Original Article

Centripetal fat patterning in South African children

Daniel T Goon[1], Abel L Toriola[2], Brandon S Shaw[3], LO Amusa[4]

ABSTRACT

***Objectives*:** The waist-to-stature ratio (WSR) is newly developed index, proposed to be of greater value as a simple anthropometric indicator, for predicting abdominal obesity and related cardiovascular co-morbidities in adults and children. This study examined age and gender differences in waist-to-stature (WSR) as measure of centripetal fat patterning in a sample of children in Pretoria, South Africa.

Methodology: A cross-sectional study of 1136 schoolchildren (548 boys and 588 girls) aged 9-13 (11.2 ± 1.3) years were studied. Anthropometric measurements included body mass, stature and waist circumference. WSR was calculated by dividing waist circumference (in cm) by stature (in cm). Data were analysed using means and standard deviation. The parametric t-test was applied to examine sexual dimorphism in fat patterning among the children. The proportion of children with a WSR < 0.50 was calculated for each age group. Statistical significance was set at $p < 0.05$.

Results: The mean value of WSR was 0.43 ± 0.06 (95% CI 0.42-0.43), with the girls having significantly ($p = 0.002$; $p < 0.05$) higher mean WSR (0.44 ± 0.06; 95% CI 0.43-0.44), compared to the boys (0.42 ± 0.06; 95% CI 0.42-0.43). WSR showed inconsistent results in both sexes and across age groups. Girls had significantly ($p = 0.005$) higher mean values of WSR at ages nine, 11, and 12. A total of 155 children (13.6%) had central obesity as measured by WSR. The proportion of boys with a WSR > 0.5 was 47 (8.6%), while girls were 108 (18.4%). The prevalence of central obesity (WSR > 0.5) was found at all age and sex categories with the highest prevalence rate found at age 13 in both sexes.

Conclusions: The fact that WSR > 0.5 (13.6%) was found in these children, even among the youngest, is a cause for concern since obesity-related problems are likely to be present among the children. The need to design and implement appropriate intervention strategies at school and community levels is evident.

KEY WORDS: Waist circumference, Waist-to-stature ratio, Central fatness, South Africa.

Pak J Med Sci July - September 2011 Vol. 27 No. 4 832-836

How to cite this article:

Goon DT, Toriola AL, Shaw BS, Amusa LO. Centripetal fat patterning in South African children. Pak J Med Sci 2011;27(4):832-836

INTRODUCTION

Recently, the importance of total body fat and distribution has been stressed as a major risk factor for both adults and children.[1] Total and in particular central adiposity is associated with risk factors for cardiovascular disease, such as hypertriglyceredemia, hypercholesterolemia, insulin resistance, elevated blood pressure, and endothelial dysfunction both in children and adults.[1-3] As such, early identification and treatment of children with central adiposity is essential in order to plan appropriate remedial strategies. Thus studying fat

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* Received for Publication: December 27, 2010

* Accepted: July 8, 2011

patterning is of concern from both epidemiological and clinical viewpoints.

The waist-to-stature (WSR) index is a valid method for assessing excessive upper body fat that poses a health risk.[4] WSR is an easy and inexpensive technique which can be used in laboratory and field settings. The WSR measure assumes that the distribution of fat is independent of age, race, and gender. This implies that individuals with a certain anthropometric measure of fat distribution would have the same degree of fat regardless of their age, race, or gender. Additionally, WSR has the advantage of better measurement of fat distribution in different ages and statures.[5] The use of this anthropometric index has hardly been studied in South African children. Therefore the purpose of this study was to screen for central fatness among South African children using WSR.

METHODOLOGY

This study was a cross-sectional survey among primary school children aged 9-13 years attending public schools in Pretoria municipality city, Gauteng province, South Africa. The sampling frame was defined using the enrolment number for each school. This study employed a stratified, two stage cluster sampling strategy. This procedure ensures adequate representativeness of the study population in the sample. The procedure involved arrangement of study population into schools and class-level clusters. The first stage involved selecting randomly, schools with a probability proportional to the size and enrolment of each school.

