore, extremely high BMI (>50 kg/m^2) has been linked to a nine-fold increase in thrombotic events and higher risks of post-cesarean wound infections, adding another layer of maternal morbidity [8]. The perinatal outcomes associated with maternal BMI are equally concerning. Higher maternal BMI is a known risk factor for fetal macrosomia, which increases the likelihood of birth trauma, shoulder dystocia, and Neonatal Intensive Care Unit (NICU) admissions [9]. A study conducted in the Jabal Akhdar region of Libya found that overweight and obese mothers had significantly higher rates of NICU admissions due to respiratory distress and metabolic disorders [10]. Conversely, underweight mothers (BMI <18.5 kg/m^2) are more likely to give birth to low birth weight infants, who face a greater risk of hypothermia, infections, and long-term developmental challenges [11]. Given these associations, it is imperative to emphasize preconception counseling and targeted interventions to maintain a healthy BMI before and during pregnancy. Public health strategies should focus on promoting optimal weight gain during pregnancy through dietary guidance, physical activity, and regular antenatal monitoring. Addressing maternal BMI as a modifiable risk factor can significantly reduce the burden of adverse obstetric and perinatal outcomes, ensuring better health for both mother and child [12].

This study aimed to evaluate the association between maternal BMI and obstetric outcomes such as GDM, PIH, and mode of delivery, as well as neonatal health outcomes, including Apgar scores and NICU admissions. The findings will help guide clinical practices and inform public health strategies to improve maternal and neonatal health by optimizing weight management during pregnancy.

METHODS

This study was conducted at Department of Obstetrics and Gynecology, Tertiary Care Hospital Bahawalpur. Type of study was cross sectional and conducted between January 14, 2022, to July 13, 2022 (IRB: EC-01-2022). Total 254 patients were included by calculating sample size by taking GDM rate of 20.83%, Confidence level 95% and Error margin as5% [13]. Non-probability consecutive sampling technique was applied for data collection. Ethical approval was taken from the Institutional Review Board (IRB) of Tertiary Care Hospital, Bahawalpur and Informed Consent was taken from all participants before being included in this study. Participants' information was confidential throughout the study. The inclusion criteria for this study were pregnant females with a single gestation who were booked and had their BMI calculated at the first antenatal visit, with complete follow-up data throughout pregnancy and delivery. Exclusion criteria included women with twin gestations, having history of medical disorder prior to pregnancy, or incomplete medical records. Data were collected using structured questionnaires and medical records, including maternal characteristics (age and BMI), obstetric outcomes (mode of delivery, pregnancy-induced hypertension, GDM, and labor complications), and perinatal outcomes (Apgar scores at 1 and 5 minutes, preterm birth, birth weight and NICU admissions). Maternal BMI was classified as underweight, normal weight overweight and obese. All the analysis was done by SPSS version 25.0. Descriptive statistics were performed by using the counts and proportions for categorical variables and means (SD) for continuous data. The Chi-square test was used to investigate maternal BMI categories for the different obstetric and perinatal outcomes with a significance level of $p < 0$. Maternal BMI versus continuous outcomes such as birth weight and Apgar scores were analyzed using Pearson correlation analysis.

RESULTS

The study included 254 females, with an age range of 18–44 years and a mean age of 30.62 ± 7.99 years, demonstrating a moderately wide age distribution among participants. The BMI of participants ranged from 16.40 to 37.80, with an average BMI of 25.72 ± 5.73, covering a broad spectrum from underweight to obese. The mean birth weight of newborns was 2943.70 ± 498.40 grams (range: 1700–4400 grams), representing expected variation in a general obstetric population. Apgar scores at 1 minute ranged from 1 to 9 (mean 4.94 ± 2.59), suggesting that some neonates required immediate medical attention. By 5 minutes, Apgar scores improved significantly (range: 5–9, mean 6.94 ± 1.46), indicating an overall recovery in neonatal condition after birth. These demographic and neonatal characteristics are summarized in Table 1.

