Association between anthropometric parameters in relation to body mass and measures of adiposity in adolescent Nigerian males

Akinola OB.[1], Olajide OJ.[1], Olanrewaju J.[2]

Abstract

Objective: Anthropometric indices are valid proxies for predicting the risk of metabolic and cardiovascular diseases across age groups and gender. The objective of the present work was to study some anthropometric measures of body mass and adiposity in male Nigerian adolescents.

Methods: In a population of male Nigerian adolescents (n=400; age: 13-19 years), data was collected for standing height, body weight and circumferences (hip, waist, neck, and mid-upper arm); and the body mass index (BMI), waist to hip ratio (WHpR) and waist to height ratio (WHtR) were then calculated. Moreover, using Pearson's correlation coefficient, we studied the association between BMI and other anthropometric variables.

Results: Average BMI was 18.38 kg/m^2 for adolescent males aged 13-15 years (n=217), and 19.03 kg/m^2 for males aged 16-19 years (n=183). In the former category (13-15 years), BMI as a measure of body mass was best positively and significantly associated with the mid-upper arm circumference (MUAC) ($r=0.673$, $p<0.01$), while in the older adolescent males (16-19 years), BMI strongly and significantly associates with hip circumference (HC).

Conclusion: Findings in the present study indicate that in adolescent male Nigerians, MUAC best serves as an alternative to BMI in early adolescence (13-15 years); while HC is the best proxy for BMI, and may be a substitute for this anthropometric index in predicting cardiometabolic risk in older adolescent male Nigerians (16-19 years). It is recommended that age- and sex-specific cut off values for MUAC and neck circumference (NC) be determined among adolescents of different nationals. Moreover, it is pertinent to characterize the associate between MUAC and the risk factors for metabolic and cardiovascular diseases in specific subpopulations.

Key words: Anthropometry, adolescence, Nigerians, cardiometabolic diseases

Correspondence Author: Dr. O. B. Akinola. E-mail: akinolub@unilorin.edu.ng

[1]Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Ilorin, Nigeria;
[2]Basic Medical Sciences Unit, College of Health Sciences, University of Ilorin, Nigeria.

Association entre les paramètres anthropométriques par rapport à la masse corporelle et les mesures de l'adiposité dans les adolescents mâles nigérians

Oluwole B. Akinola[1], Olayemi J. Olajide[1], Joseph Olanrewaju[2]

Resume

Objectif: indices anthropométriques sont des indicateurs valables pour prédire le risque de maladies métaboliques et cardiovasculaires dans tous les groupes d'âge et le sexe. L'objectif de ce travail était d'étudier certaines mesures anthropométriques de masse corporelle et de l'adiposité chez les adolescents nigérians de sexe masculin.

Méthodes: Dans une population d'adolescents nigérians de sexe masculin (n = 400; âge: 13-19 ans), les données ont été recueillies pour la hauteur, le poids corporel et circonférences (hanche, taille, le cou et le bras à mi-hauteur) debout; et l'indice de masse corporelle (IMC), rapport taille-hanche (WHPR) et rapport taille-hauteur (WHTR) ont ensuite été calculée. De plus, en utilisant le coefficient de corrélation de Pearson, nous avons étudié l'association entre l'IMC et d'autres variables anthropométriques.

Résultats: IMC moyen était 18,38 kg / m2 pour les adolescents âgés de 13-15 ans (n = 217), et 19,03 kg / m2 pour les hommes âgés de 16-19 ans (n = 183). Dans la première catégorie (13-15 ans), l'IMC en tant que mesure de la masse corporelle était mieux positivement et significativement associé à la mi-supérieure circonférence du bras (MUAC) (r = 0,673, p <0,01), tandis que dans les anciens adolescents de sexe masculin (16-19 ans), l'IMC fortement et significativement associe à la circonférence de la hanche (HC).

