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Waist to Hip Ratio Index as Anthropometric Indicator of Obesity among Pregnant Women in Port Harcourt, Nigeria

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ABSTRACT

There have been controversies on defined anthropometric indices for the assessment of obesity in pregnant women as 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 indices particularly waist to hip ratio to measure obesity and determine its prevalence in the different trimesters of pregnancy. The research is a prospective study of 460 pregnant women in the sample proportion of 110, 110, 240 in the 1st, 2nd, 3rd trimesters respectively chosen randomly from antenatal clinic of the Rivers State Primary Health care centre, Rumuepirikom, Port Harcourt, Nigeria. Measurements of height, weight, hip circumference (HP) were obtained. Basal metabolic index (BMI) was calculated from values of height and weight. Waist to hip ratio (WHR) was also calculated from waist and hip values. The result showed a BMI prevalence of 3.6%, 7.3% and 0.8%; WHR prevalence of 43.6%, 35.5% and 14.2% in the 1st, 2nd and 3rd trimesters respectively. A negative linear correlation was shown between the index and BMI as an independent variable in first trimester with value (r=-0.015). Generally, the study provides a high prevalence of WHR relation to WHO values as well as establishing 1st trimester as a good indicator of obesity in pregnant women in the population studied.

Keywords: *Body Mass Index, Waist-to-Hip Ratio, Trimesters, Waist circumference, Hip circumference, Obesity.*

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, have been found to be medically deleterious to the body. Obesity is defined by body mass index (BMI) and further evaluated in terms of fat distribution via the waist–hip ratio and total cardiovascular risk factors.

There have been several studies on the anthropometric indices of cardiovascular diseases patients including obesity in different parts of the world. However not much has been established with regards to the waist to hip ratio index 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 socio-economic status. In fact there may be obvious difference particularly in the interpretation of Waist Circumference value as there seems to be a lack of universally accepted site for measuring Waist Circumference and the large variation of Waist Circumference optimal cut-off also affected by age, sex, race and ethnicity. 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[1].

Hence, as a result of some of these shortcomings lies the inherent gap and essence of this study to investigate other reliable alternatives (waist to hip ratio) among the populace of which this study seek 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[2] and health behaviors to reduce future disease occurrence. To contribute information regarding the use of pregnancy measures of obesity in the prediction of adverse gestational outcomes, this study aim to evaluate minimal waist circumference, BMI and waist to hip ratios assessed using reported weight measured between gestational weeks. New anthropometric indices are being suggested from time to time; evidence is mounting for anthropometric indices related to abdominal obesity such as waist circumference(WC), waist-to-hip ratio (WHR), as well as indices as abdominal sagittal diameter (ASD) that are more sensitive but not feasible to be measured in population-based studies .

The main aim of this study is to measure anthropometric indices for identification of obesity and the prevalence among pregnant women in Port Harcourt.

The specific objectives are to:

1. Determine prevalence of obesity in pregnant women using BMI, WHR, WC at different stages of the indices.
2. Relate BMI as a measure of obesity against the other anthropometric indices within the different trimesters as to get a reasonably best index for prediction in pregnancy.

MATERIALS AND METHODS

Research Area

The study was undertaken in Port Harcourt metropolis of Rivers State, specifically in Rivers State primary health care center, Rumuepirikom, Port Harcourt, Nigeria chosen for its comprehensive emergency obstetric services where pregnant women of all socio-economic classes are always undergoing routine antennal care.

The Population of the Study

The populations of the study were all pregnant women on antenatal visit to the clinics in the area. Criteria for selection included all normal pregnant women with no special obesity conditions associated with them while attending the antenatal clinic.

Sample size and Sampling Techniques

The sample size was determined using Fisher's formula

$$n = \frac{Z^2pq}{d^2} \quad \text{where } q = (1 - p)$$

The calculated sample size of approximately 400 was further increased to 460 to make up for cases of attrition.
A stratified random sampling technique was used in the selection of this cross sectional study.

Exclusion Criteria: Adolescent pregnant women of less than 18 years were excluded. Secondly, women in their pregnancy term of less than one month are excluded. This is because their presence at the clinics was low or near zero thereby making no valid premise for discuss. Also women with multiple pregnancies as well as those with hyper-emesis gravidarum were excluded.

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

The Research Design

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

Method of Data Collection

The parameters taken include:

(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) Waist circumference 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) Waist to hip ratio (WHR) calculated by dividing values of Waist circumference (WC)/ Hip circumference (HC).