The second stage involved selecting classes within the participating schools systematically and with equal probability of participation. This afforded all learners in the selected classes the eligibility to participate in the study. Race was determined based on the children's parental background using questionnaire and was categorised as Black and White. Participants whose backgrounds did not meet these criteria were excluded from the study. A total of initial sample of 1286 children were selected to participate in the study. However, due to absenteeism and incomplete data of 150 participants, 1136 participants (548 boys and 588 girls) eventually completed the tests and their data were used in the statistical analysis.

The nature and scope of the study were explained to the children and their parents who gave informed consent. Approval for the study was given by the Gauteng Department of Education (DoE), Johannesburg, South Africa. The Ethics Committee of Tshwane University of Technology, Pretoria, South Africa approved the research protocol before data collection.

Anthropometric measurements consisting of stature, body mass and waist circumference (WC) were taken according to the standard procedure of International Society for the Advancement of Kinanthropometry (ISAK).[6] These measurements were performed by the same trained tester (one for each sex) whose quality of performance was evaluated against prescribed ISAK guidelines prior to the study.

Participants' body mass was measured without shoes and with light clothing to the nearest 0.1kg, using a digital scale (Tanita-HD 309, Creative Health Products, MI, USA). Their stature was measured to the nearest 0.1cm using a mounted stadiometer. Measurements of body mass and stature were taken twice and the mean of two measurements recorded. The WC was measured at the level of the narrowest point between the lower costal (10^{th} rib) border and the iliac crest. If there was no obvious narrowing then the measurement was taken at the mid-point between those two landmarks. The measurement was taken at the end of a normal expiration with the arms relaxed at the sides (required accuracy of one millimetre). Waist-to-stature ratio was calculated by dividing WC (in cm) by stature (in cm).

Data were analysed using means and standard deviations. The parametric t-test was applied to test significance level ($p < 0.05$) between sexes and races while the F-test was used to examine whether any substantial differences existed across the five age

Table-I: Mean and standard deviation (SD) for anthropometric measurements of South African boys and girls.

	Boys (n = 548)	*Girls (n =588)*	*Combined (n = 1136)*	*95% CI*	*p-value*
Variable	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*		
Body mass (kg)	41.9 ± 12.0	42.3±12.1	42.1 ± 12.0	41.4-42.8	0.001*
Stature (cm)	146.8 ± 11.1	144.0± 10.6	145.4 ± 11	144.7-146.0	0.001*
Waist (minimum)	62.2 ± 10.2	62.8 ± 10.1	62.5 ±10.1	62.0-63.1	0.381
Gluteal (hip)	77.2 ± 10.6	80.7 ± 10.4	79.0 ±10.6	78.4-79.7	0.001*
Waist-to-stature ratio	0.42±0.1	0.44±0.1	0.43±0.1	0.42-0.43	0.002*

* Statistically significant at $p < 0.05$; CI = Confidence Interval

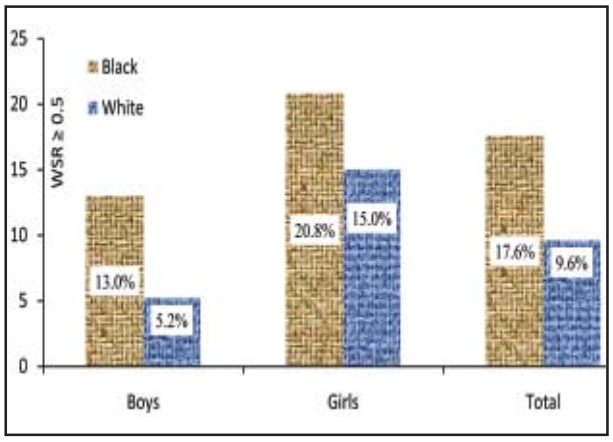

Figure-1: Proportion of waist-to-stature ratio > 0.5 according to race and gender.

groups. Correlation coefficients were computed to analyse the relationship between stature and WSR. The proportion of children with a WSR < 0.50 was calculated for each age group. All statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 17.0. The statistical significance was set at p< 0.05.

RESULTS

Shown in Table-I are the anthropometric measurements of the participants stratified by gender. Apart from WC, all other anthropometric measurements are significantly different in both sexes. The mean values for body mass and gluteal circumference were significantly (p = 0.001; p < 0.05) higher in girls compared to the boys. The boys were significantly taller (p = 0.001; p < 0.05) than the girls.

