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Study of the effect of BMI and maternal weight gain during pregnancy on maternal and fetal outcome

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Abstract
Background: To study the effect of BMI and maternal weight gain during pregnancy and its effect on maternal and fetal outcome.
Methods: This study is a prospective randomised study where 1000 women were included. BMI was calculated on the first visit and before 12 weeks and all women were followed throughout pregnancy and delivery for any maternal and fetal complications.
Results: Maximum number of women 48.6% were with normal BMI, 37.5% were overweight, 9.2% were underweight and 4.7% were obese. Incidence of pre-eclampsia was highest in group D 23% followed by group C 8.8% and this was significant (p value=0.034, <0.0001). Gestational diabetes was highest in (group D) obese subjects (19.1%, p value=<0.0001) antepartum haemorrhage and gestational hypertension was similar in all the groups. Rate of abortions was highest in (group D) obese subjects 12.8%, p value= 0.011) followed by group C %, (p value=0.033). Underweight women (group A) had largest number of preterm deliveries (17.4%, p value=0.0004) and maximum number of post-term deliveries were observed in obese women (group D) (21%, p value=0.023). Babies born to underweight women had significantly less mean birth weight (p=0.001) and those born to overweight and obese women had significantly more mean birth weight (p= 0.024) and (p=0.005) respectively.
Conclusion: The study has shown an association between maternal weight (underweight, overweight and obese) and pregnancy outcome. There is importance of prepregnancy counseling in maintaining weight of women during pregnancy to avoid maternal and fetal outcomes.

Keywords: BMI, maternal nutrition, weight gain, overweight, obese

1. Introduction
Pregnancy is a critical period during which good maternal nutrition is a key factor influencing the health of both mother and child. Nutritional deficiency is a multigenerational insult, from a mother to her newborn child. Ideally a woman should be advised preconceptionally to achieve a state of adequate nutrition.
Body mass index (BMI) is calculated as weight in kilograms divided by height in square meters (kg/m^2) [1]. Thus prepregnancy BMI and maternal weight gain in combination can be used to predict the pregnancy outcome. It is observed that greater weight gain during pregnancy compensates for the adverse effects of fetal growth associated with low maternal BMI during early gestation.
A low maternal BMI is one of the strongest indicators of adverse perinatal outcomes. Infants born to severely underweight women are at increased risk for fetal growth deficits which is associated with infant mortality. It is also associated with adverse health in adulthood, insulin resistance, hypertension and coronary heart disease [2].
The prevalence of obesity has increased sharply in past few years and is becoming a global epidemic all around the world. Obesity and excess weight gain during pregnancy is associated with a wide spectrum of adverse pregnancy outcomes including increased caesarean section rates and postpartum haemorrhage. Also there is increased risk of gestational diabetes and hypertensive disorders of pregnancy and fetal death. Obesity in pregnancy has also been shown to be associated with longer gestation and significantly increased risk of post-term delivery, which contributes to the greater need for induction of labor for prolonged pregnancy. As gestation progresses beyond term, perinatal morbidity and mortality increase as well as maternal complications [3]. Obese women undergoing C-section experience intra- operative complications such as increased blood loss (>1000cc) and prolonged operative time and also post partum

complications like more chances of thromboembolism and wound dehiscence. The perinatal problems that have been identified with maternal obesity include an increased risk of birth asphyxia, birth trauma, and neonatal hypoglycaemia.
Gestational weight gain is defined as the difference between the maternal weight measured within one week prior to delivery and the maternal weight recorded at the first visit to the hospital. Maternal weight gain in pregnancy offers a good means of assessing the wellbeing of the pregnant mother and, by inference of her baby.[4]

Materials and Methods

This prospective random study was conducted in the Department of Obstetrics and Gynaecology, Sri Devaraj Urs Medical College on a minimum of 1000 women attending antenatal OPD over a period of two years from 1st June 2013 to 31st Mayl 2015 after ethical committee approval.

Selection Criteria

A. Inclusion criteria

Pregnant women with viable singleton pregnancy with 1st antenatal visit in 1st trimester (<12 wks).

