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GENDER DIFFERENCES IN WAIST CIRCUMFERENCE IN NIGERIAN CHILDREN

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ABSTRACT

The aim of this study was to develop age and sex specific reference values for waist circumference (WC) based on a sample of 2015 primary school children (i.e. 979 boys and 1036 girls aged 9 12 years) who were randomly selected from 19 primary schools in Makurdi, Benue State of Nigeria. Waist and hip circumferences were measured with a flexible anthropometric tape according to the protocol of the International Society for the Advancement of Kinanthropometry (ISAK). Mean WC was higher in girls than in boys, and these differences were statistically significant from age 10 onwards. Similarly, hip circumference was significantly higher ($p<0.05$) in girls than in boys at all ages. Whereas waist and hip circumferences increased with age in both sexes, the increase was relatively greater for hip circumference. Generally, waist related percentiles values increased with age in boys and girls, but girls had higher values than boys in most of the age specific percentiles. WC showed significantly higher ($p <0.0001$) values in girls than in boys at ages 10 12 years, and this increased with age in both categories. The reference data obtained in this study can be used to identify children with high risk of developing obesity related disorders and form the basis for future research studies.

Key words: Anthropometry, waist circumference, abdominal obesity, reference data, Nigerian children.

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INTRODUCTION

The obesity epidemic is becoming a global problem with the prevalence of obesity increasing dramatically even in developing countries where economic status is low (Raymond, Leeder & Greenberg, 2006). No universally accepted definition of obesity exists (World Health Organisation: WHO, 2000). WHO defines obesity as a disease, in which fat has accumulated to an extent that health is adversely affected and links the condition to lifestyle related factors (WHO, 2000). The problem when evaluating risk factors of cardiovascular disease in children is that they display less obesity-related diseases than adults. The proxy measure of body mass index (BMI) is often used to screen for obesity in children and adults.

However, there are problems associated with BMI as an indicator of fatness during childhood because of the influences of age, sex and maturational factors (Burniat, Cole, Lissau & Poskitt, 2002). Also, BMI correlates not only with fat mass but also with fat-free mass (Reilly, Dorosty & Emmett, 2000; Maynard *et al*., 2001). Additionally, BMI gives no indication of body fat distribution, and clearly children, as in adults, an upper body or centralised deposition of excess body fat carries increased risk for obesity-associated metabolic complications.

Waist circumference (WC), not BMI, is one of the factors in the definition of metabolic syndrome in adults (Snijder, *et al*., 2003; Cho, Jang, Park & Cho, 2006; Hadaegh, Zabetian, Harati & Azizi, 2007). Some studies (Zannolli & Morgese, 1996; Janssen, Katzmarzyk & Ross, 2002; Moreno *et al*., 2002; Morimoto *et al*., 2007) have demonstrated WC as a better predictor of metabolic syndrome in children and may be a better reflection of the accumulation of visceral fat. However, the definition of childhood metabolic syndrome varies between studies, partly because of a lack of reference data for WC. To date, percentile curves for WC have been developed for Italian (Zonnolli & Morgese, 1996), Spanish (Moreno *et al*., 1999), British (McCarthy, Jarret & Crawley, 2001), Cypriot (Savva *et al*., 2001), Mexican (Gomez-Diaz *et al*., 2005), Canadian (Katzmarzyk, 2004), and Australian (Eisenmann, 2005) children and adolescents. In these studies, WC is included as a method by which to detect abdominal obesity, exclusive of BMI or an ancillary measure of waist-to-hip ratio (WHR).

Waist circumference is not measured as often as body mass and stature in Nigerian school children as part of their physical examination. This suggests while plenty of data on BMI are available, information regarding WC in Nigerian children is hardly reported in the literature. Numerous studies have expressed the importance of assessing WC in children to detect health risks associated with metabolic syndrome or obesity (Moreno *et al*., 2002; Morimoto *et al*., 2007; Del-Rio-Navarro *et al*., 2008).

Consequently, the present study was designed to derive cut-offs values of WC in Nigerian children and to examine their association with age and gender. The findings will provide baseline data for future studies examining the reliability of anthropometric indices as a screening tool for risk factors of metabolic disease in Nigerian children.

METHODS

Sampling

A cross-sectional survey was conducted in Makurdi, Nigeria from September to December 2006, in which a sample of 2015 participants (979 boys and 1036 girls aged 9- to 12-years) was selected using the simple random sampling technique and measured. Specifically, a two-stage probability sampling method was used. The first stage included the selection of schools and the second stage consisted of random sampling of boys and girls of each age category from the total enrollment in their schools. A representative sample of the schools from this area was drawn based on the official list obtained from the Benue State Universal Basic Education Board. A total of 19 public primary schools were randomly selected within the five geographical areas of Makurdi town (High-Level, Kanshio, North Bank, Wadata and Wurukum), Benue state, Nigeria. Twenty schools were targeted, but one school declined to participate in the study based on local administrative bureaucracy and was excluded. The children's ages and birth dates were verified against school records, which were derived from their birth certificates.

