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Effect of Early Gestational Body Mass Index (Within 12 Weeks) on Neonatal and Maternal Outcome in Nulliparous Women

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INTRODUCTION

Nutritional status of the mother which is reflected by maternal body mass index (early pregnancy) and gestational weight gain is being recognized as one of the most important predictor of the wellbeing of both mother and the developing fetus. Maternal nutrition plays a critical role in fetal growth and development [1].

Fetal programming in utero' hypothesis suggests that nutritional and environmental conditions during fetal development can have long lasting effects on an individual's physiology and metabolism, potentially predisposing them to various chronic diseases later in life such as, heart disease, hypertension and type 2 diabetes mellitus [2].

Recent data suggests that the women with high pre- pregnancy BMI are associated with the increased risk of pre-eclampsia, gestational hypertension, gestational diabetes mellitus, increased rate of caesarean section, postpartum hemorrhage, fetal macrosomia and more intrapartum complications [3-6].

In view of the above facts, the present study was planned in our hospital to study the effect of early gestational body mass index on neonatal and maternal outcome in nulliparous women.

METHODS

This prospective study was conducted in the Department of obstetrics and gynecology at Deen Dayal Upadhyay Hospital, New Delhi between April 2023 and October 2024. Before initiation, the study was approved by the Institutional Ethical Committee. 530 pregnant women were enrolled in the study who fulfilled the inclusion criteria. An informed written consent was obtained from each participant.

Inclusion criteria

All nulliparous pregnant women between 18-45 years who enrolled in first 12 weeks of pregnancy for antenatal care.

Exclusion criteria

- Pregnant women with medical comorbidities (hypertension, endocrine disorder, autoimmune disorder).
- Pregnancy with congenital malformation of baby.
- Pregnant women with hyperemesis gravidarum.
- Pregnant women with multifetal gestation.

- Pregnant women who do not deliver in DDU Hospital.

All nulliparous pregnant women within 12 weeks of pregnancy without high risk attending antenatal outpatient department were selected by consecutive sampling. Detailed history including personal history, obstetric history and socioeconomic status was noted. Socioeconomic status was classified by modified Kupp swamy score.

Maternal Weight was recorded at the first antenatal visit within 12 weeks of pregnancy to the nearest 0.1 kg. Height was measured to the nearest 0.1 cm using the same instrument for all subjects. BMI was calculated as per the formula: Height (kilograms)/weight (meter)^2.

All women were categorized at the first antenatal visit according to the modification for Asian population proposed by the WHO, as low BMI (BMI <18.5 kg/m^2), normal BMI (BMI between 18.5 and 24.9 kg/m^2), high BMI (BMI $\geq$ 25kg/m^2). They were counselled about appropriate weight gain in pregnancy.

Examination and all routine antenatal investigations were done as per protocol which includes hemogram, Viral markers, Urine routine microscopy, Thyroid function test, OGTT, Ultrasonography including doppler studies and other relevant investigations were done as and when required.

Development of antepartum complications viz hypertensive disorder of pregnancy, antepartum hemorrhage, GDM, preterm labor and intrauterine growth restriction were recorded in all the groups and statistically analyzed.

Gestational age at delivery, mode of delivery (normal, instrumental or caesarean section) and neonatal birth weight were recorded.

Neonates were labelled as small for gestational age, appropriate for gestational age and large for gestational age as per the standard charts [7,8].

STATISTICAL ANALYSIS

The collected data entered in MS EXCEL spreadsheet and analyzed using software SPSS latest version. Categorical variables presented in number and percentage (%) and continuous variables presented as mean + SD and median. Qquantitative variables compared using ANOVA and Kruskal Wallis test, and qualitative compared by chi-square testing. Relative risk ratio assessed with BMI. For testing significance p-value of <0.05 considered statistically significant.

RESULTS

In the present study 530 pregnant women were recruited and followed throughout pregnancy.

Majority of patients were in the age group of 18 to 25 years followed by patients in the age group of 26 to 30 years in all categories of BMI (Table 1). However, the association between BMI and age was not found statistically significant (p = 0.40).

Table 1: Association between BMI and age.

BMI	Age			□^{2}, p-value*
	18 to 25 years n (%)	26 to 30 years n (%)	> 30 years n (%)	
Underweight	57 (65.5)	22 (25.3)	08 (9.2)	6.24, 0.40
Normal	172 (58.3)	94 (31.9)	29 (9.8)	
Overweight	44 (49.4)	36 (40.4)	09 (10.2)	
Obese	31 (52.5)	20 (33.9)	08 (13.6)	
Total	304 (57.4)	172 (32.5)	54 (10.1)	

Table 2: Association between BMI and socio-economic status.

