International Journal of Community Medicine and Public Health
Johnson OE et al. Int J Community Med Public Health. 2016 Mar;3(3):721-729
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20160640

Research Article

Obesity in Nigeria children and adolescents-waist circumference a more sensitive indicator

Olubusola E. Johnson*, Chidozie E. Mbada, Damilola Y. Alao, Adaobi M. Okonji, Chinonye O. Nweke

Department of Medical Rehabilitation, Obafemi Awolowo University, Nigeria

Received: 19 January 2016
Revised: 20 January 2016
Accepted: 16 February 2016

***Correspondence:**
Dr. Olubusola E. Johnson,
E-mail: obnik2001@yahoo.co.uk

ABSTRACT

Background: Studies on definition of obesity using anthropometric measurements as indicators among children and adolescents are scanty in Nigeria. This study defined obesity among children and adolescents in south west Nigeria using selected anthropometric characteristics.
Methods: Participants were between 5 to 19 years. They were randomly recruited, until 2114 completed the procedure. Participant's age and sex were obtained. Height, weight, waist circumference, and hip circumference were measured using standard procedures. Data were analysed using descriptive and inferential statistics at $p<0.05$.
Results: Average ages of males and females were 14.03±2.16years, and 9.57±2.17years respectively. There were significant differences in anthropometric measures according to gender and across age groups ($p <0.05$). Males were older, bigger, and taller than females. Females however had higher WHR and WtHR ratios. Waist circumference was significantly associated ($p>0.05$) with gender ($\chi2 = 23.762$, $p = 0.001$) and age ($\chi2 = 25.585$, $p = 0.001$), with a higher percentage of males in the obese group. The 25th and 95th percentile of anthropometric measures were: BMI (kg/m^2) = ≤15.9, ≥23.0; WC = ≤56.0, ≥73.0cm; WHR = ≤0.82, ≥0.97 and WHtR ≤0.40, ≥0.48 for underweight and obese respectively.
Conclusions: Prevalence of obesity was low; WC was the most sensitive indicator for obesity. Gender and age influenced anthropometric indices.

Keywords: Adolescents, Anthropometric reference values, Children, Obesity, Waist circumference

INTRODUCTION

Comparisons of data on obesity in children and adolescents are hampered by the lack of an internationally accepted measure of obesity across several countries.[1] Nationally representative data in developing countries is particularly needed, especially for children older than 5 years old up till adolescents. Anthropometry like body mass index and waist circumference has been mostly used clinically and in population studies as definitions of obesity and overweight.[2] The primary purposes for defining overweight and obesity are to predict health risks and to provide comparisons between populations.[2,3]

Height and weight are the most commonly used indicators of the nutritional status of a child. According to a WHO working group, appropriate height-for-age of a child reflects linear growth and can measure long- term growth faltering or stunting, while appropriate weight-for-height reflects proper body proportion or the harmony of growth.[4] Weight-for-height is particularly sensitive to acute growth disturbances and is useful to detect the presence of wasting. Weight-for-age represents a convenient synthesis of both linear growth and body proportion and thus can be used for the diagnosis of underweight children.[5] The presence of under nutrition in children is assessed using these three anthropometric parameters (weight-for-age, height-for-age and weight-

for-height) and by comparing them with internationally accepted reference standards, i.e. National Center for Health Statistics (NCHS) /WHO international reference population.[6]

Body mass index (BMI) (weight in kilograms divided by the square of the height in meters) is correlated sufficiently with direct measures of fatness, significantly associated with relative fatness in childhood and adolescence, and it varies with age and gender.[7] A given value of BMI therefore needs to be evaluated against age- and gender-specific reference values. Several countries, including France, the United Kingdom, Singapore, Sweden, Denmark and the Netherlands, have developed their own BMI-for-age gender-specific reference charts using local data.[2,3] Armstrong, et al reported trends of obesity and overweight, similar to values in developed countries among South African children and adolescents.[8] Data, however, are usually derived from a single reference population, and classifying an individual as overweight or obese assumes that the individual is comparable to that reference population.[2]

The use of anthropometric indicators in the prediction of health risk is also a major limitation in that some indicators may be more sensitive than others, and so researchers have the challenge of identifying which of the indicators is most suitable for their population. Several studies have indicated that the waist-to-height ratio (WHtR) and, to a lesser extent, waist circumference (WC) appear to be better indicators of cardiovascular risk than the BMI.[9,10] Goran, et al reported that in young people aged 3-19 years, the correlation between waist circumference and dual energy X-ray absorptiometry (DEXA) of trunk fat were 0.83 for girls and 0.84 for boys.[11] In addition, children's waist circumference correlates well with CT scan measurement of subcutaneous abdominal adipose tissue (r = 0.93), and fairly well with intra-abdominal adipose tissue (r = 0.84). High waist circumference has been shown to track well into adulthood showed that central fat distribution when as assessed by waist circumference was associated with an adverse lipid profile and hyper insulin.[11]

