"A STUDY OF FIRST TRIMESTER MATERNAL BODY MASS INDEX AND GESTATIONAL WEIGHT GAIN AND THEIR ASSOCIATION WITH MATERNAL AND PERINATAL OUTCOMES"

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This is to certify that the dissertation entitled "**A STUDY OF FIRST TRIMESTER MATERNAL BODY MASS INDEX AND GESTATIONAL WEIGHT GAIN AND THEIR ASSOCIATION WITH MATERNAL AND PERINATAL OUTCOMES**" is a bonafide research work done by **REG NO: BJ0114004**

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LIST OF ABBREVIATIONS USED

GWG- Gestational Weight Gain

BMI- Body Mass Index

PIH- Pregnancy-Induced Hypertension

GDM- Gestational Diabetes Mellitus

IUGR- Intra Uterine Growth Restriction

IOM- Institute of Medicine

SGA- Small-For-Gestational Age

WHO- World Health Organization

HIV- Human Immunodeficiency Virus

NICU- Neonatal Intensive Care Unit

LMP- Last Menstrual Period

EDD- Expected Date of Delivery

ABSTRACT

Background & Objective

The maternal prepregnancy 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 worldwide[1] 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 prepregnancy 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 Obstetrics and Gynaecology, KLE's Dr Prabhakar Kore Charitable Hospital, and Medical Research Centre, Belagavi. A total of 462 pregnant women in 1st trimester 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

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

Among 462 mothers, majority of patients were in age group of 20-29 years accounting for 88.32%. Primigravida (49.13%) and multigravida (50.87%) were equally distributed.56.28% patients of the study were in normal BMI group, 31.39% were overweight BMI group and 12.34% were low BMI group.Out of 462 patients 68.61% patients had gained ≤10 kg weight during her pregnancy period whereas rest had gained >10kg.In our study, 67.32% patients had vaginal delivery followed by 31.82% underwent caesarean section. In our study, 82.46% low BMI patients had gained ≤ 10 kg weight. Whereas, 42.07% gained >10 kg of weight during their pregnancy.15.79% patients of low BMI group had preterm deliveries and 81.38% 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 weremaximum in overweight BMI group. In this study, 78.35% neonates had ≥2.5kg birth weight.43.86% of low BMI group mothers had low birth weight neonates. While 86.21% overweight mothers had >2.5 kg of birth weight neonates.Out of 462 patients 98 patients had maternal complications with incidence of preeclampsia(20) and GDM(14) were higher in overweight BMI group. 82 had perinatal complications. 14.72% neonates were IUGR, 2.38% neonates were macrosomia and 0.65% were stillbirth. Maximum IUGR (30) found in normal BMI patients and all macrosomia(11) found in overweight BMI 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.

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Chapter 1

Introduction

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 such as Pregnancy-Induced Hypertension (PIH), Gestational diabetes mellitus, 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 duringpregnancy and adverse birth outcomes, such as Pregnancy induced-hypertension, gestational diabetes mellitus(GDM), preterm delivery and perinatal mortality.[5,6,7] Maternal age, and race, parity and pre-pregnancy BMI status were important predictors for predicting cumulative weight gain during pregnancy.[8,9,10,11] Although a large body of literature suggested that GWG varied by maternal characteristics. A recent published article by Lisa et al [12] revealed the role of GWG with different maternal characteristics on pregnancy outcomes and identified no differences. The uncertain effects of maternal characteristics on GWG were also mentioned in 2009 IOM guidelines, that the committees suggested calling for more studies to fulfill the research gap in detailing the interacted effects between maternal characteristics and the trajectory of GWG on health outcomes.[10] A large body of data links a high pre-pregnancy BMI with a number of fetal and maternal complications, including fetal death, preeclampsia, gestational diabetes, macrosomia, and complicated deliveries.[13,14,15,16] Low

weight gain is associated with birth of a small-for-gestational age (SGA) infant[15,17,18] and preterm birth,[19,20] whereas high gain is associated with greater risks of macrosomia,[17,18,21]caesarean section,[22,23] and excess postpartum weight retention.[24,25,26]

Maternal anthropometry differs across populations.[27] 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 USA 2% of pregnant women have a BMI <18.5 and more than 50% have a BMI >25[28]. There is a need to assess whether the current anthropometric recommendations for pregnant women of the United States National Academy of Sciences Institute of Medicine, which are based on the data of western countries, are appropriate for preventing adverse pregnancy outcomes across populations everywhere, including India. According to new guidelines of GWG published by the Institute of Medicine (IOM) in 1990, a gain of 12.5-18 kg, 11.5-16 kg, and 7.0-11.5 kg is recommended for pregnant women who have a low pre-pregnancy BMI (i.e., <19.8), normal pre-pregnancy BMI (i.e., 19.8-26.0), and high pre-pregnancy BMI (i.e., >26.0-29.0), respectively (National Research Council 1970). The appropriateness of this recommendation was supported by many studies in the almost 10 years since it was published, such as women who gained weight within this IOM's recommendations experienced better birth outcomes than women who did not.[29] In 2009, the IOM released new guidelines for weight gain during pregnancy. (Table 1)

Table 1 New recommendations for total and rate of weight gain during pregnancy, by prepregnancy BMI

Prepregnancy BMI	Total Weight Gain		Rates of Weight Gain† 2nd and 3rd Trimester	
	Range in kg	Range in lbs	Mean (range) in kg/week	Mean (range) in lbs/week
Underweight (< 18.5 kg/m^2)	12.5–18.0	28.0–40.0	0.5 (0.4–0.6)	1.0 (1.0–1.3)
Normal weight (18.5–24.9 kg/m^2)	11.5–16.0	25.0–35.0	0.4 (0.4–0.5)	1.0 (0.8–1.0)
Overweight (25.0–29.9 kg/m^2)	7.0–11.5	15.0–25.0	0.3 (0.2–0.3)	0.6 (0.5–0.7)
Obese (≥ 30.0 kg/m^2)	5.0–9.0	11.0–20.0	0.2 (0.2–0.3)	0.5 (0.4–0.6)

†Calculations assume a 0.5–2 kg (1.1–4.4 lbs) weight gain in the first trimester
Source: *Weight Gain During Pregnancy: Reexamining the Guidelines*, K.M. Rasmussen and A.L. Yaktine, Editors. 2009: Washington (DC).

The new recommendation changed in two ways from 1990's recommendation. First, the cut off points for the BMI categories were set based on World Health Organization (WHO)'s cut off points (i.e., underweight [<18.5], normal weight [18.5–24.9], overweight [25.0–29.9], and obese [≥30]). Second, upper limit was added for obese women. In terms of the trajectory, weight gain follows a sigmoidal growth with low rate in first trimester and increased rate in second and third trimester.[30] 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 PIH is the most common medical complication of

pregnancy and preterm delivery is the leading cause of perinatal morbidity and mortality, [34,35,36] 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.

Chapter 2

Aims and Objectives

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.

Chapter 3

Review of Literature

REVIEW OF LITERATURE

Body Mass Index

WHO describes obesity as "One of the most blatantly visible, yet most neglected, public health problems that threaten to overwhelm both more and less developed countries".[37] Obesity is a major public health issue and as per WHO, it is a "killer disease" at par with HIV and malnutrition. Even in countries like India, significant proportion of overweight and obese coexist with the malnourished. Lifestyle modifications over the years have led to a more sedentary lifestyle. This is a global concern[38], as excess bodyweight is now the sixth important risk factor contributing to disease worldwide and increase level of obesity may result in a decline in the life expectancy in the future.[39]

The Body Mass Index or Quetelet Index, is a heuristic proxy for human body fat based on an individual's weight and height. It was devised between 1830 and 1850 by the Belgian polymath adolphe Quetelet during the course of developing "social physics".[40]

Body Mass Index has become in recent times an accepted measure of weight. Other measure that have been used include waist hip ratio which have been shown to be a more accurate measure but such data is seldom available, waist circumference and absolute body weight. BMI doesn't actually measure body fat. It is commonly used to diagnose weight problems in a population but is not appropriate for individual diagnosis.[41]

The revised 2009 IOM guidelines classify the population into underweight, normal weight, overweight, obese and morbidly obese depending on the BMI.[42]

Fetal risks associated with high BMI include recurrent first trimester abortions despite normal endometrial receptivity,[43]increased birth defects including neural tube defects, cardiac anomalies, omphalocele, cleft lip and palate.[44]This has been hypothesized to result from undetected type 2 diabetes in early pregnancy. In addition, high BMI is associated with fetal macrosomia resulting in adverse maternal outcomes from interventions such as induction of labour, caesarean section and adverse neonatal outcomes from shoulder dystocia such as nerve palsies.[45] High BMI has also been associated with fetal distress with resultant increase risk of fetal meconium aspiration, still birth and early neonatal death.[45,46]

Maternal risks of increased BMI have been observed in antepartum, intrapartum and postpartum period. Antenatal risk include increase risk of hypertensive disorders including preeclampsia, eclampsia and gestational diabetes.[47]

Anjana et al in 2012, has shown in her study that overweight and the obese women had a higher risk for PIH, GDM and large for gestational age baby[48]. Jain Deepika et al in 2012 has also shown in her study that increasing BMI is associated with increased incidence of caesarean delivery, PIH, postpartum haemorrhage and macrosomic baby.[49] Jain P. et al in 2013 has shown that PIH is significantly associated with increasing maternal obesity. She also spotted that with the increasing maternal obesity the risk of developing GDM and macrosomia increases.[50]

Intrapartum risk include increased risk induction of labour, caesarean section, failed instrumental delivery, increased perineal tears and postpartum haemorrhage.[51,52]

Kabiru et al 2004 in a retrospective analysis of 5131 singleton pregnancies over a period of three years, found that high early pregnancy BMI and increase in the BMI during pregnancy was associated with significantly increased caesarean rates.[53]

In the postpartum period, high BMI has been associated with increased risk of post caesarean infection and morbidity despite use of prophylactic antibiotics. Long term risk include retention of weight.

Neonatal outcomes include large for gestational age, small for gestational age, macrosomia,respiratory distress syndrome, prematurity.

Scott Pillai et al 2004 reported a higher rate of NICU admissions and still births in neonates of obese female.[54]Vasudha S et al has shown that maternal BMI has an effect on fetal outcome. Low BMI is associated with adverse perinatal outcome in terms of low birth weight. While high BMI is associated in terms of overweight and macrosomia.[55]

Maternal risk of low BMI in antenatal period include, preeclampsia, anaemia while intrapartum period include preterm delivery.

