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Effect of Pre-Pregnancy BMI & Gestational Weight Gain on Fetomaternal Outcome

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ABSTRACT
This prospective observational cohort study assessed the effect of pre-pregnancy body mass index (BMI) and gestational weight gain (GWG) on feto-maternal outcomes among 300 antenatal women followed from the first trimester until delivery and one week postpartum. Nearly half of participants had normal BMI, while 18% were underweight and 34% were overweight or obese. Adequate GWG was observed in 52%, whereas 24% each had inadequate and excessive GWG. Increasing BMI was significantly associated with gestational hypertension, pre-eclampsia, gestational diabetes mellitus, caesarean delivery and postpartum complications. Inadequate GWG was associated with low birth weight, preterm birth and NICU admission, while excessive GWG was associated with hypertensive disorders, gestational diabetes, operative delivery and macrosomia. Multivariate analysis identified overweight, obesity, inadequate GWG and excessive GWG as independent predictors of composite adverse feto-maternal outcomes. Preconception BMI optimisation, trimester-wise weight monitoring and individualised antenatal nutritional counselling are essential to improve maternal and neonatal outcomes.

INTRODUCTION

Pregnancy is a physiological state defined by metabolic, hormonal, and anatomical modifications that promote fetal growth and mother well-being. Maternal nutritional status, particularly pre-pregnancy BMI, plays a critical role in determining pregnancy outcomes, since both underweight and obesity are associated with severe maternal and neonatal consequences [1,2]. Pre-pregnancy weight influences the intrauterine environment from conception onward by reflecting long-term dietary balance and metabolic reserve.

Globally, the prevalence of overweight and obesity among women has nearly tripled since 1975, but undernutrition remains a major concern in low- and middle-income countries [3].

Maternal health systems have particular difficulties as a result of this dual burden of malnutrition, particularly in emerging countries going through a fast nutritional shift. In India, NFHS-5 statistics suggest that 14% of women of reproductive age are underweight, while 24% are overweight or obese, highlighting the cohabitation of undernutrition in rural impoverished communities and rising obesity in urban wealthy populations [4,5].

Due to chronic inflammation and insulin resistance, maternal obesity puts women at risk for problems such gestational diabetes, hypertensive disorders, thromboembolic events, and postpartum morbidity [6–9]. Conversely, maternal underweight is connected to anaemia, nutritional deficits, intrauterine growth restriction (IUGR), and premature birth [10]. Inadequate gestational weight gain (GWG) increases the risk of preterm birth, low birth weight, and neonatal morbidity, while excessive GWG raises the risk of gestational hypertension, caesarean delivery, and long-term mother obesity [11,12].

Labour outcomes are also affected by maternal BMI. Due to macrosomia and decreased uterine contractility, obese women are more likely to have protracted labor, dysfunctional contractions, and increased cesarean rates [13,14]. On the other hand, low birth weight babies are frequently born to underweight moms with insufficient GWG, which is linked to poor labor stress tolerance and a higher risk of neonatal problems [15]. Maternal obesity is associated with congenital abnormalities, stillbirth, and NICU admissions, while underweight moms are associated with small-for-gestational-age (SGA) newborns and increased neonatal mortality [16,17]. These effects on the fetus go beyond the perinatal period.

India's maternal health landscape reflects this combined burden of malnutrition, which is exacerbated by high rates of anaemia (52% among pregnant women), increased cesarean deliveries, and an increasing prevalence of gestational diabetes [4,5]. Ethnic variations in body composition and metabolic sensitivity demand region-specific evidence to improve antenatal counseling and dietary advice. Understanding the connection between pre-pregnancy BMI and GWG is therefore critical for optimising maternal and newborn health.

In light of these issues, the current study attempts to methodically assess how gestational weight growth and pre-pregnancy BMI affect feto-maternal outcomes. Finding modifiable risk factors both before and during pregnancy provides a chance to improve mother-child health in the short and long term, increase antenatal care techniques, and implement preventative interventions.

AIM:

To assess the effect of pre-pregnancy Body Mass Index (BMI) and gestational weight gain (GWG) on feto-maternal outcomes among pregnant women.

OBJECTIVES:

Primary Objectives:

1. To determine the association between pre-pregnancy BMI and maternal outcomes.
2. To evaluate the association between gestational weight gain and maternal outcomes.
3. To assess the association between pre-pregnancy BMI and foetal outcomes.
4. To determine the effect of gestational weight gain on foetal outcomes.

Secondary Objectives:

1. To compare feto-maternal outcomes among different BMI categories (underweight, normal weight, overweight, and obese).
2. To assess feto-maternal outcomes among women with inadequate, adequate, and excessive gestational weight gain.
3. To evaluate the combined effect of pre-pregnancy BMI and gestational weight gain on feto-maternal outcomes.

MATERIALS AND METHODS

Study Design

A prospective observational cohort study conducted to evaluate the effect of pre-pregnancy Body Mass Index (BMI) and Gestational Weight Gain (GWG) on feto-maternal outcomes in the Department of Obstetrics and Gynaecology in a tertiary care hospital at Puducherry. Eligible women were recruited during their first antenatal visit in the first trimester (<12 weeks of gestation) and were followed prospectively throughout pregnancy until delivery and up to one week postpartum. The study was conducted for a period of 18 months after approval from the Institutional Ethics Committee (IEC).

