Research Article
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Age categorization of overweight and obesity using waist circumference, waist height ratio and body mass index among children and youth in Nigeria

Abstract

Background: Undernutrition and obesity co-exist in Nigeria. The aim of this study was to evaluate the distribution of overweight and obesity across different age groups using waist circumference, waist height ratio and body mass index in Nigerian children.

Methods: Cross-sectional study involving 2,893 students aged 9-18 years (1,140 boys and 1,753 girls) using multistage cluster sampling design. Weight, height, Waist circumference (WC) were measured, body mass index (BMI), waist to height ratio (WHtR) were calculated. Data analyzed to get mean, SD, Spearman correlation coefficients were computed to examine the association between WC, WHtRandBMI.

Result: The mean BMI, WC and WHtR were statistically significantly higher in girls than in boys. Using WC, 107 (6.1%) of the girls and 44(3.9%) of the boys, had abdominal obesity. Increased WHtR occurred in 11.5% of the girls and 8.0% of the boys respectively. Using BMI,32.9% of the youths were either overweight (OW) or obese (OB): 28.8% in boys and 35.5% in girls. 371 (21.2%) and 252 (14.4%) of the girls were OW and OB, while 191 (16.8%) and 137 (12.0%) of the boys had OW and OB. There was a progressive increase in the WC and BMI across the age groups. A strong positive correlation coefficient was noted between WC and BMI 0.77842, between WHtR and BMI 0.73281, and between WC and WHtR 0.82197 $p< 0.0001$.

Conclusion: The prevalence of overweight and obesity in Nigerian children is increasing, higher in girls than in boys. We recommend that in addition to BMI, WC or WHtR should be used to assess central adiposity in children.

Keywords: youth, obesity, waist circumference, waist-height ratio, body mass index

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Felicia O Anumah,[1] Rifkatu Mshelia-Reng,[1] Odiase S Omonua,[1] RabiAdelaiye,[2] Ramatu A Shuaibu,[3] Kenechukwu C Odumodu,[3] Kenneth C Onugha,[4] Caleb O Ehusani[5]

[1]Department of Medicine, University of Abuja Teaching Hospital, Abuja, Nigeria
[2]Department of Community Medicine, University of Abuja Teaching Hospital, Abuja, Nigeria
[3]Department of Medicine, National Hospital Abuja, Nigeria
[4]Centre for Integrated Health Programs, Abuja, Nigeria
[5]Mark Anumah Medical Mission, Abuja, Nigeria

Correspondence: Felicia Anumah, University of Abuja Teaching Hospital, Nigeria, Email anumahnene@gmail.com

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Abbreviations: WC, waist circumference; WHtR, waist-height ratio; BMI, body mass index; OW, overweight; OB, obesity

Introduction

Childhood obesity is increasing worldwide and has become a major public health problem.[1,2] About a third of the young population is overweight or obese. This is quite disturbing because obesity is associated with subclinical inflammation and confers an increased cardiovascular risk during childhood. Studies have demonstrated that insulin resistance, type 2 diabetes, hypertension, dyslipidaemia and metabolic syndrome, are increasing in prevalence in children as a result of complications of obesity.[3,4] Globalization has led to global market integration which facilitates a shift in food culture and convergence in consumption habits (as is commonly assumed in the "Coca-Colonization" hypothesis). In this "nutrition transition", the consumption of foods high in fats, sugars, salt and sweeteners has increased throughout the developing world. This transition therefore is implicated in the rapid rise of obesity and diet-related chronic diseases, worldwide.[5–7]

The epidemic of obesity-associated diabetes is a major crisis in modern societies in which, food is plentiful and exercise is optional.[8,9] Research has shown that increased consumption of "soda" and fruit juice has closely paralleled the diabetes and obesity epidemics.[10]

