Maternal Obesity and Its Adverse Effect on Maternal and Fetal Health

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Background: The increasing prevalence of obesity worldwide has prompted the World Health Organization (WHO) to designate obesity as one of the most important global health threats. The epidemic is especially pronounced in women of reproductive age. Prepregnancy obesity is an independent risk factor for maternal and neonatal morbidity and mortality. The origin of this epidemic is unhealthy lifestyle – high energy and high-fat diet and physical inactivity. During periconceptual period and pregnancy, the composition of a woman's diet is of particular importance, as it may influence the pregnancy, the delivery and the health of the mother and the infant later on, so an excessive gestational weight gain (GWG) is not recommended. The aim of our study is to clarify the complications related to excess prepregnancy body weight on maternal and fetal health.
Methods: Hundred obese pregnant women with BMI (30-40 Kg/m^2) measured at first trimester were prospectively enrolled into this study. Routine blood pressures, random blood sugar measuring and ultrasonographic follow up are required during pregnancy for early detection of any complications related to maternal obesity and excessive gestational weight gain (GWG).
Results: cases statistically evaluated in these study were 100 pregnant females with mean age 27.34 years + 5 years SD and mean BMI 32.97 Kg/m^2 + 2.92 Kg/m^2 SD. Denoting in our study, the effect of maternal obesity om maternal and fetal health.

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Conclusion: A causal relationship between the prepregnancy BMI and obstetric complications is proven. Weight management is important for every women of reproductive age. Thus, medical Practice must consider these complications by providing early detection and management to improve both maternal and neonatal outcome.

1. INTRODUCTION

Recent years have witnessed a worldwide increase in the prevalence of pregnancy maternal obesity. The rise in obesity among pregnant women goes hand in hand with the upward trend of obesity in the general population. In addition, the percentage of women gaining excessive weight during pregnancy has also increased [1,2]. Obesity during pregnancy has detrimental effects on women's health because it is associated with increased risk for gestational diabetes mellitus, Hypertensive disorders of pregnancy (hypertension, preeclampsia or eclampsia), plus risk of future cardiovascular disease (hypertension, ischemic heart disease, heart failure and stroke) and diabetes mellitus [3].

During the third trimester and especially in the first two weeks following delivery, the risk of Venous Thromboembolism (VTE) increases in women. Deep Vein Thrombosis (DVT) is an important cause of morbidity and is the first cause of maternal death after delivery in Western Nations [4,5]. In obese pregnant women, the rates of births with intervention or by cesarean section, as well as the risk of intrapartum and postpartum complications are also higher. Furthermore, the increase of maternal obesity goes in parallel with the increase of birth weight [6,7].

Increased birth weight has been mainly attributed to increased neonatal adiposity at birth, which in turn is predictive of increased adiposity in childhood [8]. Maternal pre-gravid obesity is considered as the strongest predictor of childhood obesity and is postulated to create an adverse endometrial environment which predisposes the offspring to obesity, diabetes and cardiovascular disease in later life [9].

Congenital malformations (threefold frequent), defects in the jugular vein and abdominal wall, intestinal defects, hydrocephaly, omphalocele, neural tube defect, macrosomia, shoulder dystocia, hypoglycemia, jaundice can be listed among the negative effects of maternal obesity in the fetal and neonatal period [10-12].

The study is a prospective clinical study to assess the relationship between maternal obesity calculated by Body Mass Index (BMI) at the first trimester of pregnancy and pregnancy-related outcomes regarding the mother and fetus.

2. PATIENTS AND METHODS

This prospective cross -section study was carried out at Obstetric & Gynecology department, Tanta University Hospitals from December 2019 till February 2021.

Pregnant women were called from outpatient clinics and the schedule of their antenatal visits was the traditional one (every month in the first six months of pregnancy then every 2weeks in the 7th and 8th month of pregnancy and lastly every week till the end of pregnancy) except if there any complication arise, it would be managed according to the maternal and fetal condition. Studied women were followed till delivery and their newborns were examined for detection of any complications and abnormalities.

100 pregnant women registered for antenatal care had accepted to participate in this study, to be followed till delivery and 2 weeks post partum.

Inclusion criteria:

Age:18-35 years old.

BMI:30-40 kg/m^2

At first trimester

Exclusion criteria:

Pregnancy with medical disorders

B) Maternal measurements:

1. Height: measured once with a stand meter approximated to 1 cm, with the mother standing without shoes.

2. Weight: obtained from the clinical record or herself in (kg) and measured with an electronic scale while subjects were wearing the possible lightest clothes.

Pregnant women were obtained according to pre pregnancy BMI or BMI calculated at the first trimester of pregnancy.

4.Maternal gestational age (length of gestation):

Calculated according to:

The date of last menstrual period.

The sonographic examination.

C) Clinical examinations(general and abdominal):

According to the standard antenatal record as routine examination, and recording any complications or significant changes in the previously reported findings

D) Investigations:

Investigation were done at the first antenatal visit then repeated the mid second and the mid third Trimester and included:

Complete blood picture and blood coagulation profile.

Random blood sugar.

Urine analysis.

E) Neonatal evaluation:

1) Birth weight at delivery was categorized as:

Suboptimal (<2500gm).

Optimal (2500-4000 gm).

Above optimal (>4000 gm).

2) Presence or absence of congenital anomalies.

3) The criteria of prematurity.

F) Obstetric outcome:

All women were followed till delivery and 2 weeks postpartum.

The results of this study were assessed by:

1. BMI calculated at first trimester.
2. Ultasonographic scan performed transabdominal or transvaginal at first antenatal Visit, second trimester (16-24 weeks) and at third trimester (32-38 weeks).
3. Maternal screening for pregnancy induced hypertension(PIH), DM and thromboembolism.
4. Maternal weight gain every antenatal visit.
5. Mode of delivery and neonatal outcome.

