Evaluation of Anthropometric Profile in Obesity in Nigerian Females during Pregnancy

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Abstract

Background and Aim: Excess body fat deposition is known to be unhealthy. There have been controversies on defined anthropometric parameters for the assessment of obesity during pregnancy. This is because certain cut-off values relating to it are influenced by age, sex, ethnicity, and trimesters of pregnancy. This study is aimed at investigating the use of anthropometric parameters to measure obesity and determine its prevalence in the different trimesters of pregnancy. **Methods:** The research is a prospective study of 460 pregnant women in the sample proportion of 110, 110, and 240 in the 1st, 2nd, and 3rd trimesters, respectively, chosen randomly from antenatal clinic of the Rivers State Primary Health care centre, Rumuepirikom, Obio-Akpor, Rivers State. Measurements of height, weight, waist circumference (WC), and hip circumference were obtained. Body mass index (BMI) was calculated from values of height and weight. Waist-to-height ratio (WHtR) and waist-to-hip ratio (WHR) were also calculated from waist and hi*P* values. **Results:** The result showed a BMI prevalence of 3.6%, 7.3%, and 0.8%; WC prevalence of 15.5%, 15.5%, and 3%; WHR prevalence of 43.6%, 35.5%, and 14.2%; WHtR prevalence of 56.4%, 51.8%, and 40% all in the 1st, 2nd, and 3rd trimesters, respectively. A negative linear correlation was shown between the other indices and BMI as an independent variable in 1st trimester with value ($r = -0.015$) against a ($r = 0.085$ and 0.165) in WC and WHtR, respectively. There was an association among the other anthropometric indices against BMI with no statistically significant difference at the level of 95% ($P < 0.05$). **Conclusion:** The results of this study are therefore recommended as a guide for clinical judgment in preventive and therapeutic health care services on obesity.

Keywords: Body mass index, height, hip circumference, obesity, trimesters of pregnancy, waist circumference, waist-to-height ratio, waist-to-hip ratio, weight

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Introduction

Every individual needs a certain amount of body fat for energy, heat insulation, and shock absorption. However, excessive deposition of fat in the body, which is usually referred to as overweight or obesity, has been found to be medically deleterious to the body. Overweight specifically refers to an excess body weight compared to set standards, while obesity is to have an abnormally high proportion of total body fat.[1]

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems.[2] Obesity is a risk factor for cardiovascular disease that affects blood and its overall efficiency in the heart, vessels, and brain. In 2013, the American Medical Association re-emphasized the classification obesity as a disease, and not just a risk factor to other diseases as it fits into the medical criteria of a disease, such as impairing body function,[3] for the purpose of advancing the prevention and treatment required as applicable to other ill health and reduce its stigma of much food consumption.

Obesity is defined by body mass index (BMI) and further evaluated in terms of fat distribution via the waist -to-hip ratio (WHR) and total cardiovascular risk factors. Maternal

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obesity, based on a BMI >29.9 kg/m^2, has emerged as an important risk factor in modern obstetrics worldwide.[4,5]

There have been several studies on the anthropometric parameters of cardiovascular diseases patients including obesity in different parts of the world. This includes work[6] in South East Nigeria proposing prevalence with BMI in 1st trimester alone as 10.7%. However not much has been established with regard to other reliable parameters for obesity at different trimester levels of pregnancy in women in this South-south geopolitical zone of Nigeria of which Port Harcourt is chosen due to its physiological and socioeconomic status. For instance, values like waist circumference (WC) in African populations have not been properly defined due to lack of appropriate data, and therefore, it has been recommended that the cut points derived from European population groups are used for African subjects. In fact, there may be obvious difference particularly in the interpretation of WC value as there seems to be a lack of universally accepted site for measuring WC and the large variation of WC optimal cut-off also affected by age, sex, race, and ethnicity; and so also with other anthropometric parameters as observed in even BMI which is noted not to be sensitive to determining pregnancy obesity due to its additional weight gain from fetus and placenta as well as increase in size of maternal organs especially breast and the uterus.[7] Again in Africa, most work on this is limited by its design (retrospective) and small sample size which was recorded in Benin to be 323.[8]