Ethical considerations

Prior to the commencement of the study, the children's parents or guardians were invited to a briefing session in which they were informed about the purpose and procedures of the study. Written informed consent was subsequently obtained from the children's parents or guardians and head teachers. Permission to conduct the study and ethical clearance were granted by Benue State Universal Basic Education Board and the Ethics Committee of Tshwane University of Technology, South Africa, respectively.

Measurements

Anthropometric measurements were performed according to the protocol of the International Society for the Advancement of Kinanthropometry

(ISAK) (Marfell-Jones, Olds, Stew & Carter, 2006). Beside stature, body mass and skinfolds (which were used as part of a broader investigation) (Goon, Toriola, Shaw, Amusa & Musa, 2008) and waist and hip circumferences were measured in all participants. All measurements were performed by a trained tester (one for each sex) whose quality of performance was evaluated against prescribed criteria prior to the study. The mean intra- tester %TEMs for the WC measurements were 0.8%, while the inter-tester % TEM, were 2.0%. These values are well within the limits set by ISAK for accreditation as Level 1 Criterion Kinanthropometrist. Measurements were taken by the same investigator. Waist and hip circumferences were measured to the nearest 0.1 cm, using a flexible anthropometric tape (Lufkin W606 PM, Creative Health Products, MI, USA). Measurement of WC was taken with the participant standing and the tape wrapped at the level of the narrowest point between the lower costal (10th rib) border and the iliac crest. Hip measurements were taken at the level of the greatest posterior protuberance of the buttocks which usually corresponds anteriorly to about the level of the symphysis pubis.

Statistical Analysis

The mean and standard deviation for each anthropometric variable were calculated by sex and age group. Reference values for the 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles were computed by sex and age groups. The mean value was compared between groups by using Student *t*-test. All data were analysed using the computer software of Statistical Package of the Social Sciences (SPSS) (SPSS Inc., Chicago, IL, USA, version 15.0). For all analyses, a probability level of 0.05 or less was taken to indicate statistical significance.

RESULTS

Presented in Table 1 are the means and standard deviations (±SD) of Nigerian children's body mass and stature. Table 2 summarises the descriptive statistics of waist and hip circumferences of the children by age group and gender as well as comparisons between genders on waist and hip circumferences.

Table 1: Mean and standard deviations for body mass and stature by age and sex

			Body mass (kg)		Stature (cm)	
	Boys	Girls	Boys	Girls	Boys	Girls
Age	n	n	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
9	192	213	26.1 ± 2.8	26.3 ± 3.4	129.9 ± 5.3	131.4 ± 5.8
10	279	303	28.9 ± 3.4	29.7 ± 4.8	135.0 ± 6.0	136.1 ± 6.1
11	234	244	30.4 ± 4.0	32.8 ± 4.4	139.8 ± 6.1	141.7 ± 5.7
12	274	276	32.3 ± 4.3	35.9 ± 6.2	142.1 ± 6.7	145.4 ± 6.6

Table 2: Mean and standard deviation for waist and hip circumferences by age and sex

			Waist circumference (cm)			Hip circumference (cm)		
	Boys	Girls	Boys	Girls		Boys	Girls	
Age	n	n	Mean ± SD	Mean ± SD	p	Mean ± SD	Mean ± SD	p
9	192	213	57.3 ± 3.7	57.1 ± 3.9	0.6285	64.4 ± 4.2	65.1± 4.6	0.1528
10	279	303	59.3 ± 4.2	60.0 ± 4.2	0.0413*	67.7 ± 5.2	69.0 ± 5.4	0.0164*
11	234	244	60.2 ± 4.2	62.1 ± 4.7	0.0001*	68.9 ± 4.7	71.3 ± 5.2	0.0001*
12	274	276	61.9 ± 3.8	63.6 ± 4.1	0.0001*	71.1 ± 5.3	73.4 ± 5.5	0.0001*

*Statistically significant at $p < 0.05$.

The results indicated that, except at age nine, girls have significantly higher mean WC than boys at ages 10 to 12 years. Hip circumference was significantly higher in girls than in boys at all ages. Table 3 presents the unsmoothed sex-and age-specific WC cut-offs at the 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles. Figures 1 and 2 illustrate the percentile curves of WC for the boys and girls. As shown in the graphs, waist circumference increases with age in both sexes. Generally, percentile values are higher in girls than in boys at ages 10 to 12 years. In both categories, hip circumference is greater than waist girth, but the curves run almost parallel in boys. In girls, the hip circumference increases continuously (Figure 3).

