

ORIGINAL ARTICLE

# Body mass index among school adolescents in Sokoto, North-Western Nigeria

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## ABSTRACT

**Background:** Reports have shown significant increase in the prevalence of obesity in developing countries. There are limited representative data available from African countries on the trends in childhood obesity, because most public health- and nutrition-related efforts have been focused on under-nutrition. **Aims:** To determine the prevalence of overweight and obesity using body mass index (BMI) among school adolescents. **Design:** A cross sectional study involving apparently healthy school students in Sokoto. **Materials and Methods:** Participating schools and students were selected by a multi-stage random sampling. Anthropometric measurements were done and body mass index derived from the ratio of weight per height squared. Subjects with age and sex-adjusted BMIs of 85<sup>th</sup> to <95<sup>th</sup> and  $\geq 95^{\text{th}}$  percentiles of the International Obesity Task Force were defined as overweight and obese, respectively. **Statistical Analysis:** Data were analyzed using SPSS version 17.0 software. GraphPad InStat version 3.05 was also used to analyze some variables. Results were expressed as means with standard deviations. *P*-values <5% were considered significant. **Results:** The mean BMI of the male subjects was  $18.3 \pm 2.7 \text{ kg/m}^2$ , and  $19.3 \pm 3.1 \text{ kg/m}^2$  for the females. The prevalence of overweight was 3.3%, and that of obesity was 1.4%. **Conclusions:** The prevalence of overweight and obesity appear to be low in the study area, especially when compared to some recent studies in Africa.

**Key words:** Adolescent, body mass index, obesity, overweight

## INTRODUCTION

While obesity is one of the most common nutritional disorders in the developed countries, micronutrient deficiencies and protein-calorie malnutrition are the leading causes of malnutrition in most developing countries, particularly Africa.<sup>[1]</sup> However, some reviews have reported significant increase in the prevalence of overweight (OW) and obese (OB) individuals in developing countries.<sup>[2,3]</sup> Ten percent of the world's school-aged children are estimated to have excess body fat, a quarter of which is obese.<sup>[4]</sup> As many as 250 million people are said to be obese.<sup>[5]</sup> Obesity has significant impact on both physical and psychological health, hence it is no longer considered benign.<sup>[6,7]</sup>

The prevalence of obesity in Nigerian children has not been fully documented,<sup>[8,9]</sup> and most public health- and nutrition-related efforts have been focused on under nutrition.<sup>[4]</sup> However, it is documented that most countries in Asia, Latin America, North Africa, and the Middle East have experienced a shift in the overall structure of its dietary and disease patterns over the last few decades.<sup>[10]</sup> Therefore, this study aimed to determine the prevalence of overweight and obesity, using body mass index (BMI) among school adolescents.

## MATERIALS AND METHODS

This study was cross sectional; conducted in March, 2010. Three hundred and sixty apparently healthy students aged 10-18 years, drawn from the secondary schools within Sokoto metropolis (state capital) were enrolled. This sample size was based on the highest reported prevalence for obesity (18%) among Nigerian children and adolescents.<sup>[11]</sup> Equal numbers of subjects were drawn from public and private schools, with a male to female ratio of 1:1.

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### Sampling method

Participating schools and students were selected by a multi-stage random sampling. There were 32 secondary schools within the metropolis (21 public and 11 private) with a total of 42,135 enrolled students. The schools were stratified into private and public groups based on the three local government areas (LGAs) within the Sokoto metropolis. A total of six secondary schools were selected for the study, two (one public and one private) from each of the three LGAs within the metropolis. For each group (public or private) in an LGA, the names of the schools were written on pieces of paper which were folded and mixed up. One school was picked at random, from each of the two groups and was subsequently enrolled. At the school level, 60 students were selected per school (10 at each class level) by systematic random sampling.

### Ethical approval

Approval for the study was obtained from the Ethical Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Ministry of Education Sokoto State and the School authorities concerned. Written informed consent was obtained from parents/guardians of the participants, and verbal consent from the students.

### Measurements

Anthropometric measurements of weight and height were taken. The height was measured (to the nearest 0.1cm) using stadiometer scale (Seca 213, UK), whereas, the weight was measured (to the nearest 0.01kg), with the subject lightly dressed in their school uniforms without shoes, stockings, caps, sweater or cardigan, and all pockets were emptied out. This was to maintain uniformity and respect the sensitivity of these adolescent students. Body mass index (BMI) was derived from the ratio of weight (kg) per height squared ( $m^2$ ) for each subject. Because there are no risk-based fixed BMI values to determine overweight in children, percentile values are commonly used.<sup>[12]</sup> Therefore, the International Obesity Task Force (IOTF) BMI cut off values<sup>[13]</sup> were used. Subjects with age and sex-adjusted BMI-z scores at 85<sup>th</sup> to <95<sup>th</sup> and  $\geq 95^{\text{th}}$  percentiles were defined as overweight and obese, respectively.

