

Can Waist Circumference Be Used as an Anthropometric Parameter to Assess the Obesity Related Pregnancy Outcome: A Case Control Study

Anjali Gupta*, Sonika Mann, Savira Sethi

Department of Obstetrics and Gynaecology, Pt. B.D. Sharma PGIMS, Rohtak, India
Email: ajiii2003@yahoo.co.in

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Abstract

Introduction: The prevalence of obesity is increasing in women of reproductive age. Maternal obesity is associated with increased morbidity and mortality for both mother and offspring. BMI has been criticized as a limited measure of total obesity. Measurement of waist circumference can be useful in the assessment of abdominal obesity and disease risk. The study is aimed to evaluate the waist circumference as an anthropometric parameter in identifying women at risk of developing obstetric complications. **Material and Methods:** A prospective study was conducted at a tertiary health care centre on 200 antenatal women of age between 18 to 35 years with singleton pregnancy attending the antenatal clinic before 8 weeks of gestation. Women were divided into two groups. Group I included 100 women with waist circumference < 80 cm and Group II included 100 women with waist circumference \geq 80 cm. Weight, height and waist circumference were measured and BMI was calculated. All the women were followed throughout their pregnancies as per the routine antenatal follow up. The fetomaternal outcome was recorded and analyzed statistically. **Results:** The two groups were comparable in age, parity and demographic profile. The maternal and neonatal complications—preeclampsia ($p = 0.0052$, RR 0.5062, 95% CI 0.2935 - 0.8728), gestational diabetes mellitus, preterm labor, postdatism, need for induction of labor (p value 0.0081, RR 0.6263, 95% CI 0.4314, 0.9091), instrumental vaginal delivery, cesarean delivery ($p = 0.0072$, RR 0.5745, 95% CI 0.3696, 0.8929), shoulder dystocia, PPH, macrosomia, neonatal asphyxia, admission to NICU were reported more in Group II women as compared to Group I. **Conclusion:** Assessment of waist circumference in early pregnancy provides a simple and practical parameter for predicting obesity related pregnancy outcome. All pregnancies in centrally obese women (waist circumference \geq 80 cm) shall be acknowledged as high risk.

*Corresponding author.

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Keywords

Waist Circumference, Obesity, Pregnancy

1. Introduction

Obesity is defined by the WHO as abnormal or excessive fat accumulation that presents a risk to an individual's health [1]. India is now facing a double burden of this disease with under nutrition and underweight on one side, and a rapid upsurge in obesity and overweight, particularly in the urban settings on the other side [2]. A crude population measure of obesity is the body mass index (BMI) which is a simple index of weight-for-height—a person's weight in kilograms is divided by the square of the height in meters (kg/m^2) [1]. BMI has been criticized as a limited measure of total obesity [3].

The measurement of waist circumference provides information regarding fat topography—where body fat is stored. It is an indicator of internal fat deposits, which can coat the heart, kidneys, liver and pancreas. This is important because visceral fat in particular appears to be associated with insulin resistance which leads to type 2 diabetes and is also associated with adverse lipid profiles which in turn predispose to cardiovascular disease [4].

The prevalence of obesity is also increasing in women of reproductive age and currently it is estimated that more than one in five pregnant women are obese [5]. Maternal obesity is associated with increased morbidity and mortality for both mother and offspring [6]. High pregravid body mass index (BMI) and excessive gestational weight gain are also important predictors of short-term postpartum morbidity and higher postpartum weight retention, with the latter being associated with increased risks during future pregnancies and of lifelong obesity for women [7]. Offspring of obese mothers tend to be large for gestational age at birth and are at a higher risk of late fetal death, congenital anomaly, and admission to the neonatal unit [8] [9].

For BMI, height must be measured accurately, because small errors in the denominator are exaggerated by squaring. Also, as pregnancy progresses, this index is influenced by gestational weight gain in lean tissues, thus limiting its use in pregnancy. The use of pre-pregnancy BMI as an indicator of obesity in pregnancy, may be complicated by the fact that the weight used for this calculation is frequently self-reported, producing inaccuracies [10].

Measurements of waist circumference can be useful in the assessment of abdominal obesity and disease risk. There is a limited research regarding the use of waist circumference measurements to assess obesity related risks in pregnant women.

The present study was aimed to evaluate the waist circumference as an anthropometric parameter in identifying women at risk of developing obesity related obstetric complications.