2.1 Statistical Analysis

The sample size was calculated using Epi-Info software statistical package created by World Health organization and center for Disease Control and Prevention, Atlanta, Georgia, USA version 2002. The criteria used for sample size calculation (n>33) were 95% confidence limit, 80% power of the study, expected outcome in in treatment group 90% compared to 60% for control groups.

Analysis of data were performed by SPSS v25 (SPSS Inc., Chicago, IL, USA). Quantitative parametric variables (e.g. age) were presented as mean and standard deviation (SD). They were compared between the two groups by unpaired student's t- test and within the same group by paired T test. Quantitative non-parametric variables (e.g. VAS) were presented as median and range and compared between the two groups by Mann Whitney (U) test and within the same group by Wilcoxon test. P value < 0.05 was considered significant.

3. RESULTS

The total participants included in our study were 100 pregnant obese women with BMI (30-40Kg/m^2).
They are matched for demographic data.

Table 1. Demographic data of cases

	Range	Mean ± S.D
Age (years)	18 – 35	27.22 ± 5.02
BMI (Kg/m^2)	30 – 40	32.97 ± 2.92

This table denotes range of age of studied cases from 18 years old to 35years old, so mean age was 27.22.

Also range of BMI of studied cases was from 30:40 Kg/m^2, so mean BMI was 32.97.

Table 2. Residence of studied cases

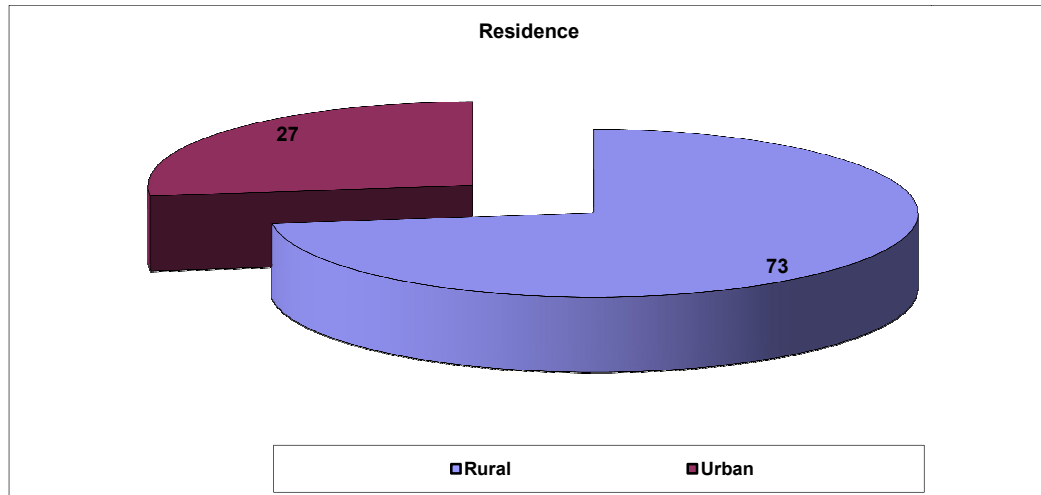| Residence	N	%
Rural	73	73
Urban	27	27
Total	100	100

Fig. 1. Residence of cases

This table and this figure are denoting residence of our case clarifying that majority of obese mothers (73%) settled in rural areas, while only 27% of cases settled in urban areas.

Table 3. Obstetric history

	Range	Mean ± S.D
Gravidity	1 – 8	2.75 ± 1.59
Parity	0 – 6	1.92 ± 1.15

This table denotes obstetric history of studied cases with minimum gravidity (1) and maximum (8), so mean gravidity was 2.75. Also with minimum parity (0) and maximum (6), so mean parity was1.92.

Table 4. Follow up of blood pressure at first and last visit

	Range	Mean ± S.D
Systolic1(mm/Hg)	100 – 120	102.95 ± 5.69
Diastolic1 (mm/Hg)	60 – 80	67.65 ± 5.00
Systolic2 (mm/Hg)	95 – 160	115.20 ± 15.95
Diastolic2 (mm/Hg)	60 – 110	74.15 ± 10.49

This table denotes antenatal follow up of blood pressure at first visit provided to studied cases and follow up offered to them allover pregnancy and early postnatal period.

Table 5. Follow up of random blood sugar at first and last visit

	Range	Mean ± S.D
RBS 1 (gm/dl)	79 – 130	104.30 ± 14.49
RBS 2 (gm/dl)	70 – 145	105.74 ± 17.83

This table denotes antenatal follow up of random blood sugar at first visit and later to detect any abnormality early.

Table 6. Expected fetal weight

	Range	Mean ± S.D
EFW (gram)	300 – 4000	2795.06 ± 626.34

This table denotes expected fetal weight measured during follow up visits.

Table 7. APGAR score of neonates

	Range	Mean ± S.D
APGAR 1	6 – 8	7.74 ± 0.61
APGAR 2	8 – 10	9.83 ± 0.56

This table denotes APGAR score done to neonates of studied cases at the first and the fifth minute of their lives.

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Table 8. Hemoglobin of obese mother before delivery

	Range	Mean ± S.D
HB (gm/dl)	6.1 – 12.7	10.55 ± 1.28

This table denotes hemoglobin of studied cases measured just before delivery or abortion.

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Table 9. Congenital abnormalities of neonates

Abnormally	N	%
No	75	75
Yes	9	9
Total	84	84

This table denotes incidence of congenital anomalies in our studied cases. 9% of infant to obese mothers, born with congenital anomalies while 75% of normally birth.