The mean value of WSR was 0.43 ± 0.1 (95% CI 0.42-0.43), with the girls having significantly (p = 0.002; p < 0.05) higher mean WSR (0.44 ± 0.06; 95% CI 0.43-0.44), compared to the boys (0.42 ± 0.06; 95% CI 0.42-0.43). WSR showed inconsistent results across both sexes and age groups. Girls had significantly (p = 0.005) higher mean WSR values at ages nine, 11, and 12 years. WSR remained fairly stable at all ages (Table-II). There was no significant (p = 0.054; p = > 0.05) difference in WSR among Black (0.43 ± 0.07; 95% CI 0.43-0.44) and White (0.43 ± 0.05; 95% CI 0.42-0.43) children.

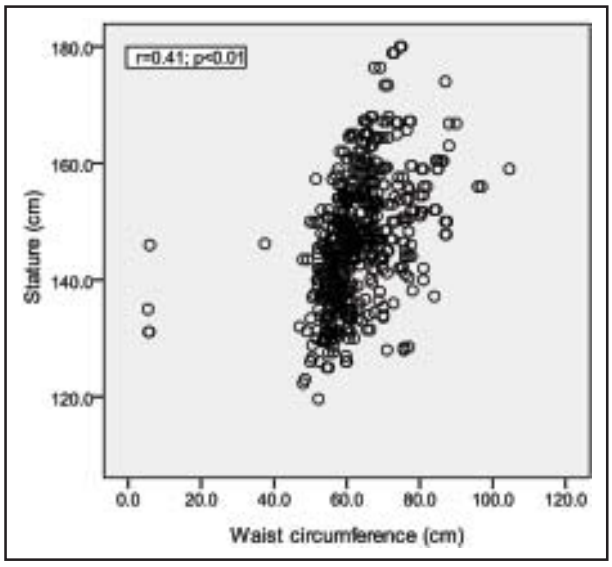

Figure-2: Correlation between stature and waist circumfernce.

Shown in Table-III is the proportion of the children with a WSR > 0.5 cut-off points for centripetal fat patterning. A total of 155 (13.6%) had central obesity as measured by WSR. The proportion of boys with a WSR >0.5 was 47 (8.6%), while girls were 108 (18.4%). The prevalence of central obesity (WSR > 0.5) was found at all ages, and in both sexes, with the highest prevalence rate observed at age 13 in both sexes. When the data were analysed according to race, a general tendency toward higher WSR was found among Black and White girls who are judged to be at greater risk than boys (Figure-1).

DISCUSSION

The findings of the study indicated that girls had significantly higher WSR mean values than boys. Similar findings were reported among Nigerian[7] and Australian[8] children. In contrast,[9-11] reported that boys had significantly higher WSR compared to girls. In Sung et al's[12] study among Hong Kong Chinese children aged 6-18 years, WSR was slightly larger in boys

Table-II: Waist-to-stature ratio of South African children according to age groups.

			Waist-to-stature ratio				
Age (years)	*Boys*	*Girls*	*Boys(Mean ± SD)*	*95% CI*	*Girls(Mean ± SD)*	*95% CI*	*p*
9	64	131	0.41 ± 0.1	0.37-0.42	0.43 ± 0.1	0.39-0.45	0.001*
10	113	138	0.43 ± 0.1	0.42-0.44	0.42 ± 0.1	0.40-0.43	0.115
11	88	72	0.42 ± 0.03	0.41-0.43	0.43 ± 0.1	0.42-0.44	0.046*
12	135	146	0.41 ± 0.04	0.41-0.42	0.44 ± 0.1	0.43-0.44	0.001*
13	148	101	0.43 ± 0.1	0.42-0.44	0.42 ± 0.04	0.41-0.43	0.501

*Statistically significant (p < 0.05); CI = Confidence Interval.

than girls and in both sexes it decreased with age but only up to age 14 years. However, Meininger et al[13] found no significant difference between males and females in the prevalence of WSR > 0.5. Again, consistent with,[7,14] the present study indicated that WSR during childhood is affected by age and gender. The variations in the mean WSR across ages of the studied sample may be a reflection of the divergence in the velocities of growth in stature and waist circumference with age. The correlation between stature and waist circumference (Figure-2) might possibly suggest that the increase in WC in childhood is partly due to linear growth. Precisely how growth in stature affects growth in WC is unknown, but this should be considered when age-related variations in WC are examined.[7] The WSR differences observable among both sexes at all ages reflects gender differences in body shape and proportions. This may likely be mediated by gender differences, physical activity and diet during childhood growth. An examination of the physical activity and dietary intake of the children in this present study showed marked differences in these variables. As regards physical activity participation, girls' engaged in less physical activity than boys. Data concerning the dietary intake of the sample demonstrated that the three component scores explained 89.0% and 98.0 of the total variance in boys and girls, respectively (data not shown).