Neonatal risk of low BMI include low birth weight, IUGR, stillbirth.

Jain Deepika et al shown that low birth weight was more common in underweight women compared to the women with normal BMI.[49] Anjana et al has shown that small for gestational age babies were more in the underweight group.[48]

Gestational weight gain (GWG)

Recommendations for GWG

The amount of weight gained during pregnancy, which is attributed by the expansion of maternal tissues, fetal and placental growth and amniotic fluid accumulation[56], can largely affect the immediate and future health of a woman and her infant.In Western countries, 28% women are overweight and 11% are in obese category[57]. There is limited data on Indian population and also there are drastic rural and urban variation in lifestyle, dietary habits and socio economics status. During the first half of the last century, American obstetricians restricted weight gain during pregnancy to prevent toxaemia, difficult births, and maternalobesity.[58,59,60] The recommendation was challenged in the 1960s, when experts began to recognize that the relatively high rates of infant mortality, disability, and mental retardation seen in the U.S. were a function of low birth weight.[61] In the 1970s, with scientific evidence supporting that the usual practice of restricting maternal weight gain was associated with increased risk of low birth weight, the recommended amount of weight gain was lifted again.[58] As the result, in the following years, there was an average increase of three kilograms and 150 grams on pregnancy weight gain and infant birth weight, respectively.[62]

However, with lifestyle changed in the past 20 years, obesity has emerged as pandemic in both developed and developing countries. In country like India due to extreme socioeconomics distribution the obesity and underweight populations are both prevalent.

For instance, in 1995 over 50% of the U.S. adult population were overweight or obese. Now the prevalence of excessive weight (i.e. BMI≥25 kg/m2) has risen to

approximate 70%.[63]Accompanying with the obesity epidemic, more than half of womengained excessive weight during pregnancy.[61, 64] As the result, women become more at risk for developing pregnancy complications and led to increased morbidity in the year after childbearing life events.[10]

Thus, in 2009, the IOM released new guidelines for weight gain during pregnancy. (Table 1) In terms of the trajectory, weight gain follows a sigmoidal growth with low rate in first trimester and increased rate in second and third trimester.[30]

Trajectory of GWG

The trajectory of GWG depicts dynamic weight changes during pregnancy. It is well-accepted that the best way to describe this process is to collect series weight gain data by weighing all pregnant women in a representative community at frequent intervals from their conception till delivery.[65]With statistical analytical approachdeveloping in the last decades, the result was available from relatively small samples with less data. Dawes et al in 1991 and Abrams et al in 1995 and 1996 described that weight did not increase linearly and reported a wide variation of GWG was seen in women with different characteristics.[66, 8]Carmichael et al in 1997 describes the pattern of GWG in women with good pregnancy outcomes and found that in each trimester weight gain varied by BMI category andexceeded IOM guidelines in all groups.[29] Although these earlier studies often named their measurement of GWG as pattern, most of them described trimesters' changes. Then, in the following years, studies started to use repeated measurements in regression models to predict the mean changes of weight gain during pregnancy,[67] which illustrated a true growth trajectory of GWG. In 2013, Hutcheon et al proposed a z-score chart for assessing GWG in pregnancy.[68]This

method, on one hand, accounted for the nonlinear shape of growth trajectories throughoutgestation, and on the other hand, by using z-score and percentiles rather than ratio, itmade less bias and solved difficulties in interpretations due to nonlinearity,because of their statistical characteristic.[69]In conclusion, to date, GWG was generated as a sigmoidal growth with relatively low rate at first trimester and fast rate at second and third trimester.[10]

Correlates of the trajectories of GWG

Maternal age, and race, parity and prepregnancy BMI status were important predictors for predicting cumulative weight gain during pregnancy.[8, 9, 10,11] In the Abrams et al study, older womenwere reported to gain more weight during the first trimester and less during the second and third.[8] Hispanic women gained faster during the second trimester than other racial groups. In the Hicker et al study, they reported a higher increase in weight in the first trimester and lower increase in the second trimester among non-Hispanic BlackAmericans.[9] This finding was also reflected in the Misar et al study, that African-Americans have higher rate of weight gain from preconception period to 16-20weeks gestation than Non-African-Americans.[70] In second and third trimester, nulliparous mother were more likely to gain excessive weight than multiparous mothers, while cigarette smokers gained less than non-smokers.[8, 71]

Although a large body of literature suggested that GWG varied by maternal characteristics, a recent published article by Lisa et al revealed no relation of GWG guidelines by those characteristics.[12]Theyexamined the role of GWG with different maternal characteristics on pregnancy outcomes and identified no differences. Sahu et al study, also stated that there is no significant relation of GWG with

maternaldemographic characteristics.[72] The uncertain effects of maternal characteristics on GWG were also mentioned in 2009 IOM guidelines, that the committees suggested calling for more studies to fullfill the research gap in detailing theinteracted effects between maternal characteristics and the trajectory of GWG on healthoutcomes.[10]

Pregnancy complications

Hypertensive disorders

In 2000, the National High Blood Pressure Education Program Working Group on High Blood Pressure in Pregnancy defined four categories of hypertension in pregnancy: Chronic hypertension,gestational hypertension, preeclampsia, and preeclampsia superimposed on chronic hypertension.[73,74]Chronic hypertension is defined as a blood pressure measurementelevated to or above 140/90 mmHg on two occasions before 20 weeks of gestation or persisting beyond 12 weeks postpartum. Gestational Hypertension is defined as a pregnant women develop hypertension (same definition as chronic hypertension) without proteinuria after 20 weeks of gestation. Originally, this hypertension during pregnancy was considered as a temporal blood pressure elevation. However, this disorder is now believed to associate with essential hypertension in the later lives of these women.[75]It may represent an early phase of pre-eclampsia, in which proteinuria has not yet appeared. Onestudy showed that around 50% of women diagnosed with PIH between 24 and 35 weeks develop preeclampsia.[76]Preeclampsia is a multi-organ disease process of unknown aetiology, which is characterized by the development of hypertension (same definition as chronic hypertension) and proteinuria after 20 weeks of gestation in a previously

normotensive and non-proteinuric patient. Severe preeclampsia increases the risk of developing eclampticseizure, which may appear also unexpectedly in patient with minimally elevated blood pressure and no proteinuria.

Epidemiology of hypertensive disorders

Hypertensive disorders are the most frequent cardiovascular events during pregnancy, occurring in about 10% of all pregnancies.[77,78] Each type of hypertensive disorders carries risks for both women and their babies, resulting in substantial maternal morbidity and perinatal mortality.[75,76,79,80,81]PIH increased significantly from 1987-2004 (by 18.5%).[82] To date, it has become a leading cause of maternal fetal mortality, threatening about 5% to 7% of all pregnancies.[83] PIH was also reported to be associated with adverse birth outcomes such as stillbirth, low birth weight, and preterm birth, due to insufficient blood supply to placenta.[79,80,81]

Association between GWG and pregnancy induced-hypertension-

Although it is possible that aforementioned fast increase in the prevalence of PIH was due to the revision of clinical guidelines published in 1990s. Many studies have demonstrated that this tremendous increase was attributed by the increased maternal obesity and abnormal GWG. High prepregnancy BMI has been well-established to associate with increased risk for PIH during pregnancy.[84,85,86]It is reported that nearly two thirds of reproductive-age women in U.S. are currently overweighedor obese, and these women are at high risk of developing hypertensivedisorders in pregnancy.[84,86,87,88]GWG is another potentially modifiable risk factor of PIH during pregnancy. Yet existing studies are inconclusive about the association between GWG and PIH.[8,89,90,91,92,93,94] A retrospective cohort study

reported that gestational weight loss was associated with the decreased risk of PIH,[95] while excessive total weight gain and high rate of weight gain during pregnancy were positively correlated to increased risk of PIH.[7,96,97]Specifically, women who develop hypertension during pregnancy are more likely to experience oedema during late pregnancy than those who remain in normotensive. As the result, the hypertensive women may gain much more weight.[98] Two European studies overcame the limitations,[99,100] particularly in Macdonald-Wallis et al. study, which examined repeated antenatal clinic measurements of weight and blood pressure. They suggested that GWG at early pregnancy affected subsequent blood pressure changes and GWG at any pregnant period were positively associated with concurrent blood pressure change.[99] However, they did not account for the potential non-linear increasing trend during early stage of pregnancy and did not consider the effect of GWG during late pregnancy when examined the effect of GWG during early pregnancy.[10] Also, both studies were conducted in European countries, therefore the results may not be generalizable to the Indianpopulation, due to different racial composition and different trends and prevalence in prepregnancy obesity, PIH, and excessive GWG.

Epidemiology of Gestational diabetes mellitus

Gestational diabetes affects 3-10% of pregnancies, depending on the population studied. Approximately 7% of all pregnancies are complicated by GDM in US, while in India it is about 3-5% according to National Diabetes Data Group 2003.[101]In the United States today, 21 million people (7% of the population) have some form of diagnosed diabetes.[102] Another 6 million people may be undiagnosed.[103]Approximately 3-10% of pregnancies in the United States are complicated by diabetes, of which 90% is gestational diabetes and 8% is preexisting,

insulin-resistant diabetes. Of all cases of diabetes complicating pregnancy the majority about 90% are gestational diabetes in India.[101]The incidence of insulin-resistant diabetes is increasing markedly in the United States, probably related to rising population obesity and shifts in ethnicity.1,35,000 pregnant women get the condition every year; approx. 1 in 2,014 or 0.05% or around 135,000 people in USA are affected.[102]

Association between GWG and Gestational Diabetes Mellitus

Gestational diabetes mellitus (GDM) complicates 1–14% of pregnancies[104] and is associated with increased risk of adverse perinatal outcomes[104,105,106,107,108] as well as long-term complications of obesity and type 2 diabetes mellitus in both mothers and children.[105,106,109,110,111] Maternal hyperglycaemia less severe than that used to define overt diabetes mellitus is also related to perinatal complications.[111,112,113,114,115] These effects may be reduced through treatment.[116] Given the rise in GDM incidence over the past decade,[117] research to identify modifiable determinants of glucose intolerance has become a public health priority.