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

Instrumentation

1. Elastic tailor's measuring tape (Butterfly model – made in China), graduated in centimeters (0-150) was used to measure the waist and hip circumferences.
2. Height meter: 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.
3. DANS weighing scale (Seca, UK) calibrated from 0-200kg was used to measure body weight to the nearest kilogram.

Method and Data Analysis

All anthropometric measurements were taken, in the morning, according to WHO recommendations by me 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 analysed using IBM SPSS 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 (S ± SD) and the comparison of indices and significance of association were done with the Analysis of variance and then regression model to find the degree of correlation between variables.

RESULTS

Descriptive Statistics and Demographics

The descriptive statistics of the anthropometric indices according to the mean and standard deviation of weight, height, body mass index, waist hip ratio, waist height ratio and waist circumference levels for pregnant women in the three trimesters are collated in table 1.

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

Indices	Variable	1st Trimester Mean ±S.D.	2nd Trimester Mean ±S.D.	3rd Trimester Mean±S.D.
	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
	Hip Cir	107.5 ±7.926	107.8±8.11	106.7±7.964
	WHR	0.9 ±0.066	0.906±0.062	0.952±0.057

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

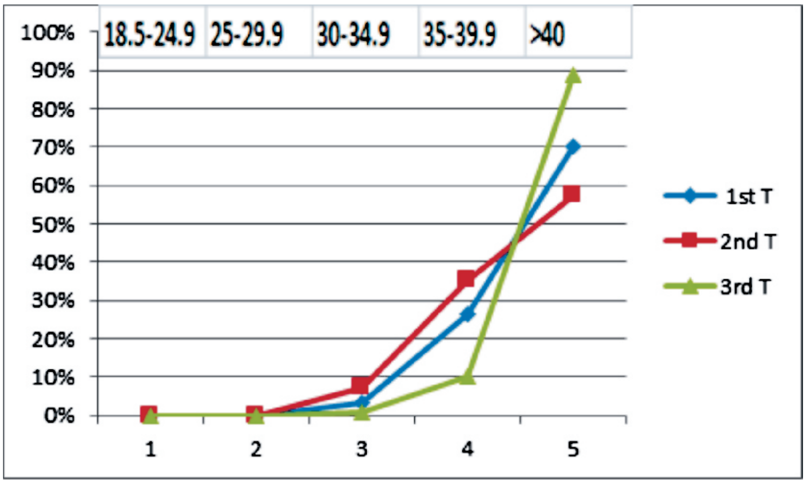
Table 2: Description of the Anthropometric parameters used, showing Prevalence Percentage rate in the different trimesters of pregnancy against their study samples. N=460

Variable	Prevalence	1st Trimester		2nd Trimester		3rd Trimester	
(A) Total number of study sample		110	24%	110	24%	240	52%
(B) 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%
(C) 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%

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 18.5-29.9kg/m^2 for a comparative prevalence. In all trimesters the prevalence value were above 50% at the >40kg/m^2 category.

Prevalence

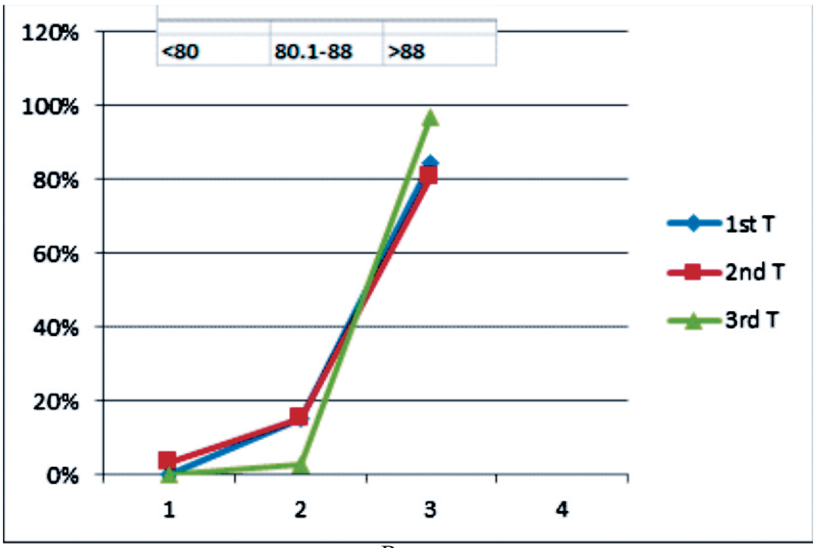


Range

Figure 1: BMI Prevalence of obesity among the trimesters.

