International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor (2018): 7.426

Effect of BMI on Fetomaternal Outcome

Dr Nalini Anand[1], Dr Aditi Samdarshi Bhardwaj[2]

Abstract: ***Background & Objective: The maternal pre -pregnancy body mass index (BMI) and gestational weight gain (GWG) is known to affect birth weight but their separate and joint associations with complications of pregnancy and delivery are unclear. The increasing incidence of obesity among women worldwide1 has become one of the most significant public health concerns. High maternal body mass index (BMI) is related to adverse maternal pregnancy outcomes such as pre-eclampsia, eclampsia, Gestational diabetes mellitus (GDM),pre- and post-term delivery, induction of labour, macrosomia, caesarean section, and postpartum haemorrhage. While, low maternal body mass index is related to low birth weight baby, small for gestation, intrauterine growth restriction(IUGR) and high incidence of NICU admission.. In 1990, the Institute of Medicine of the National Academies in the United States suggested that maternal weight gain during pregnancy should be based on pre pregnancy BMI. In this study we aim to investigate the association of first trimester BMI and GWG with maternal and perinatal outcome. Methodology: The present one year cross sectional study was conducted in the Department of were enrolled in the study. In order to explore the relationship between maternal first trimester Body Mass Index, GWG and their association with maternal and perinatal Obstetrics and Gynaecology, Guru Gobind singh government hospital, Jamnagar . A total of 250pregnant women in first trimester of pregnancy outcomes, participants were categorized into three groups based on their first trimester Body Mass Index. The data was analysed using Chi-square tests. Differences were considered significant if p < 0.05. Results: Accounting for 56.2%. Primigravida and multigravida (43.8%) were equally distributed.56.28% patients of the study were in normal BMI group, 34.4% patients had gained ≤10 kg weight during her pregnancy period whereas rest had gained >10kg.In our study, 72.4% patients had vaginal delivery followed by 25.4% underwent caesarean section. In our study, 72.72% low BMI patients had gained ≤ 10 kg weight. Whereas, 27.27% gained >10 kg of weight during their pregnancy.15.79% patients of low BMI group had preterm deliveries and 90.8% of overweight BMI patients had term deliveries.Maximum patients of our study had vaginal deliveries as compared to caesarean section accounting 73.68% patients from Low BMI group. While caesarean section were maximum in overweight BMI group. In this study, 77.2% neonates had ≥2.5kg birth weight.22.8% of low BMI group mothers had low birth weight neonates. While 80.70% overweight mothers had >2.5 kg of birth weight neonates.Out of 250 patients 98 patients had maternal complications with incidence of preeclampsia[(20)] and GDM(14) were higher in overweight BMI group. 82 had perinatal complications. 3.6% neonates were IUGR, 2% neonates were macrosomia and 0.8% were IUFD. Maximum IUGR (30) found in normal BMI patients and most macrosomia(11) found in overweight BMI patients. Among 150 mothers, majority of patients were in age group of 20-24 years were overweight BMI group and 12.34% were low BMI group out of 150 patients. Conclusions: The present revealed that an increased maternal BMI is associated with increased risk of adverse obstetric and perinatal outcomes. These include increased risk of preeclampsia, GDM, fetal macrosomia. Low maternal BMI was associated with IUGR, low birth weight, still birth and preterm deliveries.***

Keywords: Body mass index (BMI), Gestational weight gain, Preeclampsia, Gestational diabetes, IUGR, Macrosomia, Stillbirth, Low birth weight

1. Introduction

Improving maternal and child health is one of the eight Millennium Development Goals.1 However, to date, there are still nearly one third of pregnancies being affected by some type of maternal and perinatal complications macrosomia, intra uterine growth restriction (IUGR) and preterm delivery.[2] Those pregnancy or delivery complications results in about 650 deaths each year 2 and over 40% of neonatal deaths[3,4] As pointed in 2009 by the Institute of Medicine (IOM) both excessive and inadequate Gestational Weight Gain(GWG)were responsible for complications during pregnancy and adverse birth outcomes, such as Hypertensive disorders of pregnancy, gestational diabetes mellitus(GDM), preterm delivery and perinatal mortality. Maternal age, and race, parity and pre-pregnancy BMI status were important predictors for predicting cumulative weight gain during pregnancy. Although a large body of literature suggested that GWG varied by maternal characteristics.A large body of data links a high pre-pregnancy BMI with a number of foetal and maternal complications, including foetal death, preeclampsia, gestational diabetes, macrosomia, and complicated deliveries.***Excessisive*** weight gain is associated with birth of a small-for-gestational age (SGA) infant[15,17,18] and preterm birth, whereas high weight is associated with greater risks of macrosomia1caesarean section, and excess postpartum weight retention.Maternal anthropometry differs across populations. Women belonging to ethnic groups characterized by a small size have been reported to gain less weight on average during pregnancy than larger women. In developing Asian countries, including India, women generally have a lower BMI and/or smaller gestational weight gain than in developed countries.