This study showed that the proportion of children with a WSR > 0.5 exist in both sexes and at all age groups. The proportionality is highly statistically significant indicating that WSR > 0.5 was higher in girls (18.4%) compared to the boys (8.6%). Similarly, among 1-20 year-old black South African rural children, 10% of adolescents were reported to have WSR > 0.5, with significantly higher proportion of girls (15.0%) than boys (3.0%).[15] In a study involving black South African adolescents, girls (3.5%) had WSR > 0.5, whereas none of the boys did.[16] The figures of WSR > 0.5 found in this present study mimic those reported by Goon et al[7] for Nigerian children aged 9-12 years. In Goon et al's study, girls also had higher WSR> 0.5 (17.7%) than boys (9.9%). However, the figure of 44.2% (WSR >0.5) reported in Meininger et al's[13] study is exceptionally high, and children with a WSR > 0.5 were more likely to have high systolic blood pressure and/or diastolic blood pressure (odd ratio OR = 2.8. 95% CI = 1.8-4.4). The findings pertaining to WSR in this study which points to the fact that WSR > 0.5 (13.6%) was found even among the youngest in our sample is a cause for concern since obesity-related problems are likely to be present among the children. This indicates the need for interventions to reduce total or central obesity among children and intensive community-based efforts childhood obesity.

Based on age and gender comparisons, the results showed that black and white girls had more proportion of WSR and were judged to be at greater risk (WSR > 0.5) than boys. This could be attributed to the low physical activity participation level and greater intake of food with high saturated fat among the Blacks children, especially girls. This observation is evident in the data on physical activity participation and dietary food intake of the sample (data not shown).

It should be noted that assessment of fat patterning in children can be done through several methods. Ideally, to estimate visceral adipose tissue independent of total body fat, criterion measures such as computed tomography (CT) and dual energy x-ray absortiometry (DXA) would be employed. However, the use of such "gold standard" methods, has limited applicability in large surveillance samples especially largely because it is not readily unavailable and time-consuming. In its place, measurements of anthropometry (stature, body mass and circumferences) were taken to determine BMI and central fat pattern in our sample. Such measurements require portable equipment and can be carried out in remote rural areas. The use of this method has been validated.[17] Although these anthropometric measures can introduce random measurement errors, which would not confound the observed results.

It should be noted too, that data were not collected

Table-III: Percentage of children with a WSR at 0.5 or above cut-off point

		WSR >0.5
Age (years)	*n*	*%*
Boys		
9 5	6.31	
10	9	7.2
11	6	9.6
12	10	11.0
13	17	15.1
Total	47	8.6
Girls		
9 14	14.2	
10	20	14.5
11	11	15.3
12	31	21.2
13	32	23.0
Total	108	18.4
Boys/ Girls	155	13.6

n = number of sample; % = percentage;
WSR = waist-to-stature ratio.

on birth weight, breastfeeding, history or parental weight status, and other relevant precursors of childhood obesity[18,19] that might be helpful in further understanding the genesis of racial differences observed in the present study.

Another limitation of the study was that only schoolchildren (Black and White) were studied. Therefore, the results of the present study do not necessarily apply to all South African children. These limitations should be considered when interpreting the findings of this study.

CONCLUSIONS

The prevalence of WSR > 0.5 was evident among the South African children at all ages, suggesting the existence of central body fatness in the children. The caveat is that our sample is susceptible to future health risks. Additionally, the use of a simple anthropometric parameter such as WSR can be utilised to evaluate the metabolic and cardiovascular risks among South African children.

ACKNOWLEDGEMENTS

The authors are grateful to the research assistants, participants, their parents and Principals of the 15 schools which participated in the study. Tshwane University of Technology funded the study.

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