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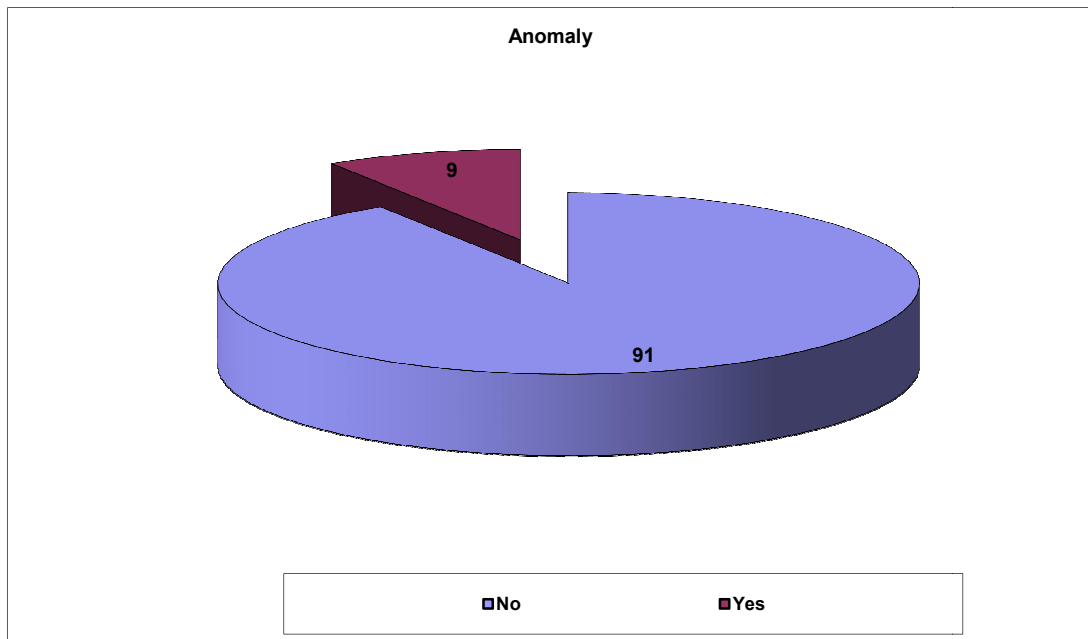
Fig. 2. Incidence of congenital anomalies of neonates of obese mothers

This figure also clarify percent of congenital anomalies in studied cases.

Table 10. Maternal complications

Maternal complications	N	%
Abortion	16	16
PET	8	8
Gestational DM	3	3
PTL	2	2
Anesthetic complications	2	2
Wound sepsis	18	18
Thromboembolism	2	2
Postpartum hemorrhage	15	15
Malpresentation	3	3

This table denotes maternal complications that developed and observed in studied cases like 16% of cases developed abortion, 8% developed PET, 3% developed GDM, 2% developed PTL, 2% developed anesthetic complications, 18% with wound sepsis, 2% with thromboembolism, 15% with postpartum hemorrhage .3% with malpresentation.
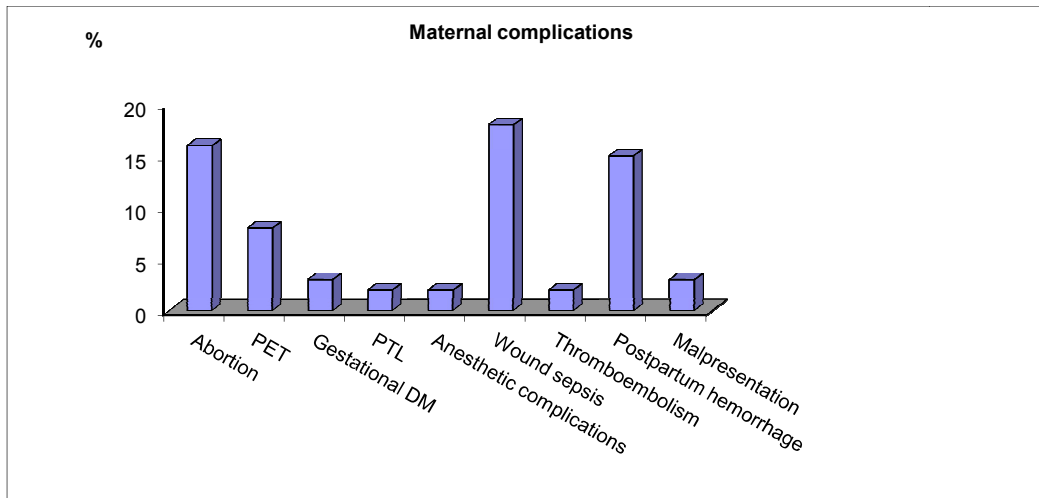
Fig. 3. Maternal complications of studied cases

This figure denotes various maternal complications that studied obese cases exposed to one or more of them.

This figure denotes fetal complications that happened in studied cases.

Table 11. Fetal complications of obese mothers

Fetal complications	N	%
Macrosomia	12	12
Congenital anomaly	9	9
IUGR	6	6
IUFD	8	8

This table denote fetal complications in studied cases macrosomic infants were 12%. IUGR&IUFD were 6,8 respectively.

Table 12. Neonatal complications

Neonatal complications	N	%
NICU	10	10
END	2	2
Jaundice	27	27

This table denotes neonatal complication that occurred to neonates born to obese mothers. 10% entered NICU .2% exposed to early neonatal death .27% developed jaundice.