Sample Size

The minimum required sample size for this study was calculated based on the prevalence of pre-pregnancy overweight (defined as BMI ≥ 25 kg/m²) among pregnant women. According to a cohort study by Goldstein et al., approximately 19 % of pregnant women were categorised as overweight in early pregnancy [18].

Using the formula for estimating a single proportion:

$$n = \frac{Z^2 \times p \times q}{d^2}$$

Where:
n = required sample size
Z = standard normal deviate at 95 % confidence level (1.96)
p = expected prevalence (0.19)
q = 1 – p (0.81)
d = absolute precision (0.05)
Substituting the values:

$$n = \frac{(1.96)^2 \times 0.19 \times 0.81}{(0.05)^2}$$

$$n \approx \frac{3.8416 \times 0.1539}{0.0025} \approx \frac{0.5913}{0.0025} \approx 237$$

Thus, the sample size required was 237 women. After adding 20 % non-response rate to the sample size calculated, the required was 284.4, so the final sample size was rounded up to 300 participants.

Inclusion Criteria: Antenatal mothers with confirmed pregnancy attending their first visit in the first trimester (<12 weeks), aged between 18 and 40 years, singleton pregnancies, women willing to participate and who provided written informed consent and all women irrespective of parity.

Exclusion Criteria: Multiple pregnancies, history of cervical insufficiency, active vaginal bleeding, pre-existing systemic diseases such as diabetes mellitus, chronic hypertension, or heart disease, uterine anomalies, placenta previa, placental abruption, or other known causes of preterm labour, pregnancies complicated by gynaecological conditions such as fibroids or ovarian cysts, pregnancies with known foetal congenital anomalies, women with irregular follow-up and insufficient data regarding gestational weight gain, pregnancies terminated before 32 weeks of gestation and women who deliver low birth weight neonates (<1000 grams).

Data collection procedure: Data collection was carried out in a structured and systematic manner using a pre-designed, pre-tested, and validated proforma. The proforma was reviewed by faculty members in the Obstetrics and Gynaecology department to ensure content validity and clarity. Participation was entirely voluntary, and confidentiality of all personal and medical information was strictly maintained.

Baseline Assessment

At enrolment, the following baseline details were recorded:

1. Socio-demographic Variables such as maternal age, educational status, occupation, socioeconomic status and residence.
2. Obstetric History includes gravidity and parity, history of previous abortions, previous cesarean section, history of gestational diabetes or hypertensive disorders and interpregnancy interval.
3. Medical and Surgical History includes history of chronic hypertension, diabetes mellitus, thyroid disorders, cardiac disease and any long-term medication use.

Clinical Examination

A thorough general and obstetric examination was performed at each visit which includes general examination and obstetric examination. Anthropometric Measurements of height, weight and pre-pregnancy weight was documented.

Follow-Up and Monitoring

In accordance with the institutional antenatal care policy, the participants were monitored prospectively. Visits were planned every month until 28 weeks of gestation, every two weeks from 28 to 36 weeks, and every week after that until delivery. At each visit, maternal weight, blood pressure, urine albumin (dipstick method), and any pregnancy-related problems were documented. To guarantee thorough follow-up and reduce missing data, adherence to planned prenatal appointments was tracked.

Outcome Assessment

Maternal and fetal outcomes were examined at delivery up to one week postpartum using direct observation hospital records. Delivery details (gestational age, mode of delivery, intrapartum difficulties) neonatal data, including birth weight (measured within one hour using a digital scale), APGAR scores at 1 5 minutes (evaluated by a pediatrician), NICU hospitalization and perinatal complications were documented. Gestational hypertension, pre-eclampsia, gestational diabetes mellitus, preterm labor, vaginal or caesarean birth, and postpartum problems were among the maternal outcomes. Foetal outcomes included birth weight, low birth weight (<2500 g), macrosomia (>4000 g), APGAR scores, NICU hospitalization, perinatal problems (stillbirth, neonatal hypoglycaemia, neonatal respiratory distress, shoulder dystocia, and long-term metabolic risk in children). All data were cross-verified with hospital records reduce information bias, and feto-maternal outcomes compared across maternal BMI categories gestational weight increase groups.

STATISTICAL ANALYSIS

Microsoft Excel was used to enter the data, and the relevant statistical software was used for analysis. The Chi-square test, independent t-test, or ANOVA were used to analyze the continuous variables, which were represented as mean ± standard deviation, and the categorical variables as frequencies and percentages. A p-value <0.05 was judged statistically significant.