In the past 20 years, the rates of obesity have tripled in developing countries. Such countries have been adopting a Western lifestyle involving decreased physical activity and overconsumption of cheap, energy-dense and micronutrient deficient foods. Such lifestyle changes are also affecting children in these countries; the prevalence of overweight among them ranges from 10 to 25%, and the prevalence of obesity ranges from 2 to 10%.[11,12] The growing prevalence of type 2 diabetes, cardiovascular disease, and some cancers is tied to excess weight. The burden of these diseases is particularly high in the low and middle-income countries.[12,13]

In many developing countries, the increase in the prevalence of obesity is of great concern. A survey in seven African countries showed that school students in Egypt had the highest rates of overweight and obesity (31.4% and 9.3%).[14] The WHO reported that in Africa,overweight and obesity among children and adolescents aged 5-19 increased dramatically from just 4% in 1975 to over 18% in 2016.[15] In Nigeria, reports from the western and eastern parts of the country showed a prevalence ranging from 1% to 18%.[16–18] It has been projected that by 2025, 11% of African children will be overweight,[19] thus lifestyle diseases such as diabetes, hypertension, cardiovascular diseases and cancer, previously known only in older adultsnow occur in children and adolescents. Thestudy aimed to evaluate the distribution of overweight and obesity across different age groups using waist circumference, waist height ratio and body mass index in Nigerian children.

Subjects and methods

The study was cross-sectional and involved 2,995 students aged 9-21 years (1,187 boys and 1,808 girls) in 20 secondary schools in the Federal Capital Territory (FCT) Abuja, Nigeria.

Sampling technique: The design of the study was multistage cluster sampling. Initially the schools were stratified into government and private schools, randomly selected from the list obtained from the School's Board and the Ministry of Education. The next stage involved random selection of students from each school according to their class (Junior Secondary 1-3, Senior Secondary 1-3).The students generally,represented different socio-economic groups, urban and rural groups.

Anthropometric measurements:Healthcare professionals were trained to carry out the anthropometric measurements. Height was measured without footwear to the nearest millimeter while weight was measured with minimal clothing and recorded to the nearest 0.1kg on calibrated scales. The body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2).[20] The point of noticeable waist narrowing was used to measure waist circumference (WC) to the nearest millimeter and waist-to-height ratio (WHtR) calculated as waist circumference (in cm) divided by height (in cm).[21] Increased waist circumference (WC) was determined using the International Diabetes Federation (IDF) 2007 consensus cutoff ≥90^{th} percentile,[22]WHtR ≥0.5 was used to detect centralobesity[23] while overweight and Obesity using BMI were defined according to WHO growth reference for school-aged children and adolescents.[24]

Statistical methods:Database management and analyses was done using SAS software (SAS Institute, Cary, North Carolina, USA) version 9.4. Non-parametric analysis was done since the data was not normally distributed. A total of 2,995 students (1,187 boys and 1,808 girls) enrolled in the study but those aged > 18 years and those with incomplete data were removed thus 2,893 (1,140 (39.4%) boys and 1,753 (60.6%) girls) were subjected to analysis. Frequency and percentages were used to describe categorical variables, while mean±Standard Deviation (SD) were calculated for continuous variables (weight, height, BMI, WC and WHtR). The difference in parameters between the boys and girls were compared with MWW test, whereas differences in levels of parameters were compared with Kruskal-Wallis H test. Spearman correlation coefficients were computed to examine the association of WC and WHtR with BMI. Statistically significant difference was $P< 0.05$.

The Federal Ministry of Education, the Federal Capital Territory Education Secretariat and the Secondary Education Board gaveapproval for the study. Written and oral consent was obtained from the school authorities, students and their parents.