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

Prevalence



Range

Figure 2: WC (cm) obesity prevalence in the trimesters.

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

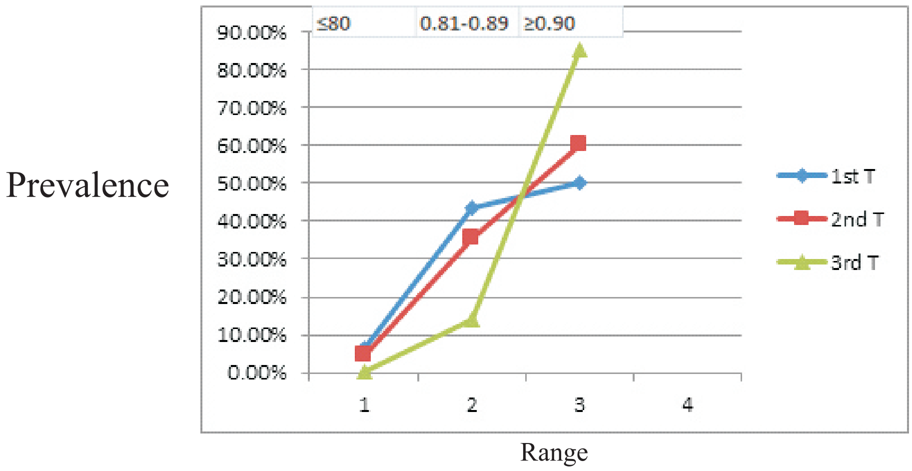


Figure 3: WHR(cm) obesity Prevalence in the trimesters of pregnancy.

There was a 44% and 36% obesity prevalence value in the 1st and 2nd trimesters respectively and 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.

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

For instance, 44%, 16%, 4% prevalence are reported with WHR, WC and BMI respectively for first 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% in the study samples. Figure 1, 2, 3 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.

Correlation Coefficient of the Various Indices

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

Table 3: Correlation coefficient of anthropometric indices in the Trimesters of Pregnancy

	Trimesters	1st	2nd	3rd
Indices		$\hat{r}$	$\hat{r}$	$\hat{r}$
BMI		1	1	1
WC		0.085	0.13	0.036
WHR		-0.015	0.149	0.079

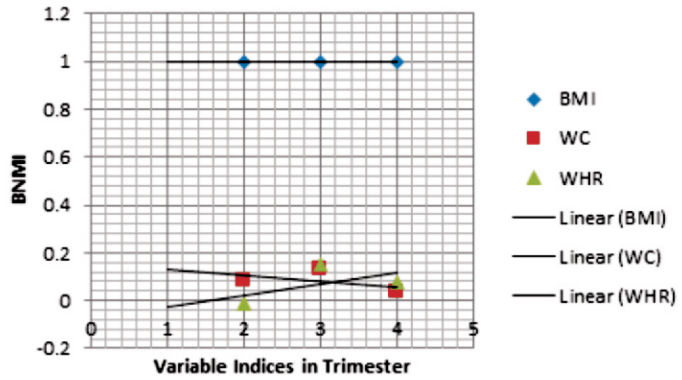


Figure 4: Simple Regression Model, showing correlation graph between BMI and WC/WHR

Analysis of Variance Computation of the mean Obesity in Pregnant Women for the different Anthropometric indices

Hypothesis:

H_0: There is no significant difference in terms of the use of BMI and the other anthropometric indices (WC, WHR) used to determine obesity in pregnant women. i.e. $_1 = _2$

H_1: There is significant difference in terms of the use of using BMI and the other indices to determine obesity in pregnant women.

Table 4: ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	63.84	2	31.92	-174.4	0.0116172	-140.65
Within Groups	-83.52	460	-0.183			
Total	**-19.67**	**462**				

Interpretation

Since F (=-174.4) is less than the critical value (= -140.6), the p-value (= 0.012) is less than $\alpha < 0.05$ we do accept the null hypothesis; and summarizes the result as follows:

