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Screening for body-weight disorders in Nigerian children using contrasting definitions

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Summary

Several indices for body-weight disorders exist in scientific literature, but it is inconclusive whether or not they can yield comparable results when applied to Nigerian children. The prevalence of weight disorders in Nigerian children was examined using the Centre for Disease Control and Prevention (CDC) body mass index (BMI) for age charts and the International Obesity Task Force's (IOTF) age- and sex-specific BMI cut-off points. Participants were 2015 pupils (979 boys and 1036 girls) aged 9–12 years, attending 19 public primary schools in Makurdi, Nigeria. Stature and body mass were measured using standard techniques. Results were analysed using student *t*-test and Chi-squared statistics, with the probability level set at ≤ 0.05. CDC's BMI charts categorized 2.1%, 1.6% (boys) and 3.2%, 2.8% (girls) as overweight and obese respectively. Corresponding data for the IOTF's BMI charts were 1.7%, 0.9% (boys) and 2.6%, 2.0% (girls). CDC cut-off points indicated higher prevalence of overweight and obesity, thus suggesting the need for a single definition for evaluating measurements of body mass-for-stature in the children. However, more disconcerting is the fact that CDC charts showed a high prevalence of underweight for the boys (87.1%) and girls (79.7%). Prevalent underweight conditions in our sample need urgent intervention. The IOTF method is limited in its utility to identify children who are underweight and may be at risk of growth faltering.

Keywords: Body mass index, CDC and IOTF charts, children.

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Introduction

Over-nutrition in terms of overweight and obesity are the most common problems found in paediatric population in nations with large numbers of middle and upper class families (1). However, in some developing countries under-nutrition can occur in isolation or can co-exist with obesity (International Diabetes Institute, World Health Organization (2,3)). While the increased worldwide prevalence of childhood obesity (4) is a threat to children's current and future health prospects, especially in western countries (5), underweight may prove to be more prevalent in under-developed and developing countries. Previous research has associated obesity with increased risk of hypertension, coronary heart disease and insulin resistance (6,7). In contrast, underweight can result in a delayed growth spurt, peak height velocity and puberty, including age at menarche (8). Both underweight and obesity can have significant and long-lasting effects on the health of children that can persist into adulthood (2,9,10).

Using data from pre-pubertal and early adolescent boys and girls, significant correlations have been reported between percentage body fat (%BF) and body mass index (BMI) (11,12). These findings support the use of BMI as a

screening tool for adiposity. However, there is evidence that BMI is a poor indicator of %BF for the individual child (13) and lacks the sensitivity for detecting change in fat mass in over-fat children and change in fat-free mass in lean children (14,15). Although BMI may seem an imperfect method to screen for overweight and obesity, as it does not distinguish overweight because of excess fat mass from overweight because of excess free mass, it is the most commonly used tool for assessing nutritional status to determine over-nutrition or under-nutrition in children (16). In this regard, BMI, also called the Quetelet's index, uses body mass relative to stature to screen for underweight, overweight and obesity in children in a clinical setting (16). Other methods of determining adiposity are more accurate (17), but have limited applicability when screening large sample sizes, especially in developing countries, largely because they are highly costly, unavailable and time-consuming. In this regard, body mass and stature are simple, inexpensive, non-invasive measurements that are recorded routinely in clinical and research settings. The BMI is commonly used to assess body mass status in children and adolescents as well as adults. However, whereas in adults the BMI cut-off points that define underweight, overweight and obesity are not linked to age and do not differ for male and female people, in growing children BMI varies with age and sex (18). Because of the variations in growth rates and wide range of body mass and stature considered normal using a specific cut-off point may identify a disproportionate number of tall and apparently overweight children, while short overweight children may not be detected. Thus producing a general BMI cut-off value for all ages and sexes in children seems problematic. For BMI to be meaningful in children it must be compared with a reference standard that accounts for age and sex differences. The American Centre for Disease Control/National Centre for Health Statistics (CDC/NCHS) (19) and British Child Growth Foundation (20) have developed population-based gender-specific percentile charts for BMI.