2. Material and Methods

The present study was a prospective clinical study comprising of 200 antenatal women of age between 18 to 35 years with singleton pregnancy attending the antenatal clinic of the Department of Obstetrics and Gynecology of tertiary health care centre, before 8 weeks of gestation. It has been passed through the institute Ethics Committee prior to the study being undertaken. Antenatal women with multiple pregnancy, any medical disorder at the time of registration, history of previous caesarean section and with $\text{BMI} < 18.5 \text{ kg}/\text{m}^2$ were excluded from the study. Those who met the criteria were enrolled and were divided into two groups—Group I (control group) included 100 women with waist circumference $< 80 \text{ cm}$ and Group II (case group) included 100 women with waist circumference $\geq 80 \text{ cm}$. The cut off value of 80 cm was taken based upon NICE guidelines [11].

An informed written consent was taken from all the women after explaining the type and purpose of study. They were subjected to detailed history and clinical examination. Gestational age was determined by the date of last menstrual period if she was sure of her dates and had regular menstrual cycles. Ultrasonography was done in all women to confirm the gestational age and to rule out multiple pregnancy. Waist circumference was measured in standing position, using a measuring tape after exposing the abdomen and positioning her with feet shoulder width apart and arms crossed over the chest, to the nearest of 0.5 cm. Waist circumference was taken at the uppermost lateral border of the iliac crest at the end of gentle expiration with the tape being placed perpendicular to the long axis of the body and horizontal to the floor. Body mass index was also calculated, and for that weight

was measured to the nearest of 0.1 Kg with digital scales without heavy clothing and height was measured to the nearest of 0.5 cm. Three times the waist circumference was measured and the smallest of them was taken into consideration. Women were subjected to ultrasonography for congenital anomalies at 18 to 20 weeks of gestation.

They were followed throughout their pregnancies as per the routine antenatal follow up and up to 6 weeks after delivery. At every follow up visit, blood pressure, weight and waist circumference were measured, maternal and fetal outcomes were recorded and compared in both the groups.

The data was analyzed using chi square test and unpaired t test. A p value < 0.05 was considered significant.

3. Results

The waist circumference in group I varied from 70 cm to 79 cm with a mean waist circumference of 76.55 ± 2.002 cm, whereas those in group II had waist circumference ranged from 80 cm to 115 cm and the mean was 87.78 ± 7.230 cm. The age wise distribution of women in two groups is shown in **Table 1**. The demographic details of both the groups were comparable, maximum women were from urban background (group I—61%, group II—65%), educated (group I—85%, group II—80%) and unemployed (group I—72%, group I—64%). Dietary pattern was also similar in both the groups (group I—76% vegetarian, 24% non-vegetarian and group II—67% vegetarian, 33% non-vegetarian). Most of the women enrolled for the study were nullipara (68% in Group I and 65% in Group II).

Only four women in group I and two in group II had height ≤ 150 cm. **Table 2** shows BMI in both the groups. Women with waist circumference ≥ 80 cm were found to have an increased risk of preeclampsia ($p = 0.0052$, RR 0.5062, 95% CI 0.2935 - 0.8728), gestational diabetes, macrosomia (birth weight > 4 kg) preterm and post-datism as shown in **Table 3**.

The increased rate of induced labor was observed in group II accounting to 38% as compared to 21% in Group I and the difference was statistically very significant (p value 0.0081, RR 0.6263, 95% CI 0.4314, 0.9091). The rate of failure of induction was also high in group II, 42%, as compared to 19% in group I and was extremely significant statistically (p value < 0.0001, RR 0.4588, 95% CI 0.1780. 1.182).

The rate of vaginal delivery decreased as the waist circumference increased. There was significantly higher rate of caesarean delivery in women with waist circumference ≥ 80 cm ($p = 0.0072$, RR 0.5745, 95% CI 0.3696, 0.8929).

Intrapartum and postpartum complications (**Table 4**) were significantly different between the groups, 16% in group I, 35% in group II ($p = 0.0033$, RR 0.5565, 95% CI 0.3620 - 0.8554).

No significant difference was observed in the mean birth weight among two groups (group I— $2.759 \text{ kg} \pm 0.4072$, group II— $2.855 \text{ kg} \pm 0.6381$, $p = 0.2062$). In women with waist circumference ≥ 80 cm, 3% of neonates had very low birth weight, while none of group I weighed less than 1.5 kg. Seventeen percent neonates of group I and 18% of group II neonates were low birth weight (<2.5 kg). One percent of group I and 6% of group II had birth weight > 4 kg.

Perinatal mortality was observed in 2% of group II women while no perinatal mortality was observed in group I ($p = 0.4975$). One percent of group I and 10% of group II neonates had APGAR score of <7 at 5 min,

Table 1. Age wise distribution.

