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***Research Article** (Open Access)*

CORRELATION OF FIRST TRIMESTER BODY MASS INDEX & GESTATIONAL WEIGHT GAIN WITH FETO-MATERNAL OUTCOME, A PROSPECTIVE STUDY

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ABSTRACT
Gestational weight gain (GWG) is a complex biological phenomenon which supports the function of growth & development of the fetus and is an important determinant of pregnancy outcome. Excessive as well as poor maternal weight gain has fetomaternal complications. Though maternal weight gain for antenatal surveillance is an important feature of prenatal care but clinical and its practical implication in pregnancy is less studied. Hence this study was conducted on 350 antenatal patients with singleton pregnancy at ≤ 12wks gestation to assess usefulness of GWG in this modern era of highly sophisticated methods of obstetric surveillance. It was a hospital based prospective analytic study in which patients were categorized into underweight, normal weight, overweight and obese categories according to BMI given by IOM (2007) which were further subdivided into three sub groups according to total gestational weight gain whether less, adequate or more than recommended by IOM. In our study, 16.9% women were underweight, 61.1% women had normal weight while 17.1% and 4.9% women were overweight and obese respectively. Mean age of the pregnant women was 24.87±3.83 years and 63.14% patients belonged to upper lower class. The mean gestational weight gain was 10.33±2.96 kg. Majority of the patients (50%) had gained less weight and 2.9% patients gained excess weight than recommended. The mean calories and protein intake was 2413.20±143.85 kcal and 68.43±5.79 grams respectively. Anemia and IUGR were more common in underweight and normal weight category and that too in women who gained less weight. GDM and pre eclampsia were more common in overweight group even if weight gain was adequate or more. In the obese category though patients gained either less or normal weight yet they suffered from pre eclampsia and GDM. Rate of LSCS was 11 to 13% in underweight and 16 to 18% in normal weight category respectively whether they had less or adequate gestational weight gain. In overweight category excess gestational weight gain was responsible for 50% LSCS rate and in obese category even when there was adequate gestational weight gain the LSCS rate was 76.92%. In underweight and normal weight categories the women who gained less gestational weight had 30% and 28.21% Low Birth Weight babies (<2.5 kg) respectively while women who gained adequate gestational weight had 0% and 9.28% LBW babies respectively (p=0.003 and p=0.0001 respectively). In the overweight category women who gained more weight had 30% babies > 3.5 kg. NICU admission was common in less GWG sub group. For pre pregnant underweight, normal weight and overweight patients gestational weight gain less than IOM recommendation increases the risk for unfavorable feto maternal outcome (anemia, IUGR and low birth weight, NICU admission) while for pre pregnant overweight patients gestational weight gain more than IOM recommendation associated with pre eclampsia and GDM. Thus it is of vital importance to stress upon weight management programs to normalize pre pregnancy BMI as both pre pregnancy BMI and GWG can influence the feto maternal outcome.

***Keywords:** Gestational Weight Gain (GWG), Body Mass Index (BMI), Fetomaternal outcome in relation to Gestational weight gain*

INTRODUCTION
Gestational weight gain (GWG) is a unique & complex biological phenomenon that supports the function of growth & development of fetus and is one of the important determinants of pregnancy outcome

(Rasmussen and Yaktine, 2009). Maternal component which includes uterine and mammary tissue mass and expanded maternal blood volume, extracellular fluid, fat stores and other tissues accounts for approximately two-third of the total weight gain during pregnancy. The products of conception which comprise of fetus, placenta and amniotic fluid accounts for approximately one third of the total gestational weight gain. By report of Committee on Nutritional Status during Pregnancy and Lactation, institute of medicine (IOM) 1990, it has been concluded that mean total Gestational weight gain of adult women giving birth to the term infant ranges from 11.5 to 16.0 kg and the mean rate of Gestational weight gain in uncomplicated singleton pregnancy is 0.45 kg/week in second trimester and 0.40 kg/week in third trimester. Later in the year of 2007, IOM revised the guidelines for GWG and formulated it as a range of weight gain during pregnancy in each category of pre pregnancy BMI (Table 1) (Rasmussen and Yaktine, 2009). BMI is a preferred indicator of nutritional status than weight alone because it depends on two commonly measured aspects of body morphology—weight and height. It is more accurate indicator of body composition such as body fat content or lean body mass, but it is not simply an obesity index.

