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Original Research Article

Role of body mass index and waist circumference in predicting of gestational diabetes mellitus, pregnancy induced hypertension and adverse pregnancy outcome amongst obese women

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ABSTRACT

Background: Risks to the pregnant women due to obesity during pregnancy include gestational diabetes, hypertensive disorders of pregnancy, sepsis, venous thromboembolism, stillbirth, preterm delivery, large for gestational age infant, cardiometabolic disease and obstructive sleep apnea. For the fetus, the risks include congenital anomalies, fetal growth restriction, macrosomia, prematurity, anomalies, and other adverse clinical outcomes. Thus, the aim of the present study was to the test hypothesis that waist circumference was as good as body mass index (BMI) to identify women at risk of obesity related complications during pregnancy.
Methods: 200 pregnant women in first trimester of pregnancy coming in antenatal outpatient department (OPD) of government medical college, Amritsar were recruited from October 2022 to March 2024. Patients were classified as obese/non obese as per Asian ethnicity specific threshold of waist circumference according to which waist circumference ≥80 cm is obese. Based on BMI women were classified as underweight, overweight and obesity. Overweight is a BMI ≥25 kg/m^2; and obesity is a BMI ≥30 kg/m^2. Pregnancies were followed up throughout pregnancy and final outcome were recorded and compared.
Results: Of the 200 participants, 13.5% were overweight, 4% were obese, another 10.5% were underweight and rest 72% had normal BMI. On the other hand, as per waist circumference the prevalence of obesity was 20% (waist circumference ≥80 cm), which was more than the combined prevalence (17.5%) of overweight (BMI=25-29.9) and obese (BMI ≥30) as per BMI. Both BMI >25 kg/m^2 and waist circumference ≥80 cm are associated with increased odds of preterm labour gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy (HDP), obstructed labour and SSI. It was statistically significant for GDM and HDP. Also, amongst women with >30 kg/m^2 (obese), the odds of abortion and antepartum haemorrhage (APH) were increased significantly.
Conclusions: Both high BMI and waist circumference/80 cm are significant risk factors for development of GDM and hypertension. Maternal obesity defined by BMI >30 is a significant risk factor for abortion and APH. These two complications are not predicted by waist circumference.

Keywords:

INTRODUCTION

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. Body mass index (BMI) is an index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of height in meters (kg/m^2), as per World Health Organization (WHO). For adults, WHO defines overweight and obesity as follows: overweight is a

BMI ≥25 kg/m^2; and obesity is a BMI ≥30 kg/m^2. Obesity is linked to increased morbidity and other health issues such as cardiovascular disease and type 2 diabetes on a global scale.

Pregnant women affected by obesity face elevated risks of gestational diabetes, hypertension, and preeclampsia, chances of miscarriage, intrauterine death, and complications during both post-term pregnancy and emergency caesarean section.[1] It is predicted that by 2025 more than 21% of women in the world will have obesity.[2] Besides maternal risks, fetal health is also impacted by maternal obesity. Fetal risks include fetal growth restriction, macrosomia, prematurity, anomalies, and other adverse clinical outcomes.

Method of screening of obesity are BMI, waist circumference, hip waist ratio, visceral adiposity index, ultrasonography (USG) measurement of abdomen fat and bioelectrical impedance. As per WHO guidelines waist circumference is measured at narrowest level between lower border of rib cage and iliac crest. Waist circumference of <80 cm as non-obese and ≥80 cm as categorized as obese according to IAS and ICCR guidelines.[3] The aim of the present study was to test the hypothesis that waist circumference was as good as BMI to identify women at risk of obesity related complications during pregnancy.

METHODS

The present study was a longitudinal observational study for which 200 pregnant women in first trimester of pregnancy coming in antenatal OPD of government medical college, Amritsar were recruited from October 2022 to March 2024.The study was conducted after approval from institutional ethics committee GMC, and patient were enrolled after written informed consent. Detailed history was taken along with thorough general examination and obstetrics examination and screening done for inclusion and exclusion criteria as follows.

Inclusion criteria

All the pregnant women at gestational age <13 weeks with single intrauterine live pregnancy were included.

Exclusion criteria

Pregnant women presenting with complications like abortion, ectopic gestation, molar pregnancy, fetal anomalies; known case of diabetes mellitus, chronic hypertensive disorder and thyroid abnormalities; pregnancy with multiple gestation; and with family history of diabetes mellitus and hypertension in maternal families were excluded.