B. Exclusion criteria

Multiple gestation
Essential hypertension
Diabetes mellitus
Cardiovascular disease
Renal disease
Pulmonary disease
Autoimmune disease

All pregnant women participating in the study were informed about the aims and objectives of the study and consent was taken. They were also counselled about the adequate dietary intake during pregnancy.
On their 1st antenatal visit before 12 wks of pregnancy the body weight (in kgs) was measured by a calibrated scale accurate to 0.5 kg and height was measured in meters.
All cases were followed up in antenatal clinic monthly upto 28 weeks, twice a week upto 36 weeks and weekly thereafter. The weight gain was noted on every visit.
Women in the study were divided according to BMI in four categories –

GROUP A	Low BMI	<18.5kg/m^2
GROUP B	Normal BMI	18.5kg/m^2 to 24.9kg/m^2
GROUP C	Overweight	25kg/m^2 to 29.9kg/m^2
GROUP D	Obese	>30kg/m^2

The guidelines (2009 IOM/NCR) [5] for weight gain and rate of weight gain during pregnancy for women with singleton pregnancy are :-

Pre pregnancyTotal weight Rate of weight gain in BMI gain (in lb)2nd&3rd trimester (lb/wk)

A. Low BMI 28-40lb (12.7 – 18.1kg) 1.0(1.0-1.3) lb/wk (<18.5 kg/m^2) 0.45 (0.45 – 0.59) kg/wk

B. Normal BMI 25-35lb (11.3 – 15.9kg) 1.0(0.8-1.0) lb/wk (18.5-24.9 kg/m^2) 0.45 (0.36 – 0.45) kg/wk

C. Overweight 15-25lb (6.8 – 11.3kg) 0.6(0.5-0.7) lb/wk (25-29.9 kg/m^2) 0.27 (0.23 – 0.31) kg/wk

D. Obese 11-20lb (5 – 9.1kg) 0.5(0.4-0.6) lb/wk (>30 kg/m^2) 0.23 (0.18 – 0.27) kg/wk

A detailed history regarding the present pregnancy was taken, information on maternal age, religion, educational status, occupation, socioeconomic status, residence, drug usage, physical activity during pregnancy was recorded.
History of previous pregnancy if any and its outcome was taken. Sex and age of the previous child, period of gestation at which delivered or aborted, birth weight, congenital anomaly, early neonatal complications or neuro-developmental delay were recorded.

The parameters evaluated during study are

A. Maternal

1. During antenatal period – Gestational hypertension, antepartum haemorrhage, preeclampsia, gestational diabetes.
2. Period of gestation at delivery – abortion (<24weeks), Preterm (24 to 37 weeks), Term (37 to 40 weeks) and post-term (>40 weeks).
3. Onset of labor – Induced or spontaneous
4. Mode of delivery- vaginal delivery, instrumental or C-section.
5. Perineal trauma
6. Post partum haemorrhage

B. Neonatal

1. Fetal outcome - Still birth, live birth or intrauterine death.
2. Birth weight of newborn – VLBW, LBW, normal birth weight, macrosomia.

Results

A total of 1000 pregnant women were enrolled in our study from 2017 to 2019, after applying inclusion and exclusion criteria.
Table 1 shows distribution of women in each BMI category. Maximum women belonged to normal BMI group (48.6%).

Table 1: Women in Each BMI Category

BMI Categories	Frequency	%
GROUP A (underweight)	92	9.2%
GROUP B (normal BMI)	486	48.6%
GROUP C (overweight)	375	37.5%
GROUP D (obese)	47	4.7%
Total	1000	100%

Table 2: Distribution of women according to age

AGE Groups (years)		BMI Categories (N=1000)				P values		
		GROUP A (N=92)	GROUP B (N=486)	GROUP C (N=375)	GROUP D (N=47)	Group B vs Group A	Group B vs Group C	Group B vs Group D
< or = 20 yr (n=62)	Frequency	10	48	4	0	0.771	<0.001	0.024
	%	10.9%	9.9%	1.1%	0.0%			
21 – 30 yrs (n=777)	Frequency	80	353	313	31	0.004	0.0002	0.330
	%	86.9%	72.6%	83.5%	66%			