Prepregnancy obesity is the most well-documented modifiable risk factor for GDM.[118,119]Some studies reported that GDM was an adverse pregnancy outcome of excessive GWG.[53,120] However, Nan li et all 2013, did not find an association of excessive GWG with GDM risk. This might be that women who were diagnosed as GDM would take more lifestyle interventions and control weight gain during pregnancy.[121]Several studies additionally suggest that the risk of glucose intolerance increases with weight gain just prior to pregnancy.[119,121,122,123] Although the exact

mechanisms by which weight gain and obesity promote diabetes mellitus are not understood fully, a combination of adiposity-generated insulin resistance and deterioration in pancreatic beta cell function are likely to be responsible for the condition.[124,125,126] Given that fat comprises approximately 30% of weight gain in pregnancy,[127,128,129] during which time women experience physiologic reductions in insulin sensitivity,[130] it seems plausible that greater gestational weight gain would also increase the risk of GDM.

Epidemiology of anemia

Anemia affects 13% of the population in the developed world, it is known to affect 44% of those living in the underdeveloped world. In India, the magnitude of this problem can be assessed from the fact that anemia affects about 13 million pregnant women out of the population of 22 million pregnant women.[131]

Association between GWG and anemia

To our best knowledge, adequate literature for association between GWG and anemia were not found. But study conducted by S Nayak et al in 2013, showed significant relation between low maternal hemoglobin and low BMI (18.5 kg/m^2).[132]

Epidemiology of Low Birth Weight

The World Health Organization (1995) estimated that there is a large gap between the incidence of low-birth-weight babies in developing countries (19percent) and developed countries (7 percent). According to the UNICEF (2004) estimates, more than 20 million infants are born with low-birth-weight in the world and low-

birth-weight babies are concentrated in two regions of the developing world: Asia (72 percent) and Africa (22 percent). India alone accounts for 40 percent of low-birth-weight babies in the overall developing world and more than half of those born in Asia.

Association between GWG and Low Birth weight

Poor maternal weight gain during pregnancy is a relatively insensitive sign of inadequate fetal growth. Some studies have found that this association has questionable clinical value and the weight gain is normal in a significant number of mothers who deliver small babies. A Neufeld et al 2004 in a poor rural population found inadequate weight gain from the first to the second trimester in mothers who delivered small for gestation infants.[56] It is not clear however, if this finding can be applicable to populations with different socioeconomical characteristics. However it is generalised practice to assess fetal growth with ultrasound if the maternal weight gain during pregnancy is poor.

Epidemiology of Macrosomia

Macrosomia is a term used to describe infants who are born large as measured by birth weight or size for gestational age. Fetal macrosomia comes with many risks, including obstetric complications for the mother. Prevalence of macrosomia across the world ranges from 5 to 20%.[133]

Association between GWG and macrosomia

Maternal BMI and GWG are the modifiable risk factors for the macrosomia. Once the pregnancy begins, maternal BMI at conception is not modifiable, but weight gain

during pregnancy can be managed clinically and " controlled weight gain" programmes are available from specialists.[133] Independent of maternal prepregnancy BMI, excess weight gain above the IOM guidelines for each BMI category is associated with increased risk of excess fetal growth, though the combination of the two can lead to even greater risk of macrosomia.[133,134,135] While obesity, diabetes and excess weight gain often can occur simultaneously this association has been seen in non-diabetic mothers with normal prepregnancy BMI who experienced excess weight gain during pregnancy.

One study in Italy showed independent effects of prepregnancy BMI and GWG on macrosomia, with women who gained in excess of the IOM recommendations having almost twice the odds of the macrosomia defined as >= 4000 grams (a OR 1.9; 95% CL 1.6 – 2.2) [134]

Studies have also looked at the risk for gestational weight loss during pregnancy, particularly the third trimester. Yee et al obese American women with GDM who lost weight during their third trimester were less likely to have macrosomic infants and Large gestational age infants compared to similar women who did not lose weight.[136]

Epidemiology of still birth

Still birth is a fetal death that occurs during pregnancy at 20 weeks or greater gestation. Approximately 25000 stillbirths are reported every year representing roughly 60% of all prenatal mortality in the US.[137] In India rates ranges from 20 to 66 per 1000 births in different states.

Association between GWG and still birth

Extant evidence suggests that inadequate gestational weight gain is a risk factor for low birth weight, intra uterine growth retardation, preterm birth and perinatal mortality.[138,139,140] At the same time, excessive gestational weight gain aside from contributing to postpartum weight retention and risk of future obesity may also contribute to poor pregnancy outcomes.

Although inadequate gestational weight gain has been linked to leading cause of infant mortality such as preterm birth and fetal growth restriction. There is a reason to believe that inadequate gestational weight gain may be associated with infant mortality independent of these factors. In two studies that were conducted when the formal gestational weight gain recommendation was 24 lbs (20-5 25-pound range), Naeye et al in 1979 and NCHS in 1986 found that women with low pre-pregnancy BMI and low gestational weight gain tended to have elevated risks of fetal and perinatal mortality (a combination of stillbirth and neonatal mortality).[141, 142] Women with elevated pre-pregnancy BMI and excessive gestational weight gain had elevated risks of the same outcomes.

Women are grouped as low BMI, normal BMI and overweight BMI. Increased as well as lowprepregnancy maternal BMI has been shown to have increased risk of adverse fetomaternal outcomes. In addition, inadequate weight gain in pregnancy has also been shown to increase the risk of these outcomes. This study was aimed at establishing the effect of first trimester BMI, GWG and their association with maternal and perinatal outcome.

Chapter 4

Methodology

METHODOLOGY

Place of study: Department of Obstetrics and Gynaecology, KLEs

Dr Prabhakar Kore Charitable Hospital, Belagavi.

Sample Size: 462

Total sample size $n=4pq/d^2$

$=4 \times 25 \times 75/ (4)^2$

$=468$

Where p = prevalence of LBW in India

q = 100-p

d = error

Study period: January 2015 to August2016

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 height^2. Itis calculated as-

BMI= (weight in kilograms/ Height in meters^2)

As per revised values by the Health Ministry of India, 2008, BMI is classified as-

- Underweight BMI : < 18.5
- Normal BMI : 18.5 – 22.9
- Overweight BMI : 23 – 24.9
- Obese BMI: 25.0 and above.

But 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) Woman coming in 1st trimester for antenatal check-up to the OPD

2) Singleton pregnancy

Exclusion Criteria:

1) Women with known medical disorders
   e.g. hypertension, diabetes.
2) Women who did not give consent.

The weighing machine used was from Equinox, an electronic personal scale CE.

Model: EB 1003

Strain Gauge sensor

Capacity: 150kg

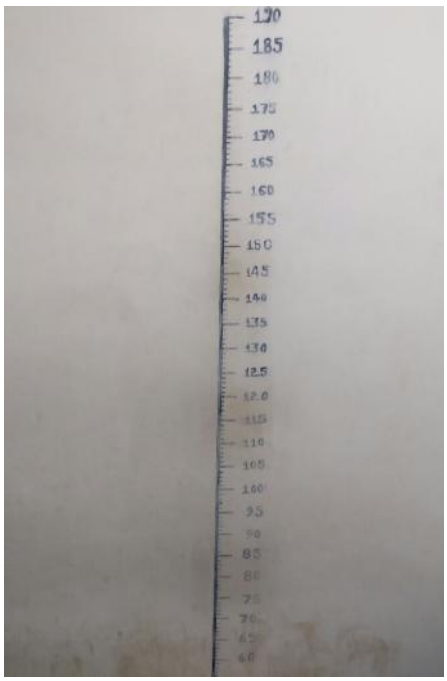
Division: 0.1kg

1.0”(25mm) LCD digits

Low battery/overload indication

Power: 1pc*3 V lithium cells (CR 2032)

Standard stadiometer was used for measuring height in meter.



Methodology:

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.

HISTORY

In all cases detailed history of the patient was taken including

-Name, age, address, education, contact number, occupation

-Presenting complaints-if any

-Obstetric history- gravida, para, number of living issues, abortion

-Menstrual history- Last menstrual period, expected date of delivery, period of gestation, if any corrected EDD

-Past obstetric history- age at marriage, age at first pregnancy, minimum birth interval from earlier pregnancy, history of abortion, any significant antenatal, intranatal, postnatal history in previous pregnancy, history of previous vaginal or C- section delivery, history of still birth, low birth weight, preterm birth, neonatal death, congenital disorders in the baby.

EXAMINATION

General examination including pulse, blood pressure, pallor, oedema. Weight was measured in kilograms. Participants were weighed without shoes, wearing light clothes.

Height was measured using a stadiometer. The participatnts were made to stand erect on the floor barefoot with both ankles together and parallel to each other and standing straight next to the wall with the wall with the heels, buttocks, shoulders and occiput touching the wall.

The data were used to calculate Quetelet index or the BMI using the formula BMI= weight in kg / height^2 in meter.

Again weight was measured in labour room on the admission of participants for delivery. Gestational weight gain was calculated from the duration of first trimester to the time of delivery.

Fetomaternal outcome-

Maternal outcome-

1) Preeclampsia- Preeclampsia is a multi-organ disorder of unknown aetiology characterised by development of hypertension to the extent of 140/90 mmHg or more with proteinuria after the 20th week in a previously normotensive and nonproteinuric women.

2) Gestational Diabetes mellitus (GDM)- GDM is defined as carbohydrate intolerance of variable severity with onset or first recognition during the present pregnancy. Screening was done in OPD on first visit by DIPSI method. Screening for GDM was performed by orally administrating 75 gm glucose and measuring the venous plasma glucose 2 hours later irrespective of previous meal. A plasma glucose value of > 140 mg percentage was considered as GDM.

3) Anaemia- According to WHO, haemoglobin level below 10gm/dL at any time of pregnancy is considered anaemia.

4) Gestational Hypertension- Blood pressure of >= 140/90 mmHg for the first time in pregnancy after 20 weeks of period of gestation without proteinuria is defined as gestational hypertension.

Perinatal outcome-

1) Low birth weight (LBW)- According to WHO, Low birth weight is defined as weight at birth of less than 2500 grams.
2) Macrosomia- Macrosomia is a term used to describe infants who are born large as measured by birth weight of more than 4000 grams or Abdominal circumference is more than 90 centile of the baby weight.
3) Stillbirth- Still birth is a fetal death that occurs during pregnancy more than 20 weeks of period of gestation.

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

Weight of the new born baby was taken immediately after the birth on baby weight machine from Medisoft

Model no- MS 201

Cap- 150kg

6 v 4.5 ah rechargeable Battery provides 20 hours backup time.

Compact Model to weight for baby, children and adult.

Using programmable Triple Accuracy-

	Capacity	Accuracy
Baby	0 to 20 kg	10 gm
Children	20 to 50 kg	50 gm
Adult	50 to 200 kg	100 gm

Auto zero tracking

Fully Digital calibration (external)

1inch high bright red led display.