All the participants were categorized as per BMI and also were classified as obese/non obese as per Asian ethnicity specific threshold of waist circumference defined by IAS and ICCR classification according to which waist circumference ≥80 cm is obese. All the patients were followed up during pregnancy for, complications like gestational diabetes mellitus, hypertension disorder of pregnancy, intrauterine growth restriction (IUGR) and the timing and events of labour/delivery and outcome were recorded.

Table 1: Clinical characteristics.

Variables	Values
BMI categories (kg/m^2)	
Normal weight	18-5 – 24.9
Overweight	25.0-29.9
Obese I	30-34.9
Obese II and III	≥35
Waist circumference (cm) in women	
Obese	≥80
Non obese	<80

Statistical analysis data analysed by statistical package for the social sciences (SPSS) statistics for windows version 23.0. Armonk, NY: IBM Corp, Chicago. P value less than 0.05 was taken as statistically significant.

RESULTS

Of the 200 participants 13.5% were overweight, 4% were obese, as per BMI. Another 10.5% were underweight and rest 72% had normal BMI. On the other hand, as per waist circumference the prevalence of obesity was 20% (waist circumference ≥80 cm), which was more than the combined prevalence (17.5%) of overweight (BMI=25-29.9) and obese (BMI ≥30) as per BMI.

For the diagnosis of abnormally increased BMI and waist circumference, the concordance rate was 94.3% in the two parameters and this accounted for 16.5% of participants. On correlation analysis, the correlation between BMI and WC were found to be poor (R2=0.049, p=0.492). Demographic details in Tables 2-5.

Sedentary lifestyle, illiteracy, nulliparity were all found to be associated with increased BMI as well as the abdominal circumference but none of these associations were statistically significant. Age >30 years was also association with highest prevalence of underweight (15.6%) as well as increased BMI (<21.87%). On correlation analysis, BMI correlated poorly with increased maternal age (R2=0.002) but the associated was poor and statistically significant between waste circumference and maternal age (R2=0.015, p value=0.0001).

Complications and outcome of participants are compared in Table 6. Abortion rate was 3%. It was as high as 25% amongst pregnant women with BMI ≥30 kg/m^2, and 7.5% amongst women with abdominal obesity BMI ≥30 kg/m^2 (obese) were associated with OR 15.66 (p=0.004) for spontaneous abortion. Waist circumference did not appear

to be as strong predictor of abortion risk as BMI ≥30 kg/m^2 (p value=0.08) with OR=4.234.

Rate of preterm birth was 9.28%. It was highest among the underweight (16%) and among the overweight (22.22%) women as per BMI. Preterm labour rate among women with waist circumference ≥80 cm was 13.5% compare to 9% among the women with waist circumference <80 cm. OR of preterm birth in those with BMI >24.9 kg/m^2 was 1.63, p=0.429 OR of preterm birth in those with waist circumference ≥80 cm was 1.7308, with p value=0.328. 7.23% of study participants developed GDM. The OR of developing GDM in those with BMI >24.9 kg/m^2 was 5.92 (p=0.002). The OR of developing GDM in those with waist circumference >80 cm was 4.636 (p value=0.006) both are statistically significant. 3.6% women had APH, out of which more than a quarter had BMI ≥30 kg/m^2, BMI >30 kg/m^2 were associated with significant risk of APH OR 18.3 (p=0.0029). Increased waist circumference was also a risk factor for APH (OR=1.737, p=0.644) but not statistically significant. 4.1% of participants had FGR. Increased BMI was not associated with increased risk of FGR (OR=0.687) but increased waist circumference was associated with increased risk of FGR (OR=1.438, p=0.664). 5.15% of patients had oligohydramnios out of which 20% had BMI ≥25 kg/m^2 and 30% had waist circumference ≥80 cm. The OR for oligohydramnios with increased BMI is 1.233 (p=0.796). The OR of oligohydramnios with WC ≥80 cm 1.89 (p=0.373).

Table 2: Distribution as per age (BMI and waist circumference) of participants.