Table 1: Demographic and Neonatal Characteristics of the Study Participants (n = 254)

Variables	Mean ± SD	Range	Remarks
Age (Years)	30.62 ± 7.99	18 – 44	Moderately wide age distribution
BMI (kg/m^2)	25.72 ± 5.73	16.40 – 37.80	Ranged from underweight to obese
Birth Weight (g)	2943.70 ± 498.40	1700 – 4400	Normal variation in obstetric population
Apgar Score at 1 minute	4.94 ± 2.59	1 – 9	Some neonates required immediate attention
Apgar Score at 5 minutes	6.94 ± 1.46	5 – 9	Indicated improvement in neonatal condition

Maternal BMI was classified into underweight, normal, overweight, and obese groups.The prevalence of gestational diabetes mellitus (GDM) was highest in obese mothers (31.9%), while underweight mothers had the lowest prevalence (10.6%). Although the p-value (0.088)

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suggests a possible relationship, statistical significance was not reached, indicating that BMI alone may not be a strong predictor of GDM in this sample. Similarly, pregnancy-induced hypertension (PIH) was more frequent in obese (23.1%) and normal-weight (48.7%) mothers, compared to underweight (7.7%) and overweight (20.5%) groups. However, this difference was not statistically significant (p = 0.463).Mode of delivery varied with BMI, with vaginal deliveries being more frequent among normal-weight (39.0%) and overweight (32.6%) mothers, while cesarean section rates were higher in obese mothers (24.6%). Instrumental deliveries were least common and mostly observed in the normal BMI category (64.7%). Despite these variations, the association was not statistically significant (p = 0.178).Labor complications were reported more frequently among normal-weight (52.1%) and overweight (25.0%) mothers, but the overall comparison across BMI categories was not statistically significant (p = 0.319).The incidence of postpartum hemorrhage (PPH) was highest in obese mothers (38.1%), whereas underweight mothers had the lowest prevalence (9.5%), yet this difference was not statistically significant (p = 0.150). The rate of preterm birth was relatively balanced across all BMI groups, with no significant differences (p = 0.741). Neonatal outcomes showed higher NICU admissions in obese (18.9%) and overweight (35.1%) mothers, while lower rates were observed in underweight (8.1%) and normal-weight (37.8%) groups, but these findings were not statistically significant (p = 0.788). These obstetric and perinatal outcomes are summarized in Table 2.

Table 2: Association of Maternal BMI with Obstetric and Perinatal Outcomes

OutcomeVariables	Underweight Frequency (%)	Normal Frequency (%)	Overweight Frequency (%)	Obese Frequency (%)	Total	p-Value
Gestational Diabetes (GDM)						
No	23 (11.1%)	90 (43.5%)	60 (29.0%)	34 (16.4%)	207	0.088
Yes	5 (10.6%)	14 (29.8%)	13 (27.7%)	15 (31.9%)	47	
Pregnancy-Induced Hypertension (PIH)						
No	25 (11.6%)	85 (39.5%)	65 (30.2%)	40 (18.6%)	215	0.463
Yes	3 (7.7%)	19 (48.7%)	8 (20.5%)	9 (23.1%)	39	
Mode of Delivery						
Vaginal	19 (11.0%)	67 (39.0%)	56 (32.6%)	30 (17.4%)	172	0.178
Cesarean	9 (13.8%)	26 (40.0%)	14 (21.5%)	16 (24.6%)	65	
Instrumental	0 (0.0%)	11 (64.7%)	3 (17.6%)	3 (17.6%)	17	
Labor Complications						
No	23 (11.2%)	79 (38.3%)	61 (29.6%)	43 (20.9%)	206	0.319
Yes	5 (10.4%)	25 (52.1%)	12 (25.0%)	6 (12.5%)	48	
Postpartum Hemorrhage (PPH)						
No	26 (11.2%)	97 (41.6%)	69 (29.6%)	41 (17.6%)	233	0.150
Yes	2 (9.5%)	7 (33.3%)	4 (19.0%)	8 (38.1%)	21	
Preterm Birth						
No	25 (11.0%)	94 (41.2%)	67 (29.4%)	42 (18.4%)	228	0.741
Yes	3 (11.5%)	10 (38.5%)	6 (23.1%)	7 (26.9%)	26	
NICU Admission						
No	25 (11.5%)	90 (41.5%)	60 (27.6%)	42 (19.3%)	217	0.788
Yes	3 (8.1%)	14 (37.8%)	13 (35.1%)	7 (18.9%)	37	