Hence, as a result of some of these shortcomings lies the inherent gap and essence of this study to investigate other reliable alternatives (other anthropometric parameters) among the populace of which this study seeks to assess. The pregnant women become a ready subject so as to get instant relation from those known to be diagnosed with the disease and pregnancy is an opportune time to review a woman's risk factor status associated with high value as observed by Denison *et al*.,[9] and health behaviors to reduce future disease occurrence. Most studies evaluating the best index of obesity that is predictive for risk, however, still remains controversial with little information for assessment based on data from Europe or the United States.

According to Niedhammer *et al*.,[10] most of published research on obesity is also based on self-reporting of height and weight which has been shown to be unreliable alone for pregnant women. To contribute information regarding the use of pregnancy measures of obesity in the prediction of adverse gestational outcomes, this study aims to evaluate minimal WC, BMI, and other parameters assessed using reported weight measured between gestational weeks. Therefore, measurements that are more sensitive to individual differences in abdominal fat might be more useful than BMI for identifying obesity-associated risk factors.[11] New anthropometric indices are being suggested from time to time; evidence is mounting for anthropometric indices related to abdominal obesity such as WC, WHR, and waist-to-height ratio (WHtR), as well as indices as an abdominal sagittal diameter that are more sensitive but not feasible to be measured in population-based studies.

Therefore, in this study, we have planned to measure the anthropometric indices (BMI, WHR, WHtR, and WC) for identification of obesity and the prevalence among pregnant women in Port Harcourt and correlate BMI against the other anthropometric parameters within the different trimesters as to get a reasonably best index for prediction in pregnancy.

Materials and Methods

The study was undertaken in Port Harcourt metropolis, the headquarters of Rivers State, specifically in Rivers State primary health care centre, Rumukuta, Port Harcourt, Nigeria, chosen for its referral base and comprehensive emergency obstetric services where pregnant women of all socioeconomic classes are always undergoing routine antenatal care. Ethical clearance for this research was obtained from the College of Medicine and Health Sciences Ethics Committee of Abia State University, Uturu, for permission from the health centers and subjects easier. Verbal, informed consent was also obtained from the pregnant women and purpose of study duly explained to them to obtain their approval and cooperation.

Inclusion criteria

The selection included all normal pregnant women with no special obesity conditions associated with them while attending the antenatal clinic.

Exclusion criteria

Adolescent pregnant women of <18 years were excluded. Second, women in their pregnancy term of <1 month were excluded. This is because their presence at the clinics was low or near zero thereby making no valid premise for discussion. Furthermore, women with multiple pregnancies as well as those with hyperemesis gravidarum were excluded.

Furthermore, there were no special controls as the subjects identified by the doctor to be at risk of obesity using BMI ≥35 kg/m^2 were noted against those not remarked about.

The research is a prospective study that primary data were collected from direct measurement taken from time of our contact with the patients in the centers. Before data collection, oral questions were asked to ascertain the months of pregnancy of the patient and other data necessary for study. A total of 460 pregnant females participated in the study after sampling and were included in the analysis. The parameters recorded were:

1. BMI done by weight value from the weighing scale and height using measuring tape and then calculated using Garrow JS and Wedsler formula of 1985 as BMI (kg/m^2) = weight/height
2. WC (cm) done by measuring the most lateral contour of the abdomen at a point midway between the lowest rib and the iliac crest in a horizontal plane by measuring tape
3. Hip circumference (HC) done (cm) by measuring the widest portion of hips or point yielding the maximum circumference over the buttocks by measuring tape

4. WHtR calculated by dividing values of WC/height for each person
5. WHR calculated by dividing values of WC/HC.

Information on parity and trimester were asked directly from the subjects and recorded.