In 2009, the IOM released new guidelines for weight gain during pregnancy. (Table 1)

Table 2. Institute of Medicine (2009) guidelines on weight gain in pregnancy.

Pre-pregnancy weight class	Pre-pregnancy BMI (kg/m²)	Total weight gain range (kg; lbs)	Mean (range) rate of weight gain in second and third trimesters (lbs/week)*
Underweight	<18.5	12.7–18.1 (28–40)	1.0 (1.0–1.3)
Normal	18.5–24.9	11.3–15.9 (25–35)	1.0 (0.8–1.0)
Overweight	25.0–29.9	6.8–11.3 (15–25)	0.6 (0.5–0.7)
Obese (all classes)	≥30.0	5.0–9.1 (11–20)	0.5 (0.4–0.6)

*Assumes a first-trimester weight gain of 0.5–2.0 kg (1.1–4.4 lbs).

The 2009 committees established this recommendation refer to a large body of literatures; however, the appropriateness of this recommendation was still controversial. Specifically, the growth trajectories of GWG and its correlates were unclear and the associations with pregnancy outcomes needed more studies to evaluate and establish.

So far the literatures on the health impacts of GWG have mainly focused on gestational diabetes, birth weight, and its linkage with childhood obesity.[5,31,8,32, 33]Limited studies have investigated the relationship between GWG and maternal blood pressure changes during pregnancy, GDM and preterm delivery. However, as hypertensive disorder is the most common medical complication.Preterm delivery is the leading cause of perinatal morbidity and mortality, so it is critical to understand the role of GWG on those health outcomes.Because of insufficient studies this research aims to seek the relationship of maternal BMI, gestational weight gain and their association with maternal and perinatal outcomes.

2. Aims and Objectives

The primary objective of the present study was:To evaluate the relationship of first trimester maternal body mass index(BMI), gestational weight gain and their association with maternal and perinatal outcomes.To Compare different complications and their association with gestational weight gain and BMI of the patients.

3. Methodology

Type of Study: Cross sectional study

Statistical Method used:
The data collected during the study period is presented in the tabular form along with appropriate graphs and charts to draw meaningful observations and interpretations. The differences in statistical parameters for different outcomes of pregnant women were tested statistically using appropriate tests viz. Chi Square tests, t-test etc and the results are present with p values < 0.05 considered statistically significant.

BMI formula:
The BMI is equal to a person's weight divided by their height2. Itis calculated as-
BMI= (weight in kilograms/ Height in meters2)

Here we have merged overweight and obese BMI group for statistical analysis purpose

- Underweight BMI : < 18.5
- Normal BMI : 18.5 – 22.9
- Overweight BMI : >23

Inclusion Criteria

1) Singleton pregnancy
2) No pre-existing condition like HTN, DM, Cardiac disease.
3) Pat taking first antenatal visit before 20 weeks of gestation who gave consent with clear antenatal records with measures of interest.

Exclusion Criteria

1) Women with known medical disorders like HTN DM, Cardiac disorders
2) Pregnant women in whom vaginal delivery was contraindicated.
3) Women with multiple gestation and with foetuses with congenital anomalies.

All the pregnant women who satisfy the inclusion criteria were taken as subjects for the study after taking written informed consent from them. A complete history work up and examination was done for the patient.
Weight was measured in labour room on the admission of participants for delivery. Gestational weight gain was calculated from the duration of first trimester or first visit before20 weeks of gestation to the time of delivery.

Fetomaternal outcome was studied at the time of delivery along with the following lines-

1) Type of delivery: spontaneous/ induced/ instrumental/ caesarean
2) If induction of labour done then indication of induction
3) If C- section done than indication of C- section
4) Maternal complication
5) Information of the baby- gestational age, time and date of the birth, weight of the baby, resuscitation status, APGAR score at 1 and 5 minutes, mortality.

4. Results

This study was carried out at department of obstetrics and gynecology at G.G. G.Hospital ,Jamnagar. A total number of 250 women were included in this study were included in this and their perinatal outcomes were studied.

Table: Distribution of participants by age groups:

Age	Number	Percentage
<20 years	44	17.60%
20-24 years	162	64.80%
25-29 years	36	14.40%
>30 years	8	3.20%
Mean Age	22.16	
Standard Deviation	3.13	
Total	250	

In our study distribution of participants according to age groups is shown in above table. Majority of the patients were in age group of 20-24 years (64.8%) followed by 25-29 years (14.4%). The mean age was 22.16 ± 3.10.