31 – 40 yrs (n=154)	Frequency	2	82	56	14	0.0002	0.442	0.028
	%	2.2%	16.9%	14.9%	29.8%			
> 40 yrs (n=7)	Frequency	0	3	2	2	0.450	0.872	0.013
	%	0%	0.6%	0.5%	4.3%			
Mean ± SD		23.74 ± 3.21	25.56 ± 4.72	25.85 ± 4.41	28.04 ± 6.46	<0.001	0.926	0.077

In the present study, an association was observed in mean age. The mean age in group A 23.74 ± 3.21 years is significantly less than group B 25.56 ± 4.72 years (p value= <0.001). But it is not different from group C 25.85 ± 4.41 years and D 28.04 ± 6.46 years (p value=0.926, 0.077). Similar observation were found by John *et al.* [6] where only 4% females were in age group of <24 years, 58% in 25-30 years.

Table 3: Socioeconomic Status

Socio Economic Status		BMI Categories (N=1000)				P values		
		Group A (N=92)	Group B (N=486)	Group C (N=375	Group D (N=47)	Group B vs Group A	Group B vs Group C	Group B vs Group D
I (n=18)	Frequency	3	8	6	1	0.299	0.958	0.807
	%	3.3%	1.6%	1.6%	2%			
II (n=480)	Frequency	40	283	140	17	0.009	<0.0001	0.004
	%	43.5%	58.2%	37.3%	36%			
III (n=446)	Frequency	43	180	202	21	0.080	<0.0001	0.302
	%	46.7%	37.0%	53.9%	45%			
IV (n=35)	Frequency	2	12	19	2	0.866	0.042	0.465
	%	2.2%	2.5%	5.1%	4%			
V (n=21)	Frequency	4	3	8	6	0.003	0.044	<0.0001
	%	4.3%	0.6%	2.1%	13%			

All women were classified according to modified kuppuswamy's socio economic status scale. Maximum number of women belonged to class III (44.6%) which is lower middle class.

In class II (the upper middle class) there were 40 (43.5%) women in group A and 283 (58.2%) in group B and the difference was significant (p value = 0.009). There were 140 (37.3%) women in group C and in group D there were 17 (36.17%) and this difference was highly significant (p value <0.0001) and significant (p value = 0.004) respectively in comparison to group B. Less underweight and more overweight and obese women belong to class II.

There were 4 (4.34%) women in group A and when compared to 3 (0.6%) women in group B who belonged to class V (the lower class) (p value = 0.003) was significant. There were 8 (2.13%) women in group C and 6 (12.77%) women in group D and when compared to group B difference was significant (p value = 0.044) and highly significant (p value<0.0001) respectively. As the socio economic status increased there were more obese and less lean subjects.

Table 4: Weight Gain During Pregnancy

Weight Gain (Kgs)		BMI Categories (N=1000)				P values		
		Group A (N=92)	Group B (N=486)	Group C (N=375	Group D (N=47)	Group B vs Group A	Group B vs Group C	Group B vs Group D
< 8 kgs (n=118)	Frequency	7	42	50	19			
	%	7.6%	8.6%	13.3%	40%			
8 – 15.9 kgs (n=672)	Frequency	65	358	227	22			
	%	70.7%	73.7%	60.5%	47%			
>16 kgs (n=210)	Frequency	20	86	98	6			
	%	21.7%	17.7%	26.1%	13%			
Mean ± SD		11.64 ± 5.42	11.35 ± 5.0	8.93 ± 1.55	8.70 ± 1.44	0.998	<0.001	<0.001

The lower limit of 8 kgs was chosen due to an evaluation of optimal gestational weight gain in relation to fetal outcome [7] and the upper limit of 15.9 kgs is the upper limit of weight gain in normal BMI group according to guidelines (2009 IOM/NRC) [5].

