



## Original Research Article

# Role of maternal Body Mass Index (BMI) in predicting the birth weight of the newborn

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## ABSTRACT

**Introduction:** The birth weight in newborns reflects on the maternal, neonatal and reproductive health of the country. Appropriate birth weight is an indicator of the health status of the newborn and also predicts the morbidity, mortality and susceptibility to a wide range of infections and diseases. There are several antenatal factors which influence the birth weight of the newborns. This study was carried out to determine whether maternal BMI predicted low birth weight.

**Materials and Methods :** A total of 185 antenatal women who presented in first trimester for regular check up were included in this cohort study. Detailed history and examination was done after getting informed consent. The height was recorded by a stadiometer and weight by standard weighing machine and BMI was calculated. The participants and were followed up till delivery. The birth weight of the baby was taken immediately after delivery and recorded. Statistical analysis was done by EPI2005 package.

**Results:** Among 185 women studied 48.6% of them were undernourished. There was a significant association between low BMI and low birth weight. Low birth weight was 34% in underweight women while it was 18% in normal women after excluding preterm ( $p < 0.05$ ).

**Conclusion:** Underweight pregnant women at booking show increased risk of having low birth weight in babies. The BMI at booking in first trimester usually reflects the pre-pregnant BMI as the weight gain in first trimester is less. This study implies a role of improving pre-pregnant nutritional status of mother which in turn impacts the neonatal outcome.

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## 1. Introduction

Weight gain is a normal sign of pregnancy. It is essential for a pregnant woman to have a healthy, nutritious and balanced diet which will help them gain weight during pregnancy. There has however been no recommended guideline regarding the allowable weight gain during pregnancy. On an average, a woman can gain up to 10 kilograms during the antenatal period for a healthy outcome of delivery.<sup>1</sup>

The assessment and monitoring of weight gain during pregnancy is best carried out using Body Mass Index. The United States' Institute of Medicine (IOM) has issued recommendations for BMI monitoring during pregnancy. According to their guidelines, the pre-pregnancy weight

is an important criteria used to determine the allowable weight gain. While women who were underweight prior to pregnancy are allowed to gain up to 18 kilograms during pregnancy, obese women are restricted to a maximum gain of 9 kilograms during pregnancy.<sup>2</sup>

Studies have shown that maternal weight gain has an impact on the pregnancy outcomes. It is a modifiable risk factor for abnormal birth weight in the newborns. A study done by Johansson K emphasized that for every kilogram of weight gain in mothers, there was an increase in the weight of the babies by 26g.<sup>3</sup> This has been established as a linear correlation which exists between maternal and fetal weight gain. At a molecular level, an underweight mother is said to have negative energy balance, and with inadequate supply of nutrients, intrauterine growth retardation ensues.<sup>4</sup> Similarly, excessive weight gain in the mothers increases the carbohydrate load in the babies, thereby resulting

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in metabolic disturbances impacting the baby's size and weight. One of the key problems with excessive weight gain is macrosomia, which complicates the delivery process.

Small for Gestational Age (SGA) and Large for Gestational Age (LGA) are significant problems in two ends of the spectrum. While SGA babies demand physical and nutritional support to gain the appropriate weight for age, LGA babies are at increased risk of various hormonal imbalances, disorders of growth and development and non communicable diseases like Diabetes mellitus. In a study by Verma et al, the prevalence of SGA among underweight mothers was 18.9% while the prevalence of LGA among obese mothers was 23%.<sup>5</sup> These babies have higher vulnerability to admission and care in neonatal intensive care units, thereby warranting increased physical, mental and financial strain on the parents and care providers.

Despite several studies on predictors of birth weight have been carried out, there are few longitudinal studies which analyze the predictive effect of maternal BMI. A cause and effect analysis will help in early monitoring of the BMI and also aid in pre-pregnancy counseling regarding the importance of optimal weight gain for a safe and healthy outcome.