Specifically, a BMI above the 95th percentile is considered as a cut-off limit for obesity in children (21). Of the reference standards currently available, only that of the International Obesity Task Force (IOTF) provides a smooth transition from the child/adolescent to the adult definition of overweight and obesity (18). Using a worldwide representative sample of children, IOTF defines overweight as the centile of BMI-for-age that passes through a BMI of 25 kilograms per square metre (kg m^{-2}) at age 18 years, and obesity as the centile that passes through a BMI of 30 kg m^{-2} (22). Although several definitions of BMI cut-off values are used to diagnose underweight, overweight and obesity in adults, there is no consensus on a cut-off point for underweight, excessive fatness, overweight or obesity in children and adolescents.

Representative data for examining the prevalence of body-weight disorders and associated ailments in Nigerian children, especially those living in Makurdi are hardly available. In Makurdi, there seems to be improved economic conditions and availability of fast food products in recent times, but these are not affordable by many families. The availability of cyber cafes that tend to promote passivity in children and adolescents is also increasing remarkably. The relevant argument is whether or not such socio-cultural and economic transformation influences the growth and development of children from this region of the country. Given that body-weight disorders in children are precursors of disease in adulthood, epidemiological studies are needed to highlight the magnitude of the problem. These data underlie the necessity of early diagnosis and treatment in order to prevent the health complications of weight disorder in adulthood.

Therefore, this study was carried out to examine the prevalence of underweight, overweight and obesity in a cross-sectional sample of 9–12-year-old Nigerian children using two contrasting indices of body mass-for-stature. Specifically, the study assessed the incidence of overweight and obesity in the children using the CDC criteria of <5th percentile for age and sex and IOTF index in order to emphasize the differences that could arise when interpreting specific BMI data using different normative standards. It was hypothesized that CDC's age- and sex-specific BMI charts and IOTF cut-off index would not yield conflicting results in screening for body-weight disorders among Nigerian children.

Methodology

Sample

This cross-sectional sample involved 19 schools randomly selected from a total of 38 schools within Makurdi metropolitan town. Participating schools were randomly selected within the five geographical areas of Makurdi town (High-Level, Kanshio, North Bank, Wadata and Wurukum). Participants were also randomly selected by balloting technique. In all selected schools children within the ages 9 and 12 years were eligible to participate in the study and were measured. School records of birth were used to establish ages of participants in the study. Children with known health complications were excluded from the study. Out of 2139 participants, because of absenteeism and incomplete data of 124 participants, 2015 participants eventually completed the anthropometric measures in 2005. These measurements were collected from September to December by a team of eight trained research assistants. Written informed consent was obtained from the participants' parents or guardians and individual head teachers. Permission for the study was granted by the Benue State Universal

Basic Education Board, Makurdi, Nigeria. The study also received approval from the Ethics Committee of Tshwane University of Technology, South Africa.

Anthropometry

Stature and body mass were measured according to the protocol of the International Society for the Advancement of Kinanthropometry (ISAK) (22). Stature was measured to the nearest 0.1 centimetre (cm) in bare feet with participants standing upright against a mounted stadiometer. Body mass was measured to the nearest 0.1 kilogram (kg) with participants lightly dressed (underwear and T-shirt) using a portable digital scale (Tanita HD 309, Creative Health Products, MI, USA). BMI was used to indirectly assess adiposity and was estimated from body mass in kilograms stature^{-2} (kg m^{-2}).