Conclusion: Les résultats de la présente étude indiquent que les adolescents de sexe masculin Nigérians, MUAC sert au mieux comme une alternative à l'IMC début de l'adolescence (13-15 ans); tandis que HC est le meilleur indicateur pour l'IMC, et peut être un substitut pour cet indice anthropométrique pour prédire le risque cardiométabolique dans les anciens Nigérians mâles adolescents (16-19 années). Il est recommandé de coupe spécifique du sexe et de l'âge de valeurs pour MUAC et la circonférence du cou (NC) déterminées chez les adolescents de différents ressortissants. De plus, il est pertinent de caractériser l'associé entre MUAC et les facteurs de risque pour les maladies métaboliques et cardiovasculaires chez les sous-populations spécifiques.

Mots clés: anthropométrie, l'adolescence, les Nigérians, les maladies cardiométaboliques

Auteur correspondant: Dr. O. B. Akinola. E-mail: akinolub@unilorin.edu.ng

[1]Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Ilorin, Nigeria;
[2]Basic Medical Sciences Unit, College of Health Sciences, University of Ilorin, Nigeria.

INTRODUCTION

In several geographical regions, childhood and adolescent overweight and obesity are steadily on the rise (1), suggesting early onset of cardiovascular risk factors, including insulin resistance, type 2 diabetes, and dyslipidaemia (2). In a recent study by Schommer, Barbiero in Brazilian children of average age 12.1 years, up to 27.6% of those children were either overweight or obese, and about 11.3% had abnormally high blood pressure (3). In addition, in a study of Israeli children aged 9-17 years, Mazor-Aronovitch (4) reported that 17.2% of the study population was overweight or obese, with elevated blood pressure.

A number of anthropometric indices serve as proxies for predicting the risk of cardiovascular and metabolic diseases in the young and old. Body mass index (BMI) has long been reputed to predict general obesity in a given population, while waist circumference (WC) and waist to hip ratio (WHpR) are better predictors of central (abdominal) obesity, which is a major contributor to insulin resistance, type 2 diabetes and cardiovascular diseases (2, 5-8)

In addition to these common indices, additional anthropometric measures of body mass have practical application in children and adults. A study of South African children aged 10-14 years concluded that mid-upper arm circumference (MUAC) has potential for clinical application as a simple indicator of body mass in children and adolescents residing in resource-limited geographic areas (9). Moreover, the potential clinical application of neck circumference (NC) as a simple and valid measure of body mass and adiposity was reported by Ferretti (10) in a Brazilian adolescent population.

Meanwhile, because of the contribution of genetic and epigenetic/environmental factors in determining anthropometric outcomes in different subpopulations and regions, it is critical to determine standardized population-specific anthropometric references that take into consideration the age, sex, socioeconomic status and location of the subpopulation. In addition to determining age- and region-specific anthropometric indicators of body mass in diverse subpopulations, it is pertinent to determine the correlation between these indices for a given population, such that one index may validly substitute for the other.

In a study by Brannsether, Eide (11) in Norwegian children, the association between specific anthropometric indices were determined for children 4-15 years of age. BMI was most strongly and positively correlated with waist circumference (WC). This indicates that, for that given (Norwegian) subpopulation, WC better predicts BMI and thus, the risk of developing cardiometabolic diseases. Moreover, among the several anthropometric indices studied recently in a population of young post-pubescent female Nigerians (16-23 years), BMI best correlates with fasting blood glucose, and is most strongly and positively associated with waist to height ratio (WHtR) (12); thereby making these indices (BMI and WHtR) best proxies for predicting metabolic and cardiovascular diseases in this (Nigerian) subpopulation.

In the present study therefore, we determined some anthropometric measures of body mass in a population of male adolescent Nigerians and report age-specific association between those indices that have the potential to predict cardiovascular risk in this particular subpopulation.

MATERIALS AND METHODS

Study population

The study population included presumably healthy male high school pupils attending selected secondary schools in Ilorin city, North-central Nigeria. Four hundred (400) adolescent male students (13-19 years old) participated in the study, which was conducted in the year 2014. After obtaining informed written consent from the participants (and their respective school authorities), each completed a questionnaire that requests information on the health status of the individual, lifestyle (e.g., smoking habit, etc), current medication, and demographics. Subjects that were physically disabled and those on medication because of ill health were excluded.