## 2. Objectives

This study was carried out to evaluate the role of maternal body mass index in predicting the birth weight of the newborns.

## 3. Methodology

### 3.1. Study setting

This cohort study was carried out in the Obstetrics and Gynecology department of our tertiary care hospital for a period of one years between August 2017 and August 2018.

### 3.2. Study population

All pregnant mothers who visited the hospital in first trimester for registration and initial evaluation during the study period formed the study population. Any pregnant mother diagnosed with systemic diseases during the first visit was excluded from the study. Women with twin/multiple pregnancies were also excluded.

### 3.3. Sample size and sampling technique

Based on the available literature, the lowest prevalence for SGA/LGA was observed for underweight women, with a prevalence of SGA of 18.9%. At 95% confidence limits, 6% absolute precision, the sample size was calculated as 163.5. Accounting 10% for non response, the sample size was calculated as 179.8 and was rounded off to 185. The participants were selected by convenient sampling.

### 3.4. Ethical approval and informed consent

Approval from the Institutional Ethics Committee was obtained prior to the commencement of the study. Each participant was explained in detail about the study and informed consent was obtained prior to the commencement of data collection.

### 3.5. Data collection

A structured interview schedule was used for data collection. Data regarding the personal history and obstetric history of the study participants were recorded. Detailed history and clinical examination was done. The height was recorded in metres by a stadiometer and weight was recorded in kilograms by standard weighing machine. Body Mass Index was calculated using the formula

$$\text{BMI} = \text{weight (in kilograms)} / \text{height (metre}^2\text{)}.$$

The participants were classified based on WHO National Institute of Health guidelines (Table 1).<sup>5</sup> The participants were followed up throughout pregnancy and at delivery, the birth weight of the baby was recorded immediately and classified (Table 2).<sup>6</sup>

### 3.6. Data analysis

**Table 1:** WHO-NIH classification of BMI:

S. No	Value (kg/m <sup>2</sup> )	Classification
1	≤19.9	Underweight (Group I)
2	20-24.9	Normal (Group II)
3	25-29.9	Overweight (Group III)
4	30-34.9	Obese (Group IV)
5	≥35	Morbid obese (Group V)

**Table 2:** Classification of birth weight

S. No	Value (kg)	Classification
1	≤2.5	Low birth weight
2	2.5-3.0	Normal
3	3.0-4.0	Above normal
4	>4.0	Macrosomia

**Table 3:** Background characteristics of the study participants

S. No	Characteristics	Frequency (N=185)	Percentage (%)
1	<b>Age (in years)</b>		
	Less than 20	59	31.9
	20-24	110	59.5
2	25 & above	16	8.6
	<b>Socioeconomic status (Kuppuswamy's classification)</b>		
	Class I	-	-
	Class II	12	6.5
	Class III	24	13.0
3	Class IV	44	23.8
	Class V	105	56.7
	<b>Parity</b>		
	1	106	57.3
	2	67	36.3
4	3	11	5.9
	Above 3	1	0.5
	<b>Body Mass Index</b>		
	Underweight	90	48.6
	Normal	89	48.2
	Overweight	6	3.2
5	Obese	-	-
	Morbid obese	-	-
	<b>Anaemia</b>		
	Mild (Hg : 10 – 10.9)	49	26.5
	Moderate (Hg 7 – 10)	83	44.9
	Severe (Hg 4 – 7)	7	3.8
6	Very Severe (Hg < 4)	1	0.5
	Nil (Hg > 11)	45	24.3
	<b>Birth weight</b>		
	Low B.W. (<2.5 kg)	47	25.4
	Normal (2.5 – 3.0 kg)	77	41.6
	Above normal (> 3 kg)	53	28.6
Abortion	3	1.7	
Pre term	5	2.7	