Pearson correlation analysis showed no statistically significant associations between maternal BMI and key obstetric or perinatal outcomes. BMI demonstrated a weak positive correlation with birth weight (r = 0.087, p = 0.168), suggesting a slight but non-significant trend of increasing birth weight with higher BMI. No significant correlations were found between BMI and Apgar scores at 1 minute (r = 0.027, p = 0.668) or at 5 minutes (r = -0.059, p = 0.349). Similarly, birth weight did not correlate significantly with Apgar scores at 1 minute (r = -0.061, p = 0.335) or at 5 minutes (r = -0.047, p = 0.454). The Apgar scores at 1 and 5 minutes were not significantly correlated with each other (r = 0.019, p = 0.763). These findings indicate that maternal BMI alone was not a strong predictor of obstetric or perinatal outcomes in this study, and other unmeasured factors such as maternal comorbidities, genetic predispositions, and prenatal care quality may influence these associations. All correlation analyses are presented in Table 3.

Table 3: Correlation Among Maternal BMI, Age, Birth Weight, and Apgar Scores

Variable	Age	BMI	Birth Weight	Apgar Score 1 Min	Apgar Score 5 Min
Age	Correlation	1.000	0.011	0.026	-0.008
	P-Value		0.857	0.675	0.897
	N	254	254	254	254

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BMI	Correlation	0.011	1.000	0.087	0.027
	P-Value	0.857	-	0.168	0.668
	N	254	254	254	254
Birth Weight	Correlation	0.026	0.087	1.000	-0.061
	P-Value	0.675	0.168	-	0.335
	N	254	254	254	254
Apgar Score 1 Min	Correlation	-0.008	0.027	-0.061	1.000
	Sig. (2-tailed)	0.897	0.668	0.335	-
	N	254	254	254	254
Apgar Score 5 Min	Correlation	-0.044	-0.059	-0.047	0.019
	P-Value	0.480	0.349	0.454	0.763
	N	254	254	254	254

To provide a better understanding of the variability and reliability of the results, confidence intervals (CIs) were calculated for key outcomes. The 95% CI for GDM in obese mothers (18.59%–45.24%) suggests a potentially higher prevalence, though variability remains due to sample size limitations. The CI for PIH in obese mothers (9.85%–36.30%) indicates a possible increased risk, while the underweight group's lower bound (0.00%) suggests a very low occurrence. Cesarean section rates in obese mothers had a CI of 14.14%–35.09%, supporting a likely higher prevalence compared to underweight mothers (4.47%–26.84%). NICU admissions were more frequent in obese mothers (5.46%–34.69%), though the wide CI range reflects uncertainty due to the sample size. While most comparisons did not reach statistical significance, the confidence intervals highlight potential trends and suggest that larger, multi-center studies with increased statistical power are needed to better define the role of BMI in obstetric and neonatal outcomes. All confidence intervals are presented in Table 4.

Table 4: Confidence Intervals for Key Outcomes

Variables	Lower CI (%)	Upper CI (%)
GDM (Obese)	18.59	45.24
GDM (Underweight)	1.82	19.45
PIH (Obese)	9.85	36.30
PIH (Underweight)	0.00	16.06
Cesarean (Obese)	14.14	35.09
Cesarean (Underweight)	4.47	26.84
NICU Admission (Obese)	5.46	34.69
NICU Admission (Underweight)	0.00	23.48

