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Jaja T
Alex Hart B

Prevalence of overall and central obesity among adolescent girls in Port Harcourt: a comparison of different methods

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Jaja T (✉)
Alex Hart B
Department of Paediatrics and Child Health, College of Health Sciences, University of Port Harcourt and University of Port Harcourt Teaching Hospital, Rivers State, Nigeria
Email: Tamunopriyej@yahoo.com

Abstract: There is no universally accepted criterion for classification of overall weight status and central obesity in adolescents. Several criteria have been used which include that recommended by Centre for Disease control, World Health Organization and the International Obesity Task Force.

Aim: The study compared various methods for determination of overall obesity in adolescents using the BMI percentiles recommended by the Centre for Disease Control (CDC), the International Obesity Task Force (IOTF) and the World Health Organization (WHO) BMI Z score and determination of central obesity using the waist circumference (WC), Waist Hip Ratio (WHR) and Waist Height Ratio (WHtR).

Methods: The study subjects consisted of 1320 girls aged 10-19 years from randomly selected girl's high school. Weight status to determine overall obesity was determined according to the CDC, IOTF and WHO criteria and central obesity determined using the WC, WHR, and WHtR. Comparison of methods was done and analysed.

Results: Prevalence of overall and central obesity varied with different methods. The prevalence of overall obesity was 106(8.02%), 69(5.22%) and 39(2.75%) using the CDC, WHO and IOTF criteria respectively. Prevalence of central obesity was 1.5%, 16.26%, 47.81% using the WC, WHtR, and WHR respectively. The agreement between criteria of WHO Z score and BMI Percentile was highest for overall obesity. (K=0.81).

There was a statistically significant association between overall weight status and central obesity using the different criteria of determination of central obesity.

Conclusion: Prevalence of overall obesity and central obesity varied based on the methods used. The highest level of agreement for overall obesity determination was obtained between WHO Z score and BMI percentile compared to WHO Z score and IOTF criteria. Prevalence of central obesity increased significantly with overall obesity in study population.

Key words: adolescents, Girls, overall and central obesity

Introduction

Obesity has remained a global health problem with prevalence increasing in both developed and developing countries and in both young and adult populations.[1,2,3] Obesity has also increased in frequency and severity in children and adolescents with a dramatic global increase in prevalence in preschool children in 144 countries since 1990.[4] In Sub- Saharan Africa, there is an evidence of transition to obesity in children despite historically known food shortages.[5] Overweight and obesity constitute a major risk factor for most non- communicable diseases such as hypertension, type 2 diabetes and other cardiovascular diseases in both adolescents and adults.

In adolescents, the Body Mass Index (BMI) is used as a reliable indicator of body fat but many adolescents classified as overweight or obese may not have high adiposity.[6, 7] The BMI is dependent on stature, age, fat distribution and musculature and its use is limited on a lack of consensus on the cut off to be used in classification of weight status in children and adolescents.[8]

There are different criteria of classification of BMI in adolescents based on age and sex. Obesity determination can also be done independent of the BMI by measuring the degree of central adiposity using simple measurements such as waist circumference, Waist Hip Ratio and Waist Height Ratio. The determination of degree of adiposity especially central adiposity has been identified as

the most important correlate and independent predictor of risk factors and morbidity.[9, 10] Adiposity generally tracks from childhood and has been associated with adult health outcome. Therefore early identification of adolescents with central adiposity is very important to prevent metabolic complications.[11] Adiposity generally tracks from childhood into adulthood.
Studies on prevalence of overall and central obesity in children and adolescents using different classification criteria have observed differences in prevalence in different populations,[12-14] The observed differences may be due to difference in the population used in constructing the various references. The choice of what represents normal weight may vary with different population groups. For Nigerian adolescents, the WHO references may seem the most adequate because of the population used in developing the references. The aim of this study was to compare the prevalence of overall obesity and central obesity among adolescent girls in public secondary schools in Port Harcourt using different criteria of BMI and Waist, Hip and height measurements.