Variables	Age group (years)			
	<20	**20-30**	**>30**	**Total**
BMI (kg/m^2)				
<18.5				
No.	3	13	5	21
Percentage	12.50	9.03	15.63	10.50
18.5-24.9				
No.	20	104	20	144
Percentage	83.33	72.22	62.50	72.00
25.0-29.9				
No.	0	23	4	27
Percentage	0.00	15.97	12.50	13.50
>30				
No.	1	4	3	8
Percentage	4.17	2.78	9.38	4.00
Total				
No.	24	144	32	200
Percentage	12.00	72.00	16.00	100.00
Waist circumference (cm)				
<80				
No.	23	113	24	160
Percentage	95.83	78.47	75.00	80.00
≥80				
No.	1	31	8	40
Percentage	4.17	21.53	25.00	20.00
Total				
No.	24	144	32	200
Percentage	12.00	72.00	16.00	100.00

Table 3: Distribution of participants as per occupation (BMI and waist circumference).

Variables	Occupation		
	Housewife	**Working women**	**Total**
BMI (kg/m^2)*			
<18.5			
No.	16	5	21
Percentage	11.59	8.06	10.50
18.5-24.9			
No.	101	43	144
Percentage	73.19	69.35	72.00

Continued.

Variables	Occupation		
	Housewife	Working women	Total
25.0-29.9			
No.	19	8	27
Percentage	13.77	12.90	13.50
>30			
No.	2	6	8
Percentage	1.45	9.68	4.00
Total			
No.	138	62	200
Percentage	69.00	31.00	100.00
Waist circumference (cm)**			
<80			
No.	113	47	160
Percentage	81.88	75.81	80.00
≥80			
No.	25	15	40
Percentage	18.12	24.19	20.00
Total			
No.	138	62	200
Percentage	69.00	31.00	100.00

*P value=0.202, **p value=0.316

Table 4: Distribution of participants as per patient education.

Variables	Education (patient)				
	Illiterate	Matric	Secondary	Graduate	Total
BMI (kg/m^2)*					
<18.5					
No.	1	10	8	2	21
Percentage	7.14	13.33	10.67	5.56	10.50
18.5-24.9					
No.	9	54	56	25	144
Percentage	64.29	72.00	74.67	69.44	72.00
25.0-29.9					
No.	4	10	9	4	27
Percentage	28.57	13.33	12.00	11.11	13.50
>30					
No.	0	1	2	5	8
Percentage	0.00	1.33	2.67	13.89	4.00
Total					
No.	14	75	75	36	200
Percentage	7.00	37.50	37.50	18.00	100.00
Waist circumference (cm)**					
<80					
No.	10	61	62	27	160
Percentage	71.43	81.33	82.67	75.00	80.00
≥80					
No.	4	14	13	9	40
Percentage	28.57	18.67	17.33	25.00	20.00
Total					
No.	14	75	75	36	200
Percentage	7.00	37.50	37.50	18.00	100.00

*P value=0.23, **p value=0.3850

Table 5: Distribution of participants as per parity.

Variables	Obstetric formula		
	Parous	Nulli parous	Total
BMI (kg/m^2)*			
<18.5			
No.	11	10	21
Percentage	10.68	10.31	10.50
18.5-24.9			
No.	75	69	144
Percentage	72.82	71.13	72.00
25.0-29.9			
No.	11	16	27
Percentage	10.68	16.49	13.50
>30			
No.	6	2	8
Percentage	5.83	2.06	4.00
Total			
No.	103	97	200
Percentage	51.50	48.50	100.00
Waist circumference (cm)**			
<80			
No.	83	77	160
Percentage	80.58	79.38	80.00
≥80			
No.	20	20	40
Percentage	19.42	20.62	20.00
Total			
No.	103	97	200
Percentage	51.50	48.50	100.00

*P value=0.951, **p value=0.831

Table 6: Comparison of odds ratio of pregnancy complication as per increased BMI and increased waist circumference.