Table: Distribution of participants by Gravida :

Gravida	Number of Patients	Percentage of patients
Primi Gravida	141	56.2%
Multi Gravida	109	43.8%
Total	250	100%

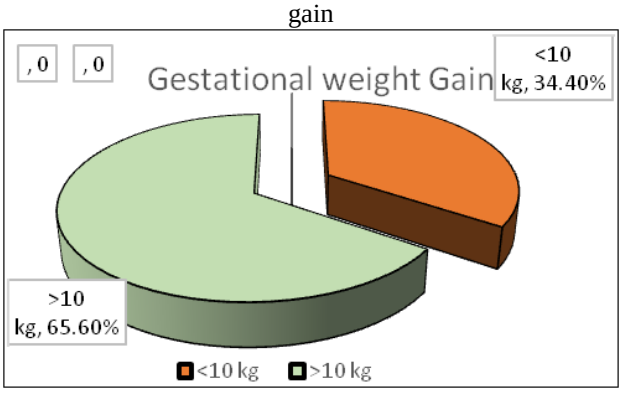
Taking gravida into consideration, we observed that there were almost equal numbering primigravida 141 (56.2%) and multigravida 109(43.8%%) in our study.

Table: Distribution of participants by BMI

BMI	Number of Patients	Percentage of patients
< 18.5	22	8.8%
18.5-22.9	171	68.4%
>23	57	22.8%
Total	250	

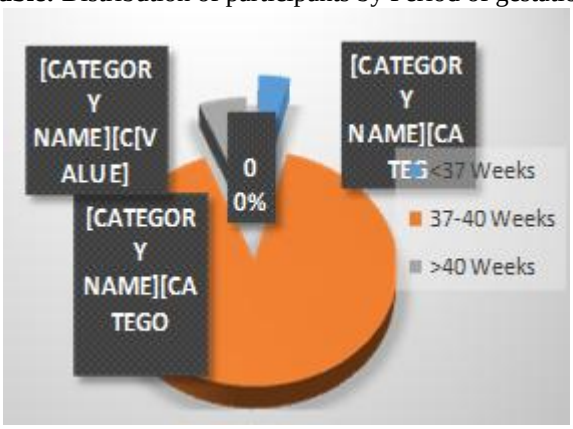
In our study, we noted that maximum number of women were in range between 18.5-22.9 BMI that is172 (68.8%) followed by 57(23%) patients having BMI >23 and 22(9%) patients having BMI <18.5.

Table: Distribution of participants by Gestational weight gain



In our study population around 34.4% i.e.86 participants had a weight gain of <10 kg and 164(65.6%) were having gestational weight gain ≥ 10kg. The mean weight gain was 11.02 ± 2.641 Kgs.

Table: Distribution of participants by Period of gestation

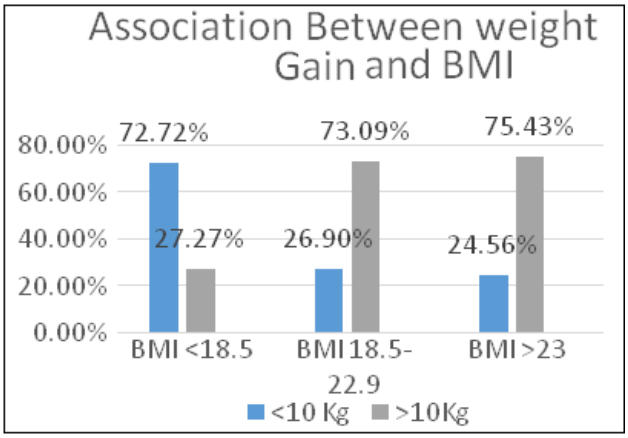


In our 250 patients, majority of the participants were having period of gestationbetween 37-40 weeks of period of gestation which constitute 225 (90.8%) patients.

Table: Distribution of participants by Mode of delivery:

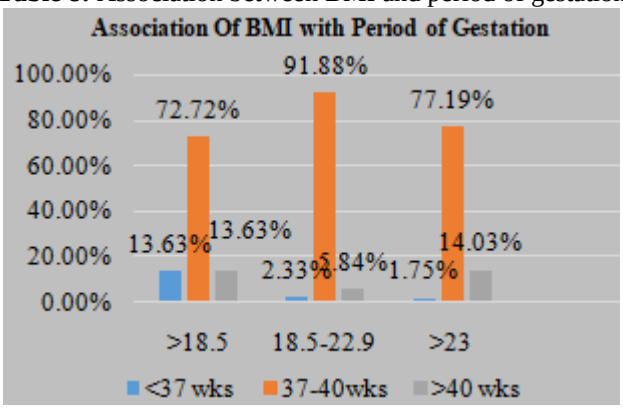
Mode Of Delivery	No Of Patients	Percentage Of Patients
Caesarean Emergency	41	16.3
Caesarean Elective	22	8.8
Vaginal Spontaneous	152	60.6
Vaginal Induced	27	10.8
Instrumental	08	3.2
Total	250	100

Taking mode of delivery into consideration, majority of the women had vaginal delivery, accounting to about 152 Spontaneous Vaginal Delivery(61%) followed by Emergency caesarean delivery in 41 (16.3%) and only 8(3.2%) women had an instrumental delivery.