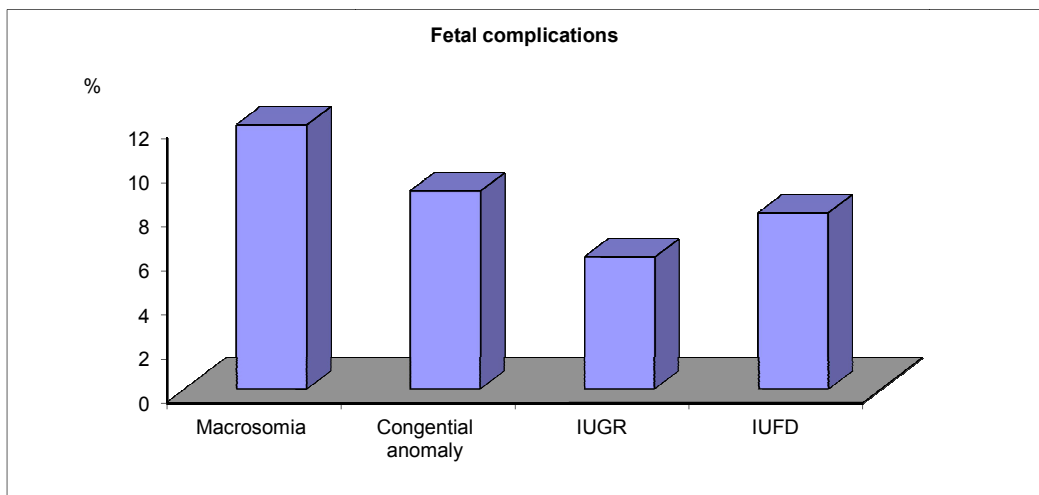This figure denotes neonatal complication that occurred to some of our cases.
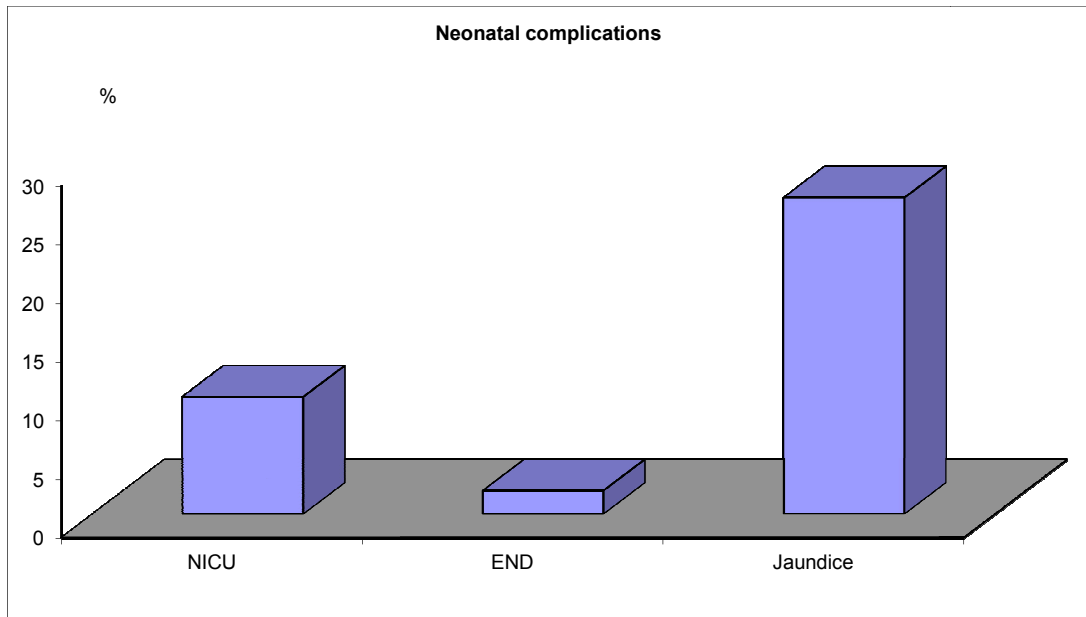

Fig. 4. Fetal complications

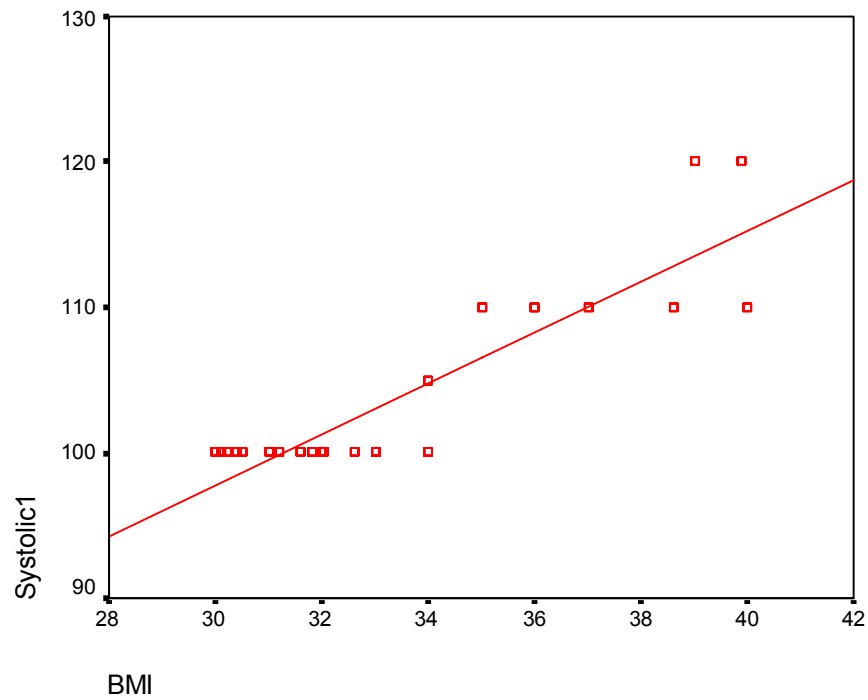**Fig. 5. Neonatal complications**

Fig. 6. Correlation between high BMI and systolic blood pressure measured at first antenatal visit