Instrumentation

Elastic tailor's measuring tape (Butterfly model – made in China), graduated in centimeters (0–150) was used to measure the waist and HCs. Height meter consists of a vertical long bar calibrated in centimeters (0–200) with a movable horizontal bar which could be adjusted to touch the vertex of the participant's head was used to measure the height of the participants. DANS weighing scale (Seca, UK) calibrated from 0 to 200 kg was used to measure body weight to the nearest kilogram.

Statistical analysis

All anthropometric measurements were taken, in the morning, according to the WHO recommendations by our and supported by clinic trained staff. Weight was measured to the nearest 0.1 kg, height to the nearest 0.5 cm. BMI (kg/m^2) and other indices were computed. Data were analyzed using IBM SPSS (United States) Statistics version 15.0. Descriptive statistics were used for demographic information, and arithmetic mean and standard deviation of the values were taken and results reported as a mean ± standard deviation, and the comparison of indices and significance of association were done with the analysis of variance and then polynomial regression model to find the degree of correlation between variables. The values were compared with the standard WHO cut-off value for each index. Obesity is considered when BMI is >30 kg/m^2 (type 1), WC its value is >81 cm (type 1), WHR is at 0.85, thus <0.85 signifies a lower risk. For WHtR, its cut-off value is >0.59 for pregnant women.

Results

Descriptive statistics and demographics

The descriptive statistics of the anthropometric indices according to the mean and standard deviation of weight, height, BMI, WHR, WHtR, and WC levels for pregnant women in the three trimesters are collated in Table 1.

Demographics and percentage prevalence of the indices based on the disposition to obesity values and range are presented in trimesters in Table 2.

Prevalence outcome

From the data of Appendix A, B, and C, that now produced Table 2, it is observed that no subject falls within BMI value of 18.5–29.9 kg/m^2 for a comparative prevalence. In all trimesters, the prevalence value was above 50% at the > 40 kg/m^2 category.

There is a higher degree of obesity up to 7.3% in the 2nd trimester at >30 kg/m^2 as shown under BMI column in Table 2 above. However, as risk increases (>40 kg/m^2), it was sharply overtaken by the 3rd trimester at the prevalence of 90% followed by 1st trimester.

Table 1: Mean and standard deviation of anthropometric indices of pregnant women in the trimesters collected for the study sample

Variable	Mean±SD		
	First trimester	Second trimester	Third trimester
Indices			
Weight	71.1±10.58	71.14±10.66	77.11±9.953
Height	1.637±0.082	1.663±0.058	1.642±0.066
BMI	43.44±6.279	42.76±6.169	48.19±19.71
HC	107.5±7.926	107.8±8.11	106.7±7.964
WC	96.51±8.152	97.64±9.005	101.4±7.231
WHR	0.9±0.066	0.906±0.062	0.952±0.057
WHtR	0.59±0.049	1.118±5.569	0.848±3.575

Data expressed were mean±SD. WHtR: Waist-to-height ratio, WHR: Waist-to-hip ratio, SD: Standard deviation, WC: Waist circumference, HC: Hip circumference, BMI: Body mass index

There was a higher prevalence rate of 16.5% in both 1st and 2nd trimesters which was however totally overtaken by the 3rd trimester as risk increases at level of >88 cm WC category as indicated by the values shown under WC column in Table 2.

There was a 44% and 36% obesity prevalence value in the 1st and 2nd trimesters, respectively, and the 3rd trimester at 14% in the >0.81 range, with an 85% value at the >0.90 (level of high risk) range for 3rd trimester from the data recorded under WHR column in Table 2.

There was a high prevalence of above 40% in all trimesters, with the 3rd trimester showing a continuous increase in the risk level of >0.59 cm WHtR range as evidenced from Table 2 under WHtR column.

In all the graph, it is clear that the 3rd trimester of pregnancy showed a remarkable high increase in all anthropometric indices indicating a positive risk to obesity in that particular trimester.

