child. This objective can be subdivided into the screening and /or prevention of maternal and fetal problems, and the preparation of couple for childbirth and child bearing. Though all mothers and children are vulnerable to disease or disability, there are certain mothers and infants who are at increased or special risk of complications of pregnancy/labor or both. "A risk factor is defined as any ascertainable characteristic or circumstance of a person (or group of such persons) known to be associated with an abnormal risk of developing, or being adversely affected by a morbid process" (WHO, 1973). Risk factors can be used to predict causes or signal, which are identifiable before the chaihuf event and unforeseen complication that can follow.

High-risk pregnancy identification is a challenging work. Many indicators have been developed to recognize high-risk pregnancy. The determination of high-risk pregnancy indicators is aimed to help the obstetricians to identify the patients in need of special attention, and also to elaborate a prognosis for them. To fulfill this need, several high-risk identification systems have been developed, but they are not suitable for all population 14 . The aim of the risk approach is to predict problems before they arrive so that women designated as high-risk can receive special attention and further care in hospital setting. Two of the important determinants of obstetric risk consist of maternal height and weight. Many studies and literature stress on the use of these indicators for identification of high-risk pregnancy. In developing countries, there is a need for the development of indicators which can be utilized at primary health care level easily. Several studies recommend the use of maternal height and weight as simple and sensitive indicators of pregnancy outcome. They are especially useful for prediction of mode of delivery, low birth weight babies and birth asphyxia. WHO collaborative study15 of maternal anthropometry and pregnancy outcome recommend the use of maternal height and weight for screening in its service application. A woman's prepregnancy body mass index (BMI) has been used as a marker of her nutritional status. Being underweight, may reflect chronic nutritional deficiency, whereas a high BMI reflects an imbalance between energy intake and expenditure and thus varying degrees of adiposity.

The Body Mass Index (BMI), or Quetelet index, is a statistical measurement which compares the patience's height and weight. Though it does not actually measure the percentage of body fat, it is used to estimate a healthy body weight based on how tall a person is. Due to its ease of measurement and calculation,it is the most widely used diagnostic tool to identify weight problems within a population, whether individuals are underweight, overweight or obese. It was invented between 1830 and 1850 by the Belgian polymath Adolphe Quetelet during the course of developing "social physics" 16. The advantage of using this index, rather than weight alone is that it is height independent, such that tall and short people of similar proportions have a similar BMI. A large body of data links a high pre-pregnancy BMI with a number of fetal and maternal complications including fetal death, pre-eclampsia, gestational diabetes, and macrosomia Obesity is fast becoming one of the major health problems and being pregnant contributes further to obesity. Maternal and neonatal complications associated with BMI are of public health importance because they add to the disease burden in women and children and increase medical costs. The association of pre-pregnancy body mass index (BMI) has been thoroughly studied as a predictor of adverse pregnancy outcomes mainly because of the belief that it is potentially modifiable before conception.

MATERIAL AND METHOD

This study was conducted after getting ethical clearance from the University ethical committee. In the present study, the pre-pregnant Body Mass Index (BMI) of 300 pregnant women with singleton pregnancy attending the antenatal clinic was calculated and they were placed in standard BMI categories and the obstetric outcome variables were evaluated.

Type of study: Prospective study

Study population: 300 pregnant women with singleton pregnancy based on the inclusion and exclusion criteria

Study setting: Depart-aaent of Obstetrics and Gynaecology, Sree Balaji Medical College and l-iospital, Chrompet, Chennai.

Inclusion criteria

- Age of 18 - 35 years
- Singleton pregnancy
- 1st trimester visit for confirmation of pregnancy
- Spontaneous conception
- Patients who can self report their pre- pregnancy BMI or have a record of it.

