RESEARCH PAPER

Growth Pattern of Schoolchildren in Sagamu, Nigeria Using the CDC Standards and 2007 WHO Standards

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Objective: To compare the median weight, height and body mass index of school children with the 2000 CDC and 2007 WHO reference values.

Settings: Schoolchildren in Sagamu, Nigeria.

Design: Cross-sectional survey.

Methods: Between November and December, 2008, 1690 school children aged 6 to 16 years from 8 primary schools were surveyed using multi-stage sampling methods. The weight, height and body mass index (BMI) were recorded for each child. The *Z*-scores of the median anthropometric parameters for each age and sex were determined with the LMS statistical method using the values of L, M and S provided on the CDC and WHO charts.

Results: The weight, height and BMI Z-scores were less than the reference values provided on the CDC and WHO charts but were generally closer to the WHO standards compared to the CDC standards. The median weight, height and BMI for females generally plotted higher on CDC and WHO chart compared to the males. The prevalence of underweight and stunting were relatively lower while the prevalence of overweight and obesity was relatively higher among children aged 6 to 10 years using the WHO references compared to the CDC reference values.

Conclusions: The WHO references would under-diagnose under-nutrition and over-diagnose overweight/ obesity in the population studied.

Key words: *Growth pattern, Growth standards, Children, Nigeria, School-age.*

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Growth pattern of children and adolescents in Sagamu, Southwest Nigeria has not been studied in the recent past. Growth parameters of children are usually interpreted in relation to international standards like the NCHS and CDC Growth Charts of 1977 and 2000, respectively. In 2007, the World Health Organisation published a new set of growth charts believed to be applicable to children reared healthily in all parts of the globe. These standards were derived from prospectively collected data from exclusively breastfed children of non-smoking mothers from the developed and developing parts of the world.

The population of children studied in Sagamu were reared by non-smoking mothers and the exclusive breastfeeding rate for the first 3 to 6 months of life ranged from 26% to 58% (Personal communication). Therefore, this population of school children was fairly comparable to the international reference populations from which CDC [1,2] and WHO standards [3] were derived.

The objective of the study was to determine the age and sex specific mean and median values of weight, height and body mass index of children aged 6 to 16 years in Sagamu, Nigeria and compare with the 2000 CDC standard values and the 2007 WHO standard values.

METHODS

This cross-sectional survey was carried out in Sagamu Local Government Area of Ogun State, Southwest Nigeria between November and December 2008. The local government area is made

up of 15 political wards with the headquarters in Sagamu township. There were 167 public and private primary schools in Sagamu Local Government Area with total school enrolment of 26, 547 children as at 2007.

The sample size was determined using the prevalence of underweight in a Nigerian population similar to the one under study [4], and was calculated to be 364 but 1,690 were studied to allow for precision. No attrition was recorded as all the recruited pupils participated in the study. Multi-stage sampling technique was adopted for the survey. In the first stage of the sampling, 8 geo-political wards (equivalent of districts) were randomly selected from the existing 15 wards (by balloting). In the second stage, one primary school was randomly selected from the schools in each of the selected wards (8 out of a total of 78 primary schools). In the third stage, all the children aged 6 to 16 years in each of the elected schools were identified and their total numbers in each school was determined. Thereafter, proportionate method was used to determine the number required to be sampled from each school using simple ratios in order to arrive at the targeted sample size of 1,690. Ethical approval was obtained from the Ethics and Scientific Review Committee of the Olabisi Onabanjo University Teaching Hospital, Sagamu and permissions were obtained from the relevant Education Authorities in the Local Government Area. Assent was obtained from the parents of the selected children.

The subjects were apparently healthy school-children and adolescents, aged 6 to 16 years who were randomly selected proportionately from the selected schools. Those with physical deformities and chronic debilitating diseases were excluded. Age to the nearest year was obtained from the school records. Weight was recorded using a portable spring balance weighing scale (Camry, England), calibrated in 0.5 kg and was standardized daily with known weights. The height was measured with a steel tape measure calibrated in metres and to the nearest centimetre using recommended proce-dures [5]. Inter-observer variability was minimized by ensuring zero-correction before every measure-ment, not more than one person measured either weight or height in a particular population and teachers in the schools served as independent observers to verify measurements occasionally.

The mean and median weight, height and BMI (wt in kg/height in m^2) were calculated for each age and sex. The median weight, height and BMI were standardized by converting them to Z-scores (SD) using the LMS method [6] . This was done with the age and sex specific values of LMS for weight, height and body mass index as provided in the 2000 CDC Growth Charts and the 2007 WHO Growth Charts. Z-scores were used to compare data against known reference values to facilitate interpretability by showing how distant from a reference point is a measured parameter. Both growth charts provided references for height and BMI for the ages under study (6 to 16 years). While the CDC charts provided weight standards for children aged 6 to 16 years, the WHO charts only provided weight standards for ages 5 to 10 years [7] . Therefore, weight assessment was only done for children aged 6 to 10 years to allow for uniformity in the comparison with both CDC and WHO standards.