Table1: Recommendations for total and average rate and range of weight gain during pregnancy in each category of pre - pregnancy BMI {IOM (2007)} (Rasmussen and Yaktine, 2009)

Pre-pregnancy BMI (kg/m^2)	**Total weight gain range (kg)**	**Rates of weight gain 2nd and 3rd trimester (mean range in kg/week)**
Underweight (< 18.5)	12.5–18	0.51 (0.44–0.58)
Healthy weight (18.5–24.9)	11.5–16	0.42 (0.35–0.50)
Overweight (25.0–29.9)	7–11.5	0.28 (0.23–0.33)
Obese (≥ 30.0)	5–9	0.22 (0.17–0.27)

Excessive as well as poor maternal weight gain has fetomaternal complications. Excessive maternal weight gain is associated with maternal complications like: hypertension, diabetes mellitus, respiratory complications, thrombo - embolic disease, increased risk of caesarean section, anesthetic complications like difficult intubation and difficult epidural placement. New born complications include congenital malformations, large for gestational age infants, shoulder dystocia, and long term adolescent complications like obesity and diabetes mellitus (Yogev and Catalano, 2009). At the same time poor gestational weight gain is associated with complications like preterm labour, intra uterine growth retardation, anemia, NICU admission and low 5 min APGAR score (Schieve *et al.*, 1999; Kramer *et al.*, 1995; Spinillo *et al.*, 1998).

Committee on the Impact of Pregnancy Weight on Maternal and Child Health (2007) described various factors which influence maternal weight gain: Biological factors – age, parity, stature etc, Metabolic factors – Level of insulin and leptin in circulation, Eating disorder like active anorexia nervosa and bulimia, Social factors – High glycemic or fat diet, amount of energy intake, unintended pregnancy, short inter pregnancy interval, type of provider advice and domestic violence

Though maternal weight gain for antenatal surveillance is an important feature of prenatal care but clinical and practical implication of abnormal weight change in pregnancy is less studied. Also little is known about effectiveness of weighing as a screening procedure for predicting feto maternal outcome. Hence there is a need to see the contexture relevance of this recommendation to our own population and to assess its usefulness and effectiveness in this modern era of highly sophisticated methods of obstetric surveillance.

MATERIALS AND METHODS

This was a tertiary Hospital based prospective analytic study which was conducted between June 2016-May 2017 on 350 antenatal patients attending the Obstetric and Gynae OPD or admitted in the ward at Hindu Rao Hospital, Delhi, in close association with the Department of pediatrics. The study included all

singleton pregnant women ≤12wks gestation at first ANC visit or pregnant women > 12wks with well maintained previous ANC records irrespective of maternal age and parity who agreed for antenatal check up and delivery at our institute. All pregnant women with recent illness, infections during pregnancy like HIV, hepatitis B, syphilis, tuberculosis Women with preexisting diabetes mellitus, hypertension, heart disease, thyroid disorder, epilepsy, bronchial asthma, chronic diarrhea, moderate to severe anemia or any other significant medical or surgical co morbidity or twin pregnancy were excluded from the study. Patients were enrolled in the study only after an informed written consent was obtained and the procedure had been explained to them. Detailed history of the patients including age, demographic profile, obstetric history, menstrual history, past history and family history was taken. After a detailed history, general physical examination and systemic examination was done. Weight was recorded without foot wears and woolen clothes or other belongings. It was recorded in kilogram unit by same weighing machine. Digital weighing machine of 100 grams accuracy of health Sense Company was used. Height was recorded in meter unit by pre-made scale in the hospital with proper instructions of posture and head position. BMI was calculated by weight (kg)/height (meter^2). As pre pregnancy BMI is difficult to measure and there is minimal difference in pre pregnancy BMI and first trimester BMI, first trimester BMI was taken in the study. On subsequent visits weight of the patient was taken by the same weighing machine and other investigations according to need were done. Any feto-maternal complications were recorded (At least once in each trimester). At the time of delivery total gestational weight gain was recorded. In the study Gestational Weight Gain of all patients was compared with recommended gestational weight gain for each WHO standard of BMI category and feto maternal outcome was noted.