Table 3: Sample size and percentage values of percentiles of waist circumference by age and sex

		Percentiles						
Age (years)	n	5th	10th	25th	50th	75th	90th	95th
Boys								
9	192	52.0	53.0	55.0	57.0	59.9	61.0	63.0
10	279	53.0	54.0	57.0	59.0	62.0	65.0	67.0
11	234	53.6	55.0	58.0	60.0	62.5	66.0	67.0
12	274	56.0	58.0	60.0	61.6	64.0	67.0	69.0
Girls								
9	213	50.5	52.0	54.0	57.0	60.0	62.0	64.0
10	303	54.0	55.0	57.0	60.0	62.4	65.5	67.0
11	244	55.0	57.0	59.0	62.0	65.0	68.0	71.0
12	276	57.0	59.0	61.0	63.6	66.0	69.0	71.0

Age indicates whole age groups, e.g., 9.0-9.99 year, etc.

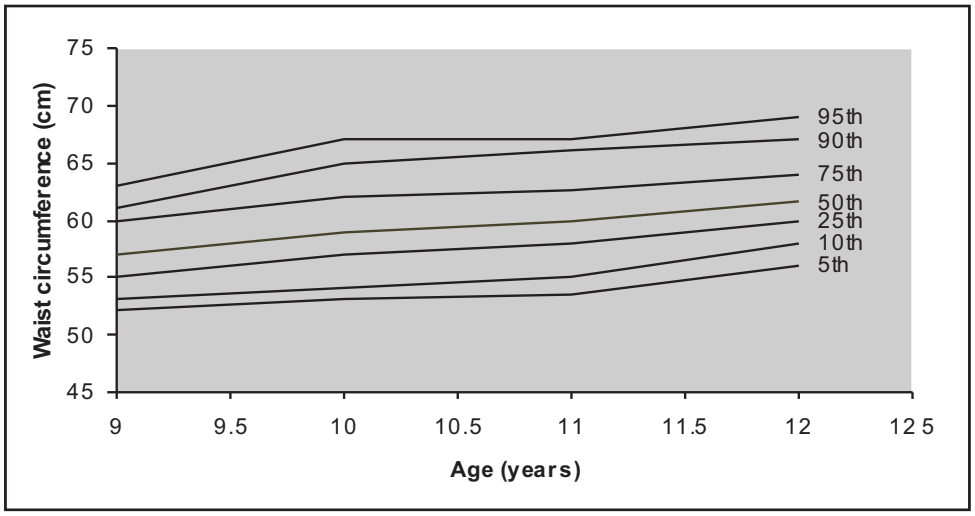

Figure 1: Waist circumference: 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles curves in Nigerian boys.

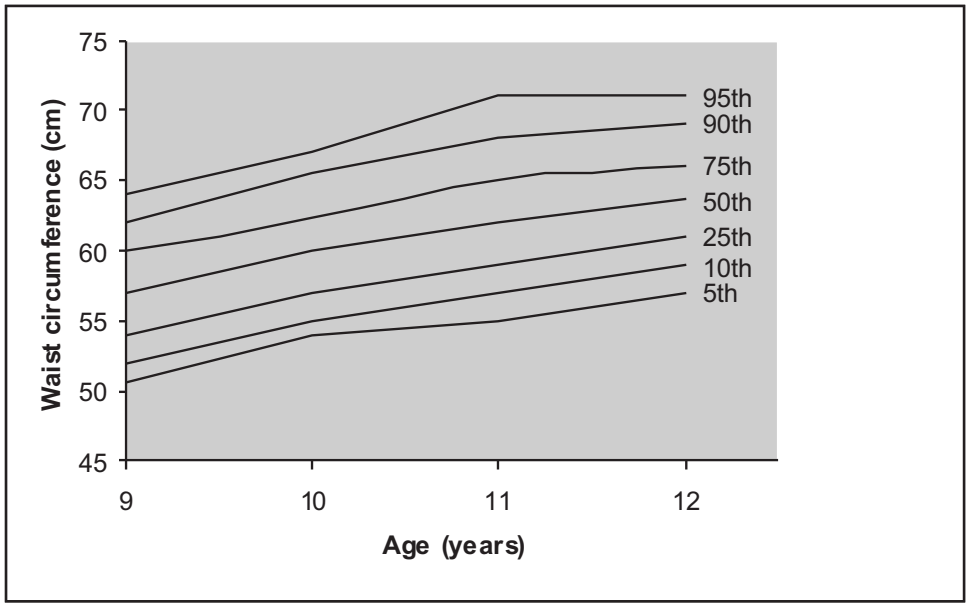

Figure 2: Waist circumference: 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles curves In Nigerian girls.