Overload protection upto 150% of the capacity soft switch

Detachable durable hip moulded baby tray.

ETHICAL ISSUES

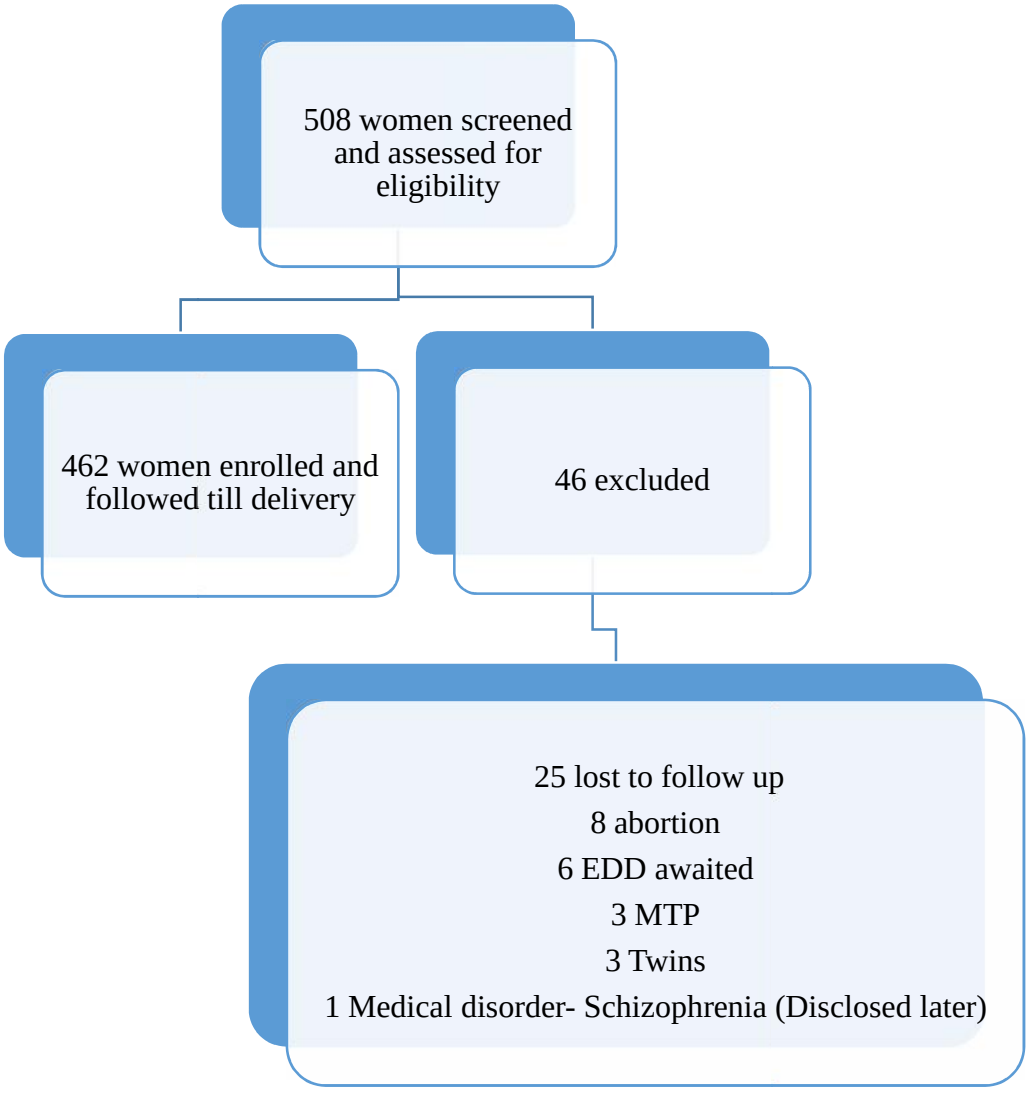
As this was an observational study with no unethical interventions, or danger to the patient due to the study itself, it is an ethically sound study. Ethical clearance was taken by the hospital committee for the same.

Chapter 5

Results

RESULTS

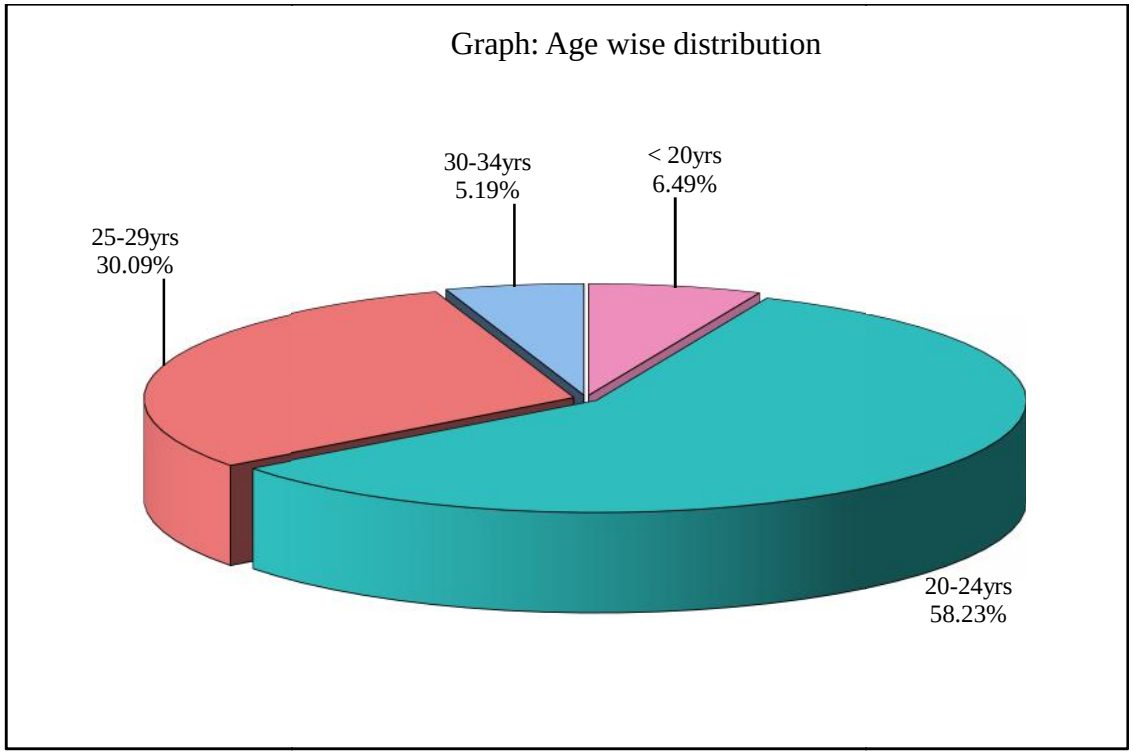
This study was conducted in the department of Obstetrics and Gynaecology of Dr Prabhakar Kore Charitable hospital and Medical Research Centre, KLE University's teaching hospital attached to Jawaharlal Nehru Medical College Belagavi, during the period of January 2015 to August 2016.



A total number of 462 women were included in this study and maternal and perinatal outcome were studied.

Table 2: Distribution of participants by age groups:

Age groups	No of patients	% of patients
<20yrs	30	6.49
20-24yrs	269	58.23
25-29yrs	139	30.09
30-34yrs	24	5.19
Mean age	23.58	
SD age	3.10	
Total	462	100.00

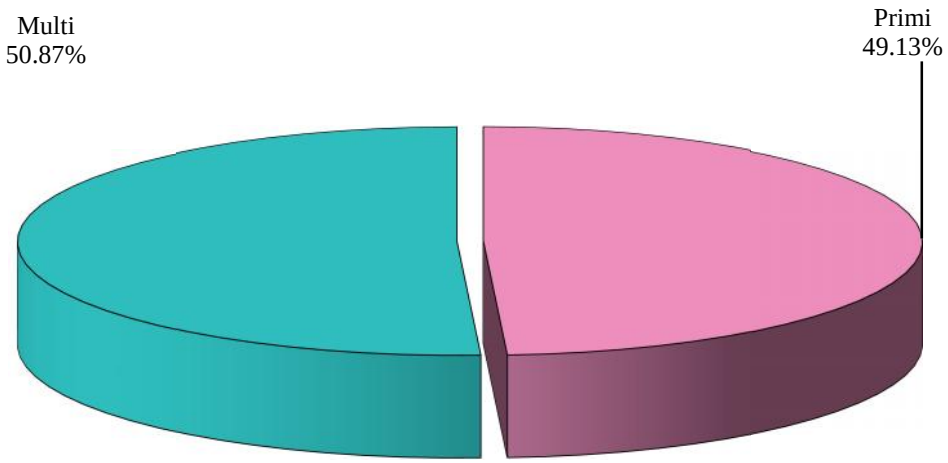


In our study distribution of participantsaccording to age groups is shown in above table. Majority of the patients were in age group of 20-24 years (58.23%) followed by 25-29 years (30.09%). The mean age was 23.58 +/- 3.10.

Table:3 Distribution of participants by Gravida :

Gravida	No of patients	% of patients
Primi	227	49.13
Multi	235	50.87
Total	462	100.00

Graph: Gravida wise distribution

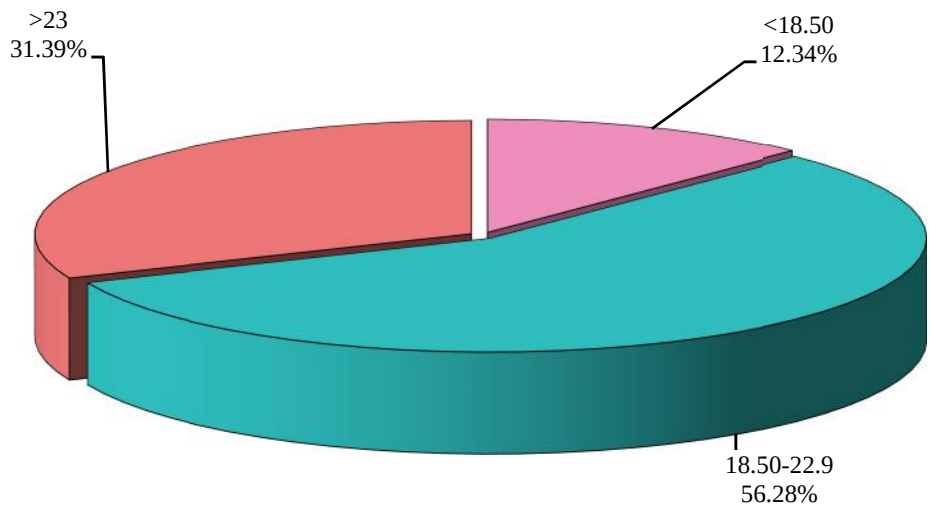


Taking gravida into consideration, we observed that there werealmost equal numbering primigravida 227(49.13%) and multigravida 235(50.87%) in our study.