For instance, 56%, 44%, 16%, and 4% prevalence were reported with WHtR, WHR, WC, and BMI, respectively, for 1st trimester only for obesity indication whereas for higher risk level, it is shown in the 3rd trimester for the respective indices above as 60%, 85%, 97%, and 89% in the study samples. Figures 1-4 shows the graph patterns as the various indices are plotted against percentage prevalence rate to easily see which of the trimesters is/are more predisposed to predict obesity tendency [Table 3].

Correlation coefficient of the various indices

Table 4 compares the correlation coefficient of BMI against other three indices in the three trimesters.

Hypothesis

- H_0: There is no significant difference in terms of the use of BMI, and three anthropometric indices (WC, WHR, and WHtR) used to determine obesity in pregnant women, i.e. $\mu_1 = \mu_2 = \mu_3$
- H_1: There is a significant difference in terms of the use of using BMI and the other indices to determine obesity in pregnant women.

Table 2: Description of the anthropometric parameters used, showing prevalence percentage rate in the different trimesters of pregnancy against their study samples (*n*=460)

Variable	First trimester, *n* (%)	Second trimester, *n* (%)	Third trimester, *n* (%)
Total number of study sample	110 (24)	110 (24)	240 (52)
BMI categories			
Normal (18.5-24.9)	-	-	-
Overweight (25-29.9)	-	-	-
Obesity/risk 1 (30-34.9)	4 (3.60)	8 (7.30)	2 (0.80)
Risk 11 (35-39.9)	29 (26.40)	39 (35.40)	25 (10.40)
Risk 111 (≥40)	77 (70)	63 (57.30)	213 (88.80)
WHR categories			
Normal (≤80)	7 (6.40)	5 (4.50)	1 (0.40)
Moderate risk (0.81-0.89)	48 (43.60)	39 (35.50)	34 (14.20)
High risk (≥0.90)	55 (50)	66 (60)	205 (85.40)
WC categories			
Normal (≤80)	0	4 (3.60)	0
Moderate risk (80.5-88)	17 (15.50)	17 (15.50)	7 (3)
High risk (>88)	93 (84.50)	89 (80.90)	233 (97)
WHtR categories			
Normal (≤0.5-0.59)	62 (56.40)	57 (51.80)	96 (40)
Risk (>0.59)	48 (43.60)	53 (48.20)	114 (60)

WHR: Waist-to-hip ratio, WHtR: Waist-to-height ratio, WC: Waist circumference, BMI: Body mass index

Table 3: Summary of prevalence percentage in the category 1 and 2 of the indices

	First trimester (%)	Second trimester (%)	Third trimester (%)
BMI (>30 and >35 kg/m^2)	3.6 and 26.4	7.3 and 35.4	0.8 and 10.4
WHR (>0.81 and >0.90 cm)	43.6 and 50	35.5 and 60	14.2 and 85.4
WC (>80.5 and >88 cm)	15.5 and 84.5	15.5 and 80.9	3 and 97
WHtR (>0.5 and >0.59 cm)	56.4 and 43.6	51.8 and 48.2	40 and 60

WHR: Waist-to-hip ratio, WHtR: Waist-to-height ratio, WC: Waist circumference, BMI: Body mass index