In United States of America (USA), a consensus definition of overweight for children younger than 2 years is those who are at or above the 95th weight-for-length percentile using the 2000 centers for disease control and prevention (CDC) growth charts.[12] In a longitudinal study by Nader, et al children who were above 50th percentile between the ages of 2–5 years and continued to increase BMI percentiles were more likely to become overweight at age 12.[13] In the USA, the 2000 centers for disease control and prevention growth charts for the United States are used to define overweight (95th percentile of the sex-specific BMI adjusted for age) and at risk for overweight (BMI 85th percentile but 95th percentile) and this definition is based on national data from 1963 to 1994.[14] Furthermore data from around 1992 to 1994 showed the prevalence of obesity (BMI 95th centile by the CDC standard) among US children aged 6-19 year was 11.1%, while the prevalence of overweight was 14.3%.[15]

Some degree of fatness is physiological, and experts differ on what is the best measure of fatness, the effect of application of a variety of existing standards on the prevalence of obesity in the same population, and the role of factors such as visceral adiposity and natural history in the definition of obesity.[16] Most countries either express data with respect to national data sets and standards or with respect to another country's published national standards, such as the US CDC's growth charts. Studies on definition of obesity using anthropometric measurements and indicators among children and adolescents are however scanty in Nigeria. This study therefore aimed at defining obesity among children and adolescents in this environment using selected anthropometry indices including body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to- height ratio (WHtR).

METHODS

This was a cross-sectional study. Participants were school aged children and adolescents between 5 to 19 years in 2012. Schools and participants were randomly selected until a total of 2114 participants, including 1051 males and 1063 female completed the study. Ninety participants were recruited from each of 24 selected schools. Random sampling technique was used to recruit participants consecutively from each arm until 15 participants were recruited from each grade (primary 1 to 6; JS1 to SS3) of the primary and secondary schools only 2114 cases were amenable to statistical analysed.

Ethical approval for this study was granted by the Ethics and Research Committee of Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria. Informed consent was obtained from the Ministry of Education, Ile-Ife, Nigeria, head teachers and principals of selected schools, and parents of participants within age range of 5 and 13 years, while assents were obtained from participants within the age range of 14 and 19 years. Procedure for data collection was explained to participants and subsequently measurements were done. Participant's age, sex and grade level were first recorded and then the following measurements were taken.

Height

Height of the participants was measured using a standardized height meter calibrated from 0 to 200 cm. The participants' heels, back, and occiput were made to touch the scale, with the participants looking straight ahead during measurement. The height of each participant was measured to the nearest 0.1m.

Body weight

Weight of participant was measured using a standardized weighing scale. It was measured in kilograms to the nearest 1.0 kg, with the participant standing in light clothing and not wearing shoes. BMI was calculated by dividing weight in kilograms by height in meters squared (kg/m^2).[17]

Waist circumference

Waist circumference of participant was measured using a tape measure. The umbilicus was used as a standard reference point for waist circumference.[18] Waist circumference of each participant was measured to the nearest 0.1cm.

Hip circumference

Hip circumference of participant was measured using a tape measure. Measurement was taken using the greater trochanter as the standard reference point.[19] Hip circumference of each participant was measured to the nearest 0.1cm.

BMI (weight in kg/height^2 in m) was calculated.[20] Waist-to-hip ratio (WHR) and waist-to-height (WHtR) ratios were also calculated.

Data were analysed using descriptive statistics of mean, median, mode, standard deviation, range, percentile and 95% confidence interval (CI) was used to summarize the data collected, with level of significance set at $p<0.05$. Descriptive data on the BMI, WC, WHR, WHtR and prevalence estimates were generated and analysed by sex and age with the use of the classification system recommended by the International Obesity Task Force. Independent t-test was used to compare mean of indices of obesity between male and female participants. One way ANOVA was used to find the difference between the mean of indices of obesity across the different age groups. Chi-square test of association was used to evaluate the association between gender, age and anthropometric.

RESULTS

General characteristics of participants

Two thousand one hundred and fourteen (2114) participants were involved in this study; 1051 (49.7%) males and 1063 (50.3%) females. Average values of age, weight, height, BMI, WC, HC, WHR, and WHtR were 11.79±3.12 (years), 38.67 $\pm$ 12.50 (kg), 1.45 $\pm$ 0.15 (m), 17.85 $\pm$ 2.91 (kg/m^2), s61.57 $\pm$ 6.89 (cm), 72.14 $\pm$ 10.57 (cm), 0.86 $\pm$ 0.07 and 0.43 $\pm$ 0.03 respectively.

Gender and age comparison of anthropometric values of the different age groups

It was observed that males were significantly older, taller, and bigger, with higher values of waist circumference than females ($p<0.05$) (Table 1). Participants were categorized by age as; 5-9 years, 10-14years and 15-19years. Age comparisons of anthropometric indicators showed that anthropometric characteristics differed significantly across age groups ($p<0.05$). Anthropometric indicators except WHR, and WHtR increased with age. WHR and WHtR were highest among participants aged 5-9 years. Least significant difference post-hoc analysis showed significant difference in the mean values of all anthropometric indicators across age groups (Table 2).