Exclusion criteria

- History of Gestational Diabetes Mellites or Hypertension in the previous pregnancy
- Diagnosed Diabetes Mellites, Hypertension, Hypothyroidism or Renal Diseases
- Women with multiple pregnancy
- Women with previous Caesarean Section

Methodology

300 women with singleton pregnancies attending the antenatal clinic at Sree Balaji Medical college and Hospital, Chrompet, Chennai who met the inclusion and exclusion criteria were taken into the study after signing an informed and written consent. Their pre-pregnancy Body Mass Index was calculated from their height and pre-pregnancy weight. They were then placed into 4 groups based on the following criteria.

a. Underweight - BMI less than l 8.5kg/m2

b. Normal - 18.5 to 24.9kg/m2

c. Overweight - 25 to 29.9kg/m2

d. Obese - 30kg/m2 and above

Detailed history including the obstetric score, last menstrual period (LMP), estimated due date (EDD), gestational age were taken and thorough general physical examination was done at the onset of the study. Routine antenatal care was given to all the subjects.

First trimester (upto 12 weeks): All women were subjected to the routine antenatal investigations like Blood Grouping and typing, Haemoglobin, Urine routine analysis, HIV, HBsAg, VDRL, Thyroid Stimulating Hormone (TSH) and oral glucose challenge test (OGCT).

Second trimester (12 - 28 weeks): Iron and Calcium supplements were started after 20 weeks. 2 doses of Injection Tetanus Toxoid were given at 20 and 28 weeks. At 20 weeks , patients were subjected to a detailed Anomaly Scan. At 24 - 28 weeks Oral Glucose Challenge Test (OGCT) was again performed and documented.

Third trimester (28 weeks till delivery): Till 30 weeks, the patient was reviewed every 4 weeks and then every 2 weeks upto 36 weeks and weekly after that till delivery. At each visit, Blood pressure was noted and thorough general examination was conducted including an abdominal examination to look for the fundal height, fetal heart and position of the fetus.

Outcome variables

The outcome variables of the study included:

Development of hypertensive disorders of pregnancy

which included gestational hypertension, pre-eclampsia, eclampsia and HELLP syndrome. Women with Chronic hypertension were excluded from this study. Diagnosis of Gestational Hypertension was made if Systolic Blood Pressure was more than l 40mmHg and Diastolic Blood Pressure more than 90mmHg after 20 weeks of gestation. Preeclamp ia was diagnosed if Proteinuria >300 mg/24 hrs or > 1+ in dipstick along with increased BP. If the patient developed seizures it was termed as eclampsia.

Development of Gestational Diabetes Mellitus (GDM)

GDM was diagnosed based on the following criteria of the DIPSI guidelines (Table 1)

Table 1: Overt Diabetes Gestational Diabetes Mellitus.

2 hr= > 200 mg/dl	Overt Diabetes
2 hr= 140 - 200 mg/dl	GDM
2 hr= 120 - 140 mg/dl	DGGT

Development of any infections like antenatal infections, bacterial vaginosis, postpartum sepsis

Outcome of pregnancy - spontaneous abortions, medically indicated abortions, live birth, still birt DGGT

Presence of congenital anomalies like neural tube defects, heart defects, ventral wall defects, and orofacial clefts

Duration of Pregnancy - Preterm, Term, Prolonged pregnancy

Onset of labour - Spontaneous or induced

Statistical analysis

Statistical analysis was done using SPSS version 17. Categorical variables were reported usin g number and percentages . Trend Chi-squire test and Fisher's Exact Test was done to find the association between the BMI categories and the outcome variables. P value < 0.05 was consider ed to be significant.

RESULTS

A Table 2 and Figure 1 shows that only 5.67% (n= 17) of our study population were in the Underweight group. 34.33% (n= 103) of the women were grouped as Normal. Overweight group had 43% (n= 129) and the remaining 17% (n= 51) were grouped as Obese.

Table 2: Distribution of subjects in different BMI groups.