Using the Z-scores derived from the CDC and WHO standards, the nutritional status of the subjects (in terms of underweight and stunting) were determined and the prevalence of each form of malnutrition were compared. Underweight was defined as weight-for-age less than -2SD for age and sex while stunting was defined as height-for-age less than -2SD for age and sex [8]. In addition, overweight was defined as BMI Z-score greater than +1 SD while obesity was defined as BMI Z-score greater than +2SD(7). Wasting was not assessed because the WHO charts provided no data for weight-for-height standards which could be used to diagnose wasting unlike the CDC charts.

The data were analyzed using the SPSS 15.0 statistical software. Mean values were compared using the Student's *t*-test and *P* values less than 0.05 defined statistical significance.

RESULTS

A total of 1,690 school children were studied, comprising of 819 (48.5%) males and 871 (51.5%) females. Overall, the males had significantly lower mean weight compared to females (25.3 kg *vs* 26.5

kg; P = 0.002) and lower BMI compared to the females (14.7kg/m^2 *vs* 15.0kg/m^2; P = 0.007). The overall mean heights of the males and females were similar (130 cm *vs* 131cm; P = 0.06).

As shown in ***Table* I**, the weight *Z*-scores were closest to the mean for male and female at age 6 years on both CDC and WHO charts. With increasing age, the difference between the weight *Z*-scores on the two reference charts got closer for females but wider for males.

Median height Z-scores for both sexes were below the mean on the CDC and WHO reference values (***Table* II**). The median height Z-scores for males were closest to the CDC and WHO reference values at age 6 years and progressively declined from age 8 years, but the pattern was not consistent for females. The distance of the height Z-scores below the reference values on both the CDC and WHO charts was most pronounced between ages 12 and 16 years for males. In addition, the median heights for females were generally closer to the CDC and WHO reference values compared to the males' median values. The height Z-scores for males on the WHO charts were higher than on the CDC charts between ages 7 and 11 years. On the other hand, the pattern for females showed greater inconsistencies in trend.

The median BMI Z-scores for both sexes were below the reference values on both CDC and WHO charts but showed no generally consistent pattern (***Table* III**). For the males, the BMI Z-scores were most distant from the mean values on both CDC and

TABLE I COMPARISON OF MEDIAN WEIGHT (KG) OF THE STUDY POPULATION WITH THE CDC AND WHO STANDARDS

Age (years)	Males			Females		
	Median	CDC*	WHO#	Median	CDC*	WHO#
6	18.5	-0.89	-0.79	18.0	-0.88	-0.78
7	20.0	-1.09	-1.01	19.0	-1.31	-1.10
8	21.0	-1.50	-1.40	21.0	-1.33	-1.14
9	22.0	-1.86	-1.74	22.0	-1.74	-1.59
10	24.5	-1.78	-1.60	25.0	-1.61	-1.51

**CDC Z-scores; #WHO Z-scores.*

TABLE II COMPARISON OF MEDIAN HEIGHT (CM) OF THE STUDY POPULATION WITH THE CDC AND WHO STANDARDS

Age (years)	Males			Females		
	Median	CDC*	WHO#	Median	CDC*	WHO#
6	113.0	-0.42	-0.49	110.0	-0.99	-1.00
7	115.5	-1.30	-1.27	116.5	-0.97	-0.78
8	122.0	-1.07	-0.93	121.0	-1.19	-0.95
9	127.0	-1.10	-0.95	127.0	-1.00	-0.89
10	131.0	-1.20	-1.06	132.0	-0.94	-1.11
11	135.5	-1.26	-1.20	135.0	-1.28	-1.50
12	137.0	-1.69	-1.70	140.5	-1.48	-1.56
13	141.0	-1.97	-2.02	145.0	-1.77	-1.64
14	146.0	-2.11	-2.17	151.0	-1.44	-1.26
15	148.0	-2.61	-2.69	153.5	-1.29	-1.19
16	154.0	-2.45	-2.43	154.0	-1.33	-1.25

**CDC Z-scores; #WHO Z-scores.*

WHO charts between 12 and 16 years of age. The pattern was similar for females except for a most pronounced reversal of the Z-scores towards the mean between 15 and 16 years of age. Generally, the Z-scores for females were higher than those of males.

***Table* IV** shows that for children aged 6 to 10 years, the prevalence of underweight and stunting were higher in both sexes when determined using the CDC standards compared to WHO standards. However, for children aged 11 to 16 years, there were no differences in the prevalence of stunting determined with either CDC or WHO standards. Further, the prevalence of overweight/obesity was lower in both sexes when determined with the CDC standards compared to the WHO standards from age 6 to 16 years.