## RESULTS

Ninety-six (26.7%) of the subjects were aged 10 to 13 years (early adolescence), 174 (48.3%) were between 14 to 16 years (middle adolescence) and 90 (25%) were aged 17 to 18 years (late adolescence). The mean ages of the male and female subjects were 15 ( $\pm 2.5$ ) years and 14.8 ( $\pm 2.6$ ) years, respectively ( $X^2 = 0.8095$ ,  $df = 2$ ,

$P = 0.667$ ). Middle socioeconomic class students formed the predominant group in the study population (47.5%), with a fair distribution between the public and private schools. Only 24.2% of the studied subjects belonged to the upper SEC stratum, out of which 65 (74.7%) were from private schools. Seventy nine (77.5%) of the lower SEC students came from public schools. ( $X^2 = 52.986$ ;  $df = 2$ ;  $P < 0.0001$ ).

### Weight

The mean weight of the study subjects were  $46.4 \pm 11.5$ kg for males, and  $47.1 \pm 9.2$ kg for the females. In both gender, the mean weight generally increased with age as depicted in Figure 1. There was a noticeable reversal in the mean weight pattern between the males and females from age 16 years, when the males became heavier than their age-matched females as shown in Figure 1 ( $t = -0.817$ ;  $df = 180$ ;  $P = 0.415$ ).

### Height

The mean values were  $158.2 \pm 11.2$ cm for males, and  $155.7 \pm 6.5$ cm for the females. Mean height generally increased with increase in age and was initially higher in the females until age 14. From 15 years through 18, the males became taller than their age-matched female counterparts ( $t = 3.166$ ;  $df = 180$ ;  $P = 0.002$ ). None of the females had a height of up to 160cm as shown in Figure 2.

### Body mass index

The mean BMI values were  $18.3 \pm 2.7$ kg/ $m^2$  for the males, and  $19.3 \pm 3.1$ kg/ $m^2$  for the females. Mean BMI values ranged from 15.7 to 20.8kg/ $m^2$  in males and 15.4 to 21.7kg/ $m^2$  in females as shown in Table 1. Mean BMI generally increased with age in both gender, with females having higher mean BMI values compared to their age male counter parts.

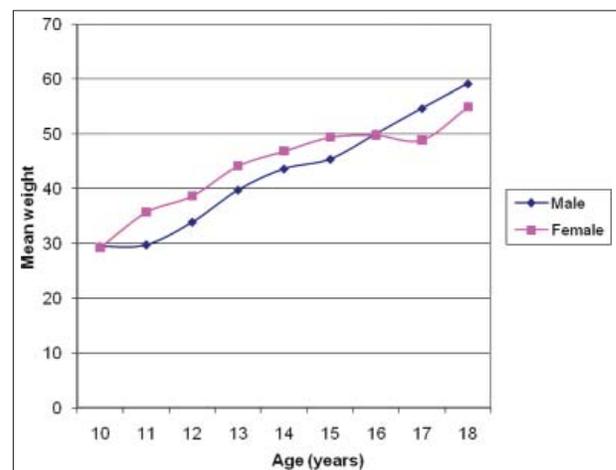


Figure 1: Comparison of the mean weight of male and female subjects

The mean BMI of the study subjects were generally lower, but comparable to that of the 50<sup>th</sup> percentile values of the CDC-2000 BMI charts as shown in Figure 3.

Table 2 shows analysis of variance for the weight, height and BMI in relation to age and gender. All the three parameters (body weight, height and BMI) varied significantly with age ( $P \leq 0.004$ ), but not with gender ( $P > 0.05$ ).

Only 17.6% of the overweight/obese subjects came from the upper SEC, 47.1% from the middle class while 35.3% were from the lower SEC as shown in Table 3 ( $X^2 = 6$ ,  $df = 6$ ,  $P = 0.423$ )

## DISCUSSION

The mean weight of the studied subjects increased with age in both males and females. The females were generally heavier than their age-matched male counterparts, though the difference was not statistically significant. This finding of females being heavier than males was

similar to that of Akesode and Ajibode,<sup>[14]</sup> among school children aged 6-19 years in Abeokuta, South-Western Nigeria. Female subjects were also initially noticed to be taller than the males up to the age of 14 years, with the difference being statistically significant. Thereafter, the males were taller. Similar pattern in mean height between the genders was reported by Ansa *et al.*<sup>[8]</sup> who also showed initial higher mean height values among their female subjects. By 15 years and beyond, the males in the latter study<sup>[8]</sup> demonstrated higher mean height values as compared to the females. This trend in height pattern could be as a result of pubertal growth spurt in the males around this age (14-15 years), which usually occur later in males than it does occur in the females. However, Owa and Adejuyigbe<sup>[11]</sup> did not demonstrate any difference in mean height values between the males and the females they studied, who were in the range of 5-15 years.