Statistical Analysis

Descriptive statistics was analyzed with SPSS version 17.0 software. Continuous variables were presented as mean ± SD. Categorical variables were expressed as frequencies and percentages. The Pearson's chi-square test or Fisher's exact test was used to determine the relationship between two categorical variables. $p < 0.05$ was considered statistically significant.

RESULTS

Patients were categorized according to BMI categories given by IOM (2007) (Rasmussen and Yaktine, 2009) into four groups. These groups were further divided into three sub groups according to gestational weight gain in each BMI category as given by IOM. In all the categories first sub group included pregnant women who gained less weight than recommended, second sub group included women who gained weight according to the recommendation while the third sub group included those who gained weight more than recommended by IOM. The description of all the sub groups is shown in Table-2. Distribution

Table2: Description of weight gain in sub groups of various categories of BMI

BMI categories (Group)	**Sub group according to total gestational weight gain**		
	Sub Group 1 (Less)	**Sub Group 2 (normal)**	**Sub Group 3 (excess)**
Underweight (A) <18.5 kg/m^2	A1 <12.5 kg	A2 12.5-18 kg	A3 >18 kg
Normal weight (B) (18.5-24.9 kg/m^2)	B1 <11.5 kg	B2 11.5-16 kg	B3 >16 kg
Overweight (C) (25-29.9 kg/m^2)	C1 < 7 kg	C2 7-11.5 kg	C3 > 11.5 kg
Obese (D) **(** >30 kg/m^2)	D1 < 5 kg	D2 5-9 kg	D3 > 9 kg

of patients according to amount of gestational weight gain in different BMI categories in our study has been shown in table 3. Distribution of patients according to age and gravidity in different BMI categories

has been shown in table 4. As shown in Table-5, 63.14% patients belonged to upper lower class, and no patients were in lower and upper class. There was no statistically significant difference amongst socio economic class in different BMI categories (p value = 0.09).

Table 3: Distribution of patients according to amount of gestational weight gain in different BMI categories

Groups (BMI Category)	Total cases (N=350)	Distribution of patients according to recommended weight gain sub group		
		Sub Group 1 (Less)	Sub Group 2 (normal)	Sub Group 3 (excess)
Group A (Underweight)	59 (16.9%)	33 (55.9%)	26 (44.1%)	0 (0.0%)
Group B (Normal weight)	214 (61.1%)	117 (54.7%)	97 (45.3%)	0 (0.0%)
Group C (Overweight)	60 (17.1%)	21 (35%)	29 (48.3%)	10 (16.7%)
Group D (Obese)	17 (4.9%)	4 (23.5%)	13 (76.5%)	0 (0.0%)
Total	350	175 (50%)	165 (47.1%)	10 (2.9%)
Total p value[1]<0.01				

[1]***Chi-square test***

Table 4: Distribution of patients according to age and gravidity in different BMI categories

Age Groups	BMI Category			
	A (N=59)	B (N=214)	C (N=60)	D (N=17)
18 - 20 yrs (n = 39)	20.5%	71.8%	7.7%	0%
21 - 25 yrs (n = 177)	19.8%	63.3%	13.6%	3.4%
26 - 30 yrs (n = 111)	13.5%	54.1%	23.4%	9.0%
>30 yrs (n= 23)	4.3%	60.9%	30.4%	4.3%
[1]**p value** 0.014 [1]**Chi-square test**				
Gravidity	**A (n=59)**	**B (n=214)**	**C (n=60)**	**D (n=17)**
Primi	55.93%	45.32%	38.33%	29.41%
Multi	44.06%	54.67%	61.67%	70.59%
[1]**p value 0.13** [1]**Chi-square test**				