Defining overweight, obesity and underweight

Two body mass-for-stature methods were used to screen for overweight and obesity among the Nigerian children in this study. First, age- and sex-specific BMI charts were used to establish the prevalence of overweight and obesity in this sample. These age- and sex-specific BMI charts were used to compare a child's BMI with the BMI distribution of a reference sample of children of similar age (23). Centile cut-off points were subsequently used to define the body mass-for-stature in the children. Second, in the absence of age- and sex-specific BMI reference charts for Nigerian children, this study used the CDC's BMI charts (24) to classify the children according to weight categories, i.e. underweight, overweight and obesity. Based on this, a BMI between the 85th and 95th percentile for age and sex was considered at risk of overweight, and a BMI at or above the 95th percentile was considered overweight or obese (25). Underweight was defined as a BMI lower than the 5th percentile for age and sex. The second method utilized was the IOTF age- and sex-specific BMI cut-off points for defining overweight and obesity in children between 2- and 18-year-olds. The cut-offs are linked to the widely accepted adult definitions for overweight and obesity, a BMI of ≥25 and 30 kg m^{-2}, respectively, at age 18 years (26). As the latter cut-off value is not amenable to interpretation based on centile categories, it was of interest in this study to compare the two definitions and determine the extent to which they can reliably estimate body-weight disorders in Nigerian children.

Statistical procedure

Means and standard deviations were calculated for body mass, stature and BMI across sex and age groups. Differences in the mean body mass, stature and BMI were evaluated for boys and girls according to age group, using an independent samples *t*-test. In order to compare differences in the prevalence of overweight and obese children using the two indices the rules of statistical inference to the proportion analysis was applied. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS), version 15.0 (SPSS, Chicago, IL, USA). The level of significance was set at $P \leq 0.05$.

Results

The anthropometric characteristics of the Nigerian children are indicated in Table 1. Overall, the mean values for body mass (boys: 29.8 ± 4.4 kg; girls: 31.5 ± 6.1 kg), stature (boys: 137.2 ± 7.7 cm; girls: 138.9 ± 8.1 cm) and BMI (boys: 15.7 ± 1.8 kg m^{-2}; girls: 15.7 ± 1.8 kg m^{-2}) were significantly higher in the girls compared with boys ($P \leq 0.05$). Although there was no significant sex difference in the mean values of body mass among the 9-year-olds ($P > 0.05$), substantial differences were noted in those aged 11–12 years old ($P \leq 0.0001$). The children in this study had mean stature ranging from 129.9 ± 5.3 cm to 142.1 ± 6.7 cm (boys) and 131.4 cm ± 5.8 to 145.4 cm ± 6.6 (girls). The girls were consistently taller than the boys in all age categories. Stature was found to increase with age regardless of sex.

Table 1 Physical characteristics according to sex and age groups

Age			Body mass (kg)			Stature (cm)			BMI (kg m^{-2})		
	Boys *n*	Girls *n*	Boys Mean (SD)	Girls Mean (SD)	*P*	Boys Mean (SD)	Girls Mean (SD)	*P*	Boys Mean (SD)	Girls Mean (SD)	*P*
9	192	213	26.1 (2.8)	26.3 (3.4)	0.4632	129.9 (5.3)	131.4 (5.8)	0.0007*	15.4 (1.3)	15.2 (1.6)	0.1503
10	279	303	28.9 (3.4)	29.7 (4.8)	0.0188*	135.0 (6.0)	136.1 (6.1)	0.0379*	15.8 (1.7)	16.0 (2.2)	0.2867
11	234	244	30.4 (4.0)	32.8 (4.4)	<0.0001*	139.8 (6.1)	141.7 (5.7)	0.0004*	15.6 (1.9)	16.3 (1.9)	0.0001*
12	274	276	32.3 (4.3)	35.9 (6.2)	<0.0001*	142.1 (6.7)	145.4 (6.6)	<0.0001*	16.0 (2.1)	16.9 (2.6)	0.0001*

*Statistically significant ($P \leq 0.05$).
BMI, body mass index; kg, kilograms; kg m^{-2}, kilograms per square metre.