Table 1: Gender comparisons of BMI, WC, WHR and WHtR of participants using independent-t test.

	Males (n = 1051)				Females (n = 1063)					
	Mean±SD	**Median**	**Minimum**	**Maximum**	**Mean±SD**	**Median**	**Minimum**	**Maximum**	**t**	**p**
Age (yr)	14.03±2.16		5.0	19.0	9.57±2.17		5.00	19.0	47.35	0.001^x
Weight (kg)	47.02±10.54	47.0	22.0	96.0	30.42±7.99	30.0	13.00	75.0	40.82	0.001^x
Height (m)	1.56±0.11	1.56	1.20	1.87	1.35±0.12	1.35	1.03	1.70	42.49	0.001^x
BMI (kg/m^2)	19.22±2.80	18.9	12.1	36.10	16.50±2.33	16.20	9.50	35.7	24.36	0.001^x
WC (cm)	65.27±6.30	65.0	46.0	100.0	57.92±5.32	57.0	44.0	89.0	28.99	0.001^x
HC (cm)	79.27±8.62	80.0	58.0	113.0	65.09±6.97	64.0	47.0	100.0	41.61	0.001^x
WHR	0.83±0.06	0.83	0.62	1.30	0.89±0.06	0.89	0.58	1.12	-27.24	0.001^x
WHtR	0.42±0.03	0.41	0.32	0.68	0.43±0.03	0.42	0.34	0.64	-7.22	0.001^x

Key: SD = standard deviation; BMI = body mass index; WC = waist circumference; HC = hip circumference; WHR = waist-to-hip ratio; WHtR = waist- to- height ratio, n = number of participants; yr = years; Kg = kilogram; m = meters; cm = centimeters; Kg/m^2 = kilograms per meter square; p^x = significance at ≤ 0.05 α- level

Table 2: Comparison of anthropometric values of the different age groups using ANOVA and LSD post hoc.

Variables	5-9 years (n = 526)	10-14 years (n = 1109)	15-19 years (n = 479)	F ratio	p-value
Age	7.70 ± 1.13[a]	11.9 ± 1.40[b]	15.9 ± 1.12[c]	5228.4	0.001[x]
Weight	26.2 ± 5.84[a]	38.3 ± 9.24[b]	53.2 ± 8.48[c]	1316.1	0.001[x]
Height	1.28 ± 0.09[a]	1.46 ± 0.11[b]	1.62 ± 0.08[c]	1583.8	0.001[x]
BMI	15.9 ± 2.22[a]	17.7 ± 2.59[b]	20.2 ± 2.61[c]	369.65	0.001[x]
WC	55.6 ± 4.47[a]	61.7 ± 5.72[b]	67.8 ± 5.79[c]	630.56	0.001[x]
HC	61.9 ± 5.74[a]	72.1 ± 8.30[b]	83.5 ± 7.25[c]	1043.4	0.001[x]
WHR	0.90 ± 0.05[a]	0.86 ± 0.06[b]	0.81 ± 0.06[c]	280.76	0.001[x]
WHtR	0.44 ± 0.04[a]	0.42 ± 0.03[b]	0.42 ± 0.04[c]	38.911	0.001[x]

Key: n = number of participants; for a particular variable, a, b c= means with different superscript are significantly different ($p \leq 0.05$); BMI = body mass index; WC = waist circumference; HC = hip circumference; WHR = waist-to-hip ratio; WHtR = waist- to- height ratio; p^x = significance at ≤ 0.05 α- level

Percentile data of participants

Percentile data for anthropometric indicators; BMI, WC, WHR, WHtR of all participants by gender and age stratifications are presented in Table 3 to 6 respectively. Percentile values of BMI and WC were observed to increase with age and higher for males except in the 15-19 years age category. The percentile values of WHR and WHtR were however higher for females. In this study, >95th percentile was used to define obesity.[21] Participants with values greater than for 23kg/m^2, 73cm, 0.97, 0.48 BMI, WC, WHR and WHtR respectively were therefore categorized as obese.

Prevalence of obesity

Prevalence of obesity was determined using ≥95th percentile cut-off. Percentage values for obesity prevalence were; BMI =2.5%, 2.5%; WC= 4.8%, 2.1%; WHR= 2.4%, 2.5%, and WtHR =2.4%, 2.3%, males and females respectively (Figure 1). Waist circumference therefore indicated highest prevalence for obesity, among male participants. Prevalence of obesity by age grouping was highest for BMI (1.27%) among 5-9 years, WC (5.01%) among 10-14years and BMI, WHR (1.09%) each among 15-19years. Waist circumference showed highest percentage prevalence of obesity, and waist-to-height showed the least percentage prevalence of obesity among all participants. Participants with values; BMI ≤15.9, ≥23.0kg/m^2; WC ≤56.0, ≥73.0cm; WHR ≤0.82 ≥0.97; and ≤0.40 ≥0.48 WHtR were underweight and obese respectively.

