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Predicting Adverse Pregnancy Outcomes in First Time Mothers: The Role of Maternal Body Mass Index

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ABSTRACT

Maternal underweight during pregnancy can profoundly "programme" the fetal physiology and metabolism, which may end up in chronic illnesses later in life. including diabetes mellitus, cerebrovascular disease and hypertension. **Objective:** To figure out the likelihood of untoward events among underweight nulliparous women. **Methods:** A descriptive cross-sectional study was performed in the Obstetrics and Gynaecology Department, Nishtar Hospital, Multan, for the period of four months from December 2024 to March 2025 using non-probability consecutive sampling. Around 401 women were included after fulfilling the selection criteria. Data were collected through a specialized form and reviewed using SPSS Version 20.0. **Results:** Mean age was 28.98 ± 4.21 years among the participants. Mean height was 165 ± 7.43 centimeter, and mean weight was 52.21 ± 3.25 kilograms. Mean body mass index (BMI) was 18.11 ± 0.23 kg/m2.Cesarean delivery was reported among 73 (18.2%), pre-eclampsia in 57 (14.2%), preterm delivery in 165 (41.1%) and low-birth-weight babies were 126 (31.5%). **Conclusions:** The results reported an upsurge in the incidence of undesirable pregnancy outcomes such as preterm births and low birth weight babies among underweight first-time mothers. Proper counselling of these cases regarding weight gain before conception can help to lessen these adverse events and can be helpful in subsequent pregnancies.

INTRODUCTION

Maternal obesity consistently receives considerable attention in the research. Conversely, maternal underweight appears to be relatively under investigated, particularly among nulliparous women [1]. Many pregnant women develop harmful practices to lose weight. Underweight status and nulliparity present a unique confluence of risk factors that can significantly impact pregnancy outcomes [2]. Pregnancy-related low maternal weight (BMI <18.5 kg/m^2) is known to increase the prevalence of low birth weight babies and the likelihood that the kids would grow up to be obese and have high blood pressure [3]. Preterm delivery, fetal growth restriction, and hypertension are among the adverse pregnancy outcomes that these women are more likely to experience [4]. According to the World Health Organization (WHO), a person is considered underweight if their body mass index (BMI) is less than 18.5 kg/m^2, normal if it is between 18.5 and 24.99 kg/m^2, overweight if it is between 25.00 and 29.9 kg/m^2, and obese if it is greater than 30 kg/m^2 [5]. Low BMI and inadequate weight gain during pregnancy exacerbate the problems [6]. Based on pre-pregnancy BMI, the Institute of Medicine (IOM) recommends a certain gestational weight gain (GWG). It states GWG: 12.5–18 kg is recommended for underweight mothers [7]. Around 9.7%

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of mothers are underweight around the globe, while the incidence is three times higher (24%) in South Asia [8]. About 14.4% of women in reproductive years have low BMI according to the National Nutritional Survey in Pakistan [8]. Maternal underweight was reported among 7.5% of women in France [9]. The effects of low BMI on outcomes of pregnancy, particularly among first-time mothers, have received relatively less attention. The precarious balance between maternal nutrient stores and fetal development highlights the need for targeted research. This knowledge gap is particularly concerning as low maternal weight has lasting implications for the future health of the newborn. By investigating birth outcomes in underweight first-time mothers, this study intends to bridge this gap. There is no such study conducted in Pakistan on this topic previously. The results would help clinicians to anticipate these untoward events among first-time mothers, and we hope to inform the development of targeted interventions for future pregnancies. It ultimately improves the excellence of care.

Maternal underweight in first-time mothers is an important but relatively under-researched contributor to adverse pregnancy outcomes such as preterm birth, low birth weight, and pre-eclampsia. Despite increasing global evidence, limited locally generated data exist in Pakistan to clearly define the magnitude and impact of low BMI in nulliparous women. Therefore, this study aimed to determine the frequency of adverse pregnancy outcomes among underweight first-time mothers and to evaluate the association between maternal BMI and perinatal complications. It also sought to identify high-risk groups to support early preventive and nutritional interventions.