Table4: Distribution of participants by BMI:

BMI	No of patients	% of patients
<18.5	57	12.34
18.5-22.9	260	56.28
>23	145	31.39
Total	462	100.00

Graph: BMI groups wise distribution

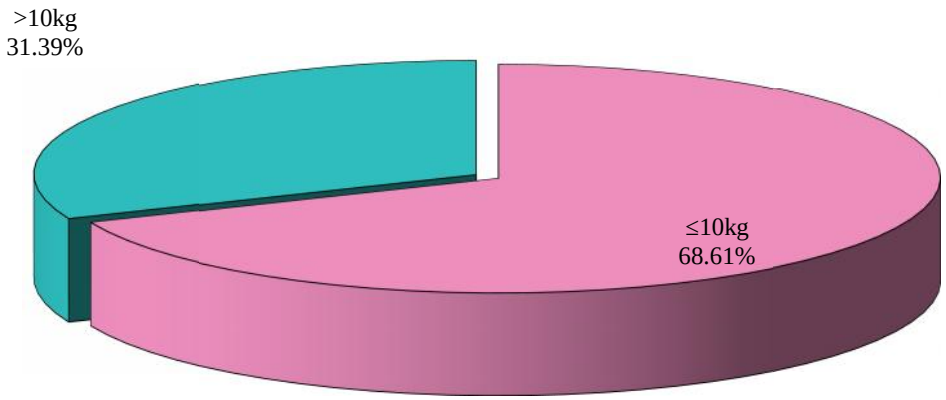


In our study, we noted that maximum number of women were in range between 18.5-22.9 BMI that is 260(56.28%) followed by 145(31.39%) patients having BMI >23 and 57(12.34%) patients having BMI <18.5.

Table:5Distribution of participants by Gestational weight gain :

Gestational weight gain	No of patients	% of patients
≤10kg	317	68.61
>10kg	145	31.39
Mean	9.39	
SD	2.19	
Total	462	100.00

Graph: Gestational weight gain wise distribution

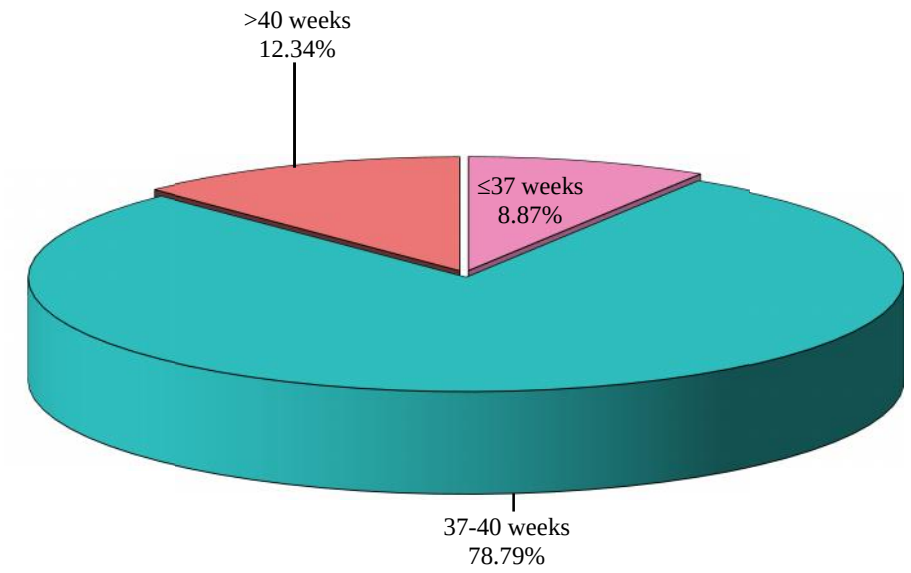


In our study population around 68.61% i.e. 317 participants had a weight gain of <= 10 kg and 145(31.39%) were having gestational weight gain above 10kg. The mean weight gain was 9.39 +/- 2.19.

Table:6 Distribution of participants by Period of gestation:

Period of gestation	No of patients	% of patients
≤37 weeks	41	8.87
37-40 weeks	364	78.79
>40 weeks	57	12.34
Total	462	100.00

Graph: Period of gestation wise distribution

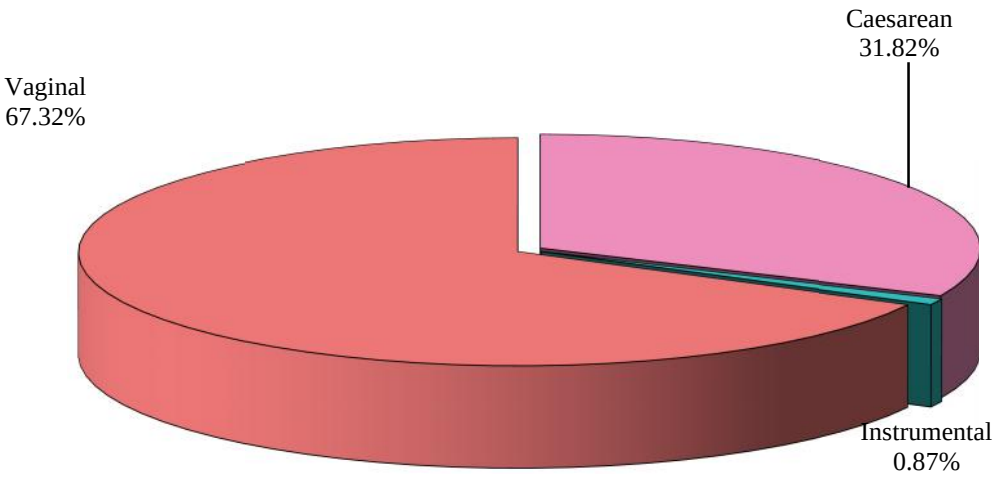


In our 462 patients,majority of the participants were having period of gestation between 37-40 weeks of period of gestation which constitute 364(78.79%) patients.

Table:7 Distribution of participants by Mode of delivery:

Mode of delivery	No of patients	% of patients
Caesarean	147	31.82
Instrumental	4	0.87
Vaginal	311	67.32
Total	462	100.00

Graph: Mode of delivery wise distribution



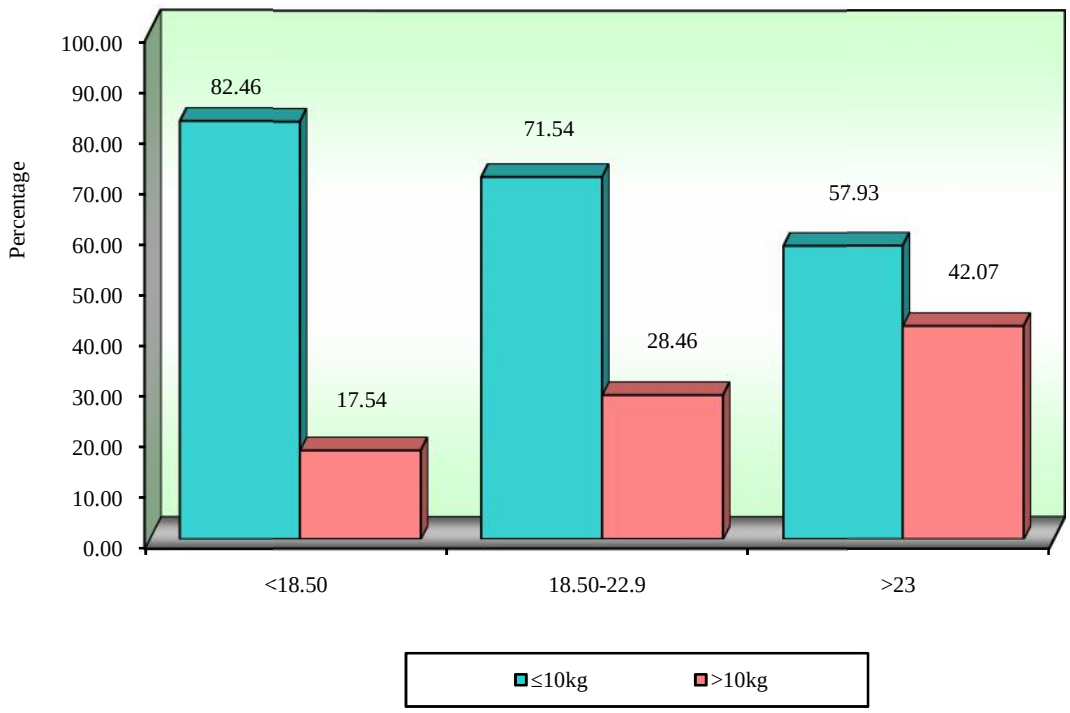
Taking mode of delivery into consideration, majority of the women had vaginal delivery, accounting to about 311(67.32%) followed by caesarean delivery in 147(31.82%) and only 4(0.87%) women had an instrumental delivery.