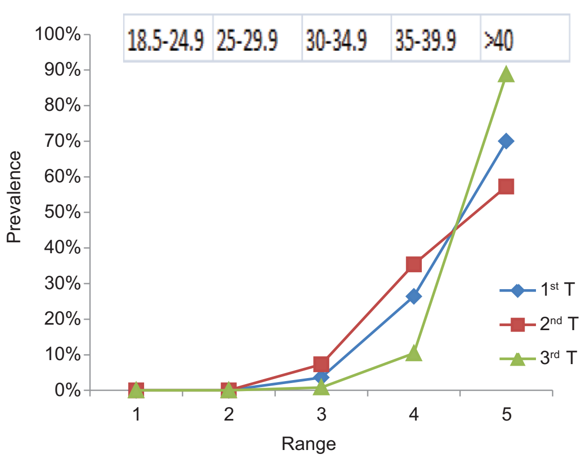

Figure 1: BMI prevalence of obesity among trimesters

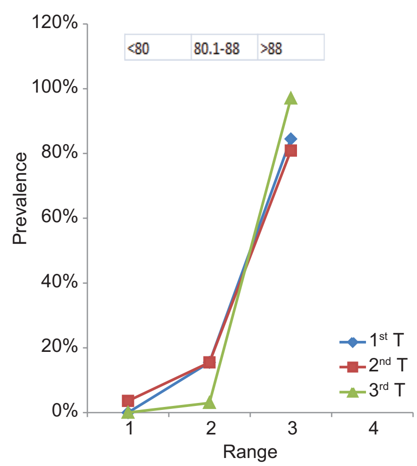

Figure 2: Waist circumference among obesity prevalence in the trimesters

Critical value

d.f.N = degree of freedom number of groups = k − 1

d.f.D. = degree of freedom sum sample sum = N − k

where: k is number of groups = 3

N is sum of all samples = 460

d.f.N. = k − 1 = 3 − 1 = 2 and d.f.D. = N − 4 = 460 − 3 = 457

From the F-distribution table, the critical value obtained at α = 0.05 is − 140.65 [Table 5].

Interpretation

Since F (=−174.4) is less than the critical value (=−140.6), the *P* value (=0.012) is less than α < 0.05 we do accept the null hypothesis; and summarizes the result as follows:

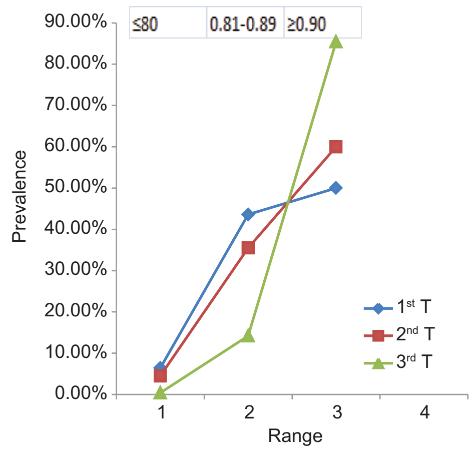

Figure 3: WHR - obesity prevalence in the trimester of pregnancy

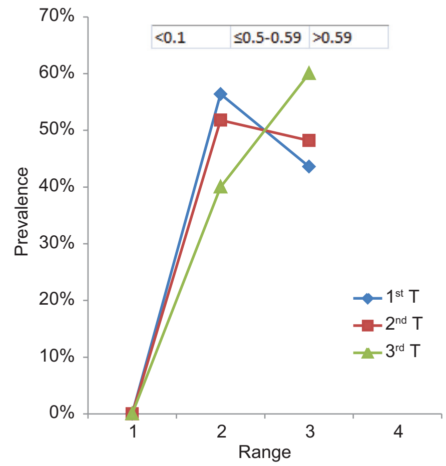

Figure 4: WHtR-obesity pregnancy among the trimester of pregnancy

Table 4: Correlation coefficient of anthropometric indices in the trimesters of pregnancy

Indices	First trimester (*r*)	Second trimester (*r*)	Third trimester (*r*)
BMI	1	1	1
WC	0.085	0.13	0.036
WHR	−0.015	0.149	0.079
WHtR	0.165	0.041	0.004

WHR: Waist-to-hip ratio, WHtR: Waist-to-height ratio, WC: Waist circumference, BMI: Body mass index

Table 5: ANOVA

Source of variation	SS	df	MS	*F*	*P*	*F* critical
Between groups	63.84	2	31.92	−174.4	0.0116172	−140.65
Within groups	−83.52	460	−0.183			
Total	−19.67	462				

SS: Sum of squares, MS: Mean square

- H_1: There is no significant difference across the trimester groups in the value of BMI and the other indices to determine obesity among pregnant women and that chance or sampling error probably accounted for any observed difference.