BMI CLASSIFICATION	TOTAL	%
Under weight	17	0.0567
Normal	103	0.3433
Over weight	129	0.43
Obese	51	0.17
Total	300	1

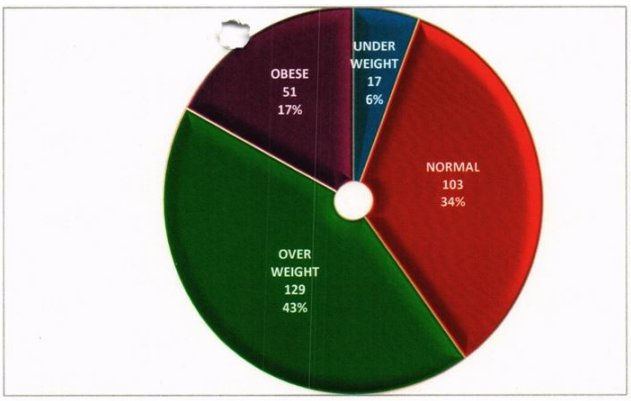

Figure 1: Distribution of subjects in different BMI groups.

Table 3 and Figure 2 depicts that the majority (66.33 % (n= 199)) of the study population were in the age group between 23-29 years. Mean age of women in the study was 24.89 years.

Table 3: Sample distribution according to age.

BMI CLASSIFICATION	AGE GROUP				
	18 - 22	23-29	30-35	TOTAL	%
Under weight	3	10	4	17	0.0567
	0.1765	0.5882	0.2353	1	
Normal	21	77	5	103	0.3433
	0.2039	0.7476	0.0485	1	
Over weight	33	84	12	129	0.43
	0.2558	0.6512	0.093	1	
Obese	12	28	11	51	0.17
	0.2353	0.549	0.2157	1	
Total	69	199	32	300	1
%	0.23	0.6633	0.1067	1	

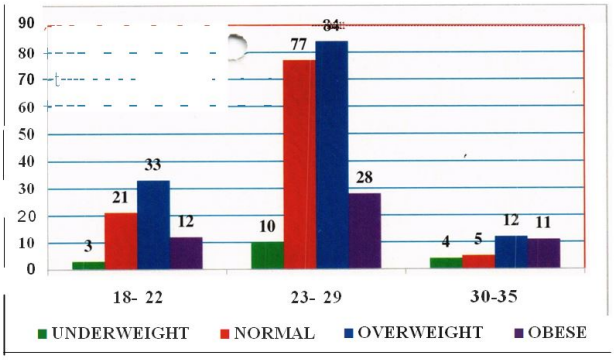

Figure2: Sample distribution according to age.

Table 4 and Figure 3 shows that majority of the women (70 % n= 210) were nulliparae (Primi).

Table 4: Sample distribution according to parity.

BMI CLASSIFICATION	PARITY				
	PRIM!	**Pl**	**P2&>**	**TOTAL**	**%**
Under weight	6	9	2	17	0.0567
	0.3529	0.5294	0.1176	1	
Normal	75	25	3	103	0.3433
	0.7282	0.2427	0.0291	1	
Over weight	93	32	4	129	0.43
	0.7209	0.2481	0.031	1	
Obese	36	11	4	51	0.17
	0.7059	0.2157	0.0784	1	

Total	210	77	13	300	1
%	0.7	0.2567	0.0433	1	

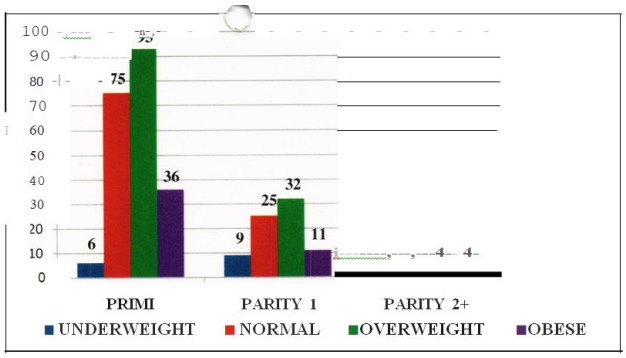

Figure3: Sample distribution according to parity.