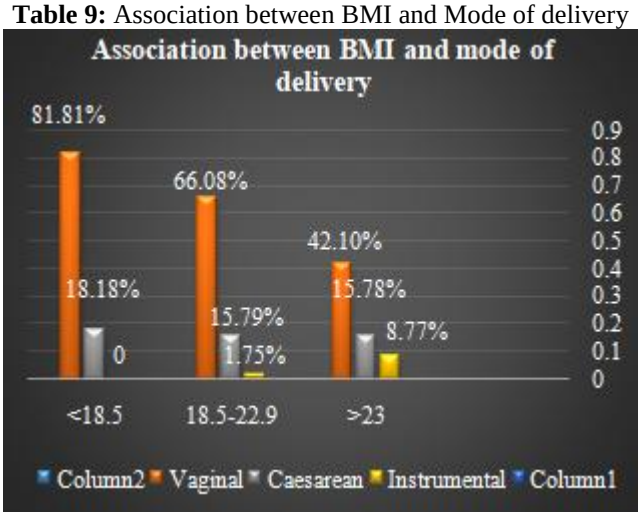
In our study of 250 patients, of the low BMI group i.e.>18.5, approximately 73% of the patients had gained less than 10 Kg weight, while in high BMI group 75% of the patients had gained >10 Kgs.

Table 8: Association between BMI and period of gestation



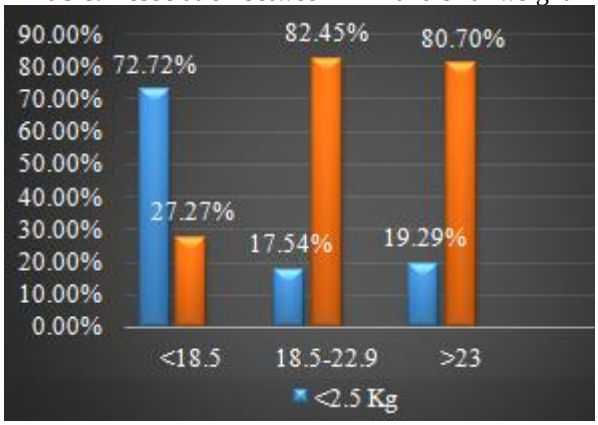
In our study we observed 3(13.63%) of low BMI mothers had preterm delivery. 44(77.19%) overweight BMI mothers had term delivery between 37-40 weeks of period of gestation. P value is 0.044 which is statistically significant. Out of 250 participants, majority of our participants had term delivery (90.8%).

Table 9: Association between BMI and Mode of delivery



When association between BMI and mode of delivery was taken into account, we Observed maximum mothers with low BMI (81.81%) had vaginal delivery. Similarly, 58(66.08%) patients with normal BMI also had vaginal delivery. Out of 57 Overweight BMI mothers, 29(42.10 %%) had vaginal and 20(15.78 %) had caesarean Delivery but it was not statistically significant. Minimal participants (8) were delivered by Instrumentation and most of these (62.5%) belonged to high BMI group.

Table: Association between BMI and birth weight



In our study we observed that, in 171 mothers with normal BMI, 138(80.70%) had neonatal birth weight ≥2.5kg and only 33(19.29%) mothers had neonatal birth weight <2.5kg. Out of 57 overweight and obese mothers, majority had neonatal birth weight ≥2.5kg that is 46 (80.70%) whereas not much difference in neonatal birth weight was noted in low BMI mothers. P value being statistically significant. (0.0001)

Table: Comparison of BMI groups with maternal complications:

Variables	<18.5	18.5-22.9	>23	Total
Pre-Eclampsia	2	11	12	25
GestationalHypertension	8	5	7	20
Anaemia	7	31	19	54
GDM/DM	1	0	7	8
Post Lscs Wound gap	1	0	3	4
Episiotomy Wound Gap	2	0	3	5
Infertility	1	0	5	6

When we compared BMI groups with maternal complication, we observed that 12. Mothers who were overweight BMI had preeclampsia.7 mothers with BMI>23 had GDM and mothers with anaemia and gestational hypertension belonged to varying BMI groups which is shown in above table. P value is significant for preeclampsia, GDM, wound Gap and Infertility. Thus, mothers who had more BMI had more risk of preeclampsia, GDM and wound gap.