Methodology

This cross- sectional observational study was done amongst secondary school girls in selected public secondary schools in Port Harcourt Local Government Area of Rivers State, Nigeria. Port Harcourt Local Government Area is one of the largest Local Government Area situated in the capital of Rivers State an oil producing state in the Niger Delta region of Nigeria. It has three districts, Diobu, Town and Trans-Amadi districts. The study population consisted of girls aged between 10 and 19 years in public day secondary schools in Port Harcourt. Three of the girls schools with no boarding facility were selected from a list of girl's secondary schools in the three Districts of Port Harcourt LGA by simple random sampling. One school was selected from each of the three districts.

Approval for this study was obtained from the school authority and ascent obtained from the students. All subjects who were willing to participate and were present in school on the 3 days of sampling allotted to each school were recruited. An average of 450 students that met the inclusion criteria were recruited from each selected school and analysed.
The participation of the subjects was voluntary and anonymous, and we adopted the use of a negative term of consent (passive parental consent form). No personal identification was allowed in the instruments to ensure the anonymity of responses. Information on biodata and general characteristics was obtained by a self- administered questionnaire supervised by researchers and trained assistants. Inclusion criteria involved students who were present on the day of data collection, who did not have any chronic medical condition and were willing to participate in the study by giving assent.
Anthropometry which included the weight, height, waist and hip circumferences was done by pretrained researcher and assistants. Each researcher and an assistant were assigned to do a particular measurement to reduce variability.
Body weight was measured using calibrated digital scale brand SECA 780 with a capacity of 150kg and 100g precision. Weight was recorded with subject standing erect without shoes and weight to the nearest 0.5kg. The scales were standardized each morning with a known weight and adjusted to zero marks before each reading. The height was performed using a stadiometer with subject erect without shoes with the back placed against the stadiometer and the head in Frankfurt plane to the nearest 0.5cm. Body Mass Index (BMI) was calculated as the weight in Kilograms divided by the height in meters squared. Weight category was divided into underweight, normal weight, overweight and obesity using The BMI percentile by CDC, according to limit proposed by Cole et al (IOTF) and WHO BMI Z score.[15, 16, 17]

WHO BMI Z score which classifies individual as values < -2 with thinness, adequate weight as -2 and 1, overweight as Z score of >1 and < 2 and obesity as Z score of ≥ 2.[15]
Using the IOTF criteria and limits proposed by Cole et al, thinness is defined as BMI of < 18.5Kg/m^2, normal weight as BMI of 18.5 to < 25kg/m^2 and overweight as BMI of ≥25kg/m2 and obesity as BMI of ≥ 30kg/m^2.[16]
Waist Circumference was performed in the horizontal plane, with the subject in standing position and abdomen exposed and measurement using an inelastic tape measure at the mid- point between the lower rib cage and iliac crest after a normal expiration. Hip circumference was measured in a standing position using an inelastic tape at the widest circumference over the buttocks running over the femoral canal outlet anteriorly and measured to the nearest 0.1cm.
Abdominal or central obesity was defined as WC ≥ 90th percentile for age and sex, [17] WHR>0.80 or WHtR ≥ 0.50.[18]

Data analysis involved initially descriptive statistics for all the variables. Statistical analysis was performed with statistical package for Social sciences version 19.0. Statistical significance was set at 0.05. The Cohen's Kappa statistics was used to analyse the correlation between the WHO BMI Z score criteria and the other measures of overall obesity.

Results

A total of 1322 out of 1350girls had complete data and were analysed. They were aged between 10 and 19 years with a mean age of 15.74±1.45. Table 1 shows the mean of various anthropometric measures for the study populations and different ages. There was a progressive increase in mean weight, BMI and Hip circumference with age. The waist hip ratio however showed a progressive reduction in mean value with age.