The mean weight gain in group A is 11.64 ± 5.42, group C is 8.93 ± 1.55, group D is 8.70 ± 1.44 on comparing with group B mean weight gain 11.35 ± 5.0 significantly less mean weight gain in group C and group D (P<0.001,<0.001) respectively. But there is no difference in mean weight gain between group A and B (p=0.998)

Table 5: Antenatal Complications

Antenatal Complications		BMI Categories (N=1000)				P values		
		Group A (N=92)	Group B (N=486)	Group C (N=375)	Group D (N=47)	Group B vs Group A	Group B vs Group C	Group B vs Group D
Pre-Eclampcia (n=71)	Frequency	2	25	33	11	0.216	0.034	<0.0001
	%	2.2%	5.1%	8.8%	23.4%			
Gestational Diabetes (n=49)	Frequency	2	16	22	9	0.571	0.056	<0.0001
	%	2.2%	3.3%	5.9%	19.1%			

Ante Partum Haemorrhage (n=23)	Frequency	3	11	8	1	0.568	0.897	0.952
	%	3.3%	2.3%	2.1%	2.1%			
Gestational Hyper Tension (n=89)	Frequency	5	40	38	6	0.359	0.335	0.290
	%	5.4%	8.2%	10.1%	12.8%			

Pre-eclampsia was present in 2 (2.2%) cases in group A (p value = 0.216), and 33 (8.8%) in group C (p value = 0.034) and 11 (23%) in group D (p value<0.0001) when compared with comparison group B 25 (5.14%) cases. There were significantly more cases of pre-eclampsia in obese and overweight women. Similar findings were reported by Tharihalli and Thathagiri [8].

There were 2 (2.2%) cases (p value = 0.571), 16 (3.3%) cases (p value = 0.056) and 9 (19.1%) cases (p value<0.0001) of gestational diabetes in group A, C and D respectively on comparing with 22 (5.9%) group B cases. There were more cases of gestational diabetes in obese and overweight.

The incidence of antepartum hemorrhage was comparable in all BMI groups In group A, C and D APH is present in 8 (8.7%), 46 (12.3%) and 7 (14.9%) subjects which was compared to 51 (10.5%) subjects in group B.

The incidence of Gestational hypertension was also found comparable in all BMI groups In group A, C and D, it is present in five (5.4%), 38 (10.1%)and 6 (13%) subjects which was compared to 40 (8.2%) subjects in group B.

Table 6: Onset of Labour

Onset Of Labour		**BMI Categories (N=1000)**				**P values**		
		Group A (N=92)	**Group B (N=486)**	**Group C (N=375)**	**Group D (N=47)**	**Group B vs Group A**	**Group B vs Group C**	**Group B vs Group D**
Spontaneous (n=875)	Frequency	81	438	325	31	0.546	0.084	<0.0001
	%	88.0%	90.1%	86.7%	66%			
Induced (n=125)	Frequency	11	48	50	16			
	%	12.0%	9.9%	13.3%	34%			

There are significantly more inductions and less spontaneous deliveries in obese (group D) women.

It was observed that the spontaneous onset of labour was seen in 438 (90.1%) women in group B and when compared to 81 (88%) women in group A (p=0.546) and 325 (86.75%) women in group C (p=0.084) the difference was not significant. In group D there were 31 (66%) subjects which were significantly less than group B (p<0.0001).

Women who had induced onset of labour were 48 (9.9%) in group B and 50 (13.3%) in group C (p=0.084), 16 (34%) in group D (<0.0001) and 11 (12%) in group A (p=0.546).

Table 7: Mode of Delivery

Mode Of Delivery		**BMI Categories (N=1000)**				**P values**		
		Group A (N=92)	**Group B (N=486)**	**Group C (N=375)**	**Group D (N=47)**	**Group B vs Group A**	**Group B vs Group C**	**Group B vs Group D**
Normal Vaginal Delivery (n=707)	Frequency	69	370	250	18	0.816	0.002	<0.0001
	%	75%	76.1%	66.7%	38.3%			
Instrumental Delivery (n=158)	Frequency	11	68	69	10	0.602	0.079	0.177
	%	12%	14.0%	18.4%	21.3%			
C-Section (n=135)	Frequency	12	48	56	19	0.361	0.016	<0.0001
	%	13%	9.9%	14.9%	40.4%			

There were significantly less normal vaginal deliveries and more C-section in overweight and obese women, whereas incidence of instrumental deliveries was comparable in all the BMI groups. This correlates with the study conducted by Cedergren M [9].

Table 8: Perineal Trauma (3 Rd AND 4th Degree Perineal Tear)

Perineal Trauma		**BMI Categories (N=1000)**				**P values**		
		Group A (N=92)	**Group B (N=486)**	**Group C (N=375)**	**Group D (N=47)**	**Group B vs Group A**	**Group B vs Group C**	**Group B vs Group D**
Present (n=10)	Frequency	0	4	5	1	0.383	0.465	0.376
	%	0%	0.8%	1.3%	2%			
Absent (n=90)	Frequency	92	482	370	46			
	%	100%	99.2%	98.7%	98%			

There was no significant association between BMI categories and perineal trauma.