METHODS

This was a descriptive cross-sectional research conducted in the labour ward (Obstetrics and Gynaecology), Nishtar Hospital, Multan, from December 2024 to March 2025 after approval from the ethical committee with ERB No. 18957/NMU. Non-probability consecutive sampling technique was used. A sample size of 401 was determined by following the formula. $n=z^2pq/d^2$, where p=11.5% (hypothesized frequency of preterm births in underweight women) [1], q=100-p, d=0.031 (3.11% margin of error), z=1.96(95% confidence interval). Underweight primigravida women who had pre-pregnancy BMI less than 18.5 Kg/m^2, 20–40 years old, with gestational age between 24-38 weeks (on ultrasound) were enrolled. This study chose only first-time mothers who presented in labour ward for planned delivery because the study focuses on the targeted high-risk population. First-time mothers might be more vulnerable to pregnancy-related complications due to their inexperience with pregnancy. This study controls the impact of parity on pregnancy outcomes and can potentially improve the outcome for future pregnancies. Women with a history of scarred uterus (myomectomy scar), presence of fetal anomalies like congenital heart disease, inherited metabolic disorders, neural tube defects and women with a previous history of diabetes, hypertension and cardiac conditions (confirmed by clinical record) were excluded. A written informed consent was taken. Data about pre-pregnancy BMI were collected via antenatal record; however, the accuracy of self-reported weights may be subject to recall bias. Using the self-reported pre-pregnancy weight cutoff criteria suggested by the WHO, the conventional calculation is weight (kg) divided by the square of body height (m)(underweight, <18.5 kg/m2). Outcome variables were preterm delivery, pre-eclampsia and cesarean delivery and low birth weight. Preterm delivery was described as the start of labour between 24-37+6 weeks of pregnancy. All those cases who had systolic pressure above 140 mm Hg and diastolic pressure >90mmHg measured at least two times with 4 hours' interval after 20 weeks of gestation and proteinuria ≥300mg/day, were labelled as pre-eclampsia, till delivery. Cesarean section delivery was labelled when the baby is born through an incision in the abdomen. Low birth weight referred as the birth weight of less than 2.5kg as measured on a digital weighing scale. Demographic data were collected via a specialized questionnaire. Each participant gave informed consent beforehand. Additionally, they received a briefing on the study's goals, guaranteeing the privacy of the data they submitted. Every method used in the study complies with the Helsinki Declaration and its later modifications as well as the institution's ethical standards. SPSS version 20.0 was used to analyze the data. For numerical data such as patient age, height, weight, and gestational age, the mean and standard deviation were computed. For outcome variables such as birth weight, pre-eclampsia, premature labor, and cesarean section, frequencies and percentages were calculated. The demographic variables were socioeconomic status, educational level, age groups and residential status. Effect modifiers like age, educational status, residential status, and socioeconomic status were controlled by making stratified tables. A chi-square test was used after stratification to determine their effect on the outcome. p-values equal to or less than 0.050 were considered significant.

RESULTS

The study included a total of 401 women who met the inclusion criteria. The mean age of our study cases was 28.98 ± 4.21 years (with a range of 20-40 years). The majority, 239 (59.6%), were between 20-30 years of age, and 162 (40.4%) were between 31-40 years. Out of 401 women, 241(60.1%) were from rural areas and 160 (39.9%)

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were from urban areas. Around 39 (9.7%) women had no formal education, and 362 (90.27%) were educated till matriculation. About 271(67.6%) were from low socioeconomic status (<Rs. 15,000 / month) and 130 (32.4%) from moderate socioeconomic status (Rs. 16000/- to 40000/month)(Table 1).