Discussion

The present study provides diagnostic properties for various obesity indices that are potentially useful in the prediction of obesity and its related adverse pregnancy outcomes. Relating prevalence data of Table 2 that produced Figure 1, it is shown that in the type 1 obesity category (>30 kg/m^2) prevalence is on the opposite side of the value observed in the type 111 obesity range (>40 kg/m^2) as the 3rd trimester reveal a sharp upward straight line of up to 89%, followed by 1st trimester (70%) and then 2nd trimester (57.3%) that moved slightly rightward rather than up. This type 1 category data of 3.6% is lower compared to a finding from Australia,[12] in Abakaliki,[13] and also a bit lower than 2008 WHO report on Nigeria of the 1st trimester. Obesity BMI figures from other African countries are also higher than those reported here in the risk level 1 of obesity. However, the figures in this report are one of the highest particularly in reference to obesity type 111. This may be due to the fact that maternal obesity is known to increase with gestational age and weight, Flegal *et al*.[14] This may also be due to the sudden high rate of food intake by women of this city at this stage of pregnancy for a "prestige" intension of giving birth to heavy, thick baby. It is also one of the lowest in reference to type 1 which may be due to anemia according to report of Baig-Ansari *et al*.,[15] Liabsuetrakul,[16] and Siega-Riz *et al*.[17] and hence likely responsible for the low birth weight common among people of this region.

From the prevalence data of WC in Table 2, a 15.5% prevalence value was observed in the 1st and 2nd trimesters against 3% in the 3rd trimester in the 80.1–88 cm WC range and a high percentage value in the > 88 cm range in all trimesters, hence the plot in Figure 2 all show an upward straight line graph. The value here 15.5% (80.1–88 cm range) is seen to be lower than 31% recorded by Siminialayi *et al*.[18] This lower onset value is likely due to societal pressure these days of "slim beauty" before and after pregnancy. In this study, it was found that WC, measured between 1st trimesters, is as good a predictor of this outcome as BMI. This also with the work of Eliana *et al*.[19] that WC predicts obesity-related adverse pregnancy outcomes at least as well as BMI in Brazilian population. However, it should be known that it differs from people and ethnicity to another and also likely influenced in this study by the expansion from the weight of the baby in the womb at the category 11. In all, the view of Ho *et al*.[20] which demonstrated that one's waist measurement should not exceed half of the body height.

From the prevalence data of WHR in Table 2, the percentage value indicated in the 0.81–0.89 cm range and ≥0.90 cm range show upward straight line graph of the 3rd trimester in Figure 3 plot. WHR here particularly in the 1st and 2nd trimesters were higher as compared to 35.7% for Iranian women, 39% for Pakistan women according a work done by Sotoudeh *et al.*[21] WHR in this show a better predictor in the 1st trimester with BMI, and would also be an independent good risk predictor, however not a risk factor intervention index. It is only a good index for risk assessment rather than risk management with a >0.9 cm signifying risk even as its negative correlation was quickly shown in the 1st trimester of pregnancy with no supposing much uterine volume effect.

From the prevalence of WHtR data of Table 2, shows a line graph toward the right side due to their <50% prevalence value observed for both 1st and 2nd trimester in the >0.59 cm category as shown in Figure 4. With comparison to the WHO value, the value in this study under this index is higher even than in other African countries. For WHtR, considering >0.5 cm standard for WHO and >0.48 cm for Chinese according to Ho *et al*.,[20] it is obvious from this data which shows over 50% for 0.5–0.59 in both 1st and 2nd trimesters that it can deduce to be another predictor for obesity risk in the trimesters for pregnant women. It should be noted however that WHtR seems a reliable index for obesity determination in the trimesters considering the actual fetal addition effect and also stand as the best for risk warning signs. The lower maternal prevalence of BMI, WC and higher WHR, WHtR prevalence agrees with a New York survey.[22]