In group B, four (0.8%) subjects had perineal trauma and five (1.3%) subjects in group C (p=0.465), one (2%) subject in group D (p=0.376) and no subjects in group A had perineal trauma (p=0.383).

Table 9: Post Partum Haemorrhage

Post Partum Haemorrghge (n=15)		BMI Categories (N=1000)				P values		
		Group A (N=92)	Group B (N=486)	Group C (N=375)	Group D (N=47)	Group B vs Group A	Group B vs Group C	Group B vs Group D
Atonic (N=9)	Frequency	1	2	5	1	0.408	0.135	0.133
	%	1.1%	0.4%	1.3%	2.1%			
Traumatic (N=6)	Frequency	0	2	3	1	0.659	0.457	0.133
	%	0.0%	0.4%	0.8%	2.1%			

From table 9, there were no significant association between post partum haemorrhage (atonic or traumatic) and BMI categories is observed.

Table 10: Fetal Outcome

Fetal Outcome		BMI Categories (N=1000)				P values		
		Group A (N=92)	Group B (N=486)	Group C (N=375)	Group D (N=47)	Group B vs Group A	Group B vs Group C	Group B vs Group D
LIVE BIRTH (n= 985)	Frequency	91	480	369	45	0.905	0.650	0.104
	%	98.9%	98.8%	98.4%	95.7%			
STILL BIRTH (n=6)	Frequency	0	3	2	1	0.450	0.872	0.252
	%	0.0%	0.6%	0.5%	2.1%			
IUD (n=9)	Frequency	1	3	4	1	0.618	0.467	0.252
	%	1.1%	0.6%	1.1%	2.1%			

The incidence of live births, stillbirths and IUD were comparable in all the groups. It was observed (Table – 15) that there were 91 (98.9%) subjects in group A, 480 (98.4%) women in group B, and 369 (98.4%) subjects in group C and 45 (95.6%) women in group D who had live births.

There were three (0.6%) stillbirths in group B and zero (0.0%) in group A, two (0.5%) in group C and one (2.0%) in group D.

In group B there were three (0.6%) IUD and one (1.1%) IUD in group A. One (2.0%) and four (1.1%) cases in group C and group D respectively.

Table 11: Birth Weight of Neonate

Birth Weight		BMI Categories (N=1000)				P values		
		Group A (N=92)	Group B (N=486)	Group C (N=375)	Group D (N=47)	Group B vs Group A	Group B vs Group C	Group B vs Group D
VLBW (<1500gms) (n=42)	Frequency	6	20	15	1	0.307	0.932	0.504
	%	6.5%	4.1%	4.0%	2.1%			
LBW (1500-2500)gms (n=106)	Frequency	28	56	21	1	<0.0001	0.002	0.047
	%	30.4%	11.5%	5.6%	2.1%			
NORMAL WEIGHT (2500-4000)gms (n=826)	Frequency	57	401	328	40	<0.0001	0.054	0.653
	%	62.0%	82.5%	87.5%	85.1%			
MACROSOMIC (>4000gms) (n=26)	Frequency	1	9	11	5	0.606	0.296	0.0003
	%	1.1%	1.9%	2.9%	10.6%			
Mean ± SD		2.62 ± 0.55	2.85 ± 0.42	2.93 ± 0.36	3.06 ± 0.38	0.001	0.024	0.005

There were six (6.5%) women in group A and 20 (4.1%) women in group B who delivered a very low birth weight baby (table – 16). There were 15 (4.0%) VLBW babies in group C and one (2.1%) VLBW baby in group D.

There were 28 (30.4%) LWB babies born in group A and 56 (11.5%) in group B. In group C and D there were 21 (5.6%) and one (2.1%) LBW baby respectively. There were more LBW babies in group A and less in group C and D.

In group A, B, C and D there were 57 (62%), 401 (82.5%), 328 (87.5%) and 40 (85.1%) normal weight babies respectively.