Table 5 and Figure 4 shows that 32.67% (n= 98) of the women belonged to upper lower class and 31.67% (n= 95) of women belonged to lower middle class. 23% (n= 69) of women were in the upper middle class. Only 5.33% (n= 16) were in the Upper class.

Table 5: Sample distribution according to socio economic classification.

	CLASSIFICATION						
BMI CLASSIFICATION	**Upper**	**Upper middle**	**Lower middle**	**Upper lower**	**Lower**	**Total**	**%**
Under weight	0	0	5	6	6	17	0.0567
	0	0	0.2942	0.3529	0.3529	1	
Normal	5	26	42	28	2	103	0.3433
	0.0485	0.2524	0.4078	0.2718	0.0194	1	
Over weight	9	32	34	49	5	129	0.43
	0.0698	0.2481	0.2636	0.3798	0.0388	1	
Obese	2	11	14	15	9	51	0.17
	0.0392	0.2157	0.2745	0.2941	0.1765	1	
Total	16	69	95	98	22	300	1
%	0.0533	0.23	0.3167	0.3267	0.0733	1	

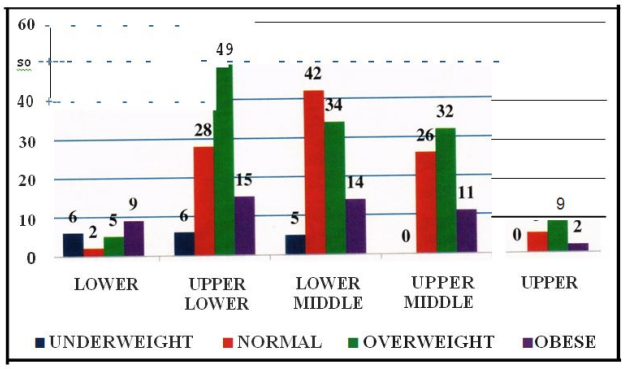

Figure4: Sample distribution according to socio economic classification.

Table 6 and Figure 5 shows that the incidence of Gestational Hypothyroidism in our study was 5.33% (n= 16). 9.80% of obese population developed hypothyroidism compared to 1.94% in the normal population. This shows that there is a statistically significant correlation of pre-pregnancy BMI and the incidence of Hypothyroidism in overweight and ooese groups (p value= <0.001)

Table 6: Correlation of prepregnant bmi and the incidence of hypothyroidism.

BMI CLASSIFICATION	HYPOTHYROID		
	YES	NO	TOTAL
Under weight	1	16	17
	0.0588	0.9412	1
Normal	2	101	103
	0.0194	0.9806	1
Over weight	8	121	129

	0.062	0.938		1
Obese	5	46	51	
	0.098	0.902	1	
Total	16	284	300	
%	0.0533	0.9467	1	
Chi-Square Test	Value	P - Value		
Trend Chi-Square Test	12.976	<0.001		

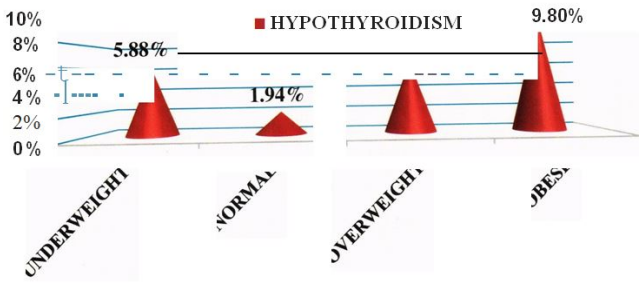

Figure5: Correlation of prepregnant bmi and hypothyroidism.