Perinatal Outcomes: Among the neonatal complications, 9(3.6%) mothers had neonates which were IUGR, 5(2%) mothers had neonates with macrosomia.

Table: Comparison of BMI groups with neonatal complications :

Complications	<18.5	18.5-22.9	>23	Total
IUGR	4	3	2	9
Macrosomia	0	1	4	5
IUFD	1	0	1	2
Preterm Birth	3	4	1	8
Birth Asphyxia	0	1	2	3
RDS	1	0	1	2

When maternal BMI was compared with neonatal complications we found out that 3 mothers with normal BMI and 4 mothers with low BMI had IUGR neonates. Only 4 overweight BMI mothers had neonates with macrosomia. Also complications like birth asphyxia, RDS and IUFD were almost equally distributed amongst the three groups.

Table: Comparison of neonatal complications(IUGR and Macrosomia) with Gestational weight gain

Variables	<10Kg	>10 Kg	Total
IUGR	5	4	09
Macrosomia	0	5	05

Mothers with weight gain of <10kg had more IUGR (12). Similarly, mothers with gestational weight gain of ≥10kg had more number of macrosomia (3). P value being statistically significant.

5. Discussion

In present study of 250 women, we studied association between first trimester maternal BMI and gestational weight gain with maternal and perinatal outcomes.

In our study the participant age ranged from 17-38 years, the maximum number of patients that is 64.8% were in age group of 20-24 years, followed by 14.4% participants below 30 years and 3.2%% above 30years. The mean age was 22.16. This is almost similar to study done by Anjana et al in 784 participants in 2012 which showed maximum number of participants in age group 18-35years48. We observed that number of primipara 56.2% and multigravida 43.8% were almost same in our study participants. Studies done by Shuchi et al and Daise et al included only participants who were primigravida.[37,143].

In the present study, we noted that maximum number of participants had a normal BMI range that is 68.4% followed by 22.8% participants having BMI>23 and 8.8% participants having BMI <18.50. This was in accordance with Anjana et al in which 52% had normal BMI range followed by overweight BMI.

Similarly study done by S.Bhattacharya et al in 241 participants had 58% with normal BMI followed by overweight BMI (22%). However, study by Sawant et al in 110 participants observed more number of Low BMI participants(49%) as compared to normal and high BMI group.

In our study of 250 participants, majority of mothers gained weight of ≥10kg which constitute 65.6% as compared to only 86(34.4%) participants who hadweightgainof<10kg.

In this study, period of gestation was term in maximum number of participants that is 90.8% followed by 6% had period of gestation more than 40 weeks and 3.2% participants had period of gestation <37weeks.However, this was in sharp contrast with Caughey AB et al who reported more number of participants beyond 40weeks of gestation in 2004.59 Results of our study show higher rates of vaginal delivery that is 72% followed by caesarean delivery in 24.8% participants and only 3.2% instrumental delivery. Similar finding was noted by Sahu et al conducted in 380 women in 2007 having 38% caesarean delivery and 2 % by instrumental delivery. Other studies by Pevzner et al, Jain et al,Anjana et al also had similar observation.[72,49,50] In our study we found majority of the participants with low BMI who where having gestational weight gain≤10kg that is 72.72% and 75.43% participants with overweight BMI had a weight gain >10kg. There was significant correlation between low BMI group and weight gain. P value being statistically significant.(p=0.0011)Similar observation was noted by EA Nohr et al and Nan Li et al in 2009 showing significant association between gestational weight gain and BMI.[19,145]

When we compared BMI with period of gestation, we observed that 37.5% participants of low BMI group had preterm delivery. P value being statistically significant in low BMI group.Similar findings was noted by Sahu et al that is 3.9% of preterm delivery in low BMI group and by Ehrenberg et al in low BMI group.[72,146] It has also been shown that overweight BMI women have poor uterine contractility and poor response to oxytocin infusion.