RESULTS

Table 1: Baseline Socio-Demographic Characteristics of Study Participants (n = 300)

Sl. No	Variable	Category	Frequency (n)	Percentage (%)
1	Age (years)	< 20	24	8
	Age (years)	21–25	102	34
	Age (years)	26–30	96	32
	Age (years)	31–35	60	20
	Age (years)	> 35	18	6
	Age (years)	Mean ± SD	26.8 ± 4.2	—
2	Educational Status	Primary	42	14
	Educational Status	Secondary	108	36
	Educational Status	Higher Secondary	90	30
	Educational Status	Graduate & above	60	20
3	Occupation	Homemaker	210	70

	Occupation	Employed	90	30
4	Socioeconomic Status*	Upper	36	12
	Socioeconomic Status*	Upper Middle	102	34
	Socioeconomic Status*	Lower Middle	120	40
	Socioeconomic Status*	Lower	42	14
5	Residence	Urban	168	56
	Residence	Rural	132	44

Socioeconomic status classified according to the Modified Kuppuswamy scale [19].

The present study included 300 antenatal women, most of whom were in their mid-twenties. A large proportion of participants belonged to the 21–25 years of age group (34%) and 26–30 years age group (32%), with a mean age of 26.8 ± 4.2 years. This indicates that the majority of pregnancies occurred within the commonly observed reproductive age range. Only a small percentage of study participants are from both extremes of age, which are age groups traditionally considered higher risk in obstetrics. Literacy status among participants was relatively encouraging. More than four-fifths of the women had completed at least secondary schooling, and one in five were graduates. Most of the women (70%) were homemakers, while 30% were employed. In terms of socioeconomic status, the majority of participants belonged to the middle socioeconomic strata, particularly the lower middle class (40%) and upper middle (34%) classes. Socioeconomic position is closely linked to nutritional intake, lifestyle habits, and access to healthcare. Regarding residence, the majority of the study participants, 56%, were from urban areas, while 44% were from rural settings (Table 1).

Table 2: Obstetric Profile of Study Participants (n = 300)

Sl. No	Variable	Category	Frequency (n)	Percentage (%)
1	Gravidity	Primigravida	132	44
1	Gravidity	Multigravida	168	56
2	Parity	Nulliparous	138	46
2	Parity	Primiparous	96	32
2	Parity	Multiparous (≥2)	66	22
3	History of Previous Abortion	Yes	54	18
3	History of Previous Abortion	No	246	82
4	Previous Caesarean Section (among multigravida, n=168)	Yes	48	28.6
4	Previous Caesarean Section (among multigravida, n=168)	No	120	71.4
5	Interpregnancy Interval (among multigravida, n=168)	< 2 years	42	25
5	Interpregnancy Interval (among multigravida, n=168)	2–3 years	78	46.4
5	Interpregnancy Interval (among multigravida, n=168)	> 3 years	48	28.6

Among the 300 study participants, in the present study, 44% of the study participants were primigravida, while a slightly higher proportion, 56%, were multigravida. This indicates that more than half of the study participants had at least experienced one prior pregnancy, which may influence maternal physiological adaptation, weight gain patterns, and pregnancy outcomes. 32% of women were primiparous, and 22% were multiparous; parity was considered an important determinant because of the different risk profile associated with different parity status. The majority of the study participants 82% had no history of abortion, and only 18% of women experienced abortion; this stress affects the upcoming pregnancy psychologically and physiologically. Out of 168 multigravida women, 71.4% of women had normal vaginal delivery, and only 28.6% had a previous history of caesarean section. The time interval between each pregnancy was nearly half (46.4%), with an interval of 2–3 years between pregnancies; however, 25% had an interval of less than 2 years. Conversely, 28.6% had an interval of more than 3 years, which has also been associated in some studies with certain obstetric risks (Table 2).

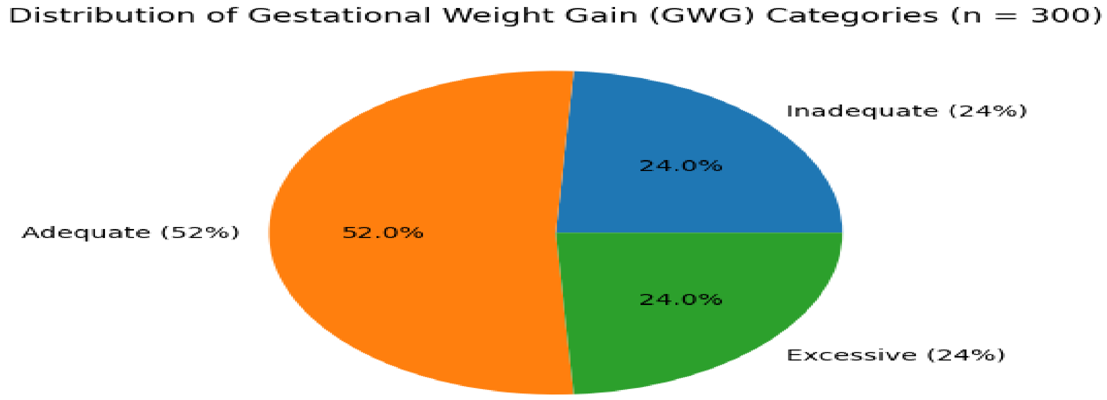
Table 3: Distribution of Pre-Pregnancy BMI Categories among Study Participants (n = 300)

Sl. No	BMI Category (kg/m²) *	Frequency (n)	Percentage (%)
1	Underweight (<18.5)	54	18.0
2	Normal weight (18.5–24.9)	144	48.0
3	Overweight (25–29.9)	66	22.0
4	Obese (≥30)	36	12.0
	Mean BMI ± SD	23.9 ± 4.1	—

BMI classified according to WHO criteria [3].