BMI	Socio-economic status				χ^2, p-value*
	Upper n (%)	Upper middle n (%)	Lower middle n (%)	n (%)	
Underweight	00 (00)	18 (20.7)	22 (25.3)	47 (54)	45.66, 0.001
Normal	02 (0.7)	72 (24.4)	91 (30.8)	130 (44.1)	
Overweight	00 (00)	29 (32.6)	29 (32.6)	31 (34.8)	
Obese	00 (00)	37 (62.7)	13 (22)	09 (15.3)	
Total	02 (0.5)	156 (29.4)	155 (29.2)	217 (40.9)	

Inadequate weight gain was generally seen in underweight category women, while adequate or excessive weight gain was observed more in the overweight and obese category (Table 3). The association between BMI and gestational weight gain was found statistically significant (p = 0.001).

Table 3: Association between BMI and gestational weight gain.

BMI	Gestational weight gain			χ^2, p-value*
	Adequate n (%)	Inadequate n (%)	Excessive n (%)	
Underweight	37 (42.5)	44 (50.6)	06 (6.9)	146.61, 0.001
Normal	108 (36.6)	171 (58)	16 (5.4)	
Overweight	42 (47.2)	18 (20.2)	29 (32.6)	
Obese	19 (32.2)	06 (10.2)	34 (57.6)	
Total	206 (38.9)	239 (45.1)	85 (16)	

The maternal complications observed in this study were hypertensive disorder of pregnancy, Gestational diabetes mellitus, IUGR, preterm labour (Table 4). The association was found to be statistically significant between BMI and hypertensive disorder of pregnancy and gestational diabetes mellitus (p = 0.001). The association between BMI and IUGR and pre-term labour was not found statistically significant (p = 0.66 and p = 0.08).

Table 4: Association between BMI and maternal complications

BMI	Maternal Complications							
	Hypertensive disorder of pregnancy		Gestational diabetes mellitus		IUGR		Pre-term labour	
	Yes n (%)	No n (%)	Yes n (%)	No n (%)	Yes n (%)	No n (%)	Yes n (%)	No n (%)
Underweight	13 (14.9)	74 (85.1)	01 (1.1)	86 (98.9)	06 (6.9)	83 (93.1)	11 (12.6)	76 (87.4)
Normal	21 (7.1)	274 (92.9)	08 (2.7)	287 (97.3)	09 (3.1)	286 (96.9)	16 (5.4)	279 (94.6)
Overweight	15 (16.9)	74 (83.1)	05 (5.6)	84 (94.4)	02 (2.2)	87 (97.8)	06 (6.7)	83 (93.3)
Obese	13 (22)	46 (78)	14 (23.7)	45 (76.3)	02 (3.4)	37 (96.6)	02 (3.4)	57 (96.6)
Total	62 (11.7)	468 (88.3)	28 (5.3)	502 (94.7)	19 (3.6)	511 (96.4)	35 (6.6)	495 (93.4)
χ^2, p-value*	15.27, 0.002		47.00, 0.001		3.47, 0.32		6.80, 0.08	

Higher proportion of patients in obese category (13.6%) underwent instrumental delivery as compared to other BMI categories (Table 5). Caesarean mode of delivery was seen in highest percentage in patients under overweight category (34.8%) as compared to other. However, the association between BMI and mode of delivery was not found statistically significant (p = 0.09).

Table 5: Association between BMI and mode of delivery.

BMI	Mode of delivery			χ^2, p-value*
	Normal n (%)	Caesarean n (%)	n (%)	
Underweight	63 (72.4)	22 (25.3)	02 (2.3)	10.93, 0.09
Normal	184 (62.4)	93 (31.5)	18 (6.1)	
Overweight	54 (60.7)	31 (34.8)	04 (4.5)	
Obese	34 (57.6)	17 (28.8)	08 (13.6)	
Total	335 (63.2)	163 (30.8)	32 (6)	

Among patients with underweight BMI, none of the patients had LGA as compared to 6.8% of LGA in patients in obese category of BMI (Table 6). The highest proportion of SGA was seen in patients with underweight BMI (46%) as compared to other categories of BMI. The association between BMI and birth weight was found statistically significant (p = 0.001).

Table 6: Association between BMI and birth weight.

BMI	Birth weight			χ^2, p-value*
	SGA n (%)	AGA n (%)	LGA n (%)	
Underweight	40 (46)	47 (54)	00 (00)	34.32, 0.001
Normal	83 (28.1)	208 (70.5)	04 (1.4)	
Overweight	19 (21.3)	69 (77.5)	01 (1.1)	
Obese	06 (10.2)	49 (83.0)	04 (6.8)	
Total	148 (27.9)	373 (70.4)	09 (1.7)	

In present study, 14.9% of patients in underweight category of BMI had severe anaemia (14.9%) as compared to other categories of BMI. Also, moderate anaemia was found to be present in higher proportion among underweight (41.4%) in comparison to other categories of BMI (Table 7). The association between BMI and anaemia was found statistically significant (p = 0.001).