Table 7 and Figure 6: The prevalence of GDM in our study was 13.67 % (n= 41). 27.45% (n=14) obese and 13.95% (n = 18) overweight developed GDM compared to only 7.77% (n= 8) normal subjects and 5.88% (n= 1) underweight subjects developing GDM. This shows that there is a significant correlation of rising prepregnancy BMI on the incidence of GDM.

Table 7: Correlation of prepregnant bmi and the incidence of GDM.

BMI CLASSIFICATION	Gestational Diabetes Mellitus		
	YES	NO TOTAL	
Under weight	1	16	17
	0.059	0.9412	1
Normal	8	95	103
	0.078	0.9223	1
Over weight	18	111	129
	0.14	0.8605	1
Obese	14	37	51
	0.275	0.7255	1
Total	41	259	300
%	0.137	0.8633	1
Chi-Square Test	Value	P- Value	
Trend Chi-Square Test	10.622	0.001	

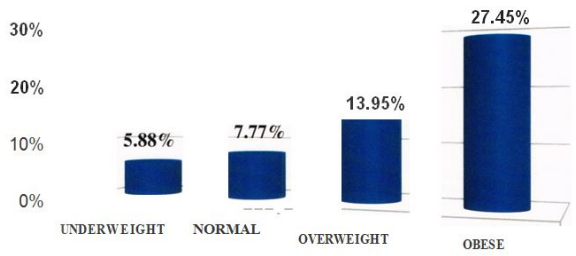

Figure6: Correlation of prepregnant bmi and the inodence of GDM.

Table 8 and Figure 7: The incidence of hypertensive disorders of pregnancy was 21.57% (n= 11) and 10.85% (n= 14) in obese and overweight groups respectively compared to an incidence of 9.71% (n= 10) in the. normal group. This shows that since the p value is less than 0.05, there is a significant increase in the incidence of Hypertensive disorders of pregnancy in rising BMI groups.

Table 8: Correlation of prepregnant BMI and the lcidrnc opiivprlltrn ionni oimrng or pregnancy.

BMI CLASSIFICATION	Hypertensive disorders		
	YES	NO	TOTAL
Under weight	1	16	17
	0.0588	0.9412	1
Normal	10	93	103
	0.0971	0.9029	1
Over weight	14	115	129
	0.1085	0.8915	1
Obese	11	40	51
	0.2157	0.7843	1
Total	36	264	300
%	0.12	0.88	1
Chi-Square Test	Value		P - Value
Trend Chi-Square Test	4.154		0.042

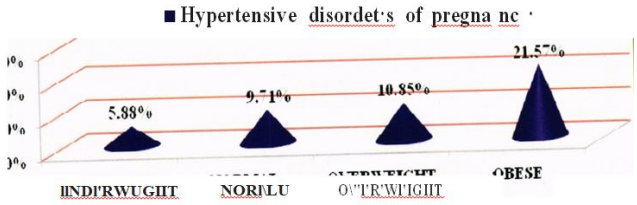

Figure7: correlation of prepregnant BMI and ypertension.

Table 9 and Figure 8: The overall prevalence of anaemia in our study was 26.33%. More than half (52.94%) the underweight population was anaemic. Only 21.71% and 21.57% of the overweight and obese groups developed anaemia. Since p value is less than 0.05.

Table 9: Correlation of prepregnant BMI and the lcidrnc opiivprlltrn ionni oimrng or pregnancy.

BMI CLASSIFICATION	ANEMIA		
	YES	NO	TOTAL
Under weight	9	8	17
	0.529	0.4706	1
Normal	31	72	103
	0.301	0.699	1
Over weight	28	101	129
	0.217	0.7829	1
Obese Class I	11	40	51
	0.216	0.7843	1
Total	79	221	300
%	0.263	0.7367	1
Chi-Square Test	Value		P- Value
Trend Chi-Square Test	6.137		0.013