Assessment of pre-pregnancy Body Mass Index (BMI) among the 300 study participants shows that nearly half of the study participants, almost 48%, had a normal BMI (18.5–24.9 kg/m²), indicating that a considerable number of study participants are with appropriate weight before conception. Body Mass Index (BMI) evaluation shows 48% of the study participants had a normal BMI (18.5–24.9 kg/m²), indicating that a substantial proportion of study participants entered pregnancy with an appropriate weight status. The mean BMI of the study population was 23.9 ± 4.1 kg/m², which falls within the normal range. A noticeable proportion of women were outside the normal BMI range. Underweight women constituted about 18%, and the majority of the participants fell under the overweight and obese categories, almost 34% of the study population. Elevated pre-pregnancy BMI increases the risk of complications such as GDM, hypertension during pregnancy, increased operative deliveries, and macrosomia (Table 3).

Figure. 1 Distribution of Gestational Weight Gain (GWG) Categories among Study participants (n=300)



*Gestational weight gain classified according to Institute of Medicine (IOM) recommendations based on pre-pregnancy BMI.

Figure 1 illustrates the distribution of gestational weight gain (GWG) categories among the 300 antenatal women included in the study. More than half of the participants, 52%, had adequate gestational weight gain; however, a substantial proportion of women did not meet the recommended guidelines. Inadequate weight gain was observed in 24% of the study population, while an equal proportion, 24%, experienced excessive weight gain during pregnancy. These findings suggest that although the majority of women attained optimal weight gain, nearly half of the study participants (48%) deviated from the recommended range.

Figure 2: Association between Pre-Pregnancy BMI and Maternal Outcomes (n = 300)

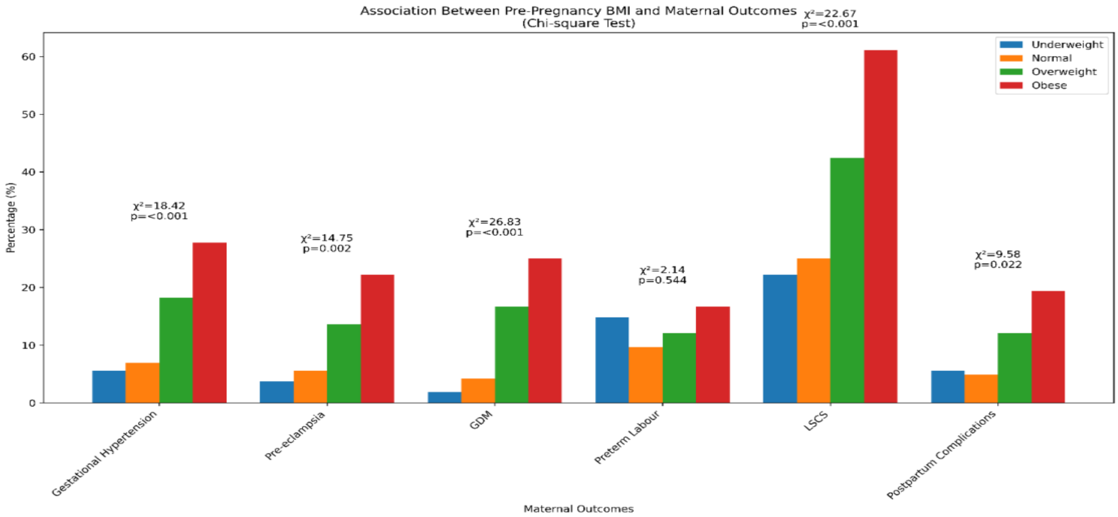


Figure 2 demonstrates a clear graded relationship between increasing pre-pregnancy BMI and adverse maternal outcomes. A progressive rise in hypertensive disorders was observed with increasing BMI. The incidence of gestational hypertension increased from 5.6% in underweight women and 6.9% in normal BMI women to 18.2% among overweight and 27.8% among obese women. This association was statistically highly significant ($\chi^2 = 18.42$; $p < 0.001$). Similarly, pre-eclampsia showed a rising trend across BMI categories, from 3.7% in underweight and 5.6% in normal BMI women to 13.6% and 22.2% among overweight and obese women, respectively ($\chi^2 = 14.75$; $p = 0.002$).

Gestational diabetes mellitus (GDM) exhibited a particularly strong association with BMI. The prevalence increased markedly from 1.9% in underweight and 4.2% in normal BMI women to 16.7% in overweight and 25.0% in obese women. This association was highly significant ($\chi^2 = 26.83$; $p < 0.001$), indicating a strong positive correlation between elevated BMI and impaired glucose metabolism during pregnancy.