Results

Table 1 presents the mean, standard deviation, minimum and maximum for age, anthropometric data of the youths by sex.The mean BMI, WC and WHtR were statistically significantly higher in girls than in boys, while the boys were taller than the girls. It is worthy of note that we had a maximum waist circumference of 118cm for girls and 117cm for boys. Table 2 Waist circumference (WC) of Nigerian youths defined by IDF 2007 criteria categorized by sex and age group. Among the girls, 107 (6.1%) had abdominal obesity and across the age groups, there was a progressive increase in the mean WC: 9-12 years (85.3±6.0 cm), 13-15 years (91.4±6.4cm) and>15 years (101.7±7.6 cm) respectively. Among the boys, 44(3.9%) had abdominal obesity. There was also a progressive increase in their mean WC across the age groups; 9-12 years (91.0±6.4cm), 13-15 years (103.2±20.1cm) and > 15 years (107.3±3.1cm) respectively. Table 3Prevalence of increased Waist Height Ratio (WHtR) among the Youths by sex and age group.

Table 1 Baseline characteristics and anthropometric measurements of subjects by sex

Characteristic	Girls						P-value	Boys					
	N (%)	Mean	SD	Min	Med	Max		n (%)	Mean	SD	Min	Med	Max
Age(years)	1,753 (60.6)	14.1	2	9	14	18	0.4045	1,140 (39.4)	14.1	2.1	9	14	18
WC (cm)		69.6	8.34	47	68	118	0.0069*		69.03	9.15	43	68	163
BMI(kg/m^2)		22	4.1	12	21.5	45	< 0.0001*		20.9	3.9	11.8	20.3	48.5
Body height (m)		1.59	0.08	1.3	1.59	1.86	< 0.0001*		1.62	0.12	1.18	1.63	1.96
Body weight, (kg)		55.09	12.26	24	54	155	0.0932		54.56	13.79	25	54	126
WHtR		0.439	0.05	0.297	0.429	0.72	< 0.0001*		0.427	0.053	0.261	0.416	1.094

P-value is MWW test for comparing means between sexes; *significant differences between males and females; N,number; SD, standard deviation; Med,median; Min, minimum; Max,maximum; BMI, body mass index; WC, waist circumference; WHtR,waist height ratio

Using a WHtR cut-off of 0.5, overall, 10.1% of the youths had increased WHtR; 11.5% of the girls and 8.0% of the boys respectively. Table 4 Body mass Index (BMI) defined byWHO 2007 reference population categorized by sex and age group.Among the girls, 371 (21.2%) were overweight while 252 (14.4%) were obese. There was a progressive increase in the BMI across the age groups; overweight 22.1±1.2, 24.4±1.2, 25.9±0.9 and obesity 27.2±3.5, 29.9±3.5 and 32.2±4.1Kg/m^2 respectively. 191 (16.8%) of the boys had overweight, while 137 (12.0%) had obesity. The BMI also increased progressively across the age groups; overweight 20.9±1.0, 23.3±1.3, 25.6±1.2 Kg/m2 and obesity 26.9±4.2, 29.0±4.4 and 31.3±4.0 kg/m^2 respectively. Overall, 32.9% of the youths were either overweight or obese: 28.8% boys and 35.5% of the girls.Table 5Spearman's correlation between Waist Circumference, Waist Height Ratio and Body mass index of the

Youths. There was a strong positive correlation coefficient between WC and BMI0.77842, between WHtR and BMI0.73281, and between WC and WHtR0.82197p< 0.0001.

Table 2 Waist circumference of the youth defined by IDF 2007 criteria by sex and age group

	Normal			Obese		
	N (%)	Mean	SD	N (%)	Mean	SD
Girls (years)						
All Girls	1646 (93.9)	68.38	6.78	107 (6.1)	88.36	7.55
12-Sep	370 (21.1)	65.63	7.05	63 (3.6)	85.29	5.97
13 -15	830 (47.4)	69	6.45	38 (2.2)	91.37	6.44
>15	446 (25.4)	69.5	6.54	6 (0.3)	101.7	7.61
Boys (years)						
All Boys	1096 (96.1)	67.94	6.97	44 (3.9)	96.06	14.23
12-Sep	271 (23.8)	65.68	7.1	27 (2.4)	90.98	8.75
13 -15	517 (45.4)	67.76	7.16	13 (1.1)	103.2	20.09
>15	308 (27)	70.23	5.74	4 (0.4)	107.3	3.1