Complications	BMI (kg/m2)	Waist circumference ≥80 cm
Abortion	OR: 15.66, p=0.004 (BMI ≥30)	OR: 4.24, p=0.08
Hypertensive disorders of pregnancy	OR: 4.814, p=0.014 (BMI ≥25)	OR: 3.932, p=0.031
Gestational diabetes mellitus	OR: 5.64, p=0.002 (BMI ≥25)	OR: 4.63, p=0.006
Preterm labour	OR: 1.63, p=0.429 (BMI ≥25)	OR: 1.73, p=0.328
Antepartum haemorrage	OR: 18.30, p=0.0029 (BMI ≥30)	OR: 1.757, p=0.519
FGR	OR: 0.68, p=0.73 (BMI ≥25)	OR: 1.43, p=0.664
Oligohydraminos	OR: 1.233, p=0.79 (BMI ≥25)	OR: 1.89, p=0.375
Obstructed labour	OR:10.322, p=0.0598 (BMI ≥25)	OR: 8.914, p=0.07
Prolonged labour	OR:0.51, p=6.55 (BMI ≥25)	OR: 0.46, p=0.609
Fetal distress	OR: 1.128, p=0.82 (BMI ≥25)	OR: 1.253, p=0.653
Need for blood transfusion	OR: 0.307, p=0.423	OR:0.267, p=0.37
PPH	OR: 0.44, p=0.442	OR: 0.939, p=0.938
Puerperal sepsis	OR: 0.952, p=0.975 (BMI ≥25)	OR: 0.82, p=0.104
Surgical site infection	OR: 2.17, p=0.21	OR: 1.781, p=0.353
APGAR score (<5 min)	OR:1.419, p=0.67	OR: 2.22, p=0.27
Need for resuscitation	OR: 2.20, p=0.27	OR: 1.89, p=0.37
Need for NICU admission	OR: 0.687, p=0.730	OR: 1.57, p=0.58
Neonatal sepsis	OR: 2.484, p=0.741	OR: 2.153, p=0.526
Neonatal mortality	OR: 2.484, p=0.741	OR: 2.153, p=0.526

5.6% developed hypertension during pregnancy. The OR of women with increased BMI to develop HDP was 4.814 (p=0.014). The OR was 2.514 (p=0.409) for obese women to develop HDP. The OR of women with WC ≥80 cm to develop HDP was 3.93 (p=0.031). Thus, both increased BMI and waist circumference are statistically significant risk factor for HDP during pregnancy.

Overall caesaren rates in our participants was 45%. Neither increased BMI (CS rate 44.5%) nor increased WC (CS rate 45.9%) was a risk factor for increased chances of caesarean delivery. Neither increased BMI nor increased waist circumference, was a risk factor for increase in mean duration of labour or incidence of prolonged labor (>20 hours). Among 194 patients 1.5% belonging to BMI >24.9 kg/m^2 and 0.5% with BMI <25 kg/m^2 had obstructed labor. The OR of obstructed labor in women w BMI >24.9 kg/m^2 was or 10.32 (p=0.598). The OR of obstructed labor in women with waist circumference ≥80 cm was 8.91 (p=0.077). Thus, increased BMI and waist circumference are a risk factor for obstructed labor but not statistically significant.

The OR of fetal distress amongst women with increased BMI was 1.128 (p=0.822) and amongst women with increased waist circumference was 1.2538 (p=0.65) both being statistically insignificant.5.6% of our participants had PPH but neither increased BMI nor waist circumference were associated with increased risk of PPH or need for blood transfusion. 1.03% women had puerperal sepsis both of whom had normal BMI (18.5 to 24.9). and waist circumference. 7.2% had SSI amongst our participants. The OR of risk for SSI with increased BMI was 2.17 (p=0.215) and with increased waist circumference ≥80 cm was 1.781 (p=0.353), both being statistically insignificant.

We had no maternal death or maternal near miss amongst our 200 participants. None of the participants needed ICU care for any reason. Although the need of NICU admission, neonatal sepsis was higher amongst women with increased BMI and with increased waist circumference, none of these associations were statistically significant.

DISCUSSION

Among our 200 participants, abortion rate was 3%. In our study, BMI was found to be associated with increased risk of spontaneous abortions while waist circumference was not. Lo et al found significantly increased risk of miscarriage (53/90; 59%) OR 1.73.[4] In obese patient when compared to normal BMI (177/406;44%) (p=0.028 and OR=1.73) There was no statistical difference in miscarriage rate among who were over-weight (OR=1.27) compared to women of normal weight. We didn't find any study which correlated waist circumference and its miscarriage rates.