**Table 4:** Association between socio economic status and maternal BMI

Socio economic Status (as per B.G. Prasad Scale)	BMI				Mean	S.D.	P Value	
	Under Weight	Normal	Over Weight	Obese				
	No.	%	No.	%	No.	%	No.	%
1 (-)	-	-	-	-	-	-	-	-
2 (12)	5	41.7	6	50	1	8.3	-	-
3 (24)	14	58.3	9	37.5	1	4.2	-	-
4 (44)	17	38.6	24	54.5	3	6.8	-	-
5 (105)	54	51.4	50	47.6	1	1.0	-	-

**Table 5:** Association between socio economic status and anaemia

S.E. Status (B.G. Prasad Scale)	Anaemia								Hb%		P value	
	Nil		Moderate		Severe		Very Severe		Mean	S.D.		
	No	%	No	%	No	%	No	%	No	%		
1 (-)	-	-	-	-	-	-	-	-	-	-	-	
2 (12)	-	-	2	16.7	9	75	1	8.3	-	-	9.01	1.33
3 (24)	3	12.5	4	16.7	17	70.8	-	-	-	-	9.51	1.07
4 (44)	11	25	15	34.1	17	38.6	1	2.3	-	*	10.09	1.4
5 (105)	31	29.5	28	26.7	40	38.1	5	4.8	1	1.0	9.93	1.67

\*Statistically significant

**Table 6:** Association between BMI and various risk factor

BMI	Birth Weight				Above Normal	Abortion	Preterm	Mean	SD	P value			
	No	%	No	%									
Under weight (90)	31	34.4	32	35.6	21	23.3	3	3.3	3	3.3	2.65	0.42	0.039*
Normal (89)	16	18.0	42	47.2	30	33.7	-	-	1	1.1	2.77	0.37	
Over Weight (6)	-	-	3	50.0	2	33.3	-	-	1	16.7	2.82	0.31	
Obese (-)	-	-	-	-	-	-	-	-	-	-	-	-	

\*Statistically significant

#### 4. Results

This cohort study was carried out among 185 antenatal women who presented in first trimester. A majority of the participants belong to the age group of 20-24 years (59.5%). About 57.6% of the participants were primi. About 44.9% of the participants were anemic. In the study, (48.6%) of the participants were Underweight and 25.4% of the participants delivered a low birth weight baby. (Table 3).

Majority of the participants who were underweight belonged to Socioeconomic class III (58.3%) while most of the overweight participants belonged to socioeconomic class II (8.3%). The mean BMI was highest in class II compared to class IV and V. However the association was statistically not significant. (Table 4)

The association between socio economic status and anemia was analysed. The mean anemia levels increased with the increase in the socioeconomic status. Majority of the participants with moderate and severe anemia belonged to socioeconomic class II (75%) The observed association was statistically significant ( $p < 0.005$ ). (Table 5)

The association between maternal body mass index and birth weight of the newborns showed that underweight mothers had an increased risk of delivering low birth weight babies (34.4%) while overweight mothers were at increased risk of delivering babies with above normal birth weight (33.3%). The observed association was statistically significant ( $p < 0.05$ ). (Table 6)

#### 5. Discussion

Maternal BMI is an indicator of the nutritional status and well being of a pregnant mother. While a lower BMI can impair the nourishment in the newborn, a higher BMI can result in various antenatal, intranatal and postnatal complications. There is an imminent need to evaluate the role of maternal BMI on the impact on the newborn.

In our study, majority of the participants were underweight (48.6%) and very few participants were overweight (3.2%). None of them were obese. However,

majority of the participants were moderately anemic (44.9%). Low birth weight was seen in 25.4% of the participants while 28.6% of the newborns weighed over 3 kilograms. A statistically significant association was found between socioeconomic status and maternal anemia ( $p < 0.05$ ). Moreover, maternal BMI was a strong predictor of the birth weight. Our study showed that underweight mothers were at an increased risk of delivering low birth weight babies (34.4%) while overweight mothers were at increased risk of delivering babies with birth weight above 3 kilograms ( $p < 0.05$ ).