Table 1: Socio-Demographic Variables among Participants (n=401)

Variables	Categories	Frequency (%)
Age (Years)	20 – 30 Years	239 (59.6%)
	31 – 40 Years	162(40.4%)
Residence	Rural	241(60.1%)
	Urban	160(39.9%)
Education	Illiterate	39(9.7%)
	Literate	362 (90.3%)
Socioeconomic Status	Low (<Rs. 15000/Month)	271(67.6%)
	Moderate (Rs 16000/- To 40000 /Month)	130(32.4%)

The study results indicated that the mean height was 165 ± 7.43 centimeter and the mean weight was 52.21 ± 3.25 kilograms. Mean body mass index (BMI) was 18.11 ± 0.23 kg/m^2.Mean gestational age was 38.74 ± 2.85 weeks. Cesarean delivery was in 73 (18,2%) participants, pre-eclampsia was in 57(14.2%) women, preterm delivery was in 165 (41.1%), and low birth weight babies were 126(31.5%) (Table 2).

Table 2: Pregnancy Outcomes in First-Time Mothers with Low BMI (n=401)

Outcome Variables	Yes	No	Total
Pre-Eclampsia	57 (14.2%)	344 (85.8%)	401 (100%)
Cesarean Section	73 (18.2%)	328 (81.8%)	401 (100%)
Preterm Delivery	165 (41.1%)	236 (58.9%)	401 (100%)
Low Birth Weight	126 (31.5%)	275 (68.6%)	401 (100%)

Pre-eclampsia, preterm delivery, Low birth weight and cesarean section deliveries were stratified concerning age, residential status, socioeconomic status, and level of education. "A significant association was observed between maternal age and preterm birth (p=0.003). Younger mothers (20–30 years) had a higher incidence of preterm delivery (56.06%) compared to older mothers (31–40 years, 18.92%), suggesting age-related vulnerability in underweight nulliparous women." However, no significant link was found between cesarean section, low birth weight and pre-eclampsia across different age groups in thin, lean first-time mothers (Table 3).

Table 3: Stratification of Pregnancy Outcomes According to Age in First-Time Mothers with Low BMI

Outcome Variables			Age Groups		p-value
			20-30 Years (239)	31-40 Years (162)	
Cesarean Delivery	Yes	73	31 (12.9%)	42 (25.9%)	0.147
	No	328	208 (87.1%)	120 (74.1%)	
Pre-Eclampsia	Yes	57	17 (7.1%)	40 (24.7%)	0.199
	No	344	222 (92.9%)	122 (75.3%)	
Pre-Term Birth	Yes	165	134 (56.06%)	31 (18.92%)	0.003
	No	236	105 (43.93%)	131 (80.08%)	
Low Birth Weight	Yes	126	78 (32.63%)	48 (29.63%)	0.762
	No	275	161 (67.36%)	114 (70.27%)	

When we compared our outcome variables with socioeconomic status, cesarean section and pre-eclampsia were not significantly related to socioeconomic status in first-time mothers with low BMI (p=0.140, p=0.072, respectively). Thin, lean first-time mothers who belonged to low socioeconomic status had a significantly increased risk of preterm birth (p=<0.001) and low birth weight (0.023) (Table 4).

Table 4: Stratification of Outcomes During Pregnancy According to Socioeconomic Status in First-Time Mothers with Low BMI

Outcome Variables			Socio-Economic Status		p-value
			Low (<Rs. 15000/ Month) (n=271)	Moderate (Rs 16000/- To 40000 /Month) (n=130)	
Cesarean Delivery	Yes	73	18	55	0.140
	No	328	253	75	
Pre-Eclampsia	Yes	57	13	44	0.072
	No	344	258	86	
Pre-Term Birth	Yes	165	139	26	<0.001
	No	236	132	104	
Low Birth Weight	Yes	126	29	97	0.023
	No	275	242	33	

DISCUSSION

A low birth weight, preterm baby is more likely to be born to thin, lean first-time moms. It is often recommended that these women put on weight before getting pregnant [8]. However, it is unknown what body mass index is best for women who wish to become pregnant. This study found very few studies in which outcomes of pregnancy are assessed in nulliparous women with low BMI. Research done in the USA compared the birth outcomes between mothers with normal or decreased BMI. They found that women with decreased BMI were mostly nulliparous [10]. Among 401 women, the mean age was 28.98 ± 4.21 years (with a range of 20-40 years). A study from Japan reported a 34 ± 4.5years mean age in lean pregnant females. These results are on the higher side compared to our study results [4]. A study from Qatar showed the mean age was 25.2 ± 4.6 among pregnant women with low BMI [5]. In another study done in France, shown mean age of 29 ±10 years was shown among women with low BMI during pregnancy, which is close to our results [6]. Of these 401 study cases, 241 (60.1%) were from rural areas, and 160 (39.9%) were from poor socioeconomic status. A study done in India reported similar results [11]. This study found that more than one-third of participants, 165 (41.1%), had preterm deliveries.