We observed 81.81% of low BMI participants had vaginal delivery followed by normal BMI group. Minimal participants were delivered by Instrumentation, but most of them belonged to high BMI group. Similar findings was noted in study by Sahu et al that 50% patients from obese underwent caesarean section and Jain P et al had 63% patients from obese who underwent caesarean section.[72,]Increased maternal BMI did not increase the risk preterm or postdate delivery in this study. These findings were in contrast, Bhattacharya et al in 2007 found a two fold increase in preterm labour in the overweight patients.[145]When association between maternal BMI and neonatal birth weight was seen, we observed that 59.09% of participants with low BMI delivered low birth weight neonates and 80.07% of participants with overweight BMI delivered neonates of ≥2.5kg. P value being statistically significant. In prospective study by Jain et al, low birth weight babies were present in 80% of underweight patients 49 and similar observation was obtained in study by Sebire et al, Sahu et al and Bhattacharya et al.[16,72,145]

In our study of 250 participants, significant maternal complication as outcomes were noted. When we tried to compare BMI groups with maternal complications, mothers with high BMI had more risk of preeclampsia, GDM in our study, also those with normal BMI had lesser extent risk of preeclampsia, GDM. Similar findings was studied by Bhattacharya et al that found a 3 times higher risk of pre-eclampsia in obese and a 7 times higher risk in morbidly obese group145.In our study we found no significant relation between anaemia and gestational hypertension with any BMI group. However, Sahu et al observed that underweight women were prone to anaemia whereas the obese women had a tendency to develop GDM and Hypertensive disorders. When an attempt was made to compare BMI groups with neonatal complication in our study, we found out that mothers with normal and low BMI had more incidence of IUGR(p=0.0001) as compared to high BMI. A study by Ehrenberg et al also showed higher incidence of IUGR in normal and low BMI as compared to high BMI group146. This is in contrast to findings by Bhattacharya et al,Sahu et al and Daise et al who found no specific relation between IUGR and any BMI group[145,72,143.] Also increased maternal BMI was shown to increase the risk of having neonatal macrosomia (p=0.0001) in our study. Similar was noted by Ehrenberg et al and Kabiru et al[146,53]. In prospective study by Jain et al, macrosomia was only present in the overweight and obese category[49].In our study, when we compared gestational weight gain with neonatal complication, we observed that mothers with weight gain of ≤10kg had more IUGR ,i.e 5 out of 9 (p=0.0001) and mothers with gestational weight gain of >10kg had more macrosomia(100%) (p=0.0001). P value being statistically significant.

6. Summary and Conclusions

The present study of 250 participants titled Majority of participants were in age group of 20-24 years accounting for 64.8%.In our study, primigravida (56.2%) and multigravida (43.8%) were equally distributed.68.4% participants of the study were in normal BMI group followed by overweight BMI group (22.8%) and 8.8% in low BMI group.Out of 250 participants 65.6% were gained ≥ 10 kg weight during their pregnancy period whereas the remaining participants 34.4% had gained <10kg.In our study, maximum participants that is 90.8% had term delivery followed by 6% with postdates and 3.2% had preterm delivery. In our study, 71.4% participants had vaginal delivery followed by 25.1% participants underwent caesarean section. Instrumental deliveries were minimal in our study i.e. 3.2%.In our study, 13.63% low BMI participants had gained ≤10 kg weight. Whereas, 75.43% gained >10 kg of weight during their pregnancy. In our study, 15.79% participants of low BMI group had preterm deliveries and 91.22% of overweight BMI participants had term deliveries. Maximum participants of our study had vaginal deliveries as compared to caesarean section. In this study, 77.2% neonates had ≥2.5kg birth weight.59.09% of low BMI group mothers had low birth weight neonates. While 80.07% overweight mothers had ≥2.5 kg of birth weight neonates. Out of 250 participants, 123 had maternal complications. Incidence of preeclampsia (25) and GDM/DM (8) were higher in overweight BMI group. Out of 250 neonates 14 had perinatal complications. 3.6% neonates were IUGR, 2% neonates had macrosomia. Maximum IUGR (4) found in low BMI patients and all macrosomia (4) found in overweight BMI patients.

Our study shows that both extremes of maternal BMI are associated with adverse obstetrics and perinatal outcomes. Hence, ideally women in the reproductive age group should be motivated to attain the prescribed BMI prior to conception and this can be possible with appropriate preconceptional counselling and a multidisciplinary approach to incorporate the required life style changes and dietary modification. The limitation of present study was its relatively smaller sample size but a similar study with a larger number of participants can be carried out to affirm our findings.

References

[1] Hogan, M. C., K. J. Foreman, M. Naghavi, S. Y. Ahn, M. Wang, S. M. Makela. Maternal mortality for 181 countries, 1980–2008: a systematic analysis of progress towards Millennium Development Goal 5.The Lancet 2010;375(9726): 1609-1623.

[2] Berg, C. J., W. M. Callaghan, C. Syverson and Z. Henderson, Pregnancy-related mortality in the United States, 1998 to 2005. Obstetrics & Gynaecology 2010; 116(6): 1302-1309.

[3] Heron, M., Deaths: leading causes for 2008. National vital statistics reports: from the Centres for Disease Control and Prevention, National Centre for Health Statistics, National Vital Statistics System 2010; 60(6): 1-94.