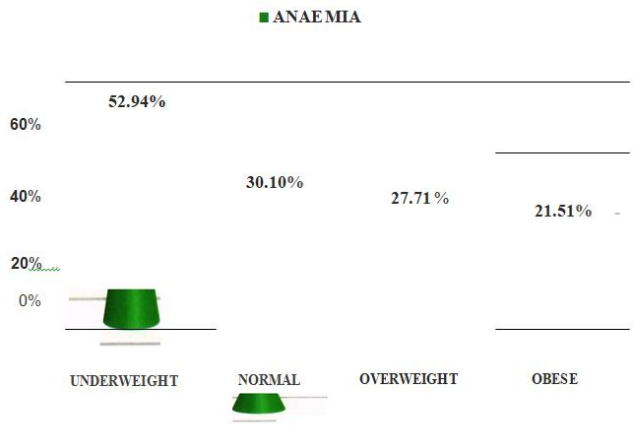

Figure8: Correlation of prepregnant BMI and anemia.

Incidence of Anaemia is significantly increased in underweight groups than overweight/obese groups.

Table 10 shows that 95% live birth was seen in our study; 1.67% medically indicated abortions; 2.67% spontaneous abortions and 2 still births are seen.

Table 10: Correlation of BMI with outcome of pregnancy.

BMI classification	Spont ab	Medically indicated ab	Live birth	Still born	Total
Under weight	0	0	16	1	17
	0	0	0.9412	0.06	1
Normal	1	1	101	0	103
	0.0097	0.01	0.9806	0	1
Over weight	3	2	123	1	· 129
	0.0233	0.016	0.9535	0.01	1
Obese	4	2	45	0	51
	0.0784	0.039	0.8824	0	1
Total	8	5	285	2	300
%	0.0267	0.017	0.95	0.01	1

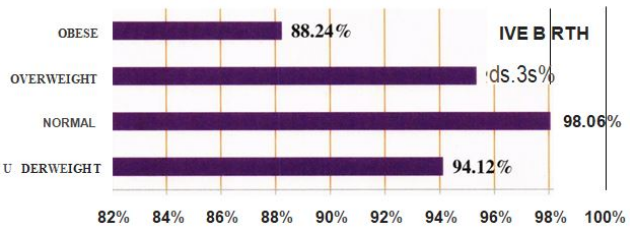

Figure9: Correlation of BMI with live birth rate.

Table 11 and Figure 9 shows that since $p < 0.05$, significant association of BMI and live birth rate exists.

Table 11: Correlation of BMI with live birth rate.

Chi-Square Test	Value	P- Value
Trend Chi-Square Test	7.126	- 0.046

DISCUSSION

In this study, 300 singleton pregnant women attending the Antenatal OPD of Sree Balaji Medical College and Hospital, Chrompet, Chennai from September 2012 who met the inclusion and exclusion criteria were studied.

The women in our study were divided into four BMI groups based on their pre-pregnancy BMI. They were:

a. Underweight- BMI less than 18.5kg/m 2

b. Normal - 18.5 to 24.9kg/m 2

c. Overweight - 25 to 29.9kg/m2

d. Obese - 30kg/m2 and above

Only 5.67% (n= 17) of our study population were in the Underweight group. BMI between l 8.5-24.9kg/m2 was seen in 34.33% (n= 103) of the women and they were grouped as Normal. Overweight group had 43% (n= 129) of the women and the remaining 17% (n= 51) of the women had a BMI of 30kg/m2 and above and were grouped as Obese. Majority of the women (43%) in our study population belonged to the Overweight BMI group and a small population (5.6%) belonged to the Underweight category. This high prevalence of obesity was contrary to our expectations , since most of our women belonged to lower middle or upper lower socioeconomic class. This could possibly be due to an increasing influx of the IT industry around Chrompet. The food habits and sedentary lifestyle changes could

have resulted in weight gain and there by this high incidence of overweight and obese women in our study.

Demographic characteristics

The mean age of women in the study was 24.89 years, with 66.33% (n= 199) being in the age group between 23-29 years. 23% (n= 69) were in the age group less than 23 yrs and 10.67% (n= 32) were in the age group 30 - 35 years.