Age Interval (Years)	Group I WC < 80 cm	Group II WC ≥ 80 cm	p Value
	N = 100	N = 100	
≤ 20	4	4	
21 - 25	61	53	
26 - 30	30	38	
31 - 35	5	5	
Total	100	100	
Mean \pm SD	24.680 \pm 2.700	25.240 \pm 3.121	0.151

WC: Waist circumference.

Table 2. Body mass index (BMI) wise distribution.

BMI (Kg/m ²)	Group I WC < 80 cm (n = 100)	Group II ≥80 cm (n = 100)	p Value
	Number	Number	
18.5 - 24.9 (Normal)	95	26	<0.0001
25.0 - 29.9 (Overweight)	5	55	<0.0001
≥30.0 (Obese)	0	19	<0.0001
Mean ± SD	21.69 ± 1.628	27.18 ± 3.656	<0.0001

Table 3. Antenatal complications among the groups.

Antenatal Complication	Group I WC < 80 cm (n = 100)	Group II WC ≥ 80 cm (n = 100)	p Value
	No of Women	No of Women	
Preeclampsia	10	26	0.0052
Gestational Diabetes Mellitus	2	6	0.2790
Macrosomia	1	6	0.1184
<37 (preterm)	10	12	0.8217
-Spontaneous Preterm Birth	7	5	0.2305
-Indicated Preterm Birth	3	7	0.2305
>40 (Postdated)	6	16	0.0400

Table 4. Intrapartum and postpartum complications.

Complications	Group I WC < 80 cm (n = 100)	Group II WC ≥ 80 cm (n = 100)	p Value
	Number	Number	
Fetal Distress	6	12	0.5647
Shoulder Dystocia	2	5	0.2425
3 rd Perineal Tear	1	3	0.3234
Postpartum Hemorrhage	4	9	1.0000
Wound Infection	3	6	1.0000
Total	16	35	0.0033

the difference was statistically found to be very significant ($p = 0.0097$). Neonatal admission to neonatal intensive care unit was 10% in group I as compared to 18% of group II neonates and was not significant ($p = 0.1528$).

At 6 week follow up visit, 28 women in group I and 16 in group II lost to follow up after discharge. Out of those who came for follow up at 6 weeks, none among the group I had high blood pressure or raised plasma glucose levels, and among the group II women, 1 (1.19%) had high blood pressure and none had raised plasma glucose levels.

4. Discussion

Obesity is a condition characterized by excess of body fat, frequently resulting in impairment of health and longevity. It is usually assessed clinically by body mass index. The ideal time to record the baseline weight for calculation of BMI of a pregnant women is before she has started gaining weight due to gestation, which is seldom available. Studies have shown that abdominal adiposity has adverse effects on health, regardless of BMI. Abdominal adiposity, measured by waist circumference, is a good marker of fat distribution, can be easily self

measured and has been considered as a better indicator of obesity related health risks than BMI [12].

Women in age group 18 - 35 years were enrolled for the study, the mean age was similar to that of Wendland *et al.* [13] (27.6 ± 5.3 years). The demographic profile of women was similar in the two groups as women in both the groups were coming from similar background and were enrolled at a tertiary care centre. In the present study, most of the women were nullipara, thus indicating that the nulliparas reported for antenatal visit earlier in the pregnancy.

We measured waist circumference of all women at booking visit before 8 weeks of gestation as at this time pregnancy will not affect the waist circumference and is in accordance with the study of Sattar *et al.* [12]. The cut off value of 80 cm was taken based on Asian population. There is higher percentage of body fat in Asians at lower BMI. So, lower threshold is needed for indicating the increased risk in this ethnicity.

Among the group II, we had not taken >88 cm as separate group as there were only a few women with waist circumference > 88 cm.

In women with waist circumference ≥ 80 cm, 26% had normal BMI ($18.5 - 24.9 \text{ kg/m}^{-2}$) thereby indicating that a normal BMI does not necessarily indicate normal levels of abdominal obesity. The height < 150 cm was found in a few women in both the groups, this suggests that height had no influence on waist circumference as the bony landmark was taken into consideration for measuring waist circumference.

Women with waist circumference ≥ 80 cm had increased risk of complications, in the present study, Few studies have reported the role of waist circumference in predicting preeclampsia, gestational Diabetes Mellitus, macrosomia. Preeclampsia was the major contributor to the maternal and perinatal morbidity. Preeclampsia developed in 26% of group II women as compared to 10% of group I women which corresponds to that of other studies [12]-[14].