Table 5: Distribution of the patients according to different socio economic class

BMI Category	Sub categories	Socio economic class			p value[1]
		Upper Lower	Lower Middle	Upper Middle	
Category A (N=59)	A1 (N=33)	69.69%	24.24%	6.06%	0.711
	A2 (N=26)	69.23%	19.23%	11.53%	
	A3 (N=0)	-	-	-	
Category B (N=214)	B1 (N=117)	61.53%	31.62%	6.83%	0.462
	B2 (N=97)	67.01%	22.68%	10.31%	
	B3 (N=0)	-	-	-	
Category C (N=60)	C1 (N=21)	61.9%	28.57%	9.52%	0.501
	C2 (N=19)	51.72%	31.03%	17.24%	
	C3 (N=10)	80%	20%	0	
Category D (N=17)	D1 (N=4)	25	50	25	0.571
	D2 (N=13)	46.15	23.07	30.76	
	D3 (N=0)	-	-	-	

[1]***Chi-square test***

Table 6: Distribution of patients according to nutritional status: calories

BMI Category	Sub categories	Nutritional Status Calories						P Value[1]
		<2200		2200 – 2600		>2600		
		No.	%	No.	%	No.	%	
Category A (N=59)	A1	4	80.0%	29	53.7%			0.5
	A2	1	20.0%	25	46.3%			
	A3	-	-	-	-	-	-	
Category B (N=214)	B1			117	54.7%			–
	B2			97	45.3%			
	B3	-	-	-	-	-	-	
Category C (N=60)	C1			14	33.3%	7	38.9%	0.9
	C2			21	50.0%	8	44.4%	
	C3			7	16.7%	3	16.7%	
Category D (N=17)	D1			0	0.0%	4	44.4%	0.082*
	D2			8	100.0%	5	55.6%	
	D3	-	-	-	-	-	-	
Total of sub categories (N=350)		221	63.14%	94	26.86%	35	10.0%	
							Total p value[1]	0.09

[*]***Fisher's exact test*** [1]***Chi-square test***

Table 6, shows that all the women who took less calories (1.43%) were in the underweight BMI category while 7.71% who took more calories were either in overweight or obese BMI categories. In the underweight category, out of 91.53% women who consumed adequate calories, 53.7% gained less weight while out of 8.47% women who consumed less calories 80% gained less weight than recommended.

Though all the women in normal weight BMI category consumed adequate calories yet 45.3% gained adequate weight. All the obese women who consumed adequate calories gained adequate weight.
Table 7 shows that 94.9% underweight BMI category consumed < 70 g proteins while 31.67% of overweight and 58.82% of obese category respectively consumed > 75 g proteins. The difference between protein intake and different BMI categories was statistically significant (p value < 0.0001).
Table 8 shows the distribution of patients according to maternal outcome in all BMI categories. Table 9 shows the distribution of patients according to mode of delivery and the effect of gestational weight gain on it. Out of 350 patients, 20.29% patients were delivered by LSCS. 11.86% patients from underweight group, 17.29% from normal weight group, 33.33% patients from overweight group and 58.82% were from obese BMI category delivered by LSCS.