In the present study, majority of the women (70 %; n= 210) were nulliparae (Primi). 27.67% women had delivered once (Pl) and 4.33% were multiparous (P=2+)

In our study, 32.67%.J);i= 98) of the women belonged to upper lower class and 31.67% (n.... 95) of women belonged to lower middle class. 23% (n= 69) of women were in the upper middle class. Only 5.33% (n= 16) were in the Upper class.

Hypothyroidism

The incidence of Gestational Hypothyroidism in our study was 5.33% (n= 16). This relatively high prevalence did not corroborate with the available data of 2-3% prevalence for subclinical hypothyroidism in western studies80 and a study of five hundred pregnant women attending two government Obstetrics and Gynecology hospitals in Chennai (2.8%)21. But in another multi-centered epidemiology study conducted at eight sites in India including Chennai, they reported a prevalence of 9.77% of Hypothyroidism in adults in Chennai. This variation in statistics may be due to the reason that subclinical thyroid dysfunction is probably more prevalent and frequently remains undiagnosed, unless specific screening programs are initiated to disclose thyroid function abnormalities in early gestation. Our study shows a statistically significant trend between pre-pregnancy BMI and the incidence of Hypothyroidism (p value= <0.001) concludfog that there is an increase in the incidence of Gestational Hypothyroidism in women with higher pre-pregnancy BMI. Previous studies have indicated positive associations between TSH and BMI in nonpregnant individuals22, 23 . Studies stated that the maternal body mass index (BMI) prior to pregnancy was positively associated with T3 and FT3. Boas Forman et al and Mbah et al. also reported higher pre-pregnancy body mass index (BMI) to be associated with gestational hypothyroidism similar to our study.

GDM

The prevalence of GDM in our study was 13.67% (n= 41). In India it is difficult to predict any uniform prevalence levels because of wide differences in living conditions, socio-economic levels and dietary habits. In a random survey performed in various cities in India in 2002-2003, an overall GDM prevalence of 16.55 per cent was observed17. In another study done in Tamil Nadu, GDM was detected in 17.8 per cent women in urban, 13.8 per cent women in semi-urban and 9.9 per cent women in rural areas88. In our study, 27.45% (n=l4) obese and 13.95% (n = 18) overweight developed GDM compared to only 7.77% (n= 8) normal subjects and 5.88% (n= 1) underweight subjects developing GDM. The trend Chi square test gives a p value of 0.001which emphasizes that there is a significant correlation of rising prepregnancy. BMI on the incidence of GDM. This is in agreement with Sabire and Colleagues who found a twofold increase in the rate of GDM in the obese. Kumari et al comparing obese and non-obese patients, found a rate of GDM of 24.5% for the obese and 2.2%for the non-obese. The risk of GDM is positively correlated with increasing BMI.

Hypertensive disorders

Earlier studies have shown an association between increasing BMI and preeclampsia. Bianco and colleagues 40 conducted a retrospective cohort study of 613 obese women and 11313 nonobese women. A fourfold increased risk for preeclampsia was reported in obese women. Kumari et al evaluated 159 obese women & 300 non obese women and concluded that a BMI greater than 40kg/m2 was associated with hypertensiv '--.0.. ...1. sorder of pregnancy in 28.8% compared with 2.9% in the non obese women.

Our study also showed a positive association of raised BMI and preeclampsia. The incidence of hypertensive disorders of pregnancy was 21.57% (n= 11) and 10.85% (n= 14) in obese and overweight groups respectively compared to an incidence of 9.71% (n= I 0) in the normal group. We also found a significantly lower risk of pre-eclampsia in underweight women (5.88%), a finding corroborated by Sebire et al20. A meta-analysis of the risk of pre-eclampsia associated with maternal BMI19 showed that the risk of pre-eclampsia doubled with each 5 to 7 Kg/m2 increase in pre-pregnancy BMI. Frederick et al. found that every 1 kg/m2 increase in pre-pregnancy BMI resulted in an 8% increased risk of preeclampsia. We had similar results in our study. The p value for correlation of pre-pregnant BMI with hypertensive disorders wasp= 0.042 which is less than 0.05 and hence in our study also there is a significant correlation of pre-pregnant BMI with incidence of hypertensive disorders in pregnancy. The trend is that there is a significant rise in the incidence of hypertensive disorders of pregnancy with rising BMI.