This figure denotes positive correlation between high BMI and systolic blood pressure measured at the first antenatal visit.
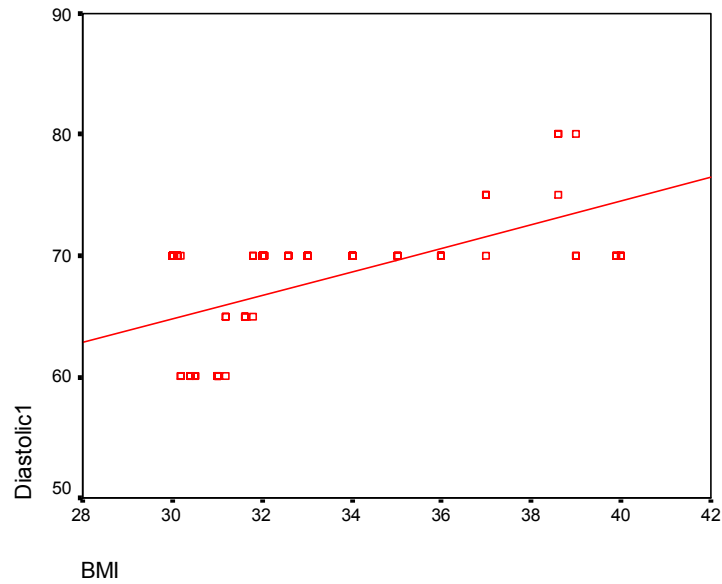
Fig. 7. Correlation between high BMI and diastolic blood pressure measured at first antenatal visit

This figure denotes the positive correlation between high BMI and diastolic blood pressure measured at the first antenatal visit.
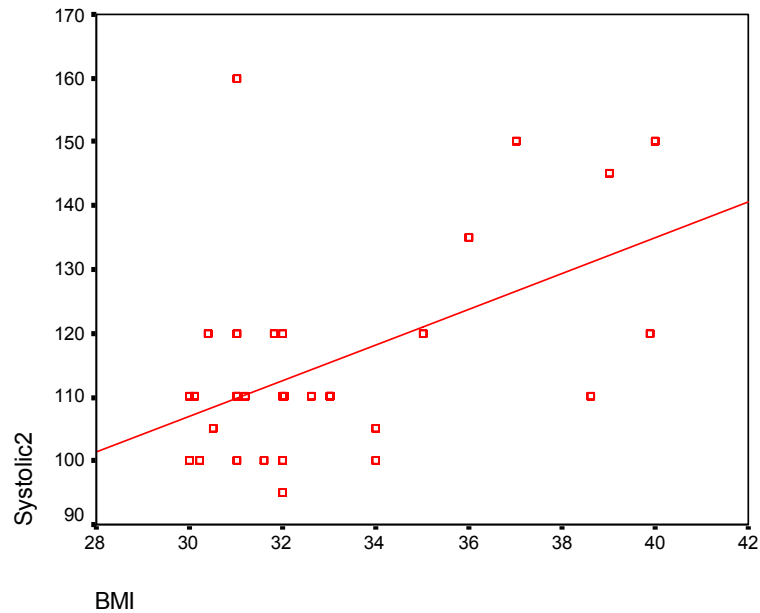

Fig. 8. Correlation between high BMI and systolic blood pressure measured at later antenatal visits

This figure denotes the positive correlation between high BMI and systolic blood pressure measured at later antenatal visits with progress of pregnancy.
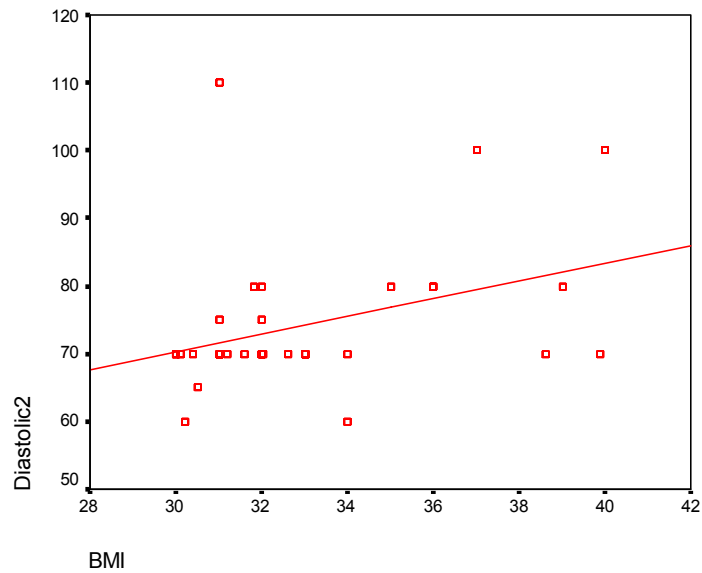
Fig. 9. Correlation between high BMI and diastolic blood pressure measured at later antenatal visits

This figure denotes the positive correlation between high BMI and diastolic blood pressure measured at later antenatal visits with progress of pregnancy.
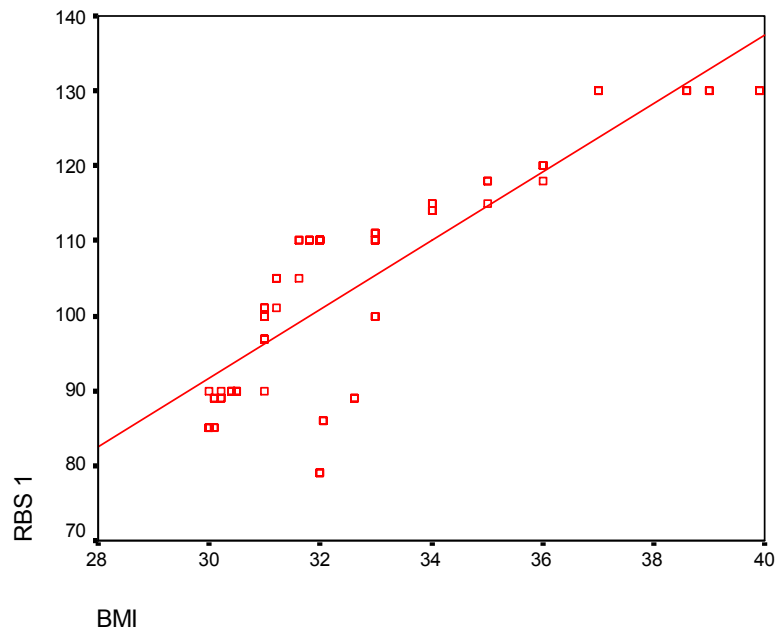