Table 1: Mean of Anthropometric Measures for Study Population

Age (yrs)	Weight (kg) Mean (s.d)	Height (cm) Mean (s.d)	BMI (kg/m^2) Mean (s.d)	WC (cm) Mean (s.d)	HiC (cm) Mean (s.d)	WHR Mean (s.d)	WHtR Mean (s.d)
General	54.35 (9.30)	157.80 (6.68)	21.77 (3.55)	72.26 (7.17)	90.38 (7.81)	0.80 (0.06)	0.46 (0.05)
<13 (n=32)	47.06 (8.57)	150.50 (7.65)	20.69 (3.25)	69.75 (4.74)	83.03 (10.59)	0.85 (0.13)	0.46 (0.03)
13-13.9 (n=78)	52.36 (10.09)	156.74 (6.9)	21.24 (3.66)	72.65 (8.08)	88.96 (8.08)	0.82 (0.06)	0.46 (0.05)
14-14.9 (n=265)	53.06 (8.17)	157.97 (6.50)	21.15 (3.49)	71.79 (7.43)	89.22 (7.82)	0.81 (0.06)	0.46 (0.05)
15-15.9 (n=363)	53.85 (10.16)	157.97 (6.54)	21.62 (3.78)	71.86 (6.84)	89.61 (7.55)	0.80 (0.05)	0.45 (0.04)
16-16.9 (n=256)	55.66 (8.52)	158.39 (6.77)	22.12 (3.13)	73.14 (6.88)	91.78 (7.52)	0.80 (0.06)	0.46 (0.04)
17-17.9 (n=223)	55.95 (9.57)	158.28 (6.36)	22.34 (3.69)	72.49 (7.96)	92.11 (7.55)	0.79 (0.05)	0.46 (0.05)
18-18.9 (n=105)	56.43 (7.78)	157.17 (6.25)	22.56 (3.27)	72.79(6.17)	92.21 (6.50)	0.79 (0.05)	0.46 (0.04)
Total (n=1320)							

Table 2 shows the prevalence of various weight categories according to the BMI criteria using the BMI percentile, WHO Z score and the IOTF classification. The BMI percentile followed by the WHO Z score showed the highest prevalence of obesity of 8.02 and 5.22 respectively. Highest prevalence of overweight was also recorded by the WHO Z score. Using Cohen's Kappa, there was a moderate agreement between BMI Z score and IOTF criteria (K= 0.505) but a strong agreement between BMI Z score and BMI percentile. (K= 0.806) These findings were statistically significant.

Table 2: Prevalence of Various Weight Status according to BMI Percentile, IOTF, WHOBMI Z score

Weight Category	BMI Percentile	IOTF	WHO BMI Z score
Underweight	35(2.64)	171(13.21)	16(1.21)
Normal weight	1049(79.35)	974(73.52)	1039(78.59)
Overweight	132(10.21)	138(10.51)	198(14.9)
Obesity	106(8.02)	39(2.95)	69(5.22)

Table 3 shows the prevalence of central obesity using WC, WHR and WHtR. The prevalence of central obesity was highest using WHR (47.81). WC and WHtR gave prevalence of 1.51 and 16.26 respectively. There was a statistically significant relationship between measures of central obesity and overall obesity using the BMI Z score. WC, WHR, WHtR increased with increasing weight category and BMI weight status. (X^2= 179.02, X2= 20.19, X2= 448.51 respectively with p value of 0.001 for each). Eighteen (90%) of subjects with central obesity using the WC were also overweight or obese. This is compared to 24% using WHR and 71% using WHtR.

Table 3: Distribution of Subjects based on overall obesity measured by WHO Z score and central obesity using various methods

		WC Percentiles		WHR		WHtR	
BMI Z Score Classification	n(%)	<90th n (%)	≥90th n (%)	≤0.80 n (%)	>0.80 n (%)	<0.5 n (%)	≥0.50 n (%)
Underweight	16 (1.21)	16 (100.0)	0 (0.00)	14 (87.50)	2 (12.50)	16 (100.0)	0 (0.0)
Normal	1039 (78.59)	1037 (99.81)	2 (0.19)	560 (53.90)	479 (46.10)	977 (94.03)	62 (49.49)
Overweight	198 (14.98)	194 (97.98)	4 (2.02)	92 (46.46)	106 (53.54)	100 (50.51)	98 (49.49)
Obese	69 (5.22)	55 (79.71)	14 (20.29)	24 (34.78)	45 (65.22)	14 (20.29)	55 (79.71)
Total	1322 (100.0)	1302 (98.49)	20(1.51)	690(52.19)	632(47.81)	1107 (83.74)	215(16.26)
		χ2=179.02, p-value=0.001		χ2=20.19 p-value=0.001		χ2=448.51 p-value=0.001	