DISCUSSION

The present study has shown that the age- and sex-specific median weight, height and body mass index of school children aged 6 to 16 years in Sagamu, Southwest Nigeria were less than the mean values on

TABLE III COMPARISON OF MEDIAN BODY MASS INDEX (KG/M^2) OF THE STUDY POPULATION WITH THE CDC AND WHO STANDARDS

Age (years)	Males			Females		
	Median	CDC*	WHO#	Median	CDC*	WHO#
6	14.4	-0.89	-0.72	14.1	-0.92	-0.81
7	14.3	-1.01	-0.92	14.2	-0.91	-0.79
8	14.3	-1.13	-1.08	14.1	-1.15	-1.01
9	14.1	-1.51	-1.44	14.2	-1.28	-1.16
10	14.3	-1.57	-1.49	14.5	-1.30	-1.22
11	14.7	-1.53	-1.46	14.9	-1.30	-1.28
12	14.9	-1.70	-1.63	15.0	-1.53	-1.58
13	14.7	-2.24	-2.19	15.8	-1.52	-1.64
14	15.4	-2.03	-2.06	15.8	-1.64	-1.78
15	15.8	-2.18	-2.15	18.1	-0.70	-0.84
16	16.1	-2.36	-2.27	19.4	-0.37	-0.48

**CDC Z-scores, #WHO Z-scores.*

TABLE IV PREVALENCE OF UNDERWEIGHT, STUNTING AND OVERWEIGHT/OBESITY AMONG SCHOOL CHILDREN IN SAGAMU, NIGERIA.

Age group	Males		Females	
6 – 10 years	CDC (*n* = 479)	WHO (*n* = 479)	CDC (*n* = 539)	WHO (*n* = 539)
Underweight	160 (33.4)	145 (30.2)	153 (28.4)	115 (21.3)
Stunting	85 (17.7)	81 (16.9)	86 (15.9)	63 (11.7)
Overweight*	9 (1.8)	18 (3.8)	16 (2.9)	18 (3.3)
11 – 16 years	*n* = 342	*n* = 342	*n* = 330	*n* = 330
Stunting	137 (40.0)	138 (40.4)	88 (26.7)	89 (26.9)
Overweight*	1 (0.29)	2 (0.58)	1 (0.3)	4 (1.2)

*Figures in parentheses indicate percentages; *Overweight and obesity.*

WHAT IS ALREADY KNOWN?

- Growth parameters of school children in most parts of the developing world plot below the references provided by the 2000 CDC Standards.

WHAT THIS STUDY ADDS?

- More children in Nigeria are likely to be regarded as overweight/obese and less are likely to be regarded as underweight and stunted using the WHO standards compared to the CDC standards.

the CDC and WHO charts but were generally closer to the WHO standards compared to the CDC standards.

Our observations are similar to findings in a previous Nigerian study in which school children in urban areas had remarkably lower mean weight and height compared with the NCHS reference population [9]. It also agreed with the findings for Pakistani [10] and Malawian children [11] who also had mean weight and height lower than the median values of NCHS references.

Overall, the observed differences in the Z-scores of the observed median weight, height and BMI on the CDC and WHO standards must necessarily be taken into consideration when interpreting anthropometric data using these standards. The observed differences in the growth parameters and nutritional status of the population studied using the CDC and WHO standards agreed with previous reports [12]. Therefore, the observed lower prevalence of underweight and stunting and higher prevalence of overweight/obesity in the 6 to 10 years group determined with the WHO standards were expected. Although, a similarly higher prevalence of overweight/obesity was also observed in the 11 to 16 years group using the WHO standards, it is unclear why there was no obvious difference in the prevalence of stunting as determined by either the CDC or WHO standards in the 11 to 16 years group. However, this observation implies that in the determination of nutritional status of school-age children, attention must be paid to specific age groups as well as the reference population applied in order to draw meaningful and comparable conclusions.

The observed higher Z-scores for females on both the CDC and WHO charts in addition to the higher prevalence of stunting among males in the 6 to 10 years and 11 to 16 years groups suggested a higher linear growth potential among females. This observation agreed with previous reports among pre-school children in ten Sub-Saharan African countries where increased prevalence of stunting among males was possibly attributed to low family socioeconomic status [13]. The details of socio-economic characteristics of the subjects were not included in the present study. Such sex differences in linear growth were previously reported from Bangladesh [14].

To conclude, the findings in this study imply that using the CDC standard, more children are likely to be regarded as abnormally short or underweight thus prompting unnecessary clinical evaluations and interventions in an under-resourced setting. On the other hand, many children with or at risk of overweight/obesity are likely to be missed using the CDC standards, thus delaying diagnosis, preventing appropriate interventions and allowing severe morbidities which are associated with overweight/obesity. The small study size is acknowledged as a limitation in this study and a larger multicentre study in southwest Nigeria is recommended. However, this study has brought to the fore, the need to comparatively evaluate the tools commonly used for growth assessment in children.

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