In our study 7.23% participants developed GDM. The OR of developing GDM in those with BMI >24.9 kg/m^2 was 5.642 (0.0025). The OR of developing GDM in those with waist circumference ≥80 cm was 4.636 (0.006) which was statistically significant. Ng et al found increased risk of having GDM among obese with OR=2.327 and p value=0.024.[5] But not among overweight. Verma et al found women who were overweight (1.2%), obese (7.1%) or morbidly obese (23%) had significantly increased risks for GDM (p<0.001) compared to women with normal BMI (0.24%).[6] Gupta et al reported that gestational diabetes was diagnosed in 6% of women with WC ≥80 cm and 2% among women with WC <80 cm.[2] Madhavan et al found that 18%of women with BMI >24.9 kg/m^2 had GDM against 2.8% among normal BMI <25 kg/m^2.[7]

In our study the incidence of PIH among obese (16.6%) as well as overweight (16.66%) women were 4 times the incidence amongst women with normal BMI (4.26%). The OR of women with increased BMI to develop HDP was 4.814 (p=0.014) with p value which is statistically significant. The OR of women with WC ≥80 cm to develop HDP was 3.93 (p=0.031). Both the odds were statistically significant. Mahboubeh et al in their study on 1000 women found significant association of obesity with the occurrence of preeclampsia. Waist hip ratio ≥20.85 in the first 12 weeks of pregnancy had a relative risk of 2.317 (CI: 1.26 to 4.27) for preeclampsia, while the relative risk with BMI >25 kg/m^2 was 3.31.[8]

In our study population 3.6% participants had APH and BMI >30 kg/m^2 was associated with significant risk of APH. Sunder et al also found the patients with high BMI had greater risk of antepartum hemorrhage compared to normal BMI group (OR=2.4, p=value 0.04).[9] Bhattacharya et al found that risk of abruptio placenta (1.9%) among morbidly obese significantly increased than normal BMI (0.6%) p<0.005.[10]

In our study out of 194 patients 4.1% of patients had FGR. The OR of FGR amongst women with increased BMI was OR:0.687 (p=0.73) which was statistically not significant. As per waist circumference ≥80 cm OR for FGR was 1.438 (p=0.664) which was statistically not significant. Sunder et al also found that high BMI patients are less likely to have FGR with OR=0.6.[9] Verma et al found highest risk for FGR amongst underweight 17.2% followed by 6.66% among overweight against 6.1% amongst normal BMI or obese.[6] Overall caesarean rates in our participant was 45%. Amongst women with overweight and obese category of BMI, cesarean rate was 44.44% and 50% respectively. Patient with normal BMI, caesarean rate was 48.22%, and the difference was not statistically significant (p value=0.616). In patients with WC ≥80 cm CS rate was 45.9% and 45.8% in women with WC <80 cm. Angeliki et al on the other hand found that the increasing maternal BMI associated with the increased odds for a caesarean section, with overweight and obese women presenting a 1.58 and 2.75 times greater risk for a caesarean section delivery, respectively.[11] Increasing maternal BMI was also

associated with an increased emergency CS delivery rate, which was 1.30 and 1.83 times greater for overweight and obese women >24.9 kg/m^2 compared to normal BMI women. Gupta et al also concluded that there was a significantly higher rate of caesarean delivery in women with WC ≥80 cm (p=0.0072, CI 95%).[2] Bhattacharya et al also found that the OR for emergency cesarean section increased with increasing BMI and protective effect seen in underweight women (OR=0.7 (95% CI 0.6,0.8)) women with morbid obesity had 3 times (95% CI:1.7,6.1).[9]

Limitations

Participants of overweight obese and women with abdominal obesity is less than expected because most such participants reported late in pregnancy and were not included in study.

CONCLUSION

Abdominal obesity measured by waist circumference is more prevalent than obesity defined by BMI amongst pregnant women and has a strong linear association with increasing age, not seen with BMI. Both high BMI and waist circumference ≥80 cm are significant risk factors for development of GDM and hypertension during pregnancy but not for fetal growth abnormalities, fetal distress, labour abnormalities, caesarean risk, PPH or puerperal sepsis. Maternal obesity defined by BMI >30 is a significant risk factor for abortion and antepartum haemorrhage, two complications not predicted by abdominal obesity. Waist circumference being a one-step procedure, not requiring special equipment or calculations can be used by peripheral health workers as a useful tool to predict complications like GDM and hypertension during pregnancy, more practical and as good as BMI.

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