There was one (1.1%) women in group A and 9 (1.9%) women in group B who delivered a macrosomic baby. There were 11 (2.9%) macrosomic babies in group C and 5 (10.6%) in group D. There were more macrosomic babies in group D (p value=0.0003). Tharihalli and Thathagiri [8] found in their study out of 500 cases macrosomia was seen in 32% obese group followed by overweight group (16%).

There is a significant difference in mean birth weight between group B 2.85 ± 0.42 kgs and 2.62 ± 0.55 kgs group A (p=0.001), 2.93 ± 0.36 kgs group C (p= 0.024) and 3.06 ± 0.38 kgs group D (p=0.005). Babies born to underweight women had less mean birth weight and those born to overweight and obese women had significantly more mean birth weight.

The APGAR score was taken at 5 minutes and it was observed that there was no difference found in any of groups. The neonates who admitted to NICU were also comparable in all groups.

Discussion

Obesity has become an epidemic worldwide. The World Health Organization (WHO) has declared obesity as a major killer disease of the millennium on par with HIV and malnutrition. BMI provides a simple numeric measure of a person's "fatness" or "thinness". For a fixed body shape and body density, and given height, BMI is proportional to weight. The weight excess or deficiency may, in part, be accounted for by body fat (adipose tissue) although other factors such as muscularity also affect BMI significantly [5]. This study adds to the increasing body of evidence which suggests that both being overweight and underweight, measured by BMI, predisposes women to complicated pregnancies, obstetric interventions and significant risks to the fetus.

In the present study, BMI distribution was comparable to Michlin R *et al*. [10] and Crane JMG *et al*. [11]. The ratio of obese women was less and underweight was more in the present study. In the observed period, although the women with overweight

and obesity in our sample belonged to a lower limit of the obesity, based on our results, we derive the conclusion that not only obesity with BMI ≥ 30.0 but also overweight with BMI between 25.0 and 29.0 is a high risk factor for the occurrence of pathological conditions in pregnancy, such as preeclampsia, GDM, gestational hypertension and IUGR.

Maximum women (44.6%) belonged to lower middle class, class III. In lower class, class V there were significantly more underweight and less obese women. It was observed that higher the socio economic class more was the BMI. The women who had received higher education and had higher family income chose to bear children at a later stage of their life and they were usually obese and overweight. In our study, obese women gained 8.70 ± 1.44 kgs weight, overweight 8.93 ± 1.55 kgs, while underweight gained 11.35 ± 5.0 kgs. These results were similar to those reported by Michlin R *et al.* [10] while they were not comparable with study done by Cadergren *et al.* [9]. The study by Cadergren *et al.* [9] was conducted in Sweden and the mean weight gain was more in all BMI categories and the prevalence of obesity is more in European countries due to sedentary life style they tend to gain more weight. According to the 2009 IOM/NRC guidelines the optimal weight gain for underweight is 12.7 – 18.1kgs and for obese it is 5 – 9.1kgs. Both extremes, excessive or inadequate gestational weight gain, can lead to adverse pregnancy outcomes.

The incidence of preeclampsia, gestational hypertension, GDM was higher in obese group which was similar to Crane JMG *et al.* [11]. The incidence of abortions was observed maximum in (group D) obese women 12.8%. In group A, B and C the incidence was 5.4%, 5.1% and 9.6% respectively. There were more abortions in higher BMI groups. This is probably because obese women are usually older in age and there oocytes are more susceptible to aneuploidy and chromosomal abnormalities leading to abortions. The number of induction of labour increased in obese women (34%). A high incidence of vaginal delivery 70.7% was observed in the present study, maximum vaginal deliveries were in group B (76.1%) followed by group A (75%), C (66.7%) and group D (38.3%). The incidence of vaginal delivery decreased with increasing BMI due to increased obstetric complications. The rate of c-section was 13.0%, 14.9% and 40.0% in underweight, overweight and obese women respectively. The results were comparable to the study conducted by Bhattacharya S *et al.* [12] 11.3%, 24.1% and 30.8% and Crane JMG *et al.* [11] 13.13%, 31.10% and 38.16% in underweight, overweight and obese women respectively. The c-section rates increased as BMI increased as there were more obstetric complications in obese subjects which lead to increased rates of c-section.