Table 3: Mean and percentile data for BMI of all participants by age group and gender (n = 2114).

BMI (Kg/m^2)									
Age Group	**Gender**	**n**	**Mean ± SD**	**Min**	**25th Percentile**	**Med**	**75th Percentile**	**95th Percentile**	**Max**
5-9 years	M	19	16.14 ± 1.53	14.0	14.9	16.2	16.9	20.9	20.9
	F	507	15.93 ± 2.24	9.5	14.6	15.7	16.9	19.8	32.7
	(M + F)	526	15.94 ± 2.22	9.5	14.6	15.8	16.9	19.8	32.7
10-14 years	M	570	18.46 ± 2.70	12.1	16.7	18.0	19.7	23.3	31.3
	F	539	16.96 ± 2.22	11.9	15.5	16.7	18.1	20.8	35.7
	(M + F)	1109	17.73 ± 2.59	11.9	16.0	17.3	19.0	22.5	35.7
15-19 years	M	462	20.29 ± 2.55	14.6	18.6	20.0	21.7	24.7	36.1
	F	17	18.58 ± 3.75	13.8	16.2	17.4	20.7	28.6	28.6
	(M + F)	479	20.23 ± 2.61	13.9	18.5	19.9	21.7	24.7	36.1
5-19 years	M	1051	19.22 ± 2.80	12.1	17.3	18.9	20.8	24.1	36.1
	F	1063	16.50 ± 2.33	9.5	15.0	16.2	17.6	20.5	35.7
	(M + F)	2114	17.85 ± 2.91	9.5	15.9	17.4	19.5	23.0	36.1

Key: SD = standard deviation; BMI = body mass index; M = male; F = female; (M + F) = males and females; n = number of participants; Kg/m^2 = kilograms per meter square, min=minimum, med= median, max=maximum

Table 4: Mean and percentile data for WC of all participants by age group and gender (n = 2114).

WC (cm)									
Age Group	**Gender**	**n**	**Mean ± SD**	**Min**	**25th Percentile**	**Med**	**75th Percentile**	**95th Percentile**	**Max**
5-9 years	M	19	53.74 ± 4.11	46.0	51.0	53.0	55.0	63.0	63.0
	F	507	55.68 ± 4.48	44.0	53.0	55.0	58.0	63.0	80.0
	(M + F)	526	55.61 ± 4.47	44.0	53.0	55.0	58.0	63.0	80.0
10-14 years	M	570	63.52 ± 5.77	51.0	60.0	63.0	67.0	72.7	99.0
	F	539	59.77 ± 4.99	49.0	56.0	59.0	62.0	69.0	89.0
	(M + F)	1109	61.69 ± 5.72	49.0	58.0	61.0	65.0	71.0	99.0
15-19 years	M	462	67.90 ± 5.70	51.0	64.0	68.0	71.0	76.9	100.0
	F	17	66.06 ± 7.79	51.0	62.0	65.0	69.0	88.0	88.0
	(M + F)	479	67.84 ± 5.79	51.0	64.0	68.0	71.0	77.0	100.0
5-19 years	M	1051	57.92 ± 5.32	46.0	61.0	65.0	69.0	75.0	100.0
	F	1063	65.27 ± 6.30	44.0	54.0	57.0	61.0	68.0	89.0
	(M + F)	2114	61.57 ± 6.88	44.0	56.0	61.0	66.0	73.0	100.0

Key: SD = standard deviation; WC = waist circumference; M = male; F = female; (M + F) = males and females; n = number of participants; cm = centimeter

Table 5: Mean and percentile data for WHR of all participants by age group and gender (n = 2114).

WHR									
Age Group	**Gender**	**n**	**Mean ± SD**	**Min**	**25th Percentile**	**Med**	**75th Percentile**	**95th Percentile**	**Max**
5-9 years	M	19	0.86 ± 0.05	0.78	0.83	0.84	0.98	0.98	0.98
	F	507	0.90 ± 0.60	0.67	0.87	0.90	1.00	1.00	1.09
	(M + F)	526	0.90 ± 0.60	0.67	0.86	0.90	1.00	1.00	1.09
10-14 years	M	570	0.84 ± 0.05	0.62	0.81	0.84	0.92	0.92	1.30
	F	539	0.88 ± 0.60	0.58	0.85	0.88	0.97	0.97	1.12
	(M + F)	1109	0.86 ± 0.60	0.58	0.82	0.86	0.96	0.96	1.30
15-19 years	M	462	0.81 ± 0.05	0.64	0.78	0.81	0.84	0.89	1.19
	F	17	0.87 ± 0.04	0.81	0.84	0.87	0.92	0.93	0.93
	(M + F)	479	0.81 ± 0.06	0.64	0.78	0.81	0.84	0.90	1.19
5-19 years	M	1051	0.83 ± 0.60	0.62	0.79	0.83	0.9	0.91	1.30
	F	1063	0.89 ± 0.56	0.58	0.86	0.88	0.98	0.98	1.12
	(M + F)	2114	0.86 ± 0.07	0.58	0.82	0.86	0.97	0.97	1.30

Key: SD = standard deviation; WHR = waist-to-hip ratio; M = male; F = female; (M + F) = males and females; n = number of participants

Table 6: Mean and percentile data for WHtR of all participants by age group and gender (n = 2114).