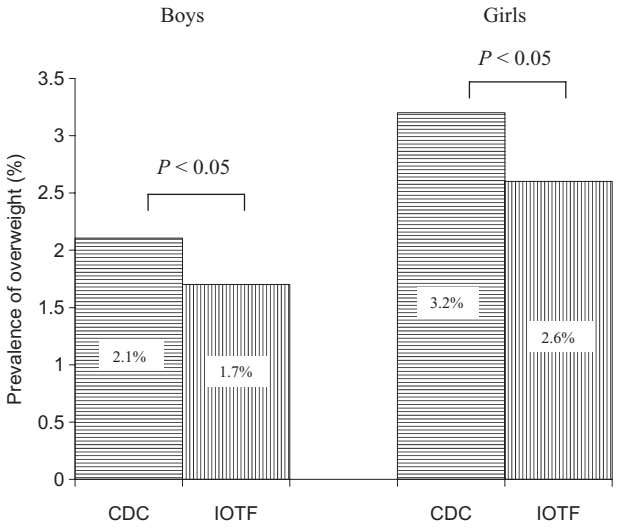

Figure 1 Prevalence of overweight in boys and girls using the Center for Disease Control and Prevention (CDC) and the International Obesity Task Force (IOTF) definitions.

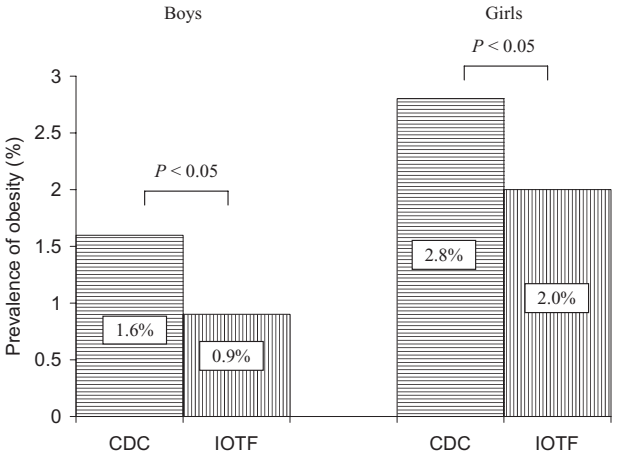

Figure 2 Prevalence of obesity in boys and girls using the Center for Disease Control and Prevention (CDC) and the International Obesity Task Force (IOTF) definitions.

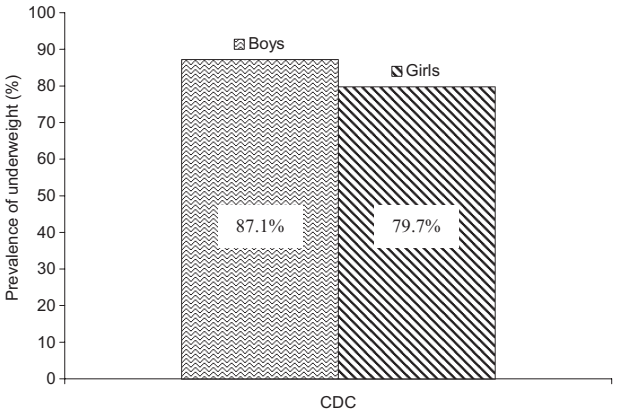

Figure 3 Prevalence of underweight in boys and girls using the Center for Disease Control and Prevention (CDC) definition (body mass index <5th percentile).

There was no significant sex difference in BMI at ages 9 and 10 years ($P > 0.05$). However, the mean difference was significant at ages 11 and 12 years, where girls exhibited significantly ($P \leq 0.0001$) higher mean BMI values compared with the boys. In this study, BMI increased linearly in girls, while in boys a contrasting downward trend in BMI was observed at ages 10–11 years, which again increased at 12 years of age (Table 1). The prevalence of overweight differed significantly between boys and girls using the definitions of the CDC and IOTF. While 2.1% and 1.7% of boys were found to be overweight according to the cut-off points of CDC and IOTF, respectively, corresponding data for overweight girls were 3.2% and 2.6% (Fig. 1). Among the boys the CDC-based estimate indicated that 1.6% were obese, whereas only 0.9% of them were so classified when the IOTF cut-off point was applied, thus yielding a significant difference ($P \leq 0.05$). In girls, the prevalence of obesity using the CDC definitions was 2.8%, which was also substantially greater than that obtained using the IOTF definition (2.0%) ($P \leq 0.05$) (Fig. 2).