Central Obesity = Waist circumference ≥90 th for age and sex; WHR >0.80; WHtR ≥0.50

Discussion

This study shows a high prevalence of overweight and obesity among adolescent girls in public secondary schools in Port Harcourt. The prevalence values of different weight category also varied according to the criteria used for the evaluation. The prevalence of obesity was 8.02%, 5.22% and 2.95% using the CDC BMI percentile, the WHO BMI Z score and IOTF criteria respectively. In using various methods in determining central obesity, this study illustrates that the percentage of adolescent girls with central obesity varied considerably depending on the method used. The value using the waist hip ratio (WHR) had the highest prevalence while Waist circumference (WC) gave the lowest prevalence of 1.5%.

The diagnosis of overweight and obesity in Nigerian children have used several methods. In a review of studies on childhood and adolescent obesity in Nigeria, WHO reference standard were the most commonly used in about 50% of the studies, the IOTF was the second most commonly used in 24% of studies.[19] Other methods used include skin fold thickness, waist circumference, Waist Hip Ratio and Waist Height ratio. Although no study compared different criteria for the prevalence of obesity in a particular population, the prevalence of obesity in adolescents using the WHO reference was between 0- 5.8% similar to the 5.2 % reported in this study. [19] In using the IOTF criteria in various studies among Nigeria Adolescents, the prevalence of obesity among females was low usually less than 2%. [20, 21]In a study in Kano metropolis, the prevalence of obesity amongst the females using the IOTF was 1.0% similar to 1.7% reported also in the Western part of Nigeria.[20,21]This is similar to the prevalence of 2.95% using the IOTF reported in this study. Also in a study of adolescents in Lagos, the prevalence of obesity using the CDC criteria reported a prevalence of obesity of 9.4%, [22] this was similar to 8.02% reported in this study.

In a study of 966 students aged 10-16 years from public secondary schools in Portugal [23] the prevalence of obesity amongst the girls was also lowest (2%) using the IOTF similar to finding in this study, the prevalence was however 5.4% in girls similar to the 5.22% using WHO Z score reported in this study. In a study by Sardinha et al of 22048 adolescents aged 10-18 years, the IOTF also gave the lowest prevalence of obesity similar to the finding in this study.[24] The study using the WHO Z score was however 9.9% higher than the 5.22% reported in this study. In a study by Wang and Wang [25] done in Russian, American and Chinese children aged 6-18year, the prevalence of obesity using the WHO Z score were all higher than the prevalence reported using the IOTF. The prevalence of obesity amongst the Russian children using the WHO Z score was double the value by the IOTF which was also similar to the report in this study where prevalence of obesity was 5.22% using the WHO Z score almost double the prevalence of 2.95% reported using the IOTF.

The report in this study of prevalence of obesity amongst females of 8.02% using the CDC BMI percentile was however higher than the prevalence of 4.5% reported in female adolescents in Ile Ife Nigeria[1] while a much lower prevalence of 1.0% was also reported in adolescents girls aged 10-20 years in Ondo state in Nigeria.[2]The difference in prevalence between this study and the previous studies may be a reflection of the increasing obesity trend. There are no studies comparing the various methods of determination of overall obesity in adolescents in our region, however different authors have used different methods.

The prevalence of obesity in most studies highlighted above has shown that the prevalence of obesity in adolescents is lowest in the classification using BMI according to the IOTF criteria. The agreement between the various criteria for overall weight status determination varied from moderate to strong. The agreement between the WHO Z score and the BMI according to the IOTF was moderate (K= 0.505) while the agreement between the WHO Z score and the BMI percentile was strong (K= 0.81) this is contrary to the finding in the report by Minghelli and colleagues[26] amongst Portuguese adolescents who reported best agreement for the classification obtained between the BMI percentile and the IOTF criteria. In a data reported by Twells and New hook[27] there was a similar strength of agreement between the BMI percentile and WHO Z score with K= 0.84 similar to K= 0.81 reported in this study. In the study amongst Portuguese adolescents, the classification of obesity showed agreement between the BMI percentile and the IOTF criteria with a substantial agreement in the age group 10-12 years (K= 0.79) and excellent in age group 13 -16 years (K=0.88).