WHtR									
Age Group	**Gender**	**n**	**Mean ± SD**	**Min**	**25th Percentile**	**Med**	**75th Percentile**	**95th Percentile**	**Max**
5-9 years	M	19	0.41 ± 0.03	0.36	0.39	0.40	0.43	0.48	0.48
	F	507	0.44 ± 0.04	0.35	0.41	0.43	0.46	0.50	0.63
	(M + F)	526	0.44 ± 0.04	0.35	0.41	0.43	0.46	0.50	0.63
10-14 years	M	570	0.42 ± 0.03	0.33	0.40	0.42	0.44	0.48	0.63
	F	539	0.42 ± 0.03	0.35	0.41	0.42	0.44	0.48	0.64
	(M + F)	1109	0.42 ± 0.03	0.33	0.40	0.42	0.44	0.48	0.64
15-19 years	M	462	0.42 ± 0.04	0.32	0.39	0.42	0.44	0.48	0.68
	F	17	0.43 ± 0.04	0.37	0.40	0.43	0.44	0.54	0.54
	(M + F)	479	0.42 ± 0.04	0.32	0.40	0.42	0.44	0.48	0.68
5-19 years	M	1051	0.42 ± 0.04	0.32	0.40	0.42	0.44	0.48	0.68
	F	1063	0.43 ± 0.03	0.35	0.41	0.43	0.45	0.49	0.64
	(M + F)	2114	0.43 ± 0.03	0.32	0.40	0.42	0.44	0.48	0.68

Key: SD = standard deviation; WHtR = waist-to-height ratio; M = male; F = female; (M + F) = males and females; n = number of participants

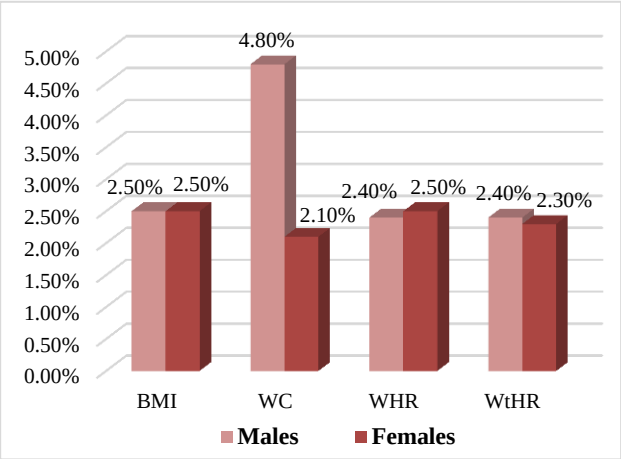

Figure 1: Prevalence of obesity using anthropometric measures.

Chi-square test of association

Association between gender and anthropometric indicators was studied with Chi square (χ^2) test of association. It was observed that only was WC had significant association with obesity ($p<0.05$), with the highest proportion (69.2%) of males in the obese category (Table 7). Chi-square association between age group and anthropometric indicators was also calculated. A significant ($p<0.05$) highest proportion (72.6%) of participants age 10-14years were in the obese category (Table 8). Neither gender nor age group was significantly associated with other anthropometric indices ($p>0.05$) (Tables 7 & 8). Waist circumference was therefore the most sensitive anthropometric indicator for obesity.

Table 7: Chi-square test of association between gender and anthropometric indicators; BMI, WC, WHR and WHtR.

	Normal	Obese	χ^2	p-value		Normal	Obese	χ^2	p-value
BMI					WC				
Male	49.7 (%)	50.0 (%)	0.004	0.953	Male	48.3 (%)	69.2 (%)	23.762	0.001[x]
Female	50.3 (%)	50.0 (%)			Female	51.7 (%)	30.8 (%)		
WHR					WHtR				
Male	49.8 (%)	49.0 (%)	0.020	0.887	Male	49.7 (%)	50.5 (%)	0.026	0.872
Female	50.2(%)	51.0 (%)			Female	50.3 (%)	49.5 (%)		

Key: BMI = body mass index; WC = waist circumference; HC = hip circumference; WHR = waist-to-hip ratio; WHtR = waist- to-height ratio; χ^2 = chi-square; p[x] = significance at $\leq$ 0.05 α- level

Table 8: Chi-square test of association between age group and anthropometric indicators; BMI, WC, WHR and WHtR.