Table:8 Association between weight gain and BMI:

BMI	≤10kg	%	>10kg	%	Total
<18.50	47	82.46	10	17.54	57
18.50-22.9	186	71.54	74	28.46	260
>23	84	57.93	61	42.07	145
Total	317	68.61	145	31.39	462
Chi-square=15.8762 P = 0.0011*					

*p<0.05

Graph:Association between weight gain and BMI

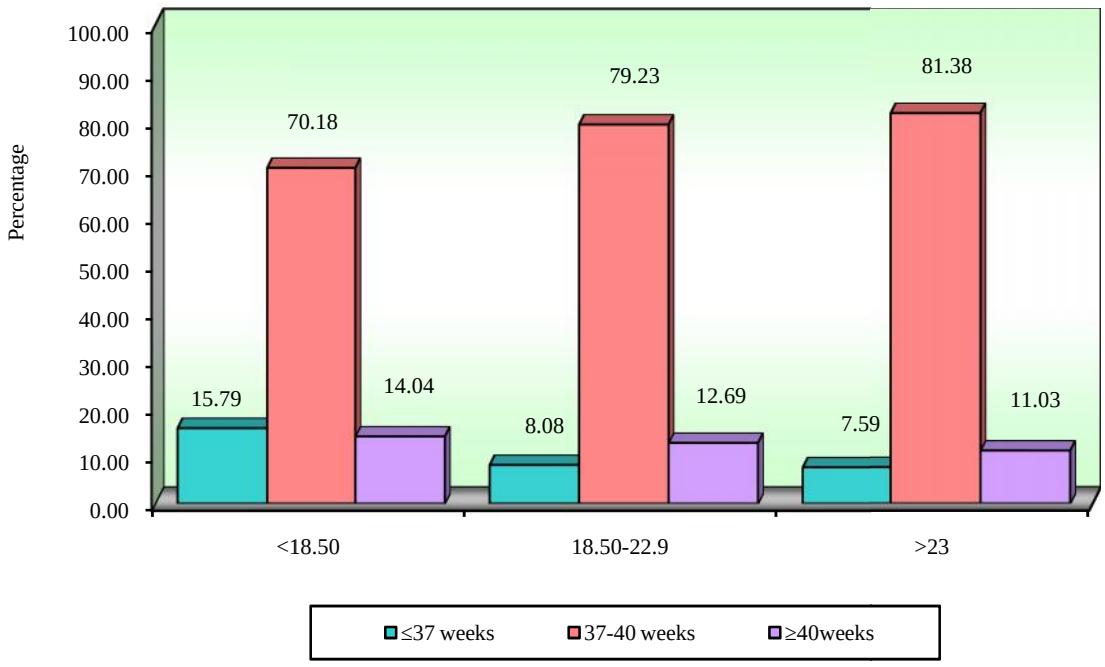


In our study of 462 participants, 47(82.46%) had gained ≤10kg weight during their pregnancy period. These 82.46% participants were from low BMI group. While 61(42.07%) overweight participants had gained >10kg weightduring their pregnancy period. P value being statistically significant.(p=0.0011)

Table:9 Association between BMI and period of gestation

BMI	≤37 weeks	%	37-40 weeks	%	≥40weeks	%	Total
<18.50	9	15.79	40	70.18	8	14.04	57
18.50-22.9	21	8.08	206	79.23	33	12.69	260
>23	11	7.59	118	81.38	16	11.03	145
Total	41	8.87	364	78.79	57	12.34	462
Chi-square=15.8762 P = 0.0011*							

Graph:Association between BMI and period of gestation

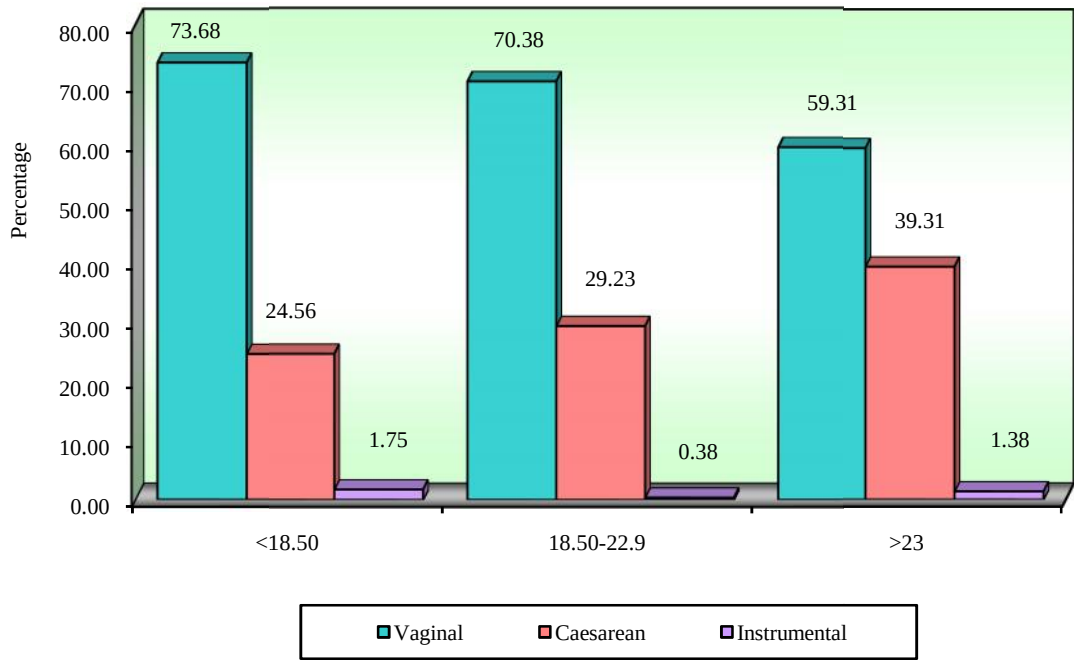


In our study we observed9(15.79%) of low BMI mothers had preterm delivery. 118(81.38%) overweight BMI mothers had term delivery between 37-40 weeks of period of gestation. P value is 0.0011 which is statistically significant. Out of 462 participants, majority of our participants had term delivery (78.29%).

Table:10 Association between BMI and Mode of delivery

BMI	Vaginal	%	Caesarean	%	Instrumental	%	Total
<18.50	42	73.68	14	24.56	1	1.75	57
18.50-22.9	183	70.38	76	29.23	1	0.38	260
>23	86	59.31	57	39.31	2	1.38	145
Total	311	67.32	147	31.82	4	0.87	462
Chi-square=10.3331, p=0.1101							

Graph:Association between BMI and Mode of delivery

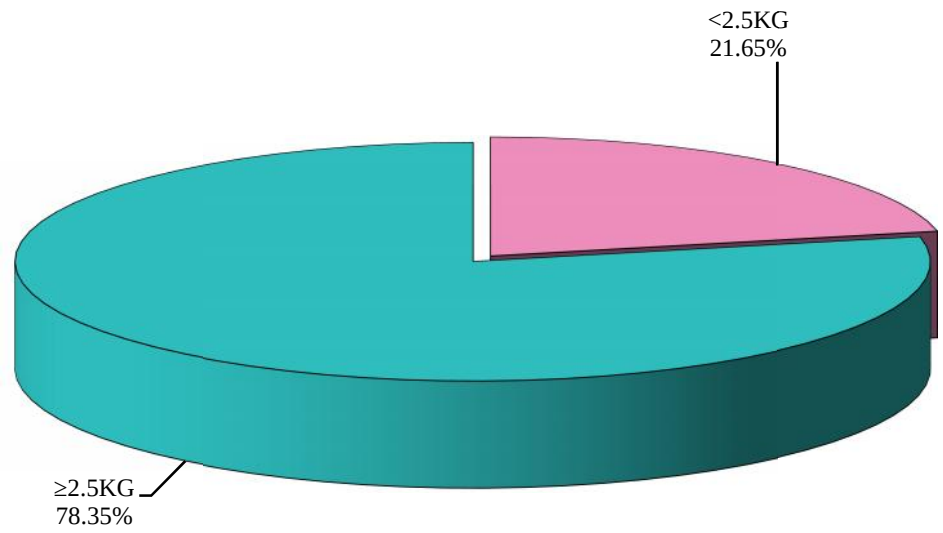


When association between BMI and mode of delivery was taken into account, we observed maximum mothers with low BMI (73.68%) had vaginal delivery. Similarly, 183(70.38%) patients with normal BMI also had vaginal delivery. Out of 145 overweight BMI mothers, 86(59.31%) had vaginal and 57(39.31%) had caesarean delivery but it was not statistically significant. Minimal participants were delivered by instrumentation in each BMI group.

Table:11 Distribution of participants by birth weight:

Birth weight	Number	%
<2.5KG	100	21.65
≥2.5KG	362	78.35
Total	462	100.00

Graph: Birth weight wise distribution



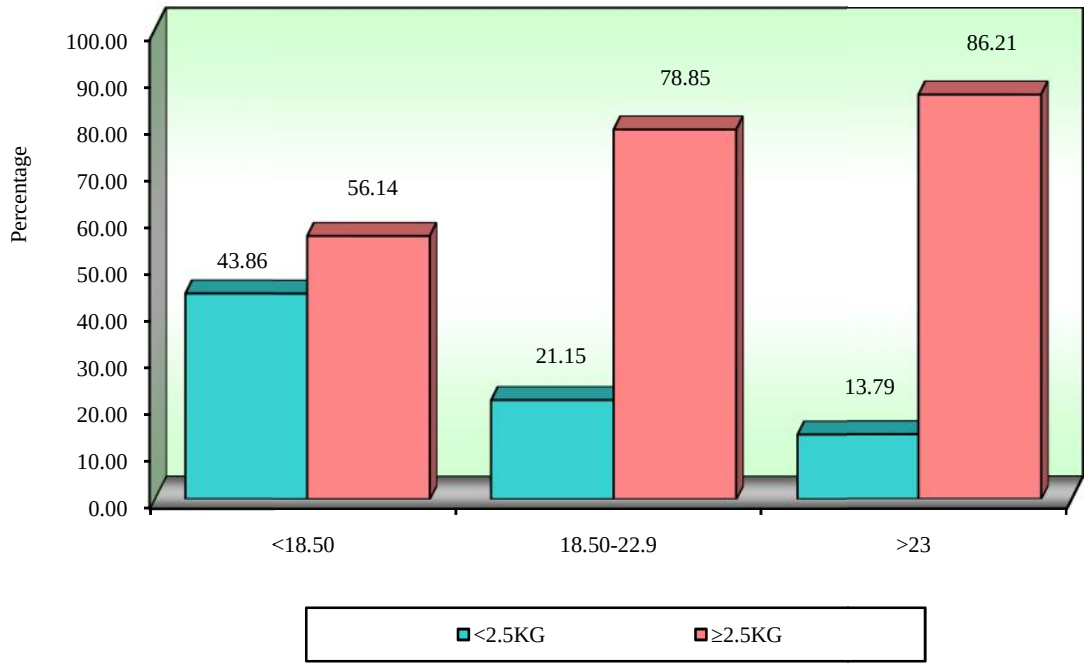
In this study, we noted that majority of mothers delivered with neonatal birth weight ≥2.5kg that is 362 patients (78.35%) and only 100 (21.65%) had neonatal birth weight of <2.5kg.