In contrast, preterm labour did not show a statistically significant association with BMI ($\chi^2 = 2.14$; $p = 0.544$), despite slightly higher proportions at the extremes of BMI.

Mode of delivery demonstrated a pronounced trend, with LSCS rates increasing substantially with rising BMI. While 22.2% of underweight and 25.0% of normal BMI women underwent LSCS, the proportion increased to 42.4% in overweight and 61.1% in obese women. This association was highly significant ($\chi^2 = 22.67$; $p < 0.001$).

Postpartum complications also showed a statistically significant increasing trend with BMI, rising from 5.6% in underweight and 4.9% in normal BMI women to 12.1% in overweight and 19.4% in obese women ($\chi^2 = 9.58$; $p = 0.022$).

Overall, the figure clearly illustrates that increasing pre-pregnancy BMI is significantly associated with a higher risk of hypertensive disorders, gestational diabetes, operative delivery, and postpartum complications, while no statistically significant association was observed with preterm labour.

Table 4: Association Between Gestational Weight Gain (GWG) and Maternal Outcomes (n = 300)

Maternal Outcome	Inadequate (n=72)	Adequate (n=156)	Excessive (n=72)	χ^2 value	p-value
Gestational Hypertension	5 (6.9%)	12 (7.7%)	18 (25.0%)	16.84	<0.001*
Pre-eclampsia	4 (5.6%)	10 (6.4%)	13 (18.1%)	9.72	0.008*
Gestational Diabetes Mellitus	3 (4.2%)	8 (5.1%)	16 (22.2%)	20.31	<0.001*
Preterm Labour	14 (19.4%)	12 (7.7%)	10 (13.9%)	6.94	0.031*
Mode of Delivery (LSCS)	18 (25.0%)	36 (23.1%)	44 (61.1%)	31.56	<0.001*
Postpartum Complications	5 (6.9%)	8 (5.1%)	12 (16.7%)	7.88	0.019*

This association table explains how the deviations in gestational weight gain influence maternal outcomes. Gestational hypertension was similarly observed among women with inadequate (6.9%) and adequate (7.7%) weight gain. However, the proportion of gestational hypertension increased significantly to 25% among women with excessive GWG. This statistically significant association ($p < 0.001$) suggests that gaining more weight than recommended during pregnancy considerably increases the risk of hypertensive disorders.

Pre-eclampsia occurred in women with inadequate weight gain, is 5.6% and 6.4% in in women with adequate weight gain, and 18.1% in women with increased weight gain during pregnancy, and it is statistically significant with the p-value of 0.008, which implies that excessive weight gain during pregnancy causes the hypertensive complications.

The relationship between gestational diabetes and gestational weight gain was observed. The mothers with adequate and decreased weight gain during pregnancy developed GDM was 5.1% and 4.2%, respectively. But the mother gained excessive weight during pregnancy, 22.2% developed GDM, and it is also statistically significant, with a p-value less than 0.001, which explains that impaired glucose metabolism remains the major contributor to gestational weight gain.

When it comes to pre-term birth, the inadequate weight gain mothers had a higher proportion of preterm birth 19.4% when compared to the mothers with adequate (7.7%) and excessive weight gain (13.9%), with a p-value of 0.031, which is statistically significant. This explains that foetal growth is largely dependent on the nutritional status of the mother.

Increased weight gain during pregnancy influences the mode of delivery. The highest proportion of LSCS was observed in women with excessive weight, almost more than half 61.1% and in women with adequate weight 23.1% only had LSCS, and 25% inadequately weight-gained mothers had LSCS.

Similarly, postpartum complications were commonly observed among women with excessive GWG (16.7%) compared to those with inadequate (6.9%) and adequate (5.1%) weight gain ($p = 0.019$), suggesting increased postpartum morbidity in this group (Table 4).

Figure 3: Association between Pre-Pregnancy BMI and Foetal Outcomes (n = 300)