IDF,international diabetes foundation; SD, standard deviation; N, number; %, percentage

Discussion

Our results in this study showed that the mean BMI, WC and WHtR, were significantly higher in girls than in the boys. This finding is similar to the report of Baalwa et al.,[25] in Uganda who found that females were more likely to be overweight (17.4% vs 3.3%) or obese (2.9% vs 1.8%).[25] It is worthy of note that we had a maximum waist circumference of 118cm in the girls and 117cm in the boys. Studies have shown that obesity in children and adolescents can track into adulthood with all its consequencies.[26,27]Garnet et al reported that 78.9% of children who were overweight or obese on the basis of BMI at 8 years, were still overweight and obese at 15 years and 69.2% of children who had increased central adiposity at 8 years continued to[29,30] be so at 15 years.[28] Waist circumference is recommended as the better index of obesity-related health risk in adults and has alsobeen found to be highly sensitive and specific as a measure of upper body fat in childhood and adolescence.[31]

In this study, 107 (6.1%) of the girls and 44 (3.9%) of the boys had abdominal obesity. In this study, the girls appeared to have more central fatness than the boys and this finding is in contrast to some other studies that have reported boys, to have more adipose tissue in the upper body.[32,33] The waist height ratio (WHtR) is an index of the amount of central fat deposition in relation to height thus useful in children. This ratio,increases when extra fat starts to accumulate on the upper body and has been suggested to be the best predictor of cardiovascular disease risk factors in children.[34]In this study, 11.5% of the girls and 8.0% of the boys had increased WHtR, indicating again more central fat distribution in the girls. In contrast, McCarthy et al, in his work found that the girls had lower WC values than the boys at any given height in two surveys.[23] Anumah et al.,[35] has developed age and sex-specific WC and WHtR cut-off points to detect abdominal obesity in Nigerian youths. In this study using BMI, overall, 32.9% of 2893 youths had combined overweight (OW) or obesity (OB), 35.5% among the girls and 28.8% among the boys.371 (21.2%) and 252 (14.4%) of the girls were either OW or OB, while 191 (16.8%) and 137 (12.0%) of the boys had Ow or OB. Peirson and his colleagues in a systematic review and meta-analysis on overweight and obesity in children and youth found that 31.5% of Canadian children were either OW or OB.[36]

Table 3 Prevalence of increased waist height ratio of the youth by sex and age group

	Underweight			Normal			Overweight			Obese		
	N (%)	Mean	SD	N (%)	Mean	SD	N(%)	Mean	SD	N (%)	Mean	SD
Girls (years)												
All Girls	22 (1.3)	14.51	1.18	1108(63.2)	19.92	2.14	371 (21.2)	24.14	1.77	252 (14.4)	28.9	3.93
12-Sep	5 (0.3)	12.98	0.91	215 (12.3)	17.83	1.57	95 (5.4)	22.08	1.24	118 (6.7)	27.18	3.45
13 -15	12 (0.7)	14.82	0.8	553 (31.6)	20.04	1.83	197 (11.2)	24.43	1.21	106 (6.1)	29.95	3.49
>15	5 (0.3)	15.32	0.84	340 (19.4)	21.04	1.98	79 (4.5)	25.91	0.94	28 (1.6)	32.17	4.06
Boys (years)												
All Boys	24 (2.1)	14.9	1.18	788 (69.1)	19.43	2.08	191 (16.8)	22.79	2.1	137 (12)	28.02	4.42
12-Sep	3 (0.3)	13.87	0.4	141 (12.4)	17.42	1.48	75 (6.6)	20.86	0.95	79 (6.9)	26.95	4.18
13 -15	14 (1.2)	14.81	0.75	390 (34.2)	19.12	1.61	80 (7)	23.31	1.29	46 (4)	29.02	4.37
>15	7 (0.6)	15.52	1.76	257 (22.5)	21	1.83	36 (3.2)	25.63	1.15	12 (1.1)	31.26	4.03