Anaemia

In this study, we found that both overweight and obesity were inversely associated with anemia. The overall prevalence of anaemia in our study was 26.33%. More than half (52.94%) the underweight population was anaemic. Only 21.71% and 21.57% of the overweight and obese groups developed anaemia. This observation is in support with a retrospective cohort study of 437 403 births, anaemia was found to be more prevalent among-"". omen who were underweight compared to the reference group (p < 0.01)91 . Bmi < 18.5 has also been associated with iron deficiency anaemia likely due to poor diet. In our study, the significance level was 0.013. Since p value is less than 0.05, incidence of Anaemia is significantly increased in underweight groups than overweight/obese groups.

Outcome of pregnancy

In our study 98.06% (n= 101) live births was seen only in the normal BMI group. It decreases as the BMI becomes abnormal - 94.12% (n= 16) in underweight women ; 95.35% (n= 123) in overweight women and 88.24% (n=45) in obese group. This trend of decreasing live birth rate as the BMI becomes abnormal is significant (p= <0.05). This may be due to the increase in abortions in obese and overweight groups. 2.33% (n= 3) of overweight population had spontaneous abortion and 1.55% (n= 2) had medically indicated abortions. 7.84% (n= 4) of obese women had spontaneous abortions and 3.92% (n= 2) had medically indicated abortions compared to 0.97% (n=l) of normal women having spontaneous and medically indicated abortions each. We observed a significant increasing trend in spontaneous abortions in increased BMI groups (p = 0.026). Though we did not have a significant level when medically indicated abortions was analysed (p= 0.266), it may be due to the fact that only 1.67% (n= 5) of our study population had medically indicated abortions. The increase in abortions in increased BMI groups (overweight and obese) is corroborated with earlier reports23' 24 which suggested that obese women have an increased risk of early miscarriage both after spontaneous conception and infertility treatment. A recent meta-analysis 25 involving , studies concluded that obesity may increase the risk of miscarriage after spontaneous and assisted conception.

Labour induction

In this study, 37.82% (n= 104) of women experienced induction of labor (4% (n=l 2) of population who underwent elective cesarean delivery are deleted). We also found that greater prepregnancy BMI was significantly related to an increased risk of induction (P = 0.032). The rates of induction were - 46.34% (n= 19) in obese group and 38.66% (n = 46) in overweight group compared to a decrease in the rate of induction among normal and underweight groups - 36.73% (n= 36) and 17.65% (n= 3) respectivel y. This confirms the findings of Sebire et al. Bianco AT et al. also reported obese women to have a 1.7 - 2.2 fold increased incidences of labour induction. The review of the literature failed to reveal research into possible reasons why obese women may be less likely to go into spontaneous labor and why they may experience more fetal compromise, even in the absence of postdates or hypertension.

CONCLUSION

Our study, the risk of postpartum haemorrhage with increasing BMI was not significant. Hence it is concluded that high prepregnancy BMI is associated with increased risk of obstetric and neonatal outcomes. Though there 1s significant association of underweight BMI with anaemia and low birth weight and preterm delivery, Underweight women appear to have better pregnancy outcoro. Js than obese or overweight women. Maintaining a normal Body Mass Index pre-conceptionally favours better obstetric and neonatal outcomes. Our study results, taken together with existing literature, suggest an independent role of pre-pregnancy BMI as a determinant of adverse pregnancy outcomes.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

FUNDING

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ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee.

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