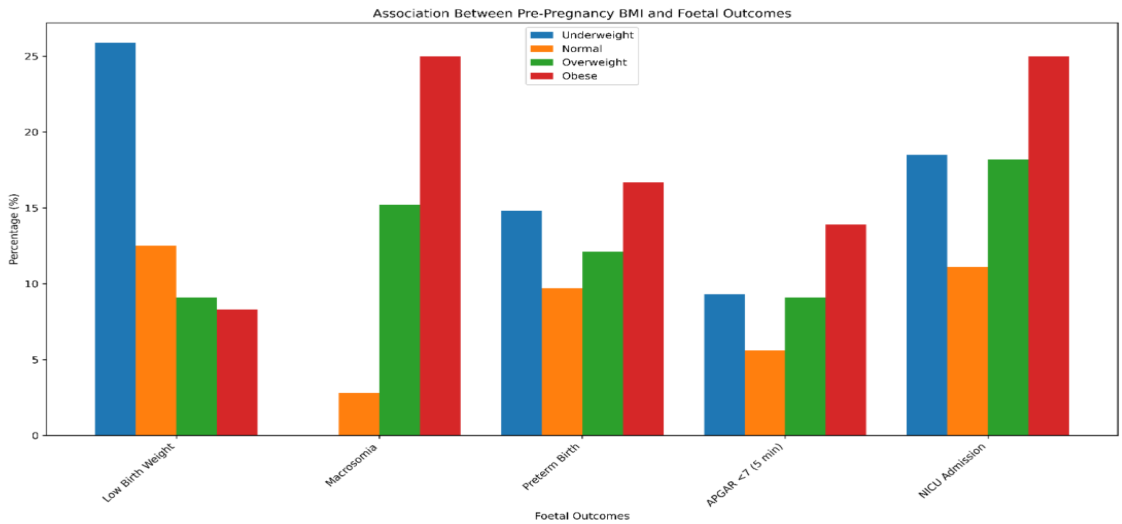


Figure 3 illustrates the relationship between pre-pregnancy BMI categories and selected neonatal outcomes. A statistically significant connection was established between maternal BMI and low birth weight (LBW). LBW newborns were most common among underweight mothers (25.9%), followed by normal BMI moms (12.5%), overweight mothers (9.1%), and obese mothers (8.3%) (χ^2 = 10.84; p = 0.013). This demonstrates the substantial correlation between LBW and maternal undernutrition. In contrast, macrosomia showed a rising tendency with increasing BMI, missing in underweight moms but gradually higher in normal BMI (2.8%), overweight (15.2%), and obese women (25.0%) (χ^2 = 28.47; p < 0.001).

For preterm birth, increased proportions were seen at both extremes of BMI—14.8% in underweight and 16.7% in obese mothers—compared to 9.7% in normal BMI. However, this connection was not statistically significant (χ^2 = 2.14; p = 0.544). Similarly, compared to underweight (9.3%) and normal BMI moms (5.6%), obese women (13.9%) had lower Apgar scores (<7 at 5 minutes), although this difference was not statistically significant (χ^2 = 3.92; p = 0.270).

NICU admissions followed a similar pattern, being greater at BMI extremes: 18.5% among underweight and 25.0% among obese mothers, compared to 11.1% in normal BMI. This trend likewise did not achieve statistical significance (χ^2 = 6.78; p = 0.079).

Table 5: Association between Gestational Weight Gain (GWG) and Foetal Outcomes (n = 300)

Foetal Outcome	Inadequate (n=72)	Adequate (n=156)	Excessive (n=72)	χ^2 value	p-value
Low Birth Weight (<2500 g)	22 (30.6%)	14 (9.0%)	5 (6.9%)	22.41	<0.001*
Macrosomia (>4000 g)	1 (1.4%)	6 (3.8%)	16 (22.2%)	28.76	<0.001*
Preterm Birth	16 (22.2%)	12 (7.7%)	8 (11.1%)	9.85	0.007*
APGAR <7 at 5 minutes	8 (11.1%)	6 (3.8%)	10 (13.9%)	7.12	0.028*
NICU Admission	18 (25.0%)	12 (7.7%)	17 (23.6%)	14.63	0.001*

A substantial correlation between prenatal weight growth and unfavourable fetal outcomes is shown in Table 5. Low birth weight (LBW) was most frequent among mothers with inadequate GWG (30.6%), compared to 9% in the acceptable group and 6.9% in the excessive group. Inadequate maternal weight growth significantly raises the likelihood of LBW, since this association was statistically significant (χ^2 = 22.41; p < 0.001).

On the other hand, high GWG was closely linked to macrosomia (>4000 g). In contrast to 3.8% in the adequate group and only 1.4% in the inadequate group, it happened in 22.2% of moms with excessive GWG (χ^2 = 28.76; p < 0.001). These results demonstrate that fetal overgrowth is predisposed by excessive maternal weight increase.

Preterm birth was more likely among women with inadequate GWG (22.2%) compared to acceptable (7.7%) and excessive GWG (11.1%). This difference was statistically significant (χ^2 = 9.85; p = 0.007), demonstrating that inadequate maternal weight increase contributes to earlier beginning of delivery.

Excessive GWG (13.9%) and inadequate GWG (11.1%) had the greatest rates of Apgar scores <7 at 5 minutes, whereas the appropriate group had 3.8%. The statistical significance of this association (χ^2 = 7.12; p = 0.028) suggests that rapid newborn adaptation may be hampered by variations from prescribed GWG.

NICU admission was required more frequently among neonates born to mothers with inadequate (18; 25.0%) and excessive GWG (17; 23.6%) compared to adequate GWG (12; 7.7%). This association was highly significant (χ^2 = 14.63, p = 0.001), highlighting that deviation from recommended gestational weight gain increases neonatal morbidity.