Table 7: Association between BMI and anaemia

BMI	Anaemia				χ^2, p-value*
	No anaemia n (%)	Mild n (%)	Moderate n (%)	Severe n (%)	
Underweight	25 (28.7)	13 (14.9)	36 (41.4)	13 (14.9)	120.80, 0.001
Normal	172 (58.3)	92(31.2)	29 (9.8)	02 (0.7)	
Overweight	61 (68.5)	18 (20.2)	09 (10.1)	01 (1.1)	
Obese	36 (61)	19 (32.2)	03 (5.1)	01 (1.7)	
Total	294 (55.5)	142 (26.8)	77 (14.5)	17 (3.2)	

DISCUSSION

The present study was an observational study conducted to assess the relationship between maternal BMI in early pregnancy and various maternal and neonatal outcomes. A total of 530 pregnant women were included, and their demographic characteristics, socio-economic status, BMI distribution, gestational weight gain, maternal complications (hypertensive disorders of pregnancy, GDM, PTL, IUGR), mode of delivery, gestational age at delivery, anemia and neonatal birth weight were analyzed.

The majority of participants (57.4%) were aged between 18 and 25 years, which is consistent with the common reproductive age group in developing countries. This finding aligns with the study by [9], who reported that 60% of their participants were within the same age range. Additionally, our study showed that 32.4% of

participants were aged between 26 and 30 years, while 10.2% were older than 30. This age distribution reflects trends in developing countries, where younger women typically constitute a large proportion of the pregnant population [10]. also found a similar age distribution. Fertility rates are generally higher in younger women in these regions, reinforcing the need for specific healthcare strategies that focus on younger populations.

The relationship between BMI and maternal complications such as gestational diabetes and hypertensive disorders was a significant finding. Obesity was associated with a higher incidence of gestational diabetes (23.7%) and hypertensive disorders (22%), which aligns with [11-14] who reported a similar trend, noting that obesity significantly increased the risk of both conditions. This further emphasizes the importance of early screening and weight management to prevent adverse maternal and neonatal outcomes in obese pregnant women.

This suggests that even while using the Asian classification, the incidence of GDM and HDP is higher in overweight and obese population as compared to normal population, which reflects on the need to change the goals of ideal weight in Asian population.

The incidence of preterm labour in underweight, normal, overweight and obese group is 12.6%, 5.4%,6.7% and 3.4%respectively. These findings are supported by the study conducted by [15], in which the incidence of PTL is 56.1%, 12.4%, 4% and 19% in underweight, normal, overweight and obese groups respectively. Preterm labour is a complication often linked to inadequate maternal nutrition, and a low BMI may serve as an indicator of this issue.

In the present study, among underweight patients, 50.6% of patients had inadequate gestational weight gain while 42.5% had adequate gestational weight gain. Among patients with normal BMI, 58% patients had inadequate gestational weight gain followed by 36.6% of patients with adequate gestational weight gain, which corresponds with [16]. In overweight and obese patients, 32.6% and 57.6% of patients had excessive gestational weight gain respectively, which corresponds with [11]. In line with the study by [15], we found that underweight participants had a higher incidence of inadequate weight gain (50.6%), while obese women experienced excessive weight gain (57.6%).

In present cohort, 30.8% of women underwent caesarean sections, which is higher than the WHO-recommended rate. This finding aligns with [9], who reported a caesarean section rate of 25% and [15], who also noted an increased caesarean rate, possibly due to the rising medicalization of childbirth.

Present study also highlighted the association between maternal BMI and neonatal birth weight. Underweight women had the highest proportion of SGA babies (46%), while obese women had the highest proportion of LGA babies (6.8%). These findings align with [11,16] who reported similar trends, reinforcing the importance of monitoring maternal weight and BMI during pregnancy to prevent adverse neonatal outcomes. Both low and high Birth weights are associated with complications.

Although obese women in our study had the highest incidence of instrumental deliveries (13.6%) and overweight women had the highest rate of caesarean sections (34.8%), the association between BMI and mode of delivery was not statistically significant ($p = 0.09$). This contrasts with [17], who found a significant increase in caesarean section rates among obese women.

Present study found a significant association between BMI and anaemia ($p = 0.001$), with 14.9% of underweight participants diagnosed with severe anaemia. [9,14] reported similar findings, noting an inverse correlation between BMI and anaemia prevalence. Underweight individuals had higher rates of moderate and severe

anaemia (56.3%), in line with findings by [12]. Overweight and obese individuals exhibited lower rates of anaemia. High incidence of anaemia in the present study may be due to catchment area, which caters to a population with low socio- economic background.

CONCLUSION

The findings observed a significant association between BMI and several key obstetric parameters, including hypertensive disorders of pregnancy, gestational diabetes mellitus and neonatal birth weight. These findings underscore the importance of optimizing maternal BMI before conception and promoting targeted nutritional and antenatal interventions to improve pregnancy outcomes.

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