From the Pearson correlation value of Table 4, a linear correlation found for all trimester levels between BMI and other indices. This is in agreement to finding from a recent study in Saudi Arabia according to El-Gilany and Hammad.[23] However, while WC and WHtR show a significant positive rank correlation, WHR shows a negative rank correlation with BMI as an independent variable in the 1st trimester alone with value ($r = -0.015$) against a ($r = 0.085$ and 0.165) in WC and WHtR, respectively. In 3rd trimester, however, the values were significant to BMI with ($r = 0.036$, 0.079 and 0.004) for WC, WHR, and WHtR, respectively.

The mean value of BMI and WC in particular increased significantly from 1st to 3rd trimesters. This is because participants' mean height remained unchanged while the mean weight increased progressively across the trimesters. From our study, WC is independent of the gestational age and could be used to identify obesity in women regardless of the weeks of the pregnancy. This finding agrees with report of Okereke *et al*.[24] but contradict the study of Wendland *et al*.[25] Hence, to use WC to identify obesity in pregnancy in our environment, different cut-off may be needed for different ranges of gestational age.

Thus, this implies that WHR in the trimesters has higher advantage of determining obesity compared to WC in pregnant women as its coefficient value here indicate a distinct way of assessing obesity outside the complacent index known of BMI being the invariable factor, for which increase weight may be due to perhaps the fetus's weight as well. From the result of the study, there was a significant trend of increased value of the prevalence of obesity with an increase in BMI, WC, WHR, and WHtR in that order in the 3rd trimester followed by 1st trimester.

Since BMI and WC value are almost similar, giving a close meaning, that their combination gives a better obesity prediction. This also the view of Sina *et al*.[26] that WC and BMI before pregnancy are good anthropometric predictors in Aboriginal women. Hence, the 1st trimester always follow behind the 3rd trimester under these two above indices; whereas, in WHtR and WHR, the level of risk is in the order 3rd, 2nd, and 1st trimester with slight lower percentage value as compared to BMI and WC.

Limitations of the study

While carrying out this study, we experienced the following limitations. First, increase in hormone levels during pregnancy was not followed practically but theoretically. Second, medical history or record of subjects on obesity condition was not verified beyond mere asking directly.

Conclusion

The study shows that there is a lesser prevalence of obesity with BMI and WC but a higher prevalence of waist to hip and WHtR in sample. From this study WHtR followed by WHR gives realistic values for obesity determination in pregnant women especially in their 1st and 2nd trimesters both for risk assessment and prediction. The use of either WC or BMI alone does not give a good indicator of obesity, but a combination of WHR and BMI can give both obesity prediction and risk indication.

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Conflicts of interest

There are no conflicts of interest.

References

1. Afridi AK, Khan A. Prevelance and etiology of obesity-an overview. Pak J Nutr 2004;3:14-25.
2. Haslam DW, James WP. Obesity. Lancet 2005;366:1197-209.
3. Pollack A. "A.M.A. Recognizes Obesity as a Disease". The New York Times. Archived from the original. 18 June, 2013.
4. Barry S, Fattah C, Farah N, Broderick V, Stuart B, Turner MJ. The growing challenge of maternal obesity. Ir Med J 2009;102:5-6.
5. Dennedy MC, Dunne F. The maternal and fetal impacts of obesity and gestational diabetes on pregnancy outcome. Best Pract Res Clin Endocrinol Metab 2010;24:573-89.
6. Chigbu C, Aja L. Obesity in pregnancy in Southeast Nigeria. Ann Med Health Sci Res 2011;1:135-40.
7. Campbell S, Lees C. Obstetrics by Ten Teachers. 7th ed. London: Arnold; 2000.
8. Djrolo F, Megnigbeto Obey A, De Souza J, Takpara I, Santos P, Alihonou E. Influence of maternal weight on pregnancy outcome in Cotonou (Benin). J Gynecol Obstet Biol Reprod (Paris) 2002;31:243-7.
9. Denison FC, Price J, Graham C, Wild S, Liston WA. Maternal obesity,