Table 7: Distribution of patients according to nutritional status: protein

BMI Category	**Sub categories**	**Protein**						**P Value[1]**
		<70 gm		**70-75 gm**		**>75 gm**		
		No.	**%**	**No.**	**%**	**No.**	**%**	
Category A (N=59)	A1	32	57.1%	1	33.3%			0.83
	A2	24	42.9%	2	66.7%			
	A3	-	-	-	-	-	-	
Category B (N=214)	B1	63	55.8%	51	53.1%	3	60.0%	0.9
	B2	50	44.2%	45	46.9%	2	40.0%	
	B3	-	-	-	-	-	-	
Category C (N=60)	C1	6	75.0%	8	24.2%	7	36.8%	0.1
	C2	2	25.0%	18	54.5%	9	47.4%	
	C3	0	0.0%	7	21.2%	3	15.8%	
Category D (N=17)	D1			1	14.3%	3	30.0%	0.603*
	D2			6	85.7%	7	70.0%	
	D3	-	-	-	-	-	-	
Total of sub categories (N=350)		177	50.57%	139	39.71%	34	9.72%	
							Total p value[1]< 0.0001	

Fisher's exact test ,[1]Chi-square test

Table 8: Distribution of patients according to maternal outcome in BMI category

BMI category	Maternal outcome									
	Anemia		IUGR		GDM		PE		PPH	
	No.	%	No.	%	No.	%	No.	%	No.	%
A (n=59)	18	30.50	14	23.72	0	0	0	0	1	1.70
B (n=214)	22	10.28	22	10.28	1	0.004	3	1.4	3	1.40
C (n=60)	4	6.67	1	1.66	5	8.33	7	11.66	9	15
D (n=17)	0	0	1	5.88	2	11.76	6	35.29	-	-
Total (N=350)	44	12.57%	38	10.86%	8	2.29%	16	4.57%	13	3.71
P[1] value	<0.0001		0.0012		0.0001		<0.0001		<0.0001	

[1]***Chi-square test***

Table 9: Distribution of patients according to mode of delivery

BMI Category	Sub category	Mode of Delivery				P Value[1]
		LSCS		NVD		
		No.	%	No.	%	
Category A (N=59)	A1(n=33)	4	12.12%	29	87.88%	0.73
	A2(n=26)	3	11.54%	23	88.46%	
	A3(n=0)	-	-	-	-	
Category B (N=214)	B1(n=117)	21	17.95%	96	82.05%	0.92
	B2(n=97)	16	16.49%	81	83.51%	
	B3(n=0)	-	-	-	-	
Category C (N=60)	C1(n=21)	10	47.62%	11	52.38%	0.03
	C2(n=29)	5	17.24%	24	82.76%	
	C3(n=10)	5	50.0%	5	50.0%	
Category D (N=17)	D1(n=4)	0	0.0%	4	100%	0.014*
	D2(n=13)	10	76.92%	3	23.08%	
	D3(n=0)	-	-	-	-	
Total of sub categories (N=350)		71	20.29%	279	79.71%	
						Total p value[1]<0.0001

[1]***Chi-square test*** **Fisher's exact test*

Table 10 shows the distribution of birth weight in different BMI categories. Out of 350 patients, 17.71% had babies with birth weight <2.5 kg, 74.86% had babies with birth weight 2.5-3.5 kg, and 7.43% had babies with birth weight >3.5 kg. Table 11 shows the effect of gestational weight gain on birth weight in various BMI categories.

Table 10: Birth weight in different BMI categories

BMI Category	Birth Weight					
	< 2.5 kg		2.5 – 3.5 kg		> 3.5 kg	
	Frequency	%	Frequency	%	Frequency	%
Category A (N=59)	10	16.95%	47	79.66%	2	3.39%
Category B (N=214)	42	19.63%	162	75.70%	10	4.67%
Category C N=60)	8	13.33%	41	68.33%	11	18.33%
Category D (N=17)	2	11.76%	12	70.59%	3	17.65%
Total (N=350)	62	17.71%	262	74.86%	26	7.43%
					p value[1] 0.007	

[1]***Chi-square test***

Table 11: Effect of gestational weight gain on birth weight in various BMI categories