When the CDC cut-off point of <5th percentile was used to define underweight, results showed that the boys (87.1%) were substantially more underweight than the girls (79.7%) ($P \leq 0.05$) (Fig. 3).

Discussion

The results of our study provide information on the prevalence of underweight, overweight and obesity in a group of preadolescent school children in Makurdi, Nigeria. The study of body-weight disorder using the CDC and IOTF BMI-based methods is of prospective interest from a theoretical standpoint. Additionally, using these age- and sex-related BMI centiles for screening for body-weight disorders in the Nigerian children may present an opportunity to monitor an individual's degree of fatness or thinness thus having the practicality of being used as a simple tool for preventing health problems associated with body weight.

The strength of the study was the large sample used to screen the children for overweight. Large sample sizes could yield significant findings that suggest that use of different diagnostic criteria to estimate the prevalence of weight disorder can lead to extremely contrasting results. The findings of the study showed that there were significant gender differences in the CDC- and IOTF-based estimates of overweight and obesity in Nigerian children. This reinforces the need to screen children for overweight and obesity using single definition. Our findings contradict

Table 2 International comparison of statistics on overweight and obesity with the present study

Country	Percentage prevalence of overweight		Percentage prevalence of obesity		References
	Boys	Girls	Boys	Girls	
Australia	13.0	12.0	–	–	(14)
Australia	27.0	27.0	11.0	12.0	(37)
Australia	14.0	5.2	16.5	5.8	(38)
East Poland	15.0	15.8	3.6	3.7	(39)
India (Punjab)	12.24	14.31	5.92	6.27	(40)
Irish	14.9	15.9	9.2	14.3	(41)
Mexico	22.3	23.6	28.0	21.2	(42)
Spain	12.0	5.0	8.0	2.0	(43)
Thailand	–	10.7	–	7.7	(44)
The Netherlands	23.4	5.2	30.2	7.2	(45)
United Arab Emirates	16.4	22.8	6.1	7.8	(46)
United Arab Emirates	19.2	13.1	19.8	12.4	(47)
USA (Kansas)	20.0	22.0	22.0	23.0	(48)
Nigeria	2.1	3.2	1.6	2.8	Present study*

*Center for Disease Control and Prevention (CDC) definition.
–, Data not available.

those of Vidal *et al.* (27), which did not show significant gender differences using both indices. Likewise, the same trend was noted in the estimated prevalence of obesity using the two definitions, in boys and girls. However, the CDC cut-off point gave the highest prevalence rates in both overweight and obesity. Consistent with other reports that compared estimates of overweight and obesity in school children with the CDC and IOTF references (27,28), our study revealed that the IOTF showed a more conservative estimate of obesity compared with the CDC's index. Additionally, the study of Kain *et al.* (29) on 6-year-old Chilean children reported that the overall prevalence of obesity to be halved when using the IOTF cut-off point compared with the CDC's reference standard.

It should be noted, however, that the very low estimates of overweight and obesity found in this study using IOTF method may underestimate the data (29) thus hindering early diagnosis and possible prevention as well as masking the problem until it has reached a significant level. The IOTF method is further limited in the fact that it has no criteria for identifying children who are underweight and may be at risk of growth faltering (30). Additionally, other studies (31,32) found a lower sensitivity and specificity when using the IOTF cut-offs for defining overweight and obesity. As such, the use of the CDC definition to screen for body mass status may seem an appropriate option. According to Vidal *et al.* (27), the CDC charts are better able to allow an early identification of a larger number of subjects affected by body mass problems, thus reducing the risk of metabolic complications associated with excessive weight gain. They further maintained that using CDC methods warrant treatment of overweight children at earlier age. It is recommended that the IOTF cut-offs when used should be combined with other indices in order to facilitate meaningful comparisons (30).