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Pre-eclampsia was found among 57(14.2%) of participants. Cesarean section deliveries were reported in 73(18.2%), and low birth weight was found in 126 (31.5%). In India, research done in nulliparous women with low BMI reported pre-eclampsia in 3.3 %, Cesarean section in 11.3% and preterm births in 12.1 % underweight women, which are quite lower than our results [11]. This was likely because more than 20,000 samples were extracted from the Aberdeen Maternity and Neonatal Databank (AMND) in their study. However, our findings align with research suggesting that younger underweight mothers may face nutritional deficiencies or inadequate gestational weight gain, exacerbating preterm labour risks [12]. Further studies should explore whether biological immaturity or socioeconomic factors (e.g., delayed prenatal care in younger women) drive this association in low-BMI populations. According to research in China, the association between preterm birth and socioeconomic position was mediated by prenatal weight growth and BMI. In women with Low gestational weight gain and suboptimal BMI, there was a significant relationship between preterm birth and low socioeconomic status. However, only half of the participants were first-time mothers in the study [12]. The study found no significant relationship between pre-eclampsia and socioeconomic status; similar to another study done in Peshawar, where no significant relationship was found between pre-eclampsia and socioeconomic status (p=0.98) [13]. Our results showed that there was no impact of socioeconomic status on the rate of cesarean section among first-time mothers with low BMI (p=0.14). Only 6.6% women with low socioeconomic status had cesarean delivery, close to the results of research done in Bangladesh, where it was 8.7% [14]. In another study, women with low BMI had a markedly elevated risk for preterm delivery (OR:1.9) [7]. Another study in France reported that 43% primigravidas with low BMI had preterm births, which was almost similar to our results, i.e 165 (41.1%), likely because the sample size was close to our study (n=407) [9]. Low BMI in mothers had an increased risk of preterm birth (OR of 1.06, 95% CI (1.04–1.09) according to another study in China [15]. About 19.9% of underweight women had preterm deliveries in a study of Pakistan, lower than our results, possibly because of a different study design [16]. An Indian study found that underweight women had a higher chance of having a small-for-gestational-age child and a premature birth [17]. In an Iranian study, the same complications were reported among women with low BMI [18]. Current results showed that there was a significant association of low birth weight (LBW) with socioeconomic status in first-time mothers with low BMI (p=0.023). A study done by Sathi *et al.* using secondary data from Demographic and Health Surveys from six South Asian countries showed the increased prevalence of low birth weight babies among women belonging to low socioeconomic status. After applying the logistic regression model, children from the poorest background had low birth weight (AOR:1.53, 95% CI:1.41-1.67) [19]. In an Indian study, 36.9% of nulliparous women with low BMI had newborns with low birth weight [20], close to our results. It could be because of quite similar demographics among the studies. Another Indian study showed a significant link between birth weight and low BMI among mothers with the odds ratio of 1.44 and 95% CI: 1.05, 1.65) [21]. Another Pakistani study showed that among patients who had a BMI <25kg/m^2, about 16.7% newborns had birth weight <2500 gm, which is almost half compared to our results [22]. Another study showed that being underweight at any time during pregnancy increased the risk of LBW babies' odds ratio of 1.2; 95% CI (1.2–1.3) [23]. A study in France showed that significant relationship between low birth weight and BMI <18.5 kg/m^2 in early pregnancy [24]. The inverse relationship between younger maternal age (20–30 years) and preterm birth in underweight first-time mother's contrasts with some studies where advanced maternal age (>35 years) is typically linked to higher preterm risk [25, 26]. In another Chinese research, cesarean section was 13.8% among primipara with low BMI; less than our study, where abdominal delivery was among 73(18.2%) women [15]. An Indian study showed a 10% abdominal delivery rate among first-time mothers with BMI<18.5kg/m2 [20]. A study done in Pakistan this year showed the cesarean section rate among thin, lean first-time mothers was13.8%; less than our results. This is probably due to the increased sample size in our study [1]. Li *et al.* China reported that low BMI in nulliparous women was significantly associated with lower risk of cesarean delivery (AOR (adjusted odds ratio) = 0.74, 95% CI (0.62-0.90)) [2]. A study from Qatar reported a 16.8% cesarean section rate among women with low BMI, close to our results [5]. When we stratified pregnancy outcomes like cesarean section, pre-eclampsia, low birth weight, and preterm delivery among nulliparous women with low BMI according to age, we found that only preterm birth was significantly correlated (p=0.003). Maternal age showed no significant association with cesarean delivery (p=0.147) or pre-eclampsia (p=0.199). Younger mothers (20–30 years) had lower cesarean rates (12.9%) than older mothers (31–40 years: 25.9%), though this difference was not statistically significant. Likewise, the incidence of pre-eclampsia was similar across all age groups (7.1% vs. 24.7%, p=0.199). Similarly, in China, women over 35 with low BMI and significant gestational weight gain had a higher risk of premature delivery [25]. In a different Chinese research, 23.2% of women who were first-time moms with low BMI had a higher chance of giving birth to an LBW baby (AOR =