	Normal	Obese	χ^2	p-value		Normal	Obese	χ^2	p-value
BMI					WC				
5-9 years	24.8 (%)	26.0 (%)	0.072	0.965	5-9 years	25.6 (%)	15.1 (%)	25.585	0.001[x]
10-14 years	52.5 (%)	51.9 (%)			10-14 years	51.0 (%)	72.6 (%)		
15-19 years	22.7 (%)	22.1 (%)			15-19 years	23.4 (%)	12.3 (%)		
WHR					WHtR				
5-9 years	25.1 (%)	21.2 (%)	1.006	0.605	5-9 years	25.0 (%)	23.2 (%)	0.208	0.901
10-14 years	52.2 (%)	56.7 (%)			10-14 years	52.4 (%)	54.5 (%)		
15-19 years	22.7 (%)	22.1(%)			15-19 years	22.7 (%)	22.2 (%)		

Key: BMI = body mass index; WC = waist circumference; HC = hip circumference; WHR = waist-to-hip ratio; WHtR = waist- to-height ratio; χ^2 = chi-square; p[x] = significance at $\leq$ 0.05 α- level

DISCUSSION

Anthropometric measurement is important in the definition of overweight and obesity among children and adolescents. Researches are pointing to the fact that overweight and obesity in childhood linger into adulthood. Defining overweight and obesity helps to predict health risks and to provide comparisons between populations.[2,3]

Gender and anthropometric indices

Male participants were bigger, taller and with higher mean value of WC and BMI compared to their female counterparts. This finding is inconsistent with that of

previous studies.[22,23] Amuta and Houmsou in their study among adolescents age 12-18 in Benue State, Nigeria reported that females between 12 and 15 years old were significantly heavier and taller than their male counterparts who were significantly heavier and taller between 16 and 18 years.[22] Amuta and Houmsou suggested that this could be due to earlier onset of pubertal growth spurt in girls than boys.[22] Possible explanation for this inconsistency is that the mean age for male participants of this study is higher (14 years) than female participants (9 years). Female participants are therefore yet to attain pubertal changes compared to their male counterparts. Sebanjo, et al in their study of 570 Nigerian children and adolescents between the ages of 5 to 19 years reported that females had higher WCs than males.[23] The result of this present study is however suggested to be as a result of males generally having android distribution of fat thus a higher waist circumference compared to their female counterparts.[24] Waist circumference is a measure of central adiposity. It measures both the subcutaneous and visceral fat and has been shown to have the most consistent and generally the strongest correlation with adverse lipid concentrations and increased blood pressure levels among children and adolescents.[9] BMI is a measure of total adiposity. It has the limitation of not been able to distinguish between muscles mass and fat mass.

The result of this study is however consistent with a study by McCarthy, et al.[25] McCarthy, et al assessed the BMI and waist circumference of 8355 children and adolescents British children of ages 5-17.[25] They submitted that males generally were taller, heavier and had higher WC value at all ages compared to their female counterparts. Comparisons of WC data between different studies need to be undertaken with caution since WC may be measured at different sites and currently there is no agreement on which site is optimal.[26] In children, WC has been measured at five different sites: (i) midway between lowest rib and superior iliac crest.[25,27,28] (ii) at the umbilical level (as in the present study).[18] (iii) at the narrowest point of the torso.[29] (iv) at the level of the right upper iliac crest.[30] (v) at the level of 2 cm above the umbilicus.[31] WC measures at these different sites in children have not been formally compared.

It was observed in this study that mean values of WHR and WHtR were higher in females than males. This result is inconsistent with other previous findings that reported a higher WHR and WHtR in males.[27,32] Their findings could be attributed to the fact that adolescent females have a greater distribution of lower body fat; thus a gyneacoid fat distribution which usually starts at about 13 years; in this population, female participants below age thirteen were more those above.[33]

Age and anthropometric indices

The BMI and WC of all participants increased with age. The result is in accordance with previous findings.[7,33] Sung and colleagues measured the WC and WHR of 14,842 Chinese children aged 6 to 18 years in 2005/2006. They recommended that if WC is to become an important public health assessment tool of central obesity in both adults and children, international agreement about measurement site is required. One possible explanation for the increase of BMI and WC is the physical changes that occur due to growth and development that occur throughout childhood and adolescence.[32] WHR and WHtR of all participants decreased with age. These results are in accordance with previous findings.[35,36]

This finding challenges the proposal that WHTR is a relatively age-independent measure that could obviate the need for age and growth-related reference standards in children. Kahn and Hsieh reported that WHTR appears to be independent of age and sex.[37] Ashwell and colleagues however have proposed the use of an age-independent universal cut-off for WHTR of 0.5.[38] This submission was as a result of their finding that the overall mean WHTR (with WC measured at the same site as in the present study) of 8135 British children aged 5 to 16 years decreased with age from 0.47 to 0.42 in boys and from 0.46 to 0.41 in girls.[38] WHTR measures obtained in this study were higher than the 1988 British study. Brannsether, et al reported in his study of WC and WHtR of Norwegian children 4-18 years of age that mean waist-to-height ratio decreased with age up until adolescence.[39]