length of gestation, risk of postdates pregnancy and spontaneous onset of labour at term. BJOG 2008;115:720-5.
10. Niedhammer I, Bugel I, Bonenfant S, Goldberg M, Leclerc A. Validity of self-reported weight and height in the French GAZEL cohort. Int J Obes Relat Metab Disord 2000;24:1111-8.
11. World Health Organization. Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation. WHO Technical Report, 894. Geneva: World Health Organization; 1997.
12. Satpathy HK, Fleming A, Frey D, Barsoom M, Satpathy C, Khandalavala J. Maternal obesity and pregnancy. Postgrad Med 2008;120:E01-9.
13. Obi SN, Obute EA. Pregnancy outcome in the obese Nigerian. Trop J Obstet Gynaecol 2004;21:32-5.
14. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. JAMA 2012;307:491-7.
15. Baig-Ansari N, Badruddin SH, Karmaliani R, Harris H, Jehan I, Pasha O, *et al*. Anemia prevalence and risk factors in pregnant women in an urban area of Pakistan. Food Nutr Bull 2008;29:132-9.
16. Liabsuetrakul T; Southern Soil-Transmitted Helminths and Maternal Health Working Group. Is international or Asian criteria-based body mass index associated with maternal anaemia, low birthweight, and preterm births among Thai population? An observational study. J Health Popul Nutr 2011;29:218-28.
17. Siega-Riz AM, Adair LS, Hobel CJ. Maternal underweight status and inadequate rate of weight gain during the third trimester of pregnancy increases the risk of preterm delivery. J Nutr 1996;126:146-53.
18. Siminialayi IM, Emem-Chioma PC, Dapper DV. The prevalence of obesity as indicated by BMI and waist circumference among Nigerian adults attending family medicine clinics as outpatients in Rivers State. Niger J Med 2008;17:340-5.
19. Eliana MD, Bruce BD, Sotero SD, Luciana BN, Maria IS. Waist circumference in the prediction of obesity related adverse pregnancy outcomes. Cad Saude Publica 2007;23:2.
20. Ho SY, Lam TH, Janus ED; Hong Kong Cardiovascular Risk Factor Prevalence Study Steering Committee. Waist to stature ratio is more strongly associated with cardiovascular risk factors than other simple anthropometric indices. Ann Epidemiol 2003;13:683-91.
21. Sotoudeh G, Khosravi S, Khajehnasiri F, Khalkhali HR. High prevalence of overweight and obesity in women of Islamshahr, Iran. Asia Pac J Clin Nutr 2005;14:169-72.
22. Cheron R, Magdalena B, Renu K, Elizabeth N, Robyn P, Lora E. Measures of adiposity and cardiovascular disease risk factors. Nyc Hanes 2004;8:A56.
23. El-Gilany AH, Hammad S. Body mass index and obstetric outcomes in pregnant in Saudi Arabia: A prospective cohort study. Ann Saudi Med 2010;30:376-80.
24. Okereke CE, Anyaehie UB, Dim CC, Iyare EE, Nwagha UI. Evaluation of some anthropometric indices for the diagnosis of obesity in pregnancy in Nigeria: A cross-sectional study. Afr Health Sci 2013;13:1034-40.
25. Wendland EM, Duncan BB, Mengue SS, Nucci LB, Schmidt MI. Waist circumference in the prediction of obesity-related adverse pregnancy outcomes. Cad Saude Publica 2007;23:391-8.
26. Sina M, Hoy W, Wang Z. Anthropometric predictors of gestational hypertensive disorders in a remote aboriginal community: A nested case-control study. BMC Res Notes 2014;7:122.