BMI Category	Sub category	Birth Weight						P Value[1]
		<2.5		2.5-3.5		>3.5		
		Frequency	%	Frequency	%	Frequency	%	
Category A (N=59)	A1 (n=33)	10	30%	23	69%	0	0.0%	0.003
	A2 (n=26)	0	0.0%	24	92.3%	2	7.6%	
	A3 (n=0)	-	-	-	-	-	-	
Category B (N=214)	B1 (n=117)	33	28.21%	82	70.09%	2	1.71%	0.0001
	B2 (n=97)	9	9.28%	80	82.47%	8	8.25%	
	B3 (n=0)	-	-	-	-	-	-	
Category C (N=60)	C1 (n=21)	5	23.8%	14	35.2%	2	9.5%	0.156
	C2 (n=29)	1	3.4%	22	75.9%	6	20.7%	
	C3 (n=10)	2	20%	5	50%	3	30%	
Category D (N=17)	D1 (n=4)	0	0.0%	3	75.0%	1	25%	0.674
	D2 (n=13)	2	15.4%	9	69.2%	2	15.4%	
	D3 (n=0)	-	-	--	-	-	-	

[1]**Chi-square test**

DISCUSSION

It has been observed in various studies that excessive weight gain as well as poor gestational weight gain is associated with various poor feto-maternal outcome & increased perinatal morbidity and mortality (Schieve *et al.*, 1999; Kramer *et al.*, 1995; Spinillo *et al.*, 1998).

In this study, 350 pregnant women with singleton pregnancy were studied after categorizing them in various BMI categories as given by IOM (2007) (Rasmussen and Yaktine, 2009) and further categorizing them according to recommended weight gain during pregnancy in each BMI category.

In the present study the distribution of patients according to BMI categories showed that 16.9% women were underweight, 61.1% women had normal weight while 17.1% and 4.9% women were overweight and obese respectively (table-3). It is comparable to the study done by Ota *et al.*, (2011) on Asian population which showed that 26.1%, 65.4% and 8.5% women were in low, normal and high BMI categories

according to Asian BMI categories and study done by Ovesen *et al.,* (2011) which showed 4.3%, 63.1%, 20.9% and 7.7% women respectively in underweight, normal weight, overweight and obese BMI categories.

In our study the mean gestational weight gain was 10.33±2.96 kg which was less as compared to study done by Ota *et al.,* (2011) (12.2±3.9 kg). Majority of the patients (50%) had gained less weight and 2.9% patients gained excess weight than recommended while 47.1% patients gained recommended weight (table 3). This is in contrast to study done by Crane *et al.,* (2009) and Haugen *et al.,* (2014) who found 17.1%, 30.6%, 52.3% and 17.9%, 33.2%, 48.8% women who gained less, normal and excess weight gain during pregnancy respectively. The amount of weight gain in different BMI categories was statistically significant (p<0.01) in our study. As most of the women belong to low socioeconomic status, not only they start pregnancy at low BMI category but also gain less weight even when they begin pregnancy at normal BMI. Excess weight gain was rarely seen.

Table 12: Comparison of various maternal outcomes in various BMI categories of our study with other studies

Maternal outcome	Studies	Categories				P value
		Underweight (A)	Normal weight (B)	Over weight (C)	Obese (D)	
Anaemia	Our study	30.50%	10.28%	6.67%	0.0%	<0.0001
	Verma (2012)	58.6%	36.2%,	15.1%,	9.5%	<0.001
Intra uterine growth restriction	Our study	23.72%	10.28%	1.66%	5.88%	0.0012
	Verma (2012)	17.2%	6.1%	6,66%	5.9%	0.002
Pre eclampsia	Our study	0.0%	1.4%	11.66%	35.29%	<0.0001
	Verma (2012)	3.4%	8.8%	9.6%	11.9%	0.01
Gestational Diabetes Mellitus	Our study	0.0%	0.004%	8.33%	11.76%	0.0001
	Verma (2012)	0.0%	0.24%	1.2%	7.1%	<0.001
	Crane *et al.,* (2009)	2.5%	1.65%	3.10%	6.31%	<0.001
Post partum haemorrhage	Our study	1.70%	1.4%	15%	0%	<0.0001
	Deshmukh *et al.,* (2016)					<0.05
	Verma (2012)	3.4%	1.47%	1.2%	1.19%	