Prevalence of obesity

Few studies in Nigeria have been published on definition of obesity among children and adolescents of Nigeria. Akesode and Ajiboode reported obesity among 457 school children between 6-19 years.[40] Authors reported a prevalence of obesity as follows 3.7%, 3.3%; 3.2%, 5.1% using skinfold thickness and age, males and females respectively. Ansa, et al also reported low prevalence of obesity among 1005 children and adolescents. Armstrong, et al also reported values similar among children and adolescents of South Africa.[8] The prevalence of obesity (using BMI) obtained in this study was however lower than those reported among healthy American and Chinese population but higher than Russian population. This inconsistency may be accounted for by difference in race and socioeconomic development level between African, Americans Chinese and Russian population. The difference could also be accounted for by the discrepancies in years in which studies were conducted and age range of reference population. Those studies were conducted between 1992 and 1994 between age ranges 6-18 years as opposed to 5-19 years in the present study. Wang submitted that the prevalence of obesity varied markedly across countries with difference socioeconomic development levels.[35] Variations in anthropometric measure (norms) among different regions and populations are believed to be due to differences in culture/ethnicity, diet, age, socioeconomic development level, anthropometric indicators including gender.[33,35,36] The present study however did not look into

socioeconomic factors. Comparison of results of the present study with that of US children and adolescents of ages 2-19 years in 2004 showed that participants of this population has higher 95th percentile BMI value.[15] This difference in findings may be because of population differences, age range variations, and discrepancies in the years of study. Comparison of percentile data of anthropometric data used in this study with other existing studies may also be limited due to variations in statistical analysis and reporting style of different authors.

This study reported anthropometric percentile values of children and adolescents, and compared these by gender and age among school-aged children and adolescents in Nigeria. The study concluded that anthropometric values increased with age, gender had an influence on anthropometric indicators, and waist circumference was a better indicator for obesity. A major limitation of this study was that the participants were recruited from a homogenous population, and gender distribution was not even for some age groups. However, further research is recommended to address these problems, including issues of external validity.

CONCLUSION

Prevalence of obesity was low; WC was the most sensitive indicator for obesity. Gender and age influenced anthropometric indices.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Ethics and Research Committee of Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria

REFERENCES

1. Jackson RT, Rashed M, Al-Hamad N, Hwalla N, Al-Somaie M. Comparison of BMI-for-age in adolescent girls in 3 countries of the Eastern Mediterranean Region. East Mediterr Health J. 2007;13:430-40.
2. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. Obes Rev. 2004;5:4-85.
3. WHO. WHO Expert Consultation: Appropriate body mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004;363:157-63.
4. WHO Working Group. Use and interpretation of anthropometric indicators of nutritional status. Bull. World Heath org. 1986;4:924-41.
5. Shetty P. Keynote paper: measures of nutritional status from anthropometric survey data; Economic and social development department, Food and Agriculture Organization of the United Nations, Rome. 2003. Available at http://www.fao.org/docrep/005/Y4249E/y4249e0b.htm. Accessed 9 September 2014.
6. WHO. Measuring change in nutritional status. Guidelines for assessing the nutritional impact of supplementary feeding programmes for vulnerable groups. Geneva. 1983. http://whqlibdoc.who.int/publications/1983/9241541660.pdf, Accessed 2 August 2015
7. Dietz W, Bellizzi M. Introduction: the use of body mass index to assess obesity in children. Am J Clin Nutr. 1999;70:123S-5S.
8. Armstrong MEG, Lambert MI, Sharwood KA, Lambert EV. Obesity and overweight in South African primary school children - the Health of the Nation Study. SAMJ. 2006;96(5):439-43.
9. Maffeis C, Pietrobelli A, Grezzani A, Provera S, Tato L. Waist circumference and cardiovascular risk factors in prepubertal children. Obes Res. 2001;9:179-87.
10. Giovannucci E, Ascherio A, Rimm EB, Coditz GA, Stampfer MJ, Willett WC. Physical activity, obesity, and risk for colon cancer and adenoma in men. Ann Intern Med. 1995;122:327-34.
11. Goran MI, Gower, BA, Treuth M, Nagy, TR. Prediction of intra-abdominal and subcutaneous abdominal adipose tissue in healthy pre-pubertal children. Int J Obes. 1998;22:549-58.
12. Centers for Disease Control Prevention. A SAS Program for the CDC Growth Charts. 2004. Available from http://www.cdc.gov/nccdphp/dnpa/growthcharts/sas.htm. Accessed 6 September, 2015.
13. Nader PR, O'Brien M, Houts R, Bradley R, Belsky J, Crosnoe R, et al. National Institute of Child Health and Human Development Early Child Care Research Network. Identifying risk for obesity in early childhood. Peds. 2006;118:e594-e601.
14. Whitlock EP, Williams SB, Gold R, Smith PR, Shipman SA. Screening and interventions for childhood overweight: A summary of evidence for the US Preventive Services Task Force. Pediatrics. 2005;116:e125-e144.
15. Wang Y, Beydoun M. The Obesity Epidemic in the United States—Gender, Age, Socioeconomic, Racial/Ethnic, and Geographic Characteristics: A Systematic Review and Meta-Regression Analysis. Epidemiol Rev. 2007;29(1):6-28.
16. Livingstone MB. Childhood obesity in Europe: a growing concern. Public Health Nutr. 2001;4:109-16.
17. De Lauzon B, Charles M. Childhood obesity: Influences of socioeconomic factor. Objective Nutrition. 2004;73. Available at, http://www.danoneinstitute.org/objective_nutrition_newsletter/on73.php. Accessed 9 September, 2014
18. Cheuk SC, Wan-Yu C, Ta Liang C, Chun Chuan S, Li Chu W, Chien Chang L. Waist circumference and risk of elevated blood pressure in children: a cross-sectional study. Br Med J. 2011;11:613.
19. Zannolli R, Morgese G. Waist percentiles: a simple test for atherogenic disease? Acta Paediatr. 1996;85:1368-9.