DISCUSSION

The present study examined the association between maternal body mass index (BMI) and obstetric and perinatal outcomes.While the findings did not reach statistical significance, they align with existing literature that suggests maternal obesity may increase the risk of gestational diabetes mellitus (GDM), pregnancy-induced hypertension (PIH), cesarean delivery, and neonatal complications.This discussion contextualizes the results in light of international research, highlighting similarities, limitations, and areas for further investigation.This study found a higher prevalence of GDM (31.9%) and PIH (23.1%) among obese mothers compared to underweight mothers (10.6% and 7.7%, respectively).Although statistical significance was not reached (p = 0.088 for GDM, p = 0.463 for PIH), the observed patterns are consistent with findings from Ballesta-Castillejos *et al.*, who reported that higher BMI significantly increases the risk of preeclampsia and emergency cesarean sections. Similarly, Ramya *et al.*, observed that obesity is associated with an increased risk of GDM and gestational hypertension [13, 14].The underlying pathophysiology likely involves insulin resistance, hyperglycemia, and pro-inflammatory states associated with obesity, which predispose pregnant women to metabolic disturbances.Choudhary *et al.*, further support this association, reinforcing that BMI impacts the development of hypertensive disorders and GDM [15].Snehlata and Lal, further corroborate this by highlighting the risks associated with high or low maternal BMI [16].Their study found that low BMI is linked with increased risks of intrauterine growth restriction (IUGR) and low birth weight, while high BMI leads to more frequent complications such as PIH and GDM.This bimodal distribution of risk underscores the need for maintaining a balanced BMI for optimal maternal and fetal health outcomes. Although this study did not confirm these associations with statistical significance, the trends emphasize the importance of preconception weight management and continuous antenatal monitoring.The study findings also align with previous research on mode of delivery and obstetric complications. We observed higher cesarean section rates in obese mothers (24.6%) compared to normal-weight mothers (40.0%) and underweight mothers (13.8%).However, statistical significance was not reached (p = 0.178).This finding is comparable to the results reported by Sinha *et al.*, who documented an increased likelihood of cesarean delivery in obese women due to the mechanical and metabolic challenges of labor [17].Similarly, Tharihalli and Thathagari found that higher BMI was associated with increased rates of operative deliveries, supporting the notion that obesity may impair the normal progression of labor and necessitate medical interventions [18].While these results did not show a statistically significant association, the observed patterns suggest that maternal BMI may influence labor outcomes and should be considered in

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antenatal care planning.Regarding neonatal outcomes, this study showed a potential link between higher BMI and lower Apgar scores at 1 minute, as well as increased NICU admissions in obese mothers (18.9%).However, these associations were not statistically significant (p = 0.788). The findings are in line with Vernini *et al.*, who reported that maternal obesity is associated with adverse neonatal outcomes, including an increased risk of macrosomia, birth trauma, and NICU admissions [19].The likelihood of fetal macrosomia in obese mothers may contribute to birth complications such as shoulder dystocia, hypoxia, and neonatal respiratory distress, necessitating NICU care. Indarti *et al.*, further emphasized the role of obesity in heightened risks of gestational diabetes, hypertensive disorders, and adverse neonatal outcomes, reinforcing the need for comprehensive prenatal care strategies to minimize risks [20].Several global studies have also highlighted the broader implications of maternal obesity on pregnancy outcomes.González-Plaza *et al.*, also Chowdhury and Choudhury reported that pre-pregnancy overweight and obesity were linked to a range of adverse perinatal outcomes, including gestational diabetes, cesarean section, and poor neonatal health [21, 22].These findings highlight the universal significance of managing maternal BMI to mitigate pregnancy-related risks.While this study did not establish definitive statistical relationships, the consistency of observed trends with prior research underscores the importance of targeted interventions to optimize maternal weight before and during pregnancy.While this study provides valuable insights, several limitations must be acknowledged.The sample size may not have been sufficient to detect statistically significant associations, as reflected in the wide confidence intervals for key outcomes.Additionally, BMI alone may not fully capture the complex interplay of metabolic, genetic, and lifestyle factors that influence pregnancy outcomes. Future research should consider larger sample sizes, prospective cohort designs, and multivariable regression models to adjust for potential confounders such as parity, socioeconomic status, and pre-existing metabolic conditions.These refinements will improve the statistical power and validity of future studies exploring the impact of maternal BMI on obstetric and perinatal health.

CONCLUSIONS

Although no statistically significant associations were identified, certain trends were observed such as higher rates of gestational diabetes mellitus, cesarean deliveries, postpartum hemorrhage, and NICU admissions among obese mothers—that suggest a potential relationship between elevated BMI and adverse pregnancy outcomes. These findings indicate that maternal BMI alone may not serve as a strong independent predictor; however, it remains a clinically relevant factor that may contribute to obstetric and neonatal risks when combined with other variables. Given the observed trends and limitations related to sample size, further research using larger, multicenter cohorts and robust statistical models is warranted to clarify these associations and inform clinical practice regarding the management of maternal BMI during pregnancy.

Authors Contribution

Conceptualization: SB
Methodology: SB
Formal analysis: RS, NH
Writing, review and editing: SU, SZC, AI
All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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