For the mean BMI, the values were consistently and significantly higher in the females, compared to those of

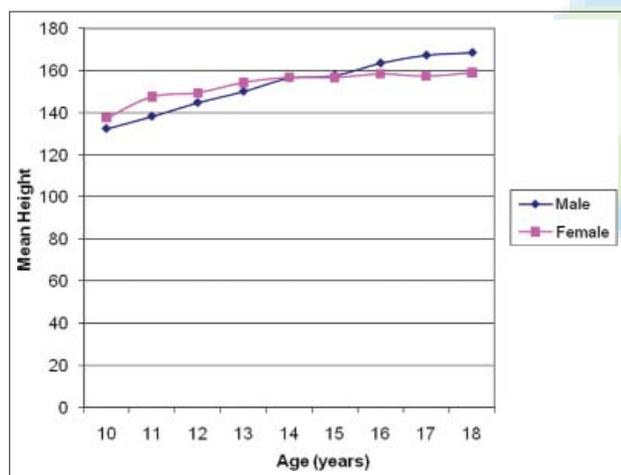


Figure 2: Mean height of males compared to that of the female subjects

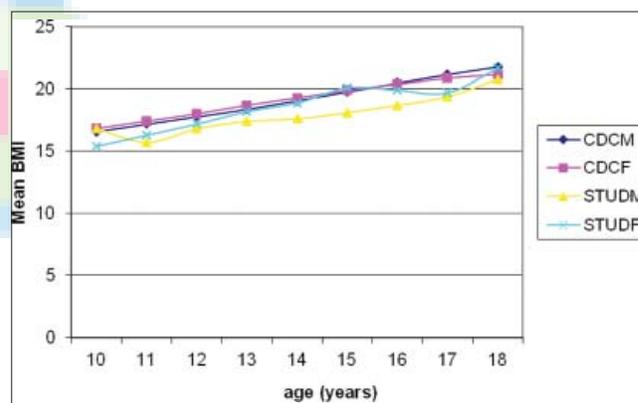


Figure 3: Comparison of the 50<sup>th</sup> percentile of the CDC-BMI curves<sup>[13]</sup> with the mean BMI of the study subjects. Key: CDC= Center for Disease Control; CDCM= CDC 50<sup>th</sup> percentile BMI for males; CDCF= CDC 50<sup>th</sup> percentile BMI for females; STUDM= mean BMI for males in present study; STUDF= mean BMI for females in present study.

Table 1: Mean Body Mass Index (BMI) ± SD according to age and gender

Age (year)	Males		Females		t	p
	n	BMI (kg/m <sup>2</sup> ) Mean (± SD)	n	BMI (kg/m <sup>2</sup> ) Mean (± SD)		
10	3	16.8 ± 0.70	2	15.4 ± 0.5557	3.333	0.186
11	5	15.66 ± 1.945	8	16.263 ± 3.3602	0.216	0.839
12	13	16.838 ± 2.7132	19	17.2 ± 2.4893	-0.363	0.723
13	28	17.439 ± 2.7478	18	18.206 ± 2.5899	-0.569	0.577
14	24	17.612 ± 1.8492	30	18.917 ± 2.2759	-1.767	0.091
15	24	18.062 ± 3.3801	31	20.081 ± 3.2983	-1.757	0.092
16	35	18.74 ± 2.572	30	19.85 ± 2.4717	-1.705	0.099
17	32	19.416 ± 2.1317	23	19.713 ± 2.4801	-1.099	0.284
18	16	20.806 ± 2.111	19	21.668 ± 4.2995	-0.292	0.774
Total	180	18.320 ± 2.7384	180	19.267 ± 3.1470	-3.448	0.001

BMI= body mass index; SD= standard deviation

**Table 2: Two-way analysis of variance (ANOVA) for the assessed parameters in relation to age and gender**

Parameter	F-value for age	F-value for gender	P-value for age	P-value for gender
Weight	19.66	0.90	<0.001	0.371
Height	8.07	0.01	0.004	0.926
BMI	13.73	4.47	0.001	0.067

**Table 3: Distribution of overweight/obese subjects according to type of school and socio-economic class**

Sec	Public schools	Private schools	Total (%)
Upper	0	3	3 (17.6)
Middle	3	5	8 (47.1)
Lower	4	2	6 (35.3)
Total	7	10	17 (100)

SEC= socioeconomic class

their male counterparts. This finding is similar to what was reported previously among Nigerian adolescents.<sup>[8,14,15]</sup> However, Cole *et al.*<sup>[16]</sup> showed BMI to increase faster in males after age 18 years. Because this study did not involve subjects above 18 years old, this fact could not be substantiated by our study. The mean BMI values in our study were generally lower but comparable to those of the 50<sup>th</sup> percentile values from the CDC-2000 BMI charts.