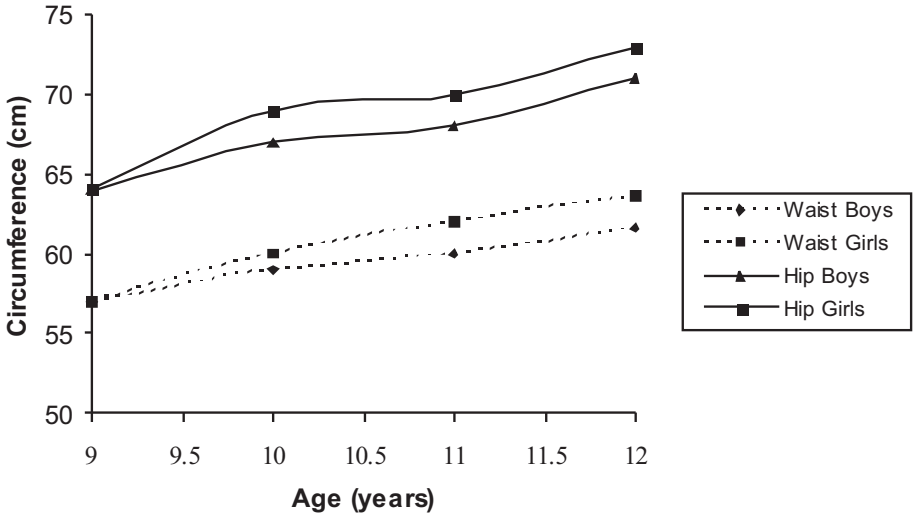

Figure 3: Waist and hip circumferences (median) in both boys and girls.

DISCUSSION

This study was aimed at investigating gender variation in WC values of Nigerian children living in Makurdi, Nigeria. The study also offers us the possibility to calculate WC reference values for Nigerian children. However, since the data were derived from school going children; they should be cautiously applied to interpret anthropometric trends in the generality of Nigerian children.

As in adults, some studies (Janssen, Katzmarzyk & Ross, 2002; Moreno *et al*., 2002; Morimoto *et al.*, 2007) have demonstrated that WC is a better predictor of metabolic syndrome in children and may be a better reflection of the accumulation of visceral fat. This consideration justifies the interest in studying changes in waist circumference during childhood. In this present study, waist circumference was found to be higher in girls than in boys and increased with age in both sexes. This finding is consistent with that reported for Japanese children (Inokuchi, Matsuo, Anzo, Takayama & Hasegawa, 2007; Morimoto *et al*., 2007). However, whilst other studies found higher WC in boys than in girls, similar findings regarding increases in waist circumference with age in both sexes have been reported (Moreno *et al*., 1999; Katzmarzyk, 2004; Fredriks *et al*., 2005).

In Australian boys and girls similar values of WC were observed prior to age 11 years, after which values were slightly higher in boys. In this present study, the larger increase in WC in girls compared to boys may be indicative of maturational changes in body composition that occur during puberty, but this was beyond the scope of the study. The hip circumference values found in our study at different ages mimico those obtained in Spanish (Moreno *et al.*, 1999), Cuban (Martinez, Devesa, Bacallao & Amador, 1994), South African (Toriola, Monyeki, Monyeki & Mothiba, 2001) and Dutch (Fredriks, Buuren, Fekkes, Verloo-Vanhorick & Wit, 2005) children. The values of hip circumference were higher in girls than in boys, especially after nine years of age. These findings support the use of age and gender specific standards for waist circumference in children.

Caution should be exercised in interpreting differences in WC across populations since such comparisons could be influenced by a variety of factors including duration of study, sample size, and the smoothing methods used for normative standards as well as genetic and environmental influences. Given the available international data on WC, age and sex-specific cut-off points for WC should be developed based on the same methodology used to establish the international BMI criteria for overweight and obesity (Cole, Bellizzi, Flegal & Dietz, 2000). This approach would facilitate global comparisons of data on prevalence rates of abdominal obesity. Taking into account that reference values of WC depend on age and gender, we propose the use 75th and 90th percentiles as cut-off points for screening of moderate and severe waist girth values in this group of children. However, more studies are needed to adjust these values, taking into consideration the interrelationships among WC, total body fat and intra-abdominal fat measured with different reference methods and targeted at a variety of health outcomes (Taylor, Jones, Williams & Goulding, 2000; Eisenmann, Heelan & Welk, 2004). Also, more research is needed to develop reference data using longitudinal designs, as most of the available reference data were documented based on cross-sectional surveys.

In light of the increasing prevalence of overweight and obesity in children and the ease with which WC can be measured in preventive health programmes, we recommend that WC be routinely measured in children in schools and hospitals for the screening and early detection of central adiposity and risk of proneness to metabolic disease.

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