Table 6: Multivariate Logistic Regression Analysis Showing Combined Effect of Pre-Pregnancy BMI and Gestational Weight Gain on Composite Adverse Feto-maternal Outcome (n = 300)

Variable	Category	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
Pre-pregnancy BMI	Underweight	1.42	0.78 – 2.61	0.246
Pre-pregnancy BMI	Normal	1 (Reference)	—	—
Pre-pregnancy BMI	Overweight	2.18	1.22 – 3.91	0.008*
Pre-pregnancy BMI	Obese	3.74	1.86 – 7.52	<0.001*
Gestational Weight Gain	Inadequate	1.96	1.08 – 3.55	0.026*
Gestational Weight Gain	Adequate	1 (Reference)	—	—
Gestational Weight Gain	Excessive	3.12	1.71 – 5.69	<0.001*
Maternal Age (>30 years)	Yes	1.58	0.94 – 2.64	0.082
Primigravida	Yes	1.21	0.73 – 2.01	0.454

Multivariate logistic regression analysis demonstrated that pre-pregnancy BMI and gestational weight gain were independent predictors of composite adverse feto-maternal outcomes. Compared to women with normal BMI, overweight women had significantly higher odds of adverse outcomes (AOR = 2.18; 95% CI: 1.22–3.91; p = 0.008), while obese women had nearly fourfold increased odds (AOR = 3.74; 95% CI: 1.86–7.52; p < 0.001). Underweight status was not significantly associated (AOR = 1.42; 95% CI: 0.78–2.61; p = 0.246). With respect to gestational weight gain, both inadequate (AOR = 1.96; 95% CI: 1.08–3.55; p = 0.026) and excessive gain (AOR = 3.12; 95% CI: 1.71–5.69; p < 0.001) were significantly associated with increased risk compared to adequate gain. Maternal age >30 years (AOR = 1.58; p = 0.082) and primigravida status (AOR = 1.21; p = 0.454) were not statistically significant predictors (Table 6).

DISCUSSION

The present study evaluated the effect of pre-pregnancy body mass index (BMI) and gestational weight gain (GWG) on feto-maternal outcomes among 300 antenatal women. Maternal nutritional status before conception and the pattern of weight gain during pregnancy are increasingly recognised as critical determinants of both short-term obstetric outcomes and long-term metabolic programming of the offspring. In the current era, where developing countries like India face a dual burden of malnutrition, understanding these relationships is of particular clinical and public health relevance.

In this study, 48% of the women had normal pre-pregnancy BMIs, 18% were underweight, and 34% were overweight or obese. While 52% of women gained enough weight during pregnancy in accordance with the Institute of Medicine's (IOM) suggested range, 48% did not, and equal percentages showed excessive and insufficient increase. A distinct trend became apparent: rising BMI was linked to macrosomia, postpartum difficulties, cesarean sections, hypertensive problems, and gestational diabetes mellitus (GDM). Low birth weight (LBW), preterm birth, and NICU hospitalization were linked to inadequate GWG, whereas hypertensive diseases, GDM, surgical delivery, and fetal overgrowth were linked to excessive GWG. Adverse composite feto-maternal outcomes were independently predicted by both BMI and GWG on multivariate analysis.

In the current study, 34% of women were overweight or obese, with 18% being underweight. This distribution represents the epidemiological change experienced in India. About 24% of women of reproductive age are overweight or obese, and about 14% are underweight, according to NFHS-5 (2019–21) [20]. The hospital-based, primarily urban context of the current study may be the reason for the slightly greater prevalence of overweight/obesity.

India continues to experience the “double burden of malnutrition,” as undernutrition persists in lower socioeconomic strata while obesity is rising in urban and middle-class populations [21,22]. This coexistence was clearly evident in our group and merits studying both extremes of BMI rather than focusing exclusively on obesity

Comparable Indian hospital-based studies have reported overweight/obesity prevalence ranging from 25–35% among antenatal women, supporting the representativeness of our findings [23,24]. Thus, the study population mirrors the current nutritional transition seen across Indian urban centers. A statistically significant increasing trend in gestational hypertension and preeclampsia was observed with rising BMI. Hypertension was noted in 5.6% of underweight women compared to 27.8% of obese women. This stepwise rise is consistent with large meta-analyses. O’Brien et al. demonstrated that obese women have a 2–3 fold increased risk of preeclampsia compared to women with normal BMI [8]. Similarly, Marchi et al. concluded that maternal obesity significantly increases the risk of hypertensive disorders due to chronic low-grade inflammation and endothelial dysfunction mediated by adipokines [9]. The pathophysiological explanation lies in insulin resistance, oxidative stress, and altered placental perfusion associated with increased adiposity. The current findings strongly align with these mechanisms and confirm that pre-pregnancy BMI is a critical modifiable risk factor for hypertensive complications.

GDM prevalence increased sharply with BMI, reaching 25% among obese women. Hedderson et al. reported a strong association between increasing BMI and GDM risk, mediated through heightened insulin resistance and beta-cell stress during pregnancy [7].

Indian studies also report GDM prevalence between 9–16%, with higher rates among overweight and obese women [25]. The findings of the present study are consistent with these observations and highlight the importance of early screening and lifestyle interventions in high-risk groups. The association observed in our cohort reinforces the clinical necessity of preconception weight optimization and close metabolic monitoring during pregnancy.

The rate of lower segment caesarean section (LSCS) rose dramatically from 22.2% in underweight women to 61.1% in obese women. Similar observation noted in the Vahratian et al. study, which reported labour dysfunction and operative delivery are increasing with the rising BMI [13]. Though the caesarean rates are increasing constantly nowadays, obesity may further increase this condition for LSCS. Dysfunctional labour patterns, macrosomia, and other intrapartum complications contribute to this pattern.