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

Relating Prevalence data of table 2 that produced Fig 1, it is shown that in the type 1 obesity category(>30kg/m^2), prevalence is as follows 3.6%, 7.3% and 0.8% in the 1st, 2nd and 3rd trimesters respectively. This is however opposite the value observed in the type 111 obesity range (>40kg/m^2) as 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 which recorded a prevalence of 10.7%[3], in Abakiliki of 7.7%[4], and also a bit lower than the 2008 WHO report on Nigeria which gave 6.5% for obesity in category 1 of 1st trimester. However for obesity 11 with values 26.4%, 35.4% and 10.4% for the respective trimesters, it is seen to be higher but not too far from a recent report in a city in Northern Nigeria where obesity prevalence was as high as 21%; so also for super obesity (obesity 111) with very high percentage in all trimesters. Obesity BMI figures from other African countries are also higher than those reported here especially in the type 1 / risk level 1 of obesity. In Ghana, obesity BMI prevalence is reported to be 13.6%[5], while the figure is 18% for the Republic of Benin[6]. An obesity BMI prevalence of 19.2% was recently reported in Dares Salam, Tanzania[7]. Beyond Africa, in Portugal, the BMI figure is 15.1% for obesity[8] while in Spain they are 13.6%[9]. However the figures presented in this report are one of the highest in the literature 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[10]. 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 anaemia according to report of

Naila[11] in urban city of Pakistan and hence likely responsible for the low birth weight common among people of this region. This assumption from the effect of low maternal BMI agrees with the work of Tippawan[12], in Thai population and Siega Riz[13].

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 80.1-88cm WC range and a high percentage value in the >88cm range in all trimesters, i.e (84.5%, 80.9%, 97%); hence the plot in Fig 2 all show an upward straight line gragh. The value here 15.5% (80.1 – 88cm range) is seen to be lower than 31% recorded by Siminialayi[14] in Okrika. 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 waist circumference, measured between first trimesters, is as good a predictor of this outcome as BMI based on weight taken at the same period with BMI. This also with the work of Eliana[15] 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 according to, 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[1] which demonstrated that one's waist measurement should not exceed half of the body height which means everyone will have an individual cut-off waist measurement should be considered. This should be more acceptable to the public than a single waist measurement for all.

From the prevalence data of WHR in table 2, the percentage value is indicated in the order of 43.6%, 35.5%, 14.2% in the 1st, 2nd, 3rd trimesters respectively in the 0.81-0.89cm range and a 50%, 60%, 85% equally in the ≥0.90cm range, which show the upward straight line graph of 3rd trimester in the Fig 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[17]. On WHR in this study, it could show a better predictor in the first trimester with BMI, and would also be an independent good risk predictor. WHR uses a value of >0.8cm for normal and according to, it is good for women of older age hence it could be said that for pregnant women whose age bracket are still within 20-45 years, it is however not a risk factor intervention index. This agrees with other work that it is only a good index for risk assessment rather than risk management with a >0.9cm signifying risk even as its negative correlation was quickly shown in the first trimester of pregnancy with no supposing much uterine volume effect.

From the Pearson correlation value of table 4, Figure 5 then shows a linear correlation found for all trimester levels between body mass index and other indices. This is in agreement to finding from a recent study in Saudi Arabia according to El-Gilary and Hammad[18]. However while WC show a significant positive rank correlation, WHR shows a negative rank correlation with BMI as an independent variable in first trimester alone with value(r=-0.015) against a (r=0.085) in WC. In 3rd trimester however, the values were significant to BMI with (r=0.036, 0.079) for WC, WHR 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 as described under literature review that WC is not influenced by height and hence a positive risk indicator as well. From our study, though WC has a strong correlation with BMI, there is no significant difference in the three trimester group which suggest that WC is independent of the gestational age and could be used to identify obesity in women regardless of the age (weeks) of the pregnancy. This finding agrees with report of Okeke[19] but contradict the study of Wendland[20]. So in order 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 study, there was a significant trend of increased value of the prevalence of obesity with an increase in BMI, WC, WHR in that order in third trimester followed by first trimester.

Since BMI and WC value are almost similar, giving a close meaning, as their combination gives a better obesity prediction. This also the view of Maryan[21] that WC and BMI prior to 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 WHR, the level of risk are in the order 3rd, 2nd, 1st trimester with slight lower percentage value as compared to BMI and WC.

CONCLUSION

First, the study shows that there is a lower prevalence of obesity with BMI and waist circumference but a higher prevalence of elevated waist to hip in Port Harcourt pregnant women. From prevalence and correlation data of this study it is clear that WHR gives a realistic values for obesity determination in pregnant women especially in their 1st and 2nd trimesters both for risk assessment and prediction in the environment of study. The use of either WC or BMI alone does not give a good indicator of obesity in the subject of study, but a combination of WHR and BMI can give both obesity prediction and risk indication. The lower BMI prevalence in the 1st trimester and its greater change during the other trimesters is likely associated with the miscarriages and still birth noted commonly amongst the subjects as mention under the introduction.

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