Our study was similar to a number of studies published. Verma et al also observed similar findings of increased risk of low birth weight among underweight mothers. Also, risk of LGA babies increased with increase in the maternal BMI<sup>5</sup> Yazdani S et al demonstrated similar findings and also emphasized that with increase in the BMI, there is an increase in the predisposition towards caesarean section, thereby accentuating the perinatal and postnatal complications.<sup>7</sup> Similar results were seen in a study done by Khashan AS et al.<sup>8</sup>

Overweight and obesity are associated with oxidative stress and rise in circulating inflammatory markers. The plasma levels of C-Reactive protein is elevated in obese individuals with increase in Tumor Necrosis Factor- $\alpha$  (TNF- $\alpha$ ), Interleukin (IL)- 6 and IL-8, which predispose to pre-eclampsia.<sup>9</sup> Obesity and overweight therefore predispose to several complications during the antenatal period, making the pregnancy a high risk one. A meta analysis done by Han Z et al reviewed the risk of low birth weight in relation to maternal BMI. Underweight mothers were at increased risk of delivering both low birth weight babies and also preterm babies. This phenomenon could be directly related to the lack of adequate nutritional support resulting in diminished fetal growth. Presence of other significant illnesses in mothers like anemia also had an indirect impact.<sup>10</sup>

## 6. Conclusion

Maternal body weight is a significant and silent predictor of the pregnancy outcome. There is a need to raise awareness among pregnant mothers on the impact of the body mass index during pre-pregnancy counseling. Our study has emphasized on the need to maintain an optimum body weight according to the height in order to have a healthy and well nourished baby. An intense evaluation in the first trimester can help the couples monitor the weight gain during pregnancy and achieve desired outcomes. There is an imminent need to rectify nutritional disorders like anemia prior to the conception in order to facilitate healthy and effective weight gain during pregnancy. Any pregnant woman must be provided with nutritional and lifestyle counseling in her initial visits in order to take informed decisions at the appropriate time.

## 7. Conflict of interest

Nil

## 8. Funding

Nil

## 9. Ethical approval

Obtained

## References

1. Park K ; 2013,. 22nd edition. New Delhi. Banarsidas Bhanot.
2. U.S. National Library of Medicine. PubMed Health. Pregnancy and birth: weight gain in pregnancy ;. Available from: <https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0072759/>.

3. Johansson K, Linne Y, Rossner S, Neovius M. Maternal predictors of birthweight: The importance of weight gain during pregnancy. *Obes Res Clin Pract.* 2007;1(4):223–90.
4. Papazian T, Tayeh GA, Sibai D, Hout H, Melki I, Khabbaz LR. Impact of maternal body mass index and gestational weight gain on neonatal outcomes among healthy Middle-Eastern females. *PLoS one.* 2017;12(7):181255–181255.
5. Verma A, Shrimali L. Maternal body mass index and pregnancy outcome. *J Clin Diagn Res.* 2012;6(9):1531–1533.
6. Ota E, Haruna M, Suzuki M, Anh DD, Tho LH, Tam N. Maternal body mass index and gestational weight gain and their association with perinatal outcomes in Viet Nam. *Bulletin of the World Health Organization.* 2011;89:127–136.
7. Yazdani S, Yosofniyapasha Y, Nasab BH, Mojaveri MH, Bouzari Z. Effect of maternal body mass index on pregnancy outcome and newborn weight. *BMC Res Notes.* 2012;5:34–34.
8. Khashan AS, Kenny LC. The effects of maternal body mass index on pregnancy outcome. *Eur J Epidemiol.* 2009;24(11):697–705.
9. Pakniat H, Mohammadi F, Ranjkesh F. The impact of body mass index on pregnancy outcome. *Journal of Midwifery and Reproductive Health.* 2015;3(2):361–367.
10. Han Z, Mulla S, Beyene J, Liao G. Maternal underweight and the risk of pre term birth and low birth weight: a systematic review and meta-analyses. *International Journal of Epidemiology.* 2011;40(1):65–101.

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