Various criteria have been used by various researchers in the determination of weight category in children and adolescents. The major limitation for the use of the IOTF is that the sample used to determine the values was not a worldwide representation since five out of the six countries used had a gross domestic product (GDP) that was above the world average with GDP known to influence the occurrence of obesity, this may have accounted for the low prevalence recorded in this study using IOTF since this population will not represent the Nigerian population. The WHO reference is however a combination of a multicentre growth study and a USA pooled data. Although the IOTF are more widely used the WHO Z score may be a better representative of population from different regions. The BMI Z score is a measure of relative weight adjusted for child age and sex. It is equivalent to the BMI percentile for age but BMI Z score is calculated based on an international reference compared to the BMI percentile which is from an internal reference. The BMI Z score has an advantage of assessing change in adiposity and to compare group means of children unlike the BMI percentile.[28]

In addition to overall obesity, central obesity is a better predictor of cardiovascular risk. Body Mass Index fails to distinguish between muscle and fat and is a poor determinant of central fat. Using various criteria in this study, the prevalence of central obesity as determined using the Waist Circumference (WC), Waist Hip Ratio (WHR) and Waist Height Ratio (WHtR) was 1.5%, 47.81% and 16.26% respectively. In a study by Rafraf and colleagues[29] of 985 adolescent high school girls aged 10-19 years in Tabriz Iran, the prevalence of central obesity using the WC, WHR and WHtR was 13.2%, 14.0% and 18.2% respectively. The prevalence of central obesity using the WC was much higher than the 1.5% recorded in this study. The report of 47.18% was however much higher than the report of 14.0% in Iran. The difference in prevalence between this study and the study in Tabriz is not very obvious but may be due to difference in the age of children in the two studies. In a study[1] in Ile Ife in Osun State amongst adolescents, the prevalence of central obesity using the WHR was 68% amongst the females much higher than the prevalence in this study. Although the WHR was high in this study and in study in Ile Ife, the higher rate in Ile Ife study may be due to the fact that it was done in adolescents in private and public schools. There are no studies comparing methods on determination of central obesity in adolescent's girls in Nigeria, however in a study by Abolfotouh et al[30]on prevalence of central obesity in Egyptian adolescents, the prevalence of central obesity was lowest(4.5%) using the WC similar to the finding in this study. In South Africa, 15% of rural adolescent girls aged 10-20years had abdominal obesity using WHtR, this was similar to the 16.26% reported in this study , however there was no comparison with other methods.[31] In another study amongst adolescent girls in Tehran using age and sex specific WC percentile, 10.1% had central obesity.[32] The difference in prevalence from different population may be due to the fact that populations vary in the rate of proportional growth and fat partitioning. The ethnicity may influence body fat distribution. The differences can also be due to the methods used to construct the various references and the population studied. The choice of what will be normal or reference can therefore vary substantially between countries prompting development of country specific growth references.

The comparison of results of central obesity in this study with results from other studies shows that the prevalence of Central Obesity using WC is much lower than reports from other countries. In this report, high proportion of obese subjects also had central obesity with a statistically significant association between overall weight and BMI according to the WHO Z score. Almost all subjects with central obesity using the waist circumference and 70% of those using the WHtR were obese or overweight showing a possible strong correlation between the methods, this rate was however low with the WHR.A low correlation between BMI and WHR (r=0.02) was also reported in the study in Ile Ife.[1] The WC is a good predictor of cardiometabolic risk and it's use have been advocated by the World Health Organization and the International Diabetes Federation. Alternatively, the WHtR can be used due to its accurate tracking indicator of fat distribution and accumulation by age it takes into account growth in both WC and Height on age.[11]

Conclusion

This study shows prevalence of overall and central obesity varies and depends on the criteria used. Highest prevalence for obesity was by the BMI percentile while WC reported lowest prevalence for central obesity. In comparison among the various criteria for classification of overall obesity in adolescent girls, the BMI percentile and the WHO Z score agreed strongly. There was statistically significant relationship between the BMI Z score and the various measures of central obesity. Population specific charts may need to be developed.

Recommendation

Surveillance and preventive Programmes should be put in place to reduce prevalence of obesity in adolescents and WC and WHtR should be routinely done to identify those at risk for developing cardiometabolic problems.

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