Table:12 Association between BMI and birth weight

BMI	<2.5KG	%	≥2.5KG	%	Total
<18.50	25	43.86	32	56.14	57
18.50-22.9	55	21.15	205	78.85	260
>23	20	13.79	125	86.21	145
Total	100	21.65	362	78.35	462
Chi-square=21.200 P = 0.0001*					

*p<0.05

Graph:Association between BMI and birth weight

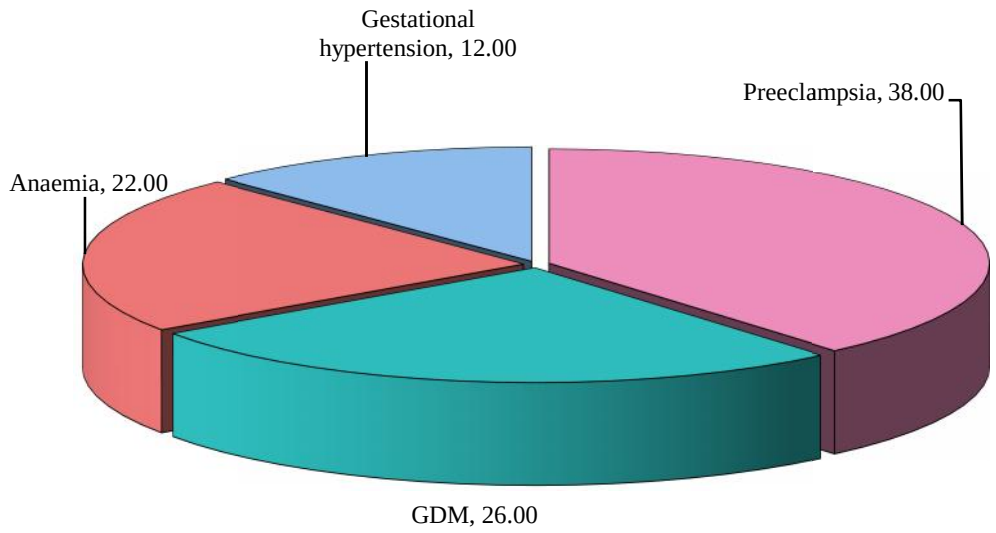


In our study we observed that,in 260 mothers with normal BMI, 205(78.85%) had neonatal birth weight ≥2.5kg and only 55(21.15%) mothers had neonatal birth weight <2.5kg. Out of 145 overweight BMI mothers, majority had neonatal birth weight ≥2.5kg that is 125 (86.21%) whereas not much difference in neonatal birth weight was noted in low BMI mothers. P value being statistically significant. (0.0001)

Table: 13 Maternal Complications:

Variables	With complications	%
Preeclampsia	38	8.23
GDM	26	5.63
Anaemia	22	4.76
Gestational hypertension	12	2.60

Graph: Maternal complications



In our study, we observed 38(8.23%) mothers had preeclampsia, 26(5.63%) had GDM, 22(4.76%) had moderate to severe anaemia and only 12(2%) mothers had gestational hypertension.

Table: 14 Comparison of BMI groups with maternal complications:

Variables	<18.50	18.50-22.9	>23	Total	Chi-square	p-value
Preeclampsia	2	16	20	38	9.1130	0.0110*
GDM	4	8	14	26	7.8210	0.0200*
Anaemia	5	11	6	22	2.3070	0.3150
Gestational hypertension	1	8	3	12	0.5560	0.7570

*p<0.05

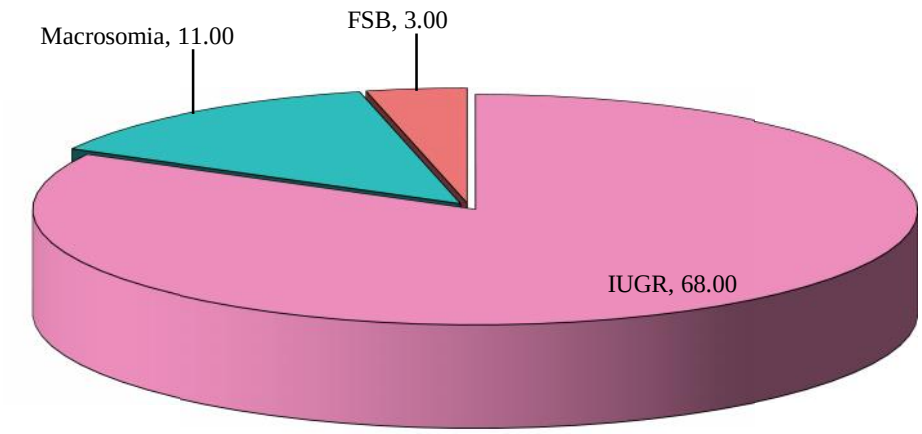
When we compared BMI groups with maternal complication, we observed that 20 mothers with overweight BMI had preeclampsia. 14 mothers with overweight BMI had GDM and mothers with anaemia and gestational hypertension belonged to varying BMI groups which is shown in above table. P value is significant for preeclampsia (0.0110) and GDM (0.0200).

Thus, mothers Overweight BMI had more risk of preeclampsia, GDM.

Table: 15 Neonatal complications :

Variables	With complications	%
IUGR	68	14.72
Macrosomia	11	2.38
FSB	3	0.65

Graph: Neonatal complications



Among the neonatal complications, 68(14.7%) mothers had neonates which were IUGR, 11(2.38%) mothers had neonates with macrosomia and only 3(0.65%) had FSB.

Table:16 Comparison of BMI groups with neonatal complications :

Variables	<18.50	18.50-22.9	>23	Total	Chi-square	p-value
IUGR	20	30	18	68	21.5490	0.0001*
Macrosomia	0	0	11	11	24.6350	0.0001*
FSB	2	1	0	3	8.4540	0.0150*

*p<0.05

When maternal BMI was compared with neonatal complications we found out that 30 mothers with normal BMI and 20 mothers with low BMI had IUGR neonates. Only 11 overweight BMI mothers had neonates with macrosomia. and 2 low BMI mothers had FSB.P value being statistically significant.

Table: 17 Comparison of neonatal complications with Gestational weight gain :

Variables	≤10kg	>10kg	Total	Chi-square	p-value
IUGR	64	4	68	24.0820	0.0001*
Macrosomia	2	9	11	13.3090	0.0001*
FSB	3	0	3	1.3810	0.2400

*p<0.05

In above table we show that mothers with weight gainof ≤10kg had more IUGR (64) and FSB (3). Similarly, mothers with gestational weight gain of >10kg had more number of macrosomia (9). P value being statistically significant.

Chapter 6

Discussion

DISCUSSION

In present study of 462 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 19-34 years, the maximum number of patients that is 88.32% were in age group of 20-29 years, followed by 6.49% participants below 30 years and 5.19% above 30years. The mean age was 23.58. This is almost similar to study done byAnjana et al in 784 participants in 2012 which showed maximum number of participants in age group 18-35years[48].Study by Jain et al in 300 women showed similar observation having mean age of 22.94.[50]

We observed that number of primipara49.1% and multigravida50.8% 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 56.28% followed by 31.29% participants having BMI>23 and 12.34% participants having BMI <18.50. This was in accordance with Anjana et al in which 52% had normal BMI range followed by overweight BMI. Study by P Jain et al with 300 participants showed 69% with normal BMI followed by participants with underweight and overweight BMI.[48,50]

Similarly study done by S.Bhattacharya et al in 24,241 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.[144,55]

In our study of 462 participants, majority of mothers gained weight of ≤10kg which constitute 68.61% as compared to only 145(31.39%) participants who had weight gain of >10kg. Similar observations were noted by Nan et al and E Nohr et al.[145,19]

In this study, period of gestation was term in maximum number of participants that is 78.79% followed by 12.34% had period of gestation more than 40 weeks and 8.87% participants had period of gestation <37weeks. Many authors have similar findings in their studies.

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 67.32% followed by caesarean delivery in 31.82% participants and only 0.87%instrumental delivery. Similar finding was noted by Sahu et al conducted in380 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 of 462 patients, when we made an attempt to find out the association between gestational weight gain and BMI, we found majority of the participants with low BMI who where having gestational weight gain≤10kg that is 82.46% and 42.07% 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] In contrast,

study by Hickey et al which noticed higher maternal BMI,gestational weight gain had no significant bearing on outcome.[9]

When we compared BMI with period of gestation, we observed that 15.79% 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]

Several reports by different authors have also found an association between maternal high BMI and prolonged duration of gestation. It has also been shown that overweight BMI women have poor uterine contractility and poor response to oxytocin infusion.

When association between BMI and mode of delivery was taken into account, we observed 73.68% of low BMI participants had vaginal delivery followed by normal BMI group. Maximum number of participants that is 39.31% from overweight BMI group underwent caesarean section. Minimal participants were delivered by instrumentation in each 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.[72,49]

This was in sharp contrast to study done by Pevzner et al,Kominiarek MA et al in 2009 which had incidence of caesarean delivery more in each BMI group as compared to our study.[68,71]

Increased maternal BMI did not increase the risk preterm or postdate delivery in this study. These findings were similar to those of Cnattingius| that found no association between preterm delivery before 37 weeks and high BMI[15]. In contrast,

Bhattacharya et al in 2007 found a two fold increase in preterm labour in the overweight patients.[145]

When neonatal birth weight was taken into account, we observed that majority of mothers (78.35%) delivered with neonatal birth weight of ≥2.5kg and only 21.65% had neonatal birth weight of <2.5kg. Study by Jain et el, Bhattacharya et al, Sahu et al observed similar findings.[49,145,72]

When we made attempt to find association between maternal BMI and neonatal birth weight, we observed that 43.86% of participants with low BMI delivered low birth weight neonates and 86.21% 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 462 participants, significant maternal complication as outcomes were noted in which 8.23% mothers had preeclampsia, 5.63% had GDM, 4.76% had moderate to severe anaemia and only 2% mothers had gestational hypertension.

When we tried to compare BMI groups with maternal complication, we found that out of 38 mothers, 20(p=0.0110) with overweight BMI had preeclampsiaand out of 26 mothers, 14(p=0.0200) with overweight BMI had GDM.Thus, mothers with high BMI had more risk of preeclampsia, GDM in our study. And 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 group[145].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 PIH. In his study normal BMI that 31% women had severe PIH and in overweight group 10% had severe PIH[72].Similar observation were also found by Jain P et al, Sabire et al, Addo et al, Sawant et al, E Nohr et al.[49,16,131,55,19.]

In our study, we observed significant neonatal complication as outcomes which shows 14.7% mothers had neonates which were IUGR, 2.38% mothers had neonates with macrosomia and only 0.65% had FSB. Similar observation were noted in study by Bhattacharya et al, Sahu et al, Sawant et al, Jain Et al.[145,72,55,49]

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 group[146]. 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].

It has been shown that maternal hyperinsulinemina contributes to neonatal

macrosomia in overweight women. Given the relative prevalence of obesity in the Indian population, and the rising rate of obesity among childbearing women, obesity may exert a more significant influence on the risk of macrosomic babies in the population[72].