In the present study, gestational diabetes mellitus was diagnosed in 6% of women with waist circumference ≥ 80 cm. The study of Wendland *et al.* [13] reported gestational diabetes in 5.5%, 7.9% and 13.5% in women with 83 cm, 88 cm and 122 cm waist circumference quintiles, which was found to be comparable with the present study. Brisson *et al.* [15] reported glycemia on a two hour glucose tolerance test in 18.0% women with waist circumference > 85 cm.

Macrosomia was reported higher in group II (6%) as compared to group I (1%) women in the present study consistent with other studies [13] [16] [17]. Wendland *et al.* [13] in their study identified macrosomia in 9%, 11.4% and 17.1% in women having 83 cm, 88 cm and 112 cm waist circumference quintiles. A study conducted by Usha Kiran *et al.* [16] comparing obese and non-obese based on BMI reported macrosomia in 14.8% of obese and 7.6% of non-obese women. Out of the 6 macrosomic neonates in group II, 3 were associated with gestational diabetes mellitus and the rest 3 were seen in women with very high waist circumference (>88 cm).

Both the preterm and postdated deliveries were higher in group II. The indicated preterm births were higher in group II (58.4%) as compared to group I (30%), while the spontaneous preterm births were lower in comparison to group I. These findings were consistent with the study by Hendler *et al.* [18], Cnattingius *et al.* [19]. Bhattacharya *et al.* [11] in their study found that obese women were at increased risk of delivery before 33 weeks (OR 2.0, 95% CI 1.3, 2.9), but the rate of postdated delivery was similar. More women in group II, required induction of labour and in agreement with other studies [11] [16] [17].

The present study observed that the rate of caesarean delivery was more in the women with waist circumference ≥ 80 cm and this was found in concordance with that of Verma and Shrimaili, ³Addo VN¹⁷, Burstein *et al.* [20] (32.9% in obese, 9% in non-obese), Usha Kiran *et al.* [16] (27% of obese women, 18% of non-obese women). Out of the vaginal births, 4.7% in group I and 11.5% in group II required instrumentation with either forceps or vacuum in the present study and was statistically insignificant.

Intrapartum and postpartum complications was found to be more in women with waist circumference ≥ 80 cm. There was no significant difference on comparing each complication in both groups as the number is small but significant difference was noted in overall complications. It was observed that the excessive blood loss in group II women was associated not only with caesarean delivery but also with vaginal delivery. Usha Kiran *et al.* [16] on comparing non-obese and obese, based on BMI, reported increased risk of shoulder dystocia (0.5% in non-obese vs. 1.5% in obese), third and fourth degree perineal tear (0.7% on non-obese vs. 0.8% in obese), post partum hemorrhage (15.5% in non-obese vs. 22% in obese) and wound infection (1.7% in non-obese vs. 1.6% in obese) in obese women. Sebire *et al.* [7] also reported an increased risk of postpartum hemorrhage in obese women.

Implications of obesity in pregnant woman for the infant included sub-optimal gestational age (both preterm

and postdate), stillbirth, low- and high-birth weight, fetal distress and neonatal intensive care. Usha Kiran *et al.* [16] reported <7 APGAR score at 5 min in 0.9% neonates of non-obese women and in 1.2% neonates of obese women. Bhattacharya *et al.* [11] also reported higher stillbirth rates in the obese (1.9%) as compared to normal BMI categories (0.9%).

In the present study, 18% of group II neonates were admitted to NICU as compared to 10% in Group I and shifted to mother side later. Usha Kiran *et al.* [16] also reported increased NICU admissions in obese group (3.8%) compared to 2.5% in non-obese group.

To, our knowledge, this is the first prospective study to correlate the waist circumference with the maternal and neonatal outcome. The limitations of our study are the moderate sample size as it did not allow subgroups and follow up in a single centre.

5. Conclusion

This clinically defined waist circumference threshold (80 cm) for abdominal obesity has been found to be associated with various maternal and neonatal complications. Even women with normal BMI had increased waist circumference and related to high risk of pregnancy complications. Waist circumference can be used to assess the pregnancy risks associated with overweight and obesity. Assessment of waist circumference in early pregnancy (before 8 weeks) provides a simple and practical anthropometric parameter for predicting pregnancy related adverse outcomes. It is suggested that all pregnancies in centrally obese women shall be acknowledged as high risk. Preconception counseling and interventions to reduce weight should be targeted at women who have waist circumference \geq 80 cm.

Conflict of Interests

The authors declare that they have no conflict of interest.

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