The incidence of instrumental deliveries, Perineal trauma and PPH was more in group D (obese). As compared to the study done by Bhattacharya S *et al.* [12] the incidence was less in all groups in the present study. This could be related to the more number of inductions in the studies done by Liu X *et al.* [13] and Bhattacharya S *et al.* [12]. Stringent anti obesity measures need to be implemented in women to prevent complications of obesity in reproductive years. The mean birth weight of neonate in normal BMI group (group B) was 2.85 ± 0.42 kgs,2.62 ± 0.55 kgs, 2.93 ± 0.36 kgs and 3.06 ± 0.38 kgs in group A, C and D respectively. The mean birth weight of neonate in the present study was less than the studies conducted by Crane JMG *et al.* [11] and Choi SK *et al.* [7] in all the groups. The mean birth weight of neonates is less in India as compared to the western countries as there were more underweight and less obese subjects in the present study.

Conclusion

The study has shown an association between maternal weight (underweight, overweight and obese) and pregnancy outcome. It is concluded that obesity is associated increased complications such as gestational diabetes, abortion and post-term pregnancies, also increased rates of inductions and operative delivery as the mean birth weight of neonate is more in obese women but no increased rates are observed in overweight women. Pre-eclampsia is prevalent in both overweight and obese women.

In underweight women the adverse outcomes observed were increased incidence of preterm deliveries and less mean birth weight of the neonate. The incidence of obesity has increased sharply in the past few years in India. All the pregnancies in obese women should be acknowledged as high risk and managed according to the guidelines. Management should include pre-pregnancy counseling to reduce weight.

References

1. Park K. Epidimiology of chronic non communicable disease and conditions in Park's Text Book of Preventive and Social Medicine. 21th ed Jabalpur: M/s Banarsidas Bhanot; 2011, 366-8.
2. Ronnenberg GA, Wang X, Xing H, Chen C, Chen D, Guang W *et al*. Low Preconceptional Body Mass Index is Associated with Birth Outcome in a Prospective Cohort of Chinese Women. J Nutr. 2003; 133:3449-55.
3. Arrowsmith S, Wray S, Quenby S. Maternal obesity and labor complications following induction of labor in prolonged pregnancy. Br J Obstet Gynaecol 2011; 118:578–88.
4. Addo VN. Body mass index, weight gain during pregnancy and obstetric outcomes. Ghana Med J. 2010; 44(2):64-9.
5. Islam A, Khan NA, Ehsan A. Complications of raised BMI in pregnancy. Professor Med J Sep. 2010; 17(3):498-504.
6. John J, Mahendran M. Maternal and fetal outcomes of obese pregnant women: a prospective cohort study. Int J Reprod Contracept Obstet Gynecol. 2017; 6(2):725-9.
7. Choi SK, Park IY, Shin JC. The effects of pre-pregnancy body mass index and gestational weight gain on perinatal outcomes in Korean women: a retrospective cohort study. Reprod Biol Endocrin 2011; 9:6.
8. Tharihalli C, Thathagari V. Study of correlation between maternal body mass index with maternal and perinatal outcome. Int J Reprod Contracept Obstet Gynecol. 2017: 6(1):164-7.
9. Cedergren M. Effects of gestational weight gain and body mass index on obstetric outcome in Sweden. Int J of Obstet Gynecol 2006; 93:269-74.
10. Michlin R, Oettinger M, Odeh M, Khoury S, Ophir E, Barak M. Maternal Obesity and Pregnancy Outcome. Isr Med Assoc J 2000; 2:10-3.
11. Crane JMG, White J, Murphy P, Burrage L, Hutchens D. The Effect of Gestational Weight Gain by Body Mass Index on Maternal and Neonatal Outcomes. J Obstet Gynecol Can 2009; 31(1):28-35.
12. Bhattacharya S, Campbell MD, Liston WA, Bhattacharya S. Effect of Body Mass Index on pregnancy outcomes in nulliparous women delivering singleton babies. BMC Public Health 2007; 7:168.
13. Liu X, Du J, Wang G, Chen Z, Wang W, Xi Q. Effect of pre-pregnancy body mass index on adverse pregnancy outcome in north of China. Arch Gynecol Obstet 2011; 283:65-70