N, number; SD, standard deviation; %, percentage

Angel Rivera et al in a systematic review of childhood and adolescent overweight and obesity in Latin America in 2013 found combined OW or OB ranging from 18.9% to 36.9% in school-aged children 5-11 years and 16.6% to 35.8% in adolescents 12-19 years.[37] Reddy et al in their work on the increase in overweight and obesity in South African adolescents, found that among the females, Ow increased from 24.3% in 2002 to 29.0% in 2008, OB from 5.0% in 2002 to 7.5% in 2008. In the males, OW increased from 6.3% in 2002 to 11.0% in 2008, OB 1.6% in 2002 to 3.3% in 2008.[38] Our result demonstrated a progressive increase in the mean WC and BMI across the age groups. Chrzanowska et al.,[39] studied changes in BMI in children and adolescents in Cracow, Polandfrom 1971 to 2000 and

found that the greatest increases occurred in the youngest age group (7-12 years for boys and 7-10 years for girls), increases were lowest in the oldest age groups; 16-18 years in boys and 14-18 years in girls.[39] Ng et al in their study on the use of BMI and waist circumference for predicting cardiovascular risk factor clustering in Chinese adolescents also noticed an increasing trend of BMI over time in their adolescents.[40]

Table 4 Body mass index of the youth defined by WHO 2007 reference population by sex and age group

	WHtR<0 .5	WHtR ≥0.5
	N (%)	N (%)
Girls (years)		
All Girls	1552 (88.5)	201 (11.5)
12-Sep	361 (20.6)	72 (4.1)
13 -15	780 (44.5)	88 (5)
>15	411 (23.5)	41 (2.3)
Boys (years)		
All Boys	1049 (92)	91 (8)
12-Sep	248 (21.8)	50 (4.4)
13 -15	498 (43.7)	32 (2.8)
>15	303 (26.6)	9 (0.8)

WHO,world health organization;WHtR,waist height ratio; N,number; %,percentage;<,less than; ≥, greater or equal to

Table 5 Spearman's correlation between waist circumference, waist height ratio and body mass index of the youths

	WC	WHtR	BMI
WC	1	0.82197	0.77842
		*<.0001	<.0001
WHtR	0.82197	1	0.73281
	<.0001		<.0001
BMI	0.77842	0.73281	1
	<.0001	<.0001	

*is p-value;WC,waist circumference;WHtR,waist height ratio; BMI,body mass index

Our study showed a significant correlation between WC and BMI, WHtR and BMI, WC and WHtR p< 0.0001. This means that the higher the BMI, the higher the waist circumference, and the higher the waist-to-height ratio in these youths. Evidence in literature has shown that both absolute total fat and adipose tissue distribution are closely associated with cardio-metabolic risks.[41,42] However, Al-Daghri et al in their study found BMI to be superior among all obesity indices in terms of relationship with adipokins and cardio-metabolic risk factors.[43] Ho et al in their work, reported that the three obesity indices are highly inter-correlated and showed similar magnitudes of association with plasma glucose, blood pressure serum triglycerides and HDLc for both sexes. However, further analysis revealed that among males, BMI seemed to have a stronger independent influence than central obesity on blood pressure, plasma lipids and serum insulin. While central obesity showed a stronger association with plasma glucose, HDL and serum insulin in females.[44]

Conclusion

In conclusion, the prevalence of overweight and obesity in Nigerian children and youth is increasing, higher in girls than in boys especially between 9-15 years. Unabated will lead to the emergence of diabetes and cardiovascular disease. Therefore, we recommend that in addition to BMI, WC or WHtR should be used to assess central adiposity in children and youths. Furthermore, in view of the detrimental effects on health and the cost to healthcare system, implementation of programs to prevent unhealthy weight gain in children and adolescents are urgently needed in Nigeria.

Limitation: In this study,assessment ofserum insulin and lipid levels would have enabled us evaluate the cardiovascular risk of these children and youths with overweight and obesity.

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Conflicts of interest

The authors declare that there is no conflict of interest associated with this manuscript.

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