20. Hassan NE, El-Masry SA, El-Sawaf AE. Waist circumference and central fatness of Egyptian primary school children.World Health Organization: Eastern Mediterr Health J. 2008.
21. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International Survey. BMJ. 2000;320:1240-3.
22. Amuta, EU, Houmsou, RS. Assessment of Nutritional Status of School Children in Makurdi, Benue State. Pak J Nutr. 2009;8(5):691-4.
23. Senbanjo IO, Njokanma OF, Oshikoya KA. Waist Circumference Values of Nigerian Children and Adolescents. Ann Nutr Metab. 2009;54:145-50.
24. Qing He, Horlick M, Thornton J, Wang J, Richard N, Pierson, et al. Sex-Specific Fat Distribution Is Not Linear Across Pubertal Groups in a Multiethnic Study. Obes Res.2004;12:725-33.
25. McCarthy HD, Jarrett KV, Crawley HF. Original Communication The development of waist circumference percentiles in British children aged 5.0 ± 16.9 years. Eur J Clin Nutr. 2001;55:902-7.
26. Wang J, Thornton JC, Bari S, Williamson B, Gallagher D, Heymsfield SB, et al. Comparisons of waist circumferences measured at 4 sites. Am J Clin Nutr. 2003;77:379-84.
27. Moreno ALA, Zaragozano FJ, Mur de Frenne L, Feja SC, Rodríguez MG, Sarría CA, et al. Fat distribution in children and adolescents of both sexes. Esp Pediatr. 1998;49:135-9.
28. Fredriks AM, van Buuren S, Fekkes M, Verloove-Vanhorick SP, Wit JM. Are age references for waist circumference, hip circumference and waist-hip ratio in Dutch children useful in clinical practice? Eur J Pediatr. 2005;164:216-22.
29. Katzmarzyk PT. Waist circumference percentiles for Canadian youth 11-18 years of age. Eur J Clin Nutr. 2004;58:1011-5.
30. Fernandez JR, Redden DT, Pietrobelli A, Allison DB. Waist circumference percentiles in nationally representative samples of African-American, European-American, and Mexican-American children and adolescents. J Pediatr. 2004;145:439-44.
31. Weili Y, He B, Yao H, Dai J, Cui J, Ge D, et al. Waist-to-height ratio is an accurate and easier index for evaluating obesity in children and adolescents. Obes Res. 2007;15:748-52.
32. Freedman DS, Kahn HS, Mei Z, Grummer-Strawn LM, Dietz WH, Srinivasan SR, et al. Relation of body mass index and waist-to-height ratio to cardiovascular disease risk factors in children and adolescents: the Bogalusa Heart Study. Am J Clin Nutr. 2007;86:33-40.
33. Moreno. Epidemiology of Obesity in Children and Adolescents: Prevalence and Etiology. Springer series on epidemiology and public health. 2010
34. Sung RY, Yu CC, Choi KC. Waist circumference and body mass index in Chinese children: cutoff values for predicting cardiovascular risk factors. Int J Obes. 2007;31:550-8.
35. Wang Y. Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status. Int J Epidemio. 2001;30:1129-36.
36. Chao-Yang Yang, Chien-Yu Peng, Ying-Chieh Liu, Wen-Zhi Chen, Wen-Ko Chiou. Surface Anthropometric Indices in Obesity-related Metabolic Diseases and Cancers. Chang Gung Med J. 2006;34:1-22.
37. Kahn HS, Imperatore G, Cheng YJ. A population-based comparison of BMI percentiles and waist-to-height ratio for identifying cardiovascular risk in youth. J Pediatr. 2005;146:482-8.
38. Ashwell M, Hsieh SD. Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. Int J Food Sci Nutr. 2005,56:303-7.
39. Brannsether B, Roelants M, Bjerknes R, Júlíusson PB. Waist circumference and waist-to-height ratio in Norwegian children 4–18 years of age: Reference values and cut-off levels. Acta Paediatr. 2011;100,12:1576-82.
40. Akesode FA, Ajibode HA. Prevalence of obesity among Nigerian school children. Soc Sci Med. 1983;17:107-11.

Cite this article as: Johnson OE, Mbada CE, Alao DY, Okonji AM, Nweke CO. Obesity in Nigeria children and adolescents-waist circumference a more sensitive indicator. Int J Community Med Public Health 2016;3:721-9.