[4] Martin, J. A., B. E. Hamilton, S. J. Ventura, M. J. Osterman and T. Mathews. Births: final data for 2011. National Vital Statistics Report 2013; 62(1): 1-90.

[5] Abrams, B., V. Newman, T. Key and J. Parker. Maternal weight gain and preterm delivery.ObstetGynecol 1989; 74(4): 577-583.

[6] Crane, J. M., J. White, P. Murphy, L. Burrage and D. Hutchens. The effect of gestational weight gain by body mass index on maternal and neonatal outcomes.J ObstetGynaecol 2009; Can 31(1): 28-35.

[7] Gaillard, R., E. A. Steegers, A. Hofman and V. W. Jaddoe. Associations of maternal obesity with blood pressure and the risks of gestational hypertensive disorders.The Generation R Study.J Hypertens 2011; 29(5): 937-944.

[8] Abrams, B. and S. Selvin. Maternal weight gain pattern and birth weight.ObstetGynecol 1995; 86(2): 163-169.

[9] Hickey, C. A., S. P. Cliver, S. F. McNeal, H. J. Hoffman and R. L. Goldenberg. Prenatal weight gain patterns and birth weight among non-obese black and white women. ObstetGynecol 1995; 88(4 Pt 1): 490-496.

[10] Institute of Medicine (IOM) and National Research Council (NRC). Weight Gain During Pregnancy: Reexamining the Guidelines. Washington, DC, The NationalAcademies Press; 2009.

[11] Nohr, E. A., M. Vaeth, J. L. Baker, T. I. Sorensen, J. Olsen and K. M. Rasmussen.Pregnancy outcomes related to gestational weight gain in women defined by their body mass index, parity, height, and smoking status. Am J ClinNutr 2009; 90(5): 1288-1294.

[12] Bodnar, L. M., J. A. Hutcheon, R. W. Platt, K. P. Himes, H. N. Simhan and B. Abrams. Should gestational weight gain recommendations be tailored by maternal characteristics? Am J Epidemiol 2011; 174(2): 136-146.

[13] Baeten JM, Bukusi EA, Lambe M. Pregnancy complications and outcomes among overweight and obese nulliparous women. Am J Public Health 2001; 91:436–40.

[14] Cedergren MI. Maternal morbid obesity and the risk of adverse pregnancy outcome.ObstetGynecol 2004; 103:219 –24.

[15] Cnattingius S, Bergstrom R, Lipworth L, Kramer MS. Prepregnancy weight and the risk of adverse pregnancy outcomes. N Engl J Med 1998; 338:147–52.

[16] Sebire NJ, Jolly M, Harris JP, et al. Maternal obesity and pregnancy outcome: a study of 287,213 pregnancies in London. Int J ObesRelatMetabDisord 2001; 25:1175– 82.

[17] Cogswell ME, Serdula MK, Hungerford DW, Yip R. Gestational weight gain among average-weight and overweight women—what is excessive? Am J ObstetGynecol 1995; 172:705– 12.

[18] Stotland NE, Cheng YW, Hopkins LM, Caughey AB. Gestational weight gain and adverse neonatal outcome among term infants. ObstetGynecol 2006; 108:635–43.

[19] Nohr EA, Bech BH, Vaeth M, Rasmussen KM, Henriksen TB, Olsen J. Obesity, gestational weight gain and preterm birth: a study within the Danish