Fig. 10. Correlation between high BMI and random blood sugar measured at the first antenatal visit

This figure denotes the positive correlation between high BMI and random blood sugar measured at the first antenatal visit.
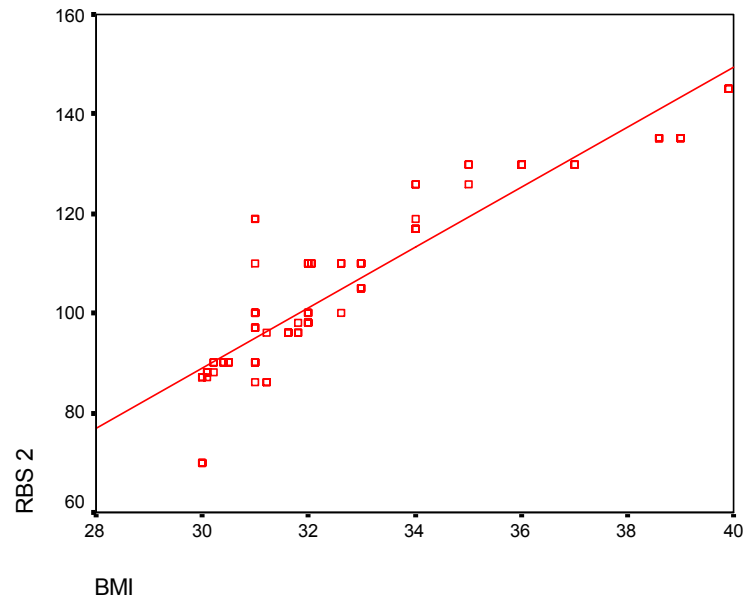
Fig. 11. Correlation between high BMI and random blood sugar measured at later antenatal visits

This figure denotes the positive correlation between high BMI and random blood sugar measured at later antenatal visits with progress of pregnancy.
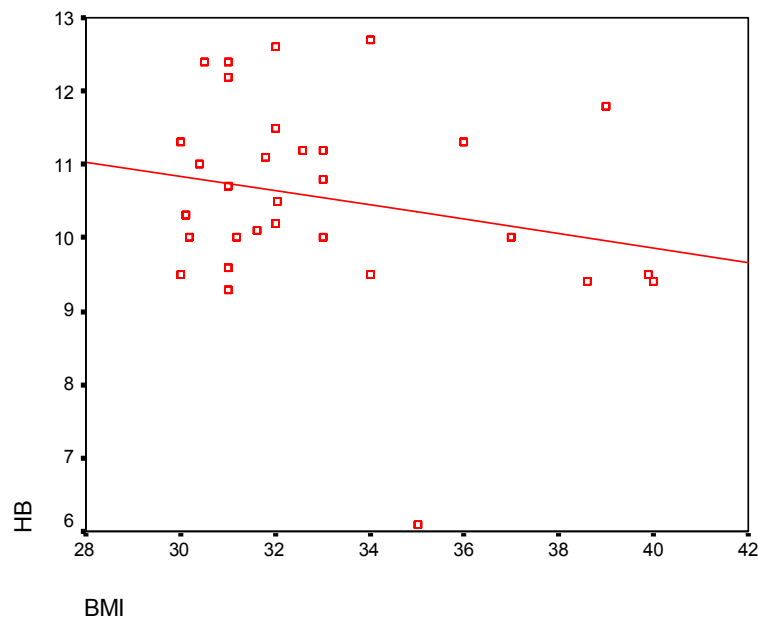

Fig. 12. Correlation between high BMI and HB

This figure denotes the negative correlation between high BMI and incidence of anemia due to unhealthy lifestyle.
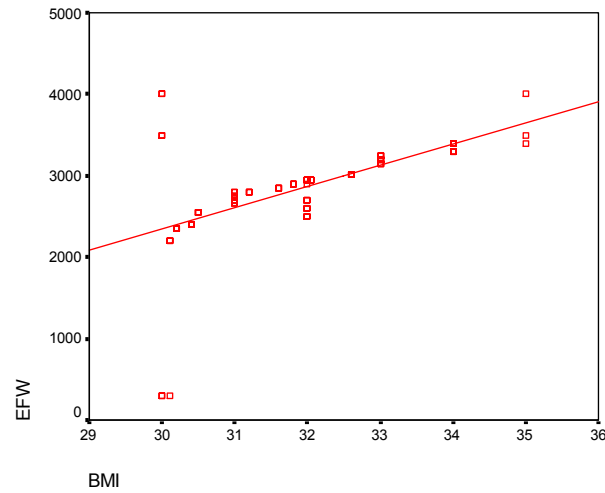
Fig. 13. Correlation between high BMI and expected fetal weight

This figure denotes the positive correlation between high BMI and increasing expected fetal weight.

Table 13. Correlation between high BMI &fetal complications

BMI	Fetal complications	
	No	Yes
Range	30 – 39	30 – 40
Mean ± SD	32.53 ± 2.44	34.16 ± 3.73
T. test	2.558	
P. value	0.012*	

Fig. 14. Correlation between high BMI and fetal complications

This table and figure denote the positive correlation between high BMI and incidence of fetal complications.