Anthropometric parameters assessed

For each participant, the following anthropometric parameters were taken in duplicate by the same observer: body weight, standing height, hip circumference, waist circumference, neck circumference, and mid-upper arm circumference. Standing height was taken in the Frankfurt (orbitomeatal) position with the aid of a stadiometer; while body weight was recorded using a Hana mechanical scale (China). Waist circumference was measured with a tape placed at a point mid-way between the costal margin and the iliac crest. Hip circumference was taken using a measuring tape

placed at the level of the grater trochanter of the femur. Moreover, neck circumference was taken near the midpoint of the neck, just below the laryngeal prominence; while mid-upper arm circumference was taken at a point midway between the olecranon and acromion.

From the data obtained, the following anthropometric indices were calculated:

Body mass index (BMI) = weight (kg)/ height^2 (m^2)

Waist to hip ratio (WHpR) = waist circumference (cm)/hip circumference (cm)

Waist to height ratio (WHtR) = waist circumference (cm)/height (cm)

Statistics

Anthropometric indices measured are reported as mean ± standard deviation (mean ± SD). Association between some of the anthropometric parameters were tested by the Pearson's correlation coefficient method, with the aid of the SPSS version 20. Differences between the mean values were considered significant at $p<0.01$.

RESULTS

In the study population (adolescent male Nigerians), the mean BMI for all the study subjects (boys aged 13-19 years) is 18.38 kg/m^2 and 19.03, respectively (Table 1). In both age categories (13-15 years and 16-19 years), the mean WHtR and WHpR are 0.42 and 0.85, respectively. Moreover, in the 13-15 years age category, average values of 67.09 cm, 78.81 cm, 30.40 cm and 22.46 cm were obtained for WC, HC, NC, and MUAC in this age group, while relatively higher values of 69.60 cm, 81.81 cm, 31.87 cm, 23.72 cm, respectively, were recorded in the 16-19 years age group. Among the anthropometric indices estimated in the adolescent male Nigerians (13-15 years age category), BMI has the strongest association positively and significantly with MUAC ($r=0.673$, $p<0.01$; Table 2), but correlates weakly with WHpR ($r= 0.003$, $p>0.01$). However, in the older 16-19 years age category, BMI has the strongest positive correlation with HC ($r=0.640$; $p<0.01$), but is also strongly and positively associated with MUAC ($r=0.614$; $p<0.01$). The association between a number of anthropometric indices in adolescent male Nigerians (including WHtR, WHpR, HC, WC, NC and MUAC) are indicated in Tables 2.

DISCUSSION

In this study, we report the association between BMI and a number of related measures of body mass in adolescent male Nigerians (13-19 years). In the age category 13-15 years, BMI is best associated positively and significantly with MUAC, while in male adolescents aged 16-19 years, BMI was best correlated significantly and positively with HC, and then MUAC.

Therefore, the findings in the present study establishes a strong positive association between BMI and MUAC in male adolescent Nigerians of ages 13-15 years residing in the North-central region. This finding is essential as it shows that in this particular male population, BMI can be predicted by using a much simple anthropometric index – the MUAC.

The MUAC, taken midway between the olecranon and acromion, may thus validly substitute for BMI for determining body mass in male Nigerians during early adolescence. In a related study in South African male and female children and adolescents (5-14 years), MUAC has the prospect of being reliably used to identify overweight and obesity in this category of subjects, with a high degree of accuracy (9). This further supports the opinion that in young adolescent Africans, MUAC is invaluable in estimating body mass and degree of fatness. It is also worthy to note the strong and positive association between MUAC and neck circumference (NC) in this specific age group (Table 2); and this makes NC as well a valid indicator of body mass during adolescence. Indeed, anthropometric data from Brazilian children resident in Sao Paulo established NC as a reliable predictor of body adiposity (10).