When the BMI for the age were converted to z-scores, the BMI for age z-scores generally increased with the age in both gender. This means that the subjects tend to increase in weight relative to a standard (SD/z score) over time. This connotes more tendencies for obesity with age amongst this adolescent group. This finding is consistent with that of Kimani-Murage *et al.*,<sup>[17]</sup> among adolescents in rural South Africa.

The BMI-based prevalence rate for obesity in this study is within the range reported by Janssen *et al.*,<sup>[18]</sup> among school-aged children aged 10-16 years, from 34 countries in Europe (2000-2002). This study<sup>[18]</sup> found large variations in the prevalence figures for obesity (ranging from 0.4 to 7.9%) using BMI as diagnostic criteria.

The gender-specific prevalence of obesity in this study is comparable between the males and females. However, for the gender-specific prevalence for overweight, the prevalence rate was found to be more in the females. This female preponderance in overweight/obesity is in conformity with the other earlier Nigerian studies by Ansa *et al.*,<sup>[8]</sup> Owa, and Adejuyigbe<sup>[11]</sup> as well as Akesode and Ajibode.<sup>[14]</sup> Furthermore, obesity studies in South Africa have all reported obesity to be more prevalent among South African female adolescents compared with

their male counterparts.<sup>[19-21]</sup> Similarly, Mokhtar *et al.*,<sup>[22]</sup> in North Africa stated that overweight increases with age and seemed to take hold in adolescence, particularly among the girls.

Highest frequencies of overweight/obesity in our female subjects were recorded among the age group 18 years, followed by those aged 15 and 16 years. This finding is consistent with that of Akesode *et al.*,<sup>[14]</sup> who demonstrated that highest frequencies of obesity and overweight in females occurred in age groups 18 and 17 years, respectively. However, the highest prevalence of obesity/overweight among male subjects in this study was found among the age groups 13 and

15 years. Fat gain has been shown to occur in both boys and girls early in adolescence, but it ceases and may even temporarily reverse in boys, while it continues throughout adolescence in girls.<sup>[4]</sup> The females lay down fat as a natural part of the ontogeny of their sexual and reproductive physiology, whereas the males gain proportionately more muscle mass rather than fat.<sup>[23-25]</sup> Since BMI is a screening tool, that does not measure adiposity directly,<sup>[12,26]</sup> additional clinical assessment is required to further ascertain the overall health of all children with high BMI-for age values.

Furthermore, assessment of body fat distribution by measurement of waist circumference, waist-to-hip ratio, or skin fold thickness at different sites (trunk skin folds relative to the limb skin folds) are additional markers of the health risks associated with overweight and obesity.<sup>[27]</sup> Truncal obesity is considered to be more dangerous because the adipose tissues in this area are more lipolytic, thus, they generate more free fatty acids when metabolized with resultant increase in the generation of oxidant stress molecules.<sup>[28]</sup> However, this aspect of body fat distribution is outside the scope of our study. There is therefore the need for further studies on this important aspect of obesity, which like the BMI, can be readily determined even in resource poor settings.

When both obesity and overweight were combined in terms of socioeconomic classification of the subjects, only 17.6% of the overweight/obese subjects belonged to the upper SEC, 47.1% belonged to the middle

socioeconomic class, whereas, the remaining 35.3% came from the lower SEC. However, this distribution was not statistically significant. Majority of these overweight/obese subjects (59%) came from private schools. Therefore, our finding did not favor the higher SEC as a significant risk factor for overweight and obesity as reported by other studies.<sup>[11,17]</sup> The negative association between lower SEC and obesity may be related to lack of awareness of the problems of obesity as well as excessive eating of cheaper, high calorie diet by the lower SEC groups, who are usually poorer and less informed section of the community.

## CONCLUSION

The prevalence of overweight and obesity appear to be low in the study area, especially when compared to some recent studies in Africa. However, there is the need to monitor the trends in the African sub region where under nutrition is still a problem, so that early detection and prompt measures are taken to prevent its multi-systemic complications.

## Recommendation

National surveys on childhood obesity are required in order to establish an overall prevalence rate for overweight and obesity among the Nigerian children and adolescents.

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