Many authors studied association between stillbirth and maternal BMI which showed increased risk of still births in underweight BMI participants compared to normal BMI group. P value being statistically significant. Our study had only minimal low BMI mothers having complication as stillbirth compared to normal or high BMI. In the study by Cunningham et al perinatal deaths were more prevalent in underweight category but in contrast S Pillai et al found increased rate of still births with obesity in mother.[44,54]

In our study, when we compared gestational weight gain with neonatal complication, we observed that mothers with weight gain of ≤10kg had more IUGR (p=0.0001) and mothers with gestational weight gain of >10kg had more macrosomia (p=0.0001). P value being statistically significant.

Various studies done have shown that suboptimal weight gain in pregnancy has been associated with poor pregnancy outcomes. However, the idealweight gain in pregnancy has remained controversial with revisions being made severally over the years. Excessive weight gain in pregnancy has been associated with increased risk of preeclampsia, GDM, fetal macrosomia and inadequate weight gain has been associated with increased incidence of IUGR and preterm deliveries.

Thus, our study showed significant association between maternal BMI and gestational weight gain with maternal and perinatal outcomes.

Chapter 7

Conclusion

CONCLUSION

We are aware that India faces a dual burden of obesity and an underweight population and this is primarily due to drastic variation observed in the rural and the urban population, varied dietary habits and different socio economic status. Both pre pregnancy obesity and low pre pregnancy BMI are associated with adverse pregnancy outcomes such as preeclampsia, GDM, prematurity, fetal growth restriction and perinatal morbidity and mortality.

In the present study we included 462 pregnant women their first trimester BMI was calculated, gestational weight gain during pregnancy was noted and association between BMI and maternal and perinatal outcome were studied. 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.

Chapter 8

Summary

SUMMARY

The present study of 462 participants titled **"A STUDY OF FIRST TRIMESTER MATERNAL BODY MASS INDEX AND GESTATIONAL WEIGHT GAIN AND THEIR ASSOCIATION WITH MATERNAL AND PERINATAL OUTCOMES"**was conductedduring the period from January 2015 to August 2016 in the department of Obstetrics and Gynaecology at KLES Dr Prabhakar Kore Hospital and Medical Research Centre, Belagavi. The findings of the study has been summarized as follows:

- Majority of participants were in age group of 20-29 years accounting for 88.32%.
- In our study, primigravida (49.13%) and multigravida (50.87%) were equally distributed.
- 56.28% participants of the study were in normal BMI group followed by overweight BMI group (31.39%) and 12.34% in low BMI group.
- Out of 462 participants 68.61% were gained ≤ 10 kg weight during their pregnancy period whereas the remaining participants 31.39% had gained >10kg.
- In our study, maximum participants that is 78.79% had term delivery followed by 12.34% with postdatism and 8.87% had preterm delivery.
- In our study, 67.32% participants had vaginal delivery followed by 31.82% participants underwent caesarean section. Instrumental deliveries were minimal in our study.
- In our study, 82.46% low BMI participants had gained ≤10 kg weight. Whereas, 42.07% gained >10 kg of weight during their pregnancy.
- In our study, 15.79% participants of low BMI group had preterm deliveries and 81.38% of overweight BMI participants had term deliveries.

- Maximum participants of our study had vaginal deliveries as compared to caesarean section. Caesarean section were maximum in overweight BMI group (39.31%).
- In this study, 78.35% neonates had ≥2.5kg birth weight.
- 43.86% of low BMI group mothers had low birth weight neonates. While 86.21% overweight mothers had ≥2.5 kg of birth weight neonates.
- Out of 462 participants, 98 had maternal complications. Incidence of preeclampsia (20) and GDM (14) were higher in overweight BMI group.
- Out of 462 neonates 82 had perinatal complications. 14.72% neonates were IUGR, 2.38% neonates had macrosomia and 0.65% were stillbirth.
- Maximum IUGR (30) found in Normal BMI patients and all macrosomia(11) found in overweight BMI patients.
- There were 64 neonates with IUGR whose mothers had gained ≤ 10 kg weight during their pregnancy and 11 neonates were macrosomic whose mother had gained >10kg weight.

Chapter 9

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Annexure

Annexure I

ANNEXURE I

CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mrs _____we are requesting you to enroll yourself in study titled **"FIRST TRIMESTER MATERNAL BODY MASS INDEX AND GESTATIONAL WEIGHT GAIN AND THEIR ASSOCIATIONS WITH MATERNAL AND PERINATAL OUTCOME"** conducted by Dr._____, Post Graduate in M.S. Obstetrics And Gynaecology under the guidance of Dr. _____ Professor Department of Obstetrics And Gynaecology, J.N. Medical College, Belgaum under KLE university, Belgaum.

Respected Madam, we request you to enroll yourself to participate in our study as you are eligible for participating in the study. During the study you will be asked some questions regarding your present and past pregnancy and you are supposed to answer to the best of your knowledge.

Objective and Purpose of study:

To evaluate the relationship of first trimester maternal BMI and GWG with maternal and perinatal outcome.

Need for study:

The prevalence of low birth weight is higher in Asian countries mainly due to under nutrition during pre pregnancy. Birth weight is an important tool to predict the future growth and survival of newborn. Birth weight in turn depends on maternal health and nutrition. Hence the study attempt to evaluate the

relationship of maternal first trimester BMI, gestational weight gain and perinatal outcome.

Procedure Involved:

If you agree to enroll yourself in my study, you will be interviewed regarding your obstetric history, present, past and family history, then your height and weight will be taken in opd and in labour room when you will come for delivery. The weight of your baby will also be measure immediately after the birth.

Risks and Benefits:

There will be no benefit of taking part in this research but you may get knowledge about the importance of pre pregnancy and gestational weight and its effect on new born. It will help to reduce the prevalence of low birth weight. There are no observable risks associated with the study.

Voluntary Participation/Withdrawal:

Taking part in the study is voluntary. You may choose not to enroll yourself in this study. Your decision will not change present or future health care services offered to you at K.L.E.S hospital.

Privacy and Confidentiality:

The only people to know that you are a research subject are members of the research team. No information about you or information provided by you during the research will be disclosed to other without your written permission except:

1. In emergency to protect your rights and welfare.
2. If required by law.

Authorization to Publish Results:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with you will remain confidential.

Financial Incentives for participation:

No financial incentives are being offered to enrolled patients.

Questions:

In case you have any questions related to the study, you can contact Dr. _____ Department of Obstetrics And Gynaecology, KLES Hospital and MRC, phone number: _____or Dr_____Professor Department of Obstetrics And Gynaecology, KLES Hospital and MRC, Belgaum

If you have any queries about your rights as a study subject, you may call Dr._____ , Prof. & Head of Pathology as Chairperson of J. N. Medical College Institutional Ethics Committee on Human Subjects Research, Phone No._____ ext- ____at J. N. Medical College, Belgaum or phone number: _____
.

CONSENT STATEMENT

I, _____ voluntarily agree for the participation as a subject of study. By signing this consent form I am not giving up any of my legal rights, I may withdraw from the study anytime. I am signing the consent form after having read or been read form in vernacular language, including the risks and the benefits and having all my questions answered.

Subject Name : _____

Signature or the Left Thumb Print of Subject : _____

Witness Name: _____ *Signature:* _____

Investigator Name : _____ *Signature*: _____

Date: _____

Place: _____

Annexures

Annexure II

ANNEXURE II

PROFORMA

"FIRST TRIMESTER MATERNAL BODY MASS INDEX AND GESTATIONAL WEIGHT GAIN AND THEIR ASSOCIATION WITH MATERNAL AND PERINATAL OUTCOMES."

- IP.NO :

1. SUBJECT INFORMATION

- NAME :
- AGE :
- ADDRESS :
- CONTACT NUMBER:
- EDUCATION:
- OCCUPATION:

2. CURRENT PREGNANCY

- GRAVIDA
- PARA:
- LIVING:
- ABORTION :
- LMP :
- EDD :
- PERIOD OF GESTATION :
- USG EDD :

3. PAST OBSTETRIC HISTORY

- AGE AT MARRIAGE:
- AGE AT FIRST PREGNANCY:
- MINIMUM BIRTH INTERVAL FOR EARLIER PREGNANCY:

- HISTORY OF SPONTANEOUS ABORTION:
- HISTORY OF INDUCED ABORTION:
- HISTORY OF PREECLAMPSIA/GESTATIONAL DIABETES MALLITUS/ANEMIA/ISOIMMUNIZATION/ANY OTHER INFECTION/ ANTEPARTUM HEMORRAGE
- HISTORY OF NORMAL VAGINAL DELIVERY
- HISTORY OF C SECTION DELIVERY
- HISTORY OF STILL BIRTH:
- HISTORY OF LOW BIRTH WEIGHT:
- HISTORY OF PRETERM BIRTH:
- HISTORY OF ANY NEONATAL DEATH:
- HISTORY OF ANY CONGINITAL DISORDER IN THE BABY:

4. GENERAL EXAMINATION:

- DATE OF VISIT:
- HEIGHT:
- WEIGHT:
- PALLOR:
- OEDEMA:

5. VITALS- PR: BP:

6. HEALTH SERVICES USE DURING PREGNANCY:

- NUMBER OF TIMES OF ANC VISIT:
- FOLIC ACID INTAKE STATUS
- HEMATINIC SUPPLEMENTATION STATUS:
- CALCIUM SUPPLEMENTATION INTAKE STATUS:
- NUTRITION STATUS:

6. INFORMATION ON LABOUR

- DATE AND TIME OF DELIVERY :
- TYPE OF DELIVERY : SPONTANEOUS/ INDUCED/CAESEARIAN
- IF INDUCED, INDICATION:
- IF CAESEARIAN, INDICATION:

7. INFORMATION OF THE BABY

- GESTATIONAL AGE :
- TIME OF BIRTH :
- SEX :
- WEIGHT IN KGS :
- LENGTH IN CM:
- DID THE BABY CRY AFTER BIRTH :
- DID THE BABY NEED RESUSCITATION:
- APGAR SCORE : 1MINUTE : 5MINUTE :
- MORTALITY

SIGNATURE AND NAME OF THE INVESTIGATOR:

Annexures

Annexure III

ANNEXURE III – MASTER CHART

LMP - Last Menstrual Period

EDD - Expected Date of Delivery

POG - Period of Gestation

LBW - Low Birth Weight

C Section - Ceasarean Section

BMI - Body Mass Index

GDM - Gestational Diabetes Mellitus

IUGR - Intra Uterine Growth Restriction

FSB - Fresh Still Birth