The results of this study are in contrast with those from several European and industrialized countries and/or countries in which the economic transition is in an advanced stage. The prevalence of overweight and obesity in our sample appears to be relatively low as compared with those reported in the literature (Table 2).

A possible explanation of the very low prevalence of overweight and obesity and high prevalence of underweight in the school children in Makurdi, Nigeria, could be that unlike in most Western countries, the children have limited access to high-calorie snacks and fast food that are hardly affordable. Another plausible explanation is that the Nigerian children may have been engaged in more physically demanding activities compared with their contemporaries in developed countries. Majority of the children walk to school daily regardless of the distance, and this may have enhanced their physical activity levels. Recent studies have reported higher levels of physical activity in children associated with active travel to school (33,34).

BMI-for-age however might not necessarily be appropriate in suggesting that so many of the children in this study are largely free from overweight or obesity. The BMI values may actually be misleading because of the body proportions of these children. Because BMI is derived from mass divided by height squared and it might not accurately reflect risk of underweight individuals who are shorter and stockier. The present study revealed a high prevalence of underweight in Nigerian children, a finding that indicates a possibility that the school children were at risk of under-nutrition.

Although no empirical data exist on nutritional intake and food practices in the semi-urban town of Makurdi, the level of poverty and ignorance of the children's parents could significantly impact their nutritional intake. Most children from public primary schools in this area seem to be from low socioeconomic backgrounds and therefore may not eat a balanced diet daily. Many of the children do not take breakfast before going to school and are not guaranteed three square meals. While the above explanation is anecdotal, it should not be ignored as a possible explanation of nutritional intake among the children. A potential limitation of the study is that BMI is only a surrogate measure of body composition, with an inability to differentiate between fat-free mass and the adipose tissue.

Perhaps another pertinent issue concerns the definition of appropriate cut-off points for evaluating abnormalities in body weight. The cut-off points for CDC and IOTF used to screen body-weight disorders in this study were derived based on an arbitrarily set BMI value, which reflect changes in BMI that occur with age in the boys and girls. Although BMI has become a very common way of estimating overweight/obesity, it does not indicate variations in fat and fat-free mass. It is clear that BMI cannot give an accurate value or estimate of an individual's percentage fat mass, which is the morbid factor of obesity. However, recently it has been indicated that overweight/obesity measured by BMI during childhood is a strong predictor of obesity and coronary heart disease risk factors in young adulthood (35), which emphasizes the importance of our data from a preventive point of view.

Conclusion

In comparison with previous published reports, this study documents a considerably higher level of underweight in Nigerian school children. The study also revealed that there is low prevalence of overweight and obesity in either categories of Nigerian boys and girls. The high prevalence of underweight found in this study has implications for the children's growth and development. The determination of and correction for community and household factors such as nutritional and socioeconomic status of the children should be investigated to ascertain the extent to which these factors are linked with under-nutrition. Future studies examining physical activity levels as well as the environmental conditions that affect body composition and health of the children are needed to elucidate factors associated with the prevalence of underweight, overweight and obesity in this population. Based on the premise that body size is influenced by economic, environmental, genetic and nutritional factors, having growth standards that are nationally representative is an essential consideration (36). However, there is no national reference standard for assessing obesity and weight disorders in Nigerian children. Such data are fundamentally important from public health perspective as they would provide reliable bases for instituting appropriate strategies to identify and combat factors associated with body-weight disorders in children. It will also be important in future studies to define obesity or underweight based on population-specific percentiles rather than using cut-off points derived from other geographical settings with contrasting levels of socioeconomic development.

Conflict of Interest Statement

No conflict of interest was declared.

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