Mean age of the pregnant women was 24.87±3.83 years and ranged from 18 to 34 years. Majority of the patients (50.57%) were in the age group of 21-25 years which is similar to the studies carried out by Haugen *et al.,* (2014) and Verma (2012) who also found 64.1%-68.7% and 43.87% of women in the age group of 21-25 years respectively. Overweight and obese women were seen more often in the older age group. The difference between ages in different BMI categories was statistically significant (p 0.014) in the present study similar to study done by Haugen M *et al.,* (2014) (p<0.001).

44.06%, 54.67%, 61.67% and 70.59% multigravida women were in underweight, normal weight, overweight and obese women which is similar to the study done by Ovesen *et al.,* (2011) who found 51%, 53.3%, 59.3% and 61.5% multigravida women in the similar BMI categories respectively. There was no statistically significant difference between gravidity and different BMI categories. As the socioeconomic

status of the women increased number of women gaining less gestation weight than recommended decreased in all the BMI categories although no statistically significant difference was found between socio-economic class and BMI category (p value = 0.09).

Calories and protein consumption is an important component for adequate gestational weight gain. The mean calories and protein intake was 2413.20±143.85 kcal and 68.43±5.79 grams respectively. It was observed that if a pregnant woman took less calories she definitely gained less weight though gestational weight gain was not statistically related with calorie intake in any of the BMI categories. Olafsdottir *et al.* (2006) concluded that a higher energy intake in late pregnancy was associated with a lower risk of insufficient gestational weight gain and a higher risk of excessive gestational gain. Women who had insufficient gestational weight gain had a lower percentage intake from fat and a higher percentage intake from carbohydrates than women who had optimal or excessive gains. In the present study only total calorie intake was taken into consideration and type of food whether rich in carbohydrate or fat was not taken into account. Majority of women who had consumed adequate or excess protein gained adequate gestational weight gain. Even after consuming adequate calories and protein, many women gained less weight than recommended in all the categories except obese category because the amount of exercise done by them was not considered along with consumption of calories.

Anemia and IUGR were more common in underweight and normal weight BMI category and that too in women who gained less weight. GDM and pre eclampsia were more common in overweight group if weight gain was more than adequate. Risk of pre eclampsia and GDM was more if there was increase in BMI category. In the obese category though patients gained either less or normal weight yet they suffered from pre eclampsia and GDM. Comparison of maternal outcome in our study in various BMI categories with other studies has been shown in table 12. Ovesen *et al.,* (2011) also got similar significance for GDM in different category of BMI. Deshmukh *et al.,* (2016) and Haugen *et al.,* (2014) found similar significance for pre eclampsia in different BMI categories ($p<0.05$).

Table 13. Comparison of mode of delivery in various BMI categories of our study with other studies

LSCS as mode of delivery	**Categories**				P value
	Underweight (A)	**Normal weight (B)**	**Over weight (C)**	**Obese (D)**	
Our study	11.86%	17.29%	33.33%	58.82%	<0.0001
Crane *et al.,* (2009)	13.13%	23.78%,	31.10%,	38.16%	
Verma (2012)	12%	15%	21.8%	36.9%	0.001
Bharpoda *et al.,* (2016)	27.27%	19.56%	25%	60%	

In our study, LSCS were more common in overweight and obese BMI category and it was statistically significant ($p<0.0001$). Ovesen *et al.,* (2011), Haugen *et al.,* (2014) and Verma (2012) also found similar significance in their studies ($p <0.001$ for each). Comparison of mode of delivery in various BMI categories of our study with other studies has been shown in table 13.