Furthermore, in older adolescent Nigerian males (16-19 years) residing in the North-central region, BMI best associates positively and significantly with hip circumference (HC), and then with MUAC, as predictors of body mass. Therefore, while BMI remains a valid indicator of body mass in most age groups, including adolescent males (13), HC and MUAC are the best alternatives to BMI as measures of body mass and adiposity in male Nigerians during late adolescence. The strong association between HC and cardiovascular risk in adolescents has been established in the findings of Schommer, Barbiero (3) in Brazilian adolescents in which HC was the best predictor of high blood pressure in both sexes.

Thus, our studies concludes that during early

adolescence in male Nigerians (ages 13-15 years), MUAC associates strongly and positively with BMI in this very population. In older adolescent males (16-19 years), HC best associates strongly and positively with BMI and therefore, could substitute for this index in this age group.

It is therefore recommended that age- and sex-specific cut-off values for MUAC and HC be determined among adolescents of diverse nationals. Moreover, it is pertinent to characterize the association between MUAC and the risk factors for metabolic and cardiovascular diseases, such as insulin resistance, fasting blood glucose, dyslipidaemia, and blood pressure, etc, in this specific population.

ACKNOWLEDGEMENT: The authors are highly indebted to the Principal Officers of Government Secondary School, Cherubim and Seraphim Secondary School, Government Day Secondary School, and David Akintola College, all in Ilorin, a city in the North-central geopolitical zone of Nigeria, for their kind approval to use their students as subjects for this study.

Conflict of interest: No conflict of interest was declared.

REFERENCES

1. Chan TF, Lin WT, Huang HL, Lee CY, Wu PW, Chiu YW, et al. Consumption of sugar-sweetened beverages is associated with components of the metabolic syndrome in adolescents. Nutrients. 2014;6(5):2088-103.
2. Dube S, Msonza T, Gwamuri T, Dube C, editors. A survey on the association between blood glucose levels, lipidemia and selected type 2 diabetes predisposing risk factors in Bulawayo district Zimbabwe. 4th International Conference on Appropriate Technology; 2010; Accra Ghana.
3. Schommer VA, Barbiero SM, Cesa CC, Oliveira R, Silva AD, Pellanda LC. Excess weight, anthropometric variables and blood pressure in schoolchildren aged 10 to 18 years. Arq Bras Cardiol. 2014;102(4):312-8.
4. Mazor-Aronovitch K, Lotan D, Modan-Moses D, Fradkin A, Pinhas-Hamiel O. Blood pressure in obese and overweight children and adolescents. Isr Med Assoc J. 2014;16(3):157-61.
5. Schmidt MI, Duncan BB, Canani LH, Karohl C, Chambless L. Association of waist-hip ratio with diabetes mellitus. Diabetes Care. 1992;15(7):912-4.
6. Dalton M, Cameron AJ, Zimmet PZ, Shaw JE, Jolley D, Dunstan DW, et al. Waist circumference, waist–hip ratio and body mass index and their correlation with cardiovascular disease risk factors in Australian adults. J Internal Med. 2003;254:555-63.
7. Norberg M, Eriksson JW, Lindahl B, Andersson C, O. Rolandsson O, Stenlund H, et al. A combination of HbA1c, fasting glucose and BMI is effective in screening for individuals at risk of future type 2 diabetes: OGTT is not needed. J Internal Med. 2006;260:263-71.
8. Ghazali SM, Sanusi RA. Waist circumference, waist to hip ratio, and body mass index in the diagnosis of metabolic syndrome in Nigerian subjects. Nig J Physiol Sci. 2010;25:187-95.
9. Craig E, Bland R, Ndirangu J, Reilly JJ. Use of mid-upper arm circumference for determining overweight and overfatness in children and adolescents. Arch Dis Child. 2014;99(8):763-6.
10. Ferretti Rde L, Cintra Ide P, Passos MA, Ferrari GL, Fisberg M. Elevated neck circumference and associated factors in adolescents. BMC Public Health. 2015;15(1):015-1517.
11. Brannsether B, Eide GE, Roelants M, Bjerknes R, Juliusson PB. Interrelationships between anthropometric variables and overweight in childhood and adolescence. Am J Hum Biol. 2014;26(4):502-10.
12. Akinola OB, Omotoso GO, Akinlolu AA, Ayangbemi KD. Identification of the anthropometric index that best correlates with fasting blood glucose and BMI in post-pubescent female Nigerians. Anat J Afr. 2014;3(2):324-8.
13. Ejtahed HS, Asghari G, Mirmiran P, Hosseinpour-Niazi S, Sherafat-KazemZadeh R, Azizi F. Body mass index as a measure of percentage body fat prediction and excess adiposity diagnosis among Iranian adolescents. Arch Iran Med. 2014;17(6):400-5.