National Birth Cohort. PaediatrPerinatEpidemiol 2007; 21:5– 14.
[20] Stotland NE, Caughey AB, Lahiff M, Abrams B. Weight gain and spontaneous preterm birth: the role of race or ethnicity and previous preterm birth. ObstetGynecol 2006; 108:1448 –55.
[21] Zhou W, Olsen J. Gestational weight gain as a predictor of birth and placenta weight according to pre-pregnancy body mass index. Acta Obstet Gynecol Scand 1997; 76:300 –7.
[22] Witter FR, Caulfield LE, Stoltzfus RJ. Influence of maternal anthropometric status and birth weight on the risk of caesarean delivery. ObstetGynecol 1995; 85:947–51.
[23] Young TK, Woodmansee B. Factors that are associated with caesarean delivery in a large private practice: the importance of prepregnancy body mass index and weight gain. Am J ObstetGynecol 2002; 187:312– 8.
[24] Muscati SK, Gray-Donald K, Koski KG. Timing of weight gain during pregnancy: promoting fetal growth and minimizing maternal weight retention. Int J ObesRelatMetabDisord 1996; 20:526 –32.
[25] Ohlin A, Rossner S. Maternal body weight development after pregnancy. Int J Obes 1990; 14:159 –73.
[26] Olson CM, Strawderman MS, Hinton PS, Pearson TA. Gestational weight gain and postpartum behaviors associated with weight change from early pregnancy to postpartum. Int J ObesRelatMetabDisord 2003; 27:117–27.
[27] World Health Organization. Meeting to develop a global consensus on preconception care to reduce maternal and childhood mortality and morbidity Geneva, World Health Organization. 2012.
[28] Ota E, Haruna M, Suzuki M, DucAnh D, Tho LH, Thanh Tam NT, Thiem VD, HienAnh NT, Isozaki M, Shibuya K, Ariyoshi K, Murashima S, Moriuchi H, Yanai H: Maternal body mass index and gestational weight gain and their association with perinatal outcomes in Viet Nam. Bull World Health Organ 2011; 89(2):127-136.
[29] Carmichael, S., B. Abrams and S. Selvin. The pattern of maternal weight gain in women with good pregnancy outcomes.American Journal of Public Health1997; 87(12): 1984-1988.
[30] Yaktine, A. L. and K. M. Rasmussen. Weight Gain During Pregnancy: Reexamining the Guidelines, National Academies Press; 2009.
[31] Hediger, M. L., T. O. Scholl, D. H. Belsky, I. G. Ances and R. W. Salmon. Patterns of weight gain in adolescent pregnancy: effects on birth weight and preterm delivery. ObstetGynecol 1989; 74(1): 6-12.
[32] Viswanathan, M., A. M. Siega-Riz, M. K. Moos, A. Deierlein, S. Mumford, J. Knaack. Outcomes of maternal weight gain. Evid Rep Technol Assess (FullRep) 2012; (168): 1-223.
[33] Magriples, U., M. H. Boynton, T. S. Kershaw, K. O. Duffany, S. S. Rising and J. R. Ickovics. Blood pressure changes during pregnancy: impact of race, body mass index, and weight gain. Am J Perinatol 2013; 30(5): 415-424.
[34] Peters, R. M. and J. M. Flack. Hypertensive disorders of pregnancy. J ObstetGynecol Neonatal Nurs 2004; 33(2): 209-220.
[35] Steegers, E. A., P. von Dadelszen, J. J. Duvekot and R. Pijnenborg. Preeclampsia. Lancet 2010; 376(9741): 631-644.
[36] Luton, D., A. Forestier, S. Courau and P. F. Ceccaldi. Preconception care in France.Int J GynaecolObstet; 2014.
[37] Shuchi, L., Asha A., and Gurcharan K. To assess the effect of maternal BMI on obstetrical outcome.Int J Advancements in research & technology; 2012.
[38] James WP. WHO recognition of the global obesity epidemic.Int J Obes(Lond) 2008; 32 Suppl 7:S120-6.
[39] Haslam DW, James WP. Obesity. Lancet 2005; 366:1197-1209.
[40] Eknoyan, Garabed. Adolphe Quetelet (1796-1874) – The average man and indices of obesity. Nephrol Dial Transplant 2008; 23(1):47-51.
[41] Department of Health and Human Services for disease control and prevention, CDC. BMI, considerations for health practitioners 2009; 1 -3.
[42] Institute Of Medicine of the National Academies. Weight gain during pregnancy.Reexamining the guidelines.2009; 1:2.
[43] Lashen H., Fear K.., Sturdee DW. Obesity associated with increased risk of first trimester and recurrent miscarriages. Hum Reprod 2004; 19: 1644-1646.
[44] Waller DK, Mills JL, Simpson JL, Cunningham JC Et Al. Are obese women at higher risk of producing malformed offspring? AJOG 1995; 172: 243-247.
[45] Cedergren MI, Kallen B. Maternal obesity and infant heart defects. Obes Res 2003; 11:1065-71
[46] Weiss J. Et Al. Obesity, obstetric complications and caesarean delivery rates, a population based screening study, AJOG 2004; 103: 1091-7.
[47] Usha KT, Hemmadi S, Bethel J, Evans J. Outcome of pregnancy in a woman with increased body mass index. BJOG, 2005; 112: 768-772.
[48] Anjana Verma and LalitShrimali Index Maternal Body Mass and Pregnancy Outcome J Clin Diagnosis Res. 2012; 6(9): 1531–1533.
[49] Jain Deepika, KhutetaRakesh., Effect of Body Mass Index on Pregnancy Outcomes in Nulliparous women Delivering Singleton Babies: Observational Study The Journal of Obstetrics and Gynecology of India. 2012; 62(4):429–431.
[50] Jain P., Joshi, T. &Kural, M.R., "relation of early pregnancy BMI with maternal and fetal outcome: A Prospective study, Int journal of science and nature. 2013; 4(4):642-645.