Table 14. Correlation between high BMI & neonatal complications

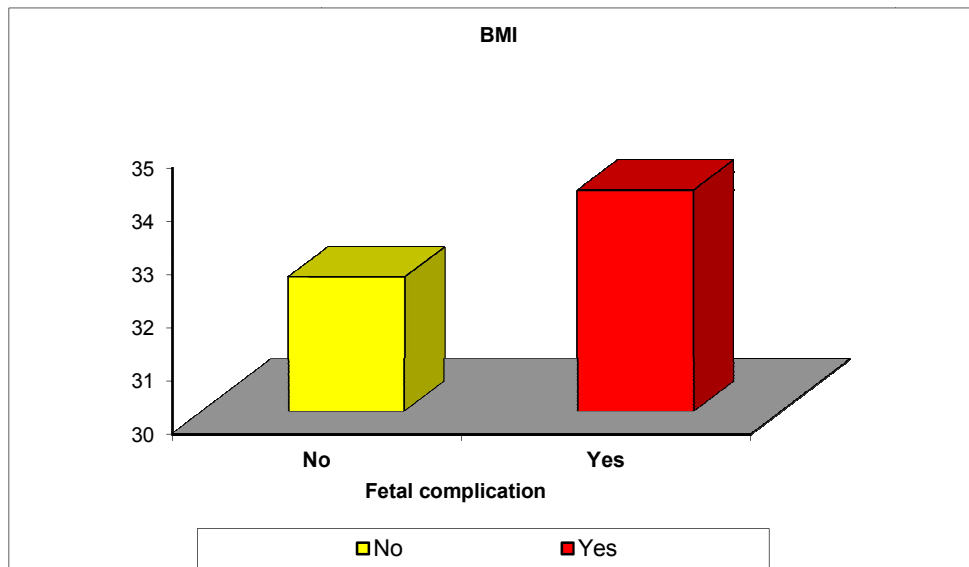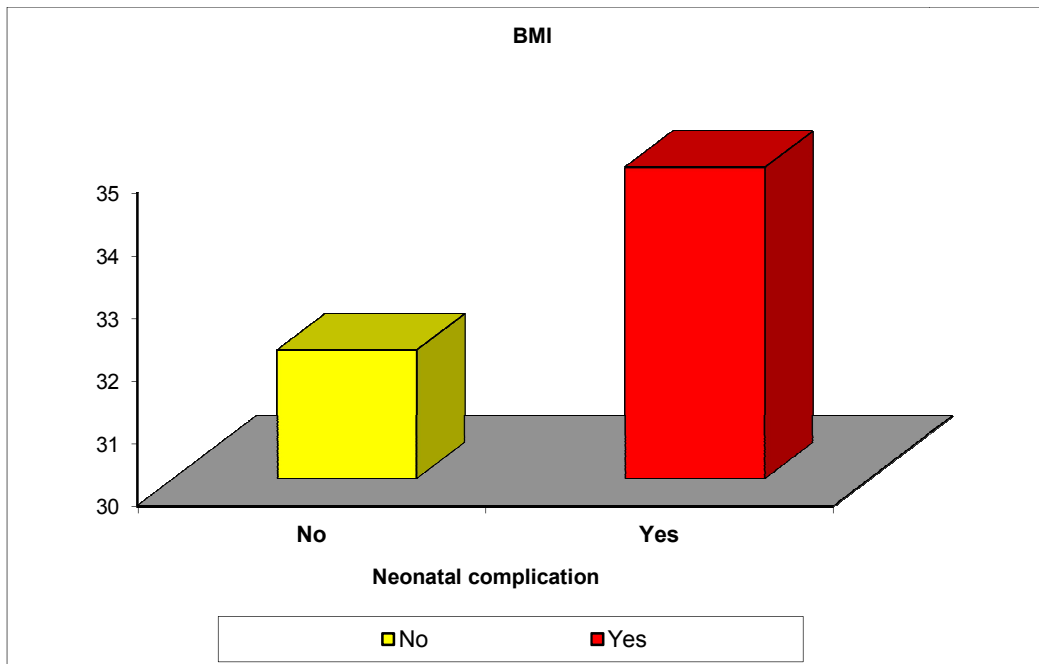| BMI	Neonatal complication	
	No	Yes
Range	30 – 39	30 – 40
Mean ± SD	32.06 ± 2.02	34.98 ± 3.58
T. test	5.190	
P. value	0.001*	

BMI

Fig. 15. Correlation between high BMI and neonatal complications

This table and figure denote the positive correlation between high BMI and incidence of neonatal complications.

This figure denotes a macrosomic baby weighing about 4000gm born to one of our obese mothers.

Fig. 16. Macrosomic baby born to obese mother

Fig. 17. Infected cesarean scar wound of obese mother

This figure denotes how obesity increase incidence of infection and bad healing process.

Fig. 18. DVT cellulitis in leg of obese mother

This figure denotes how obesity increases incidence of thromboembolism.

4. DISCUSSION

Obesity, which is broadly defined as excess body weight for a given height, remains a continuing global health concern, as it is associated with increased risk of numerous chronic diseases including type 2 diabetes (T2D), hypertension, and cardiovascular disease (CVD). Body mass index (BMI) (weight in kg/height in m^2), the most widely used formula to define obesity (BMI ≥30 kg/m^2), while not being a true measure of adiposity, is simple to use in health screenings and epidemiological surveys [13]. Obesity is a significant health concern among women of reproductive age. Obesity during pregnancy is associated with an increased risk of adverse perinatal outcomes and higher health care costs [14].

Our study analyzed 100 obese pregnant women (BMI =30-40 Kg/m^2 which measured at first trimester of pregnancy.

In our study, there is a significant relation between maternal obesity and menstrual history as most of cases started menarche at age of 10-12years old, the menses is regular with average duration 3-5days. age at menarche was inversely related with adiposity in adulthood. Early maturation could predict obesity in adulthood. Our study agreed with a previous study by Werneck et al., (2018), however Sohn, (2016) reported that the relationship between age at menarche and body mass index is negative. The size of the relationship, however, is negligible. It thus appears that age at menarche is not a good predictor of future body fat in Indonesia and possibly other developing countries [15].