Table 1. Some anthropometric parameters of adolescent male Nigerians

	Adolescent boys (13-15 yrs)				Adolescent boys (16-19 yrs)			
	n	Mean±SD	Min. value	Max. value	n	Mean±SD	Min. value	Max. value
Height(cm)	217	160.02±9.99	128.00	182.00	183	166.28±7.47	143.00	184.00
Weight(kg)	217	47.42±8.68	29.00	75.00	183	52.74±7.41	34.00	74.00
WC (cm)	217	67.09±5.42	53.00	88.00	183	69.60±4.49	58.00	86.00
HC (cm)	217	78.81±6.56	60.00	99.00	183	81.81±5.36	65.00	96.00
BMI (kg/m^2)	217	18.38±1.96	12.02	25.59	183	19.03±1.99	13.28	24.74
WHpR	217	0.85±0.04	0.75	0.98	183	0.85±0.04	0.74	0.98
WHtR	217	0.42±0.03	0.35	0.55	183	0.42±0.03	0.37	0.53
NC (cm)	217	30.40±3.00	22.60	43.00	183	31.87±2.53	24.00	38.00
MUAC (cm)	217	22.46±2.53	13.50	31.00	183	23.72±2.32	18.00	30.00

Table 2. Correlations between anthropometric indices according to age groups**of** 400 male adolescent Nigerians

	Age group (years)	**BMI**	**WC**	**HC**	**WHpR**	**WHtR**	**NC**	**MUAC**
BMI	13-15	1	0.603*	0.581*	0.003	0.461*	0.533*	0.673*
	16-19	1	0.598*	0.640*	-0.076	0.581*	0.546*	0.614*
WC	13-15	0.603*	1	0.802*	0.251*	0.648*	0.620*	0.705*
	16-19	0.598*	1	0.699*	0.352*	0.741*	0.453*	0.531*
HC	13-15	0.581*	0.802*	1	-0.374*	0.308*	0.746*	0.785*
	16-19	0.640*	0.699*	1	-0.429*	0.377*	0.672*	0.706*
WHpR	13-15	0.003	0.251*	-0.374*	1	0.502*	-0.236*	-0.173*
	16-19	0.076	0.352*	-0.420*	1	0.445*	-0.296*	-0.244*
WHtR	13-15	0.461*	0.648*	0.308*	0.502*	1	0.181*	0.307*
	16-19	0.581*	0.741*	0.377*	0.445*	1	0.168	0.309
NC	13-15	0.533*	0.620*	0.746*	-0.236*	0.181*	1	0.711*
	16-19	0.546*	0.453*	0.672*	-0.296*	0.168*	1	0.732*
MUAC	13-15	0.673*	0.705*	0.785*	-0.173*	0.307*	0.711*	1
	16-19	0.614*	0.531*	0.706*	-0.244*	0.309*	0.732*	1

* $P<0.01$

Age: 13-15 years: 13-15.99 years; 16-19 years: 16-19.99 years

Abbreviations BMI: body mass index, WC: waist circumference, HC: hip circumference, WHpR: waist to hip ratio, WHtR: waist to height ratio, NC: neck circumference, MUAC: mid upper arm circumference