Rate of LSCS was 11 to 13% in underweight and 16 to 18% in normal weight BMI category respectively whether they had less or adequate gestational weight gain. In overweight category excess gestational weight gain was responsible for 50% LSCS rate and in obese category even when there was adequate gestational weight gain the LSCS rate was 76.92%. There was also statistical significance between LSCS in sub group of overweight and obese BMI category (p 0.03 and 0.014). Even if patients gained adequate weight the chances of patient to undergo LSCS was 11.25%, 16.49%, 17.24% and 76.92% in underweight, normal weight, overweight and obese group of BMI category.

As shown in table 10, there were 16.95%, 19.63%, 13.33% and 11.76% Low Birth Weight babies (< 2.5 kg) and 3.39%, 4.67%, 11.33% and 17.65% babies with birth weight > 3.5 kg born to underweight,

normal weight, overweight and obese categories of BMI respectively which was statistically significant (p=0.007). Crane *et al.,* (2009) found 10.63%, 3.54%, 3.60% and 3.06% Low Birth Weight babies (in contrast to our study) and 6.25%, 11.93%, 18.27% and 21.17% babies with birth weight >3.5kg (similar to our study) born to underweight, normal weight, overweight and obese categories of BMI respectively. The different finding is possibly due to study on different race, ethnicity, food habits, and prevalence of diseases and health care facilities. Deshmukh *et al.,* (2016) and Bharpoda *et al.,* (2016) also found statistically significant difference for birth weight in different BMI category (p <0.05 and p=0.002 respectively).

In underweight and normal weight categories of BMI the women who gained less gestational weight had 30% and 28.21% Low Birth Weight babies respectively while women who gained adequate gestational weight had 0% and 9.28% babies with birth weight < 2.5 kg respectively. Rather 92.3% and 82.47% women who gained adequate weight had babies with birth weight 2.5 kg – 3.5 kg in both these categories (p=0.003 and p=0.0001 respectively). In the overweight category women who gained more weight had 30% babies > 3.5 kg. 75.9% and 69.2% women had babies with birth weight 2.5 kg – 3.5 kg, when weight gain was adequate in overweight and obese categories respectively though it was not statistically significant. Our hospital caters pregnant women of low socioeconomic status so very less women were in obese category and there was no woman who gained excess weight in this category. Thus gestational weight gain is an important component of birth weight as low GWG is commonly associated with LBW while high GWG is associated with high birth weight.

Out of 350 babies 7.14% babies were admitted to NICU as a neonatal complication. 6.78%, 7.01%, 8.33% and 5.88% babies were admitted in NICU from underweight, normal weight, overweight and obese categories of BMI. Similar study conducted by Crane *et al.,* (2009) and Verma (2012) found 7.50%, 7.96%, 9.38%, 9.94% and 6.03%, 4.68%, 7.87%, 9.5% NICU admission respectively in underweight, normal weight, overweight and obese categories of BMI respectively. How ever there was no statistical significance between NICU admission in different categories of BMI (p=0.97). NICU admission were common in less GWG sub group of underweight, normal weight and overweight BMI categories while in obese category it was more common in adequate weight gain sub group. Thus gaining less weight than recommended during pregnancy can leads to neonatal complication and further to NICU admission.

CONCLUSIONS

In normal pregnancy variable amount of weight gain is a constant feature which depends on upon various biological, metabolical and social factor. Less protein intake during pregnancy is associated with less gestational weight gain than recommendation. For pre pregnant underweight, normal weight and overweight patients gestational weight gain less than IOM recommendation increases the risk for unfavorable feto maternal outcome (anemia, IUGR and low birth weight, NICU admission) while for pre pregnant overweight patients gestational weight gain more than IOM recommendation associated with pre eclampsia and GDM. Thus it is of vital importance to stress upon weight management programs to normalize pre pregnancy BMI as both pre pregnancy BMI and GWG can influence the feto maternal outcome. Preconception counseling and awareness regarding exercise and healthy nutritious diet should be done.

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