Santangeli et al., (2015) recognized higher BMI as a risk factor for both mother and her fetus. Our study found that 16% of our obese cases experienced abortion, so we thought a relationship between obesity and incidence of abortion .our study agreed with Kaur et al., (2017), which found also that higher rate of abortion in obese women (7%) as compared to normal weight women (2%) [16].

Another study in Nepal made by Ghimire et al., (2020) found that obesity is associated with risk of miscarriage. Pregnancy planning and counselling on healthy weight for women of reproductive age in Nepal may help promote healthy behaviours and decrease the likelihood of miscarriage [17].

Regarding maternal complications in our study, there was significant relation between obesity and incidence of PET, gestational DM, post-partum hemorrhage, wound sepsis and anesthetic complications (p value=0.001). Little significant relation regarding preterm labor and thromboembolism.

3% of our cases experienced gestational diabetes, while 8% experienced preeclampsia (PET). Beside that 15% of our cases suffered from postpartum hemorrhage. Only 2% experienced preterm labor.

Our study agreed with Kaur et al., (2017) regarding increased incidence of eclampsia, gestational diabetes and postpartum hemorrhage with obesity with highest percentage in obese followed by overweight [18]. While our study disagreed with these study in in rate of incidence of PTL.

Our study agreed with Arora et al., (2013) regarding weak relation of incidence PTL among pregnant obese while disagreed with our study

regarding incidence of postpartum hemorrhage as they found no relation between obesity and incidence of postpartum hemorrhage [19].

Our result showed significant increase in rate of CS (58%) in obese mothers similar to Breckenkamp et al., (2019) who reported the same increase [20].

Another study made by Kinay et al., (2020) reported that Intra-abdominal adhesion formation following cesarean delivery is more common in obese women [21].

In our study, only 2% of our studied cases developed thrombo embolism .James, (2015) concluded in their study that Pregnancy increases the risk of thrombosis four- to five-fold. 75 to 80% of pregnancy-related thrombotic events are venous and 20 to 25% t are arterial. The main reason for the increased risk is hypercoagulability. Both genetic and environmental risk factors can increase the risk of thrombosis. The maternal consequences of thrombosis of pregnancy include permanent vascular damage, disability, and death [22].

A previous study made by Tsai and Marshall, (2015) discovered that Thromboembolic disease was noted to be 4 to 5 times higher in the pregnant-state ,which is the leading cause of maternal death in the United States. Obesity increased the risk of VTE by 4.4 times When compared to nonobese women, moderately obese women had double the risk of antepartum VTE and severely obese women had four times the risk of antepartum VTE [23].

A Danish study noted obesity to be associated with increased risk of VTE during pregnancy and puerperium specifically. Obesity was associated with a higher risk of PE compared to deep venous thrombosis. In a study from Norway, BMI>25 kg/m^2 in combination with immobilization increased the risk of antepartum VTE by 62 folds [24].

Regarding fetal complications, our study found statistically significant relation between obesity and incidence of fetal complications(p value =0.012).one of these fetal complications were macrosomia and high birth weight >3500gm. 12% of our cases delivered macrosomic infants .our study agreed with a previous study made by Dai et al., (2018) which found that pre-pregnancy obesity should be considered as an important risk factor for macrosomia [25].

9% of our cases delivered infant with congenital anomalies. Dodd and Clare, (2017) reported that several possible pathways have been postulated in setting a relation of maternal obesity to incidence of congenital anomalies. However, absolute contribution of maternal obesity to the risk of fetal anomalies remains difficult to determine [26].

Our study reported no significant relation regarding IUGR&IUFD. Other studies like ElShanti et al., (2020) suggest that obesity may be one of the factors leading to IUGR&IUFD [27].

Our study reported only 2% of obese mothers suffered from early neonatal death (END). Mitanchez and Pascale, agreed with our study that Maternal obesity alone increased the risks for adverse neonatal outcomes, including macrosomia, perinatal mortality, induced preterm birth and birth defects [28].

Our study demonstrates that increasing maternal BMI is significantly associated with poor fetal Apgar scores and increased NICU admission.

Barthélémy and Mbangama, (2015) [29] found higher significant increased blood pressure, low hemoglobin level, increased level of glucose among obese pregnant women in follow up [30].

Also Parveen et al., (2018) admitted in their study that maternal obesity as an important risk factor for serious obstetric complications like GDM, PIH, pre-eclampsia and caesarean section. The association of low Apgar scores and maternal BMI was mostly linear with increasing weight. Similarly, NICU admission rate was significantly associated with greater maternal BMI. It showed strong relationship of obesity and low apgar scores at 5 min [31].

Finally, our study recorded 52% of infants of our studied cases were having mix between breast feeding and artificial milk(Mean ± SD= 33.56 ± 1.97).20% were having exclusive breast feeding (Mean ± SD=32.88 ± 2.39). 10% were having only artificial milk(Mean ± SD=36.53 ± 4.19)

Another study by Fan and Amanda, (2021) [32] admitted that maternal obesity at eight weeks postpartum was high with overweight or obese mothers. Breastfeeding initiation was high across all BMI categories at 98.3%. By eight weeks, 32.2% of mothers had ceased breast feeding. Breastfeeding continuation at eight weeks was negatively correlated with elevated BMI.

Breastfeeding cessation in mothers with elevated BMI correlated with psycho-social concerns and lack of previous breastfeeding experience.

Our study agreed that pregestational obesity is associated with numerous maternal, fetal and neonatal risks [33].

5. CONCLUSIONS

A causal relationship between the pre pregnancy BMI and obstetric complications is proven. Weight management is important for every women of reproductive age. Thus, medical Practice must consider these complications by providing early detection and management to improve both maternal and neonatal outcome.

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline Patient's consent and ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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