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1.44, 95% CI (1.1–1.89)). Additionally, they discovered that among first-time moms with low BMI, there was a significant statistical correlation between age and premature delivery (p=0.001) [2]. Maternal age had no effect on cesarean sections among nulliparous mothers with low BMI (p=0.147). Nonetheless, a Korean study revealed a strong correlation between first-time moms' age and abdominal delivery [26]. According to a Chinese study, women under 35 who had a BMI of less than 18.5 kg/m2 had a decreased risk of preeclampsia after correcting for other factors (OR=0.588, 95% CI=0.48 7–0.708) [27].According to our findings, 57 individuals (14.2%) had pre-eclampsia.This may be because pre-eclampsia is also a risk factor for the first pregnancy.There was no statistically significant difference in the probability of pre-eclampsia across the various age groups with low BMI(p=0.199). In study done by Bibi *et al.* in Pakistan showed PIH was 7.7% among women with low BMI, which is almost half of our results.This may be because of a smaller number of participants included in their study [1]. In a research done in Qatar, 1% thin lean mothers had gestational hypertension [5]. The risk of pre-eclampsia in women with a BMI <18.5 kg /m_2 was 5.9% in an American research [10]. Li *et al.* from China reported that among first-time moms, being underweight was substantially linked to a decreased risk of gestational hypertension (AOR=0.45, 95% CI (0.2-0.82)) [2]. This is one of the few studies that emphasizes the pregnancy outcomes of thin and lean first-time mothers. Nishtar Hospital, Multan, is the hub of South Punjab, where women from various neighboring regions congregate. Hence, the findings of this research will be significantly more useful in guiding the establishment of national guidelines in Pakistan.

The study is limited by its single-center, cross-sectional design, which restricts generalizability and causal interpretation of findings. Possible recall bias in pre-pregnancy weight estimation and lack of control for all confounding variables (such as dietary intake and gestational weight gain) may also influence results. Future research should include large-scale, multicenter prospective cohort studies with accurate BMI tracking and broader adjustment for confounders. Additionally, targeted nutritional counseling and interventional studies are recommended to assess whether improving maternal BMI before and during pregnancy can reduce adverse outcomes.

CONCLUSIONS

The results showed that underweight women had increased rates of unfavorable perinatal outcomes, including preterm births among 41% women and low birth weight babies among around one third of women. The targeted group may have long-term maternal and newborn complications as a result of these unfavorable outcomes. It can be avoided if these cases receive effective counselling in terms of weight gain before conception.

Authors' Contribution

Conceptualization: AA
Methodology: ST, KR, ANR, S
Formal analysis: AA, SK
Writing review and editing: AA, ST, KR, ANR, S
Review and Editing: AA, ST, KR, ANR, S

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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