After the child's birth, pregnant mothers with high BMI and increased weight gain throughout the pregnancy experienced an infection at the wound site, thromboembolism, delayed healing, and prolonged hospitalization [9]. The results of this study exhibit a similar pattern with the existing evidence suggesting that maternal adiposity complicates not only pregnancy but also the puerperium.

Despite the fact that numerous research have demonstrated that obese women are more likely to give birth prematurely, the current investigation did not find any statistically significant results. Han et al. found a weak correlation between underweight status and premature birth [26]. The present study's lack of statistical significance could be the result of the tertiary care center's efficient obstetric management or sample size restrictions.

LBW was significantly higher among underweight mothers (25.9%). Kramer emphasized maternal undernutrition as a key determinant of fetal growth restriction [17]. Similarly, Han et al. demonstrated increased risk of LBW among underweight women [26].

The biological plausibility lies in reduced placental perfusion, micronutrient deficiencies, and limited maternal nutrient reserves. Our findings are consistent with this established evidence.

Macrosomia increased progressively with BMI, reaching 25% among obese women. Yu et al. confirmed a strong association between maternal obesity and macrosomia [14]. Overgrowth happens through a hyperglycaemic state of the mother and excess nutrient transfer stimulates foetal insulin production, promoting overgrowth.

NICU admission rates were greater at both BMI extremes, however they were statistically correlated with gestational weight increase but not with pre-pregnancy BMI. Other cohort studies demonstrated the similar findings [9,15]. These results imply that newborn adaptability may be hampered by both maternal undernutrition and fat.

Both extremes condition will have bad maternal effects, excessive weight gain during pregnancy, which in turn increases risk hypertension, Diabetes, LSCS, and postpartum problems. Excessive GWG is linked to hypertensive problems and surgical delivery, according to Goldstein et al. Inadequate GWG was linked to premature birth in our study, and Mamun et al. similarly showed higher cesarean rates with excessive weight gain [11,12]. Inadequate weight gain raises the probability of unfavorable perinatal outcomes, according to Deputy et al [27].

Multivariate regression demonstrated that overweight (AOR 2.18), obesity (AOR 3.74), inadequate GWG (AOR 1.96), and excessive GWG (AOR 3.12) were independent predictors of adverse composite outcomes.

Importantly, maternal age and gravidity were not significant after adjustment. This suggests that nutritional factors exert a stronger influence than demographic factors in determining pregnancy outcomes. This reinforces the need for:

Preconception BMI optimisation

Trimester-wise weight monitoring

Individualised nutritional counselling

STRENGTHS AND LIMITATIONS

This prospective observational study's strengths include simultaneous examination of pre-pregnancy BMI and gestational weight increase, assessment of both maternal and newborn outcomes, and use of multivariate regression analysis to uncover independent factors. Limitations include its single-centre hospital-based design, possible memory bias in pre-pregnancy weight, lack of long-term neonatal follow-up, and the absence of extensive food and physical activity evaluations. Nevertheless, the agreement of the findings with existing literature supports the validity of the study conclusions.

CONCLUSION

This prospective study was conducted among 300 study participants to assess the effect of pre-pregnancy BMI on the maternal and foetal outcomes.

The findings indicate that a woman's nutritional status before conception and the pattern of weight gain during pregnancy have a meaningful impact on the course and outcome of pregnancy.

Nearly one-third of the participants were either overweight or obese at the time of conception, while notable proportion was underweight. This reflects the ongoing coexistence of undernutrition and rising overweight in our population. Although more than half of the women gained weight within the recommended range, a considerable number did not achieve optimal gestational weight gain, highlighting the importance of closer nutritional supervision during antenatal care.

The effect of pre-pregnancy BMI is reflected in the form of increasing frequency of hypertensive disorders, gestational diabetes mellitus, cesarean delivery, and postpartum complications as pre-pregnancy BMI increased. Women who were overweight or obese faced a substantially higher risk of adverse maternal outcomes compared to those with normal BMI. Likewise, excessive gestational weight gain was associated with metabolic complications, higher operative delivery rates, fetal macrosomia, lower APGAR scores, and greater need for neonatal intensive care.

Women without proper weight gain during pregnancy, and women with underweight before marriage, are at risk of delivering low birth weight infants and are likely to have an unfavourable outcome. Statistical analysis of other factors explained that abnormal BMI and inappropriate gestational weight gain remained important predictors of adverse outcomes even after accounting for other maternal factors. This highlights the independent role of maternal nutrition in determining pregnancy outcomes.

In conclusion, being at an appropriate weight and a healthy BMI before conception and gaining gradual weight throughout pregnancy are essential steps in improving feto-maternal outcomes. The following steps can be taken for improving the maternal and foetal outcomes, like enhancing preconception counselling, risk identification at the earliest, individual dietary guidance, and consistent monitoring during antenatal visits, can help reduce preventable complications and promote better outcomes for both mother and child.

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