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BODY MASS INDEX VARIATIONS AMONG ADOLESCENTS FROM KANO METROPOLIS, NIGERIA

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ABSTRACT
Bodyweight and height measurements were carried out on 2, 100 healthy teenagers (1050 males and 1050 females) randomly selected in Kano metropolis. These measurements were used to calculate Body Mass Index (BMI) according to the formula weight (kg)/height^2 (m). Mean BMI values increased with age in the subjects irrespective of sex. However, female subjects had higher mean BMI values than their male counterparts in all the age groups. Mean BMI values ranged from 17.0 to 20.9 in males and from 18.0 to 24.0 in females. These BMI ranges of values were used as the basis for classification of the subjects as underweight, normal and overweight.

Key words: adolescence, body mass index, anthropometric assessment, nutritional status

INTRODUCTION

Adolescence is a significant period of human growth and maturation. Unique changes occur during this period and adult patterns are established. Adolescence is a period of increased nutritional requirements.

Adolescent anthropometry is important because it allows the monitoring and evaluation of the hormone – mediated changes in growth and maturation. It also provides indicators of nutritional status and health risk and may be diagnostic of obesity (WHO, 1976). Adolescent anthropometry varies significantly worldwide (Eveleth and Tanner, 1990).

Body mass index (BMI) is a numerical index which is calculated by dividing weight (Kg) by the square of height (m). BMI is used with age – independent cut – off to define overweight or thinness in adults. In adolescence, BMI values are reported for each age group. Thus, BMI for age serves as the best anthropometric indicator for use in adolescence, it incorporates the required information on age, it has been validated as an indicator of total body fat in the upper percentiles (Himes and Bouchard, 1989), and it provides continuity with recommended adult indicators (Bauer and Maffeis, 2002).

BMI ranges of values have been used to classify underweight, normal and overweight adults (Must *et al.,* 1991a). The BMI range classification is as follows:- BMI <16.00 (grade – 3 – underweight), BMI: 16.00 – 16.99 (grade – 2 – underweight), BMI: 17.00 – 18.49 (grade – 1 – underweight), BMI: 18.50 – 24.99 (normal), BMI: 25.00 – 29.99 (grade – 1- overweight), BMI: 30.00 – 39.99 (grade – 2 – overweight) and BMI $\geq$ 40.0 (grade – 3 – overweight). However, no similar classification exists for the adolescence period (Lin *et al,* 2002).

Thinness or low BMI – for – age has < 5th percentile and individuals at risk of overweight have $\geq$ 85th percentile with reference to international standards (Must *et al.,* 1991a; Must *et al.,* 1991b). Reference anthropometric data for adolescents in the locality is scanty (Atiku *et al.,* 1997). Therefore, this work attempts to establish a reference data for classifying adolescents as underweight, normal and overweight for the local population.

MATERIALS AND METHODS

Body weight (Kg) and height (m) measurements were carried out on 2,100 apparently healthy subjects aged 13 – 19 years (1050 males and 1050 females) randomly selected in Kano metropolis. The BMI was calculated from the formula: weight (kg) / height^2 (m). The height of each subject was measured to the nearest 0.1cm, with the aid of a heightometer. The heightometer contains a vertical board with an attached metric rule and a horizontal headboard that can be brought into contact with the uppermost point on the head. Heights and weights were measured when the subject was standing upright barefooted and wearing little clothing. Weight was taken with the aid of a Shermond model weighing scale to the nearest 100g.

Statistical Analysis

Student's 'test' was used to calculate the level of significance in mean BMI values for males and females in all the age groups.

RESULTS

Table 1 presents the BMI-for-age distribution according to age and sex. Mean BMI values increased with age in the subjects irrespective of sex. Amongst male subjects, mean BMI values differed significantly ($p<0.05$) from 13 years to 19 years, from 15 years to 19 years and 16 years to 19 years. Except for 15 years versus 16 years and 18 years versus 19 years, mean BMI values differed significantly ($p<0.05$) between the age groups amongst female subjects.

Interestingly, for all age groups, mean BMI values differed significantly ($p<0.05$) between males and females. Mean BMI values ranged from 17.0 to 20.9 in males and from 18.0 to 24.0 in females. These ranges of mean BMI values were used for BMI-range classification as shown in Tables 2 and 3. Table 2 presents the distribution of female subjects according to BMI – range classification. The distribution of subjects in grade – 3 – underweight category (BMI <15.5) decreases with increase in age from 13 years to 17 years. Subjects in the normal BMI range category BMI: 18.0 – 22.9) had the highest percentage distribution in all the age groups except the 13 years age group.

Male subjects in the grade – 3 – underweight category (BMI < 14.5) were distributed in the age groups of 13, 14, 15 and 16 years, while grade – 2 – underweight (BMI 14.5 – 15.9) and grade – 1 – underweight (BMI 16.0 – 16.9) had subjects in all the age groups studied (Table 3). Except for the 13 and 14 years age groups, between fifty and sixty percent of the male subjects fell in the normal BMI range (BMI 17.0 – 24.9) in the other age groups.

Table 1: BMI – for – age distribution in subjects according to age and sex in Kano metropolis (June – August, 2007)

	BMI (kg/m^2)	
AGE (YEARS)	**MALES**	**FEMALES**
13	17.0±2.48 (150)	18.0±3.11 (150)
14	17.6±1.39 (150)	18.3±2.11 (150)
15	17.9±3.37 (150)	19.1±3.05 (150)
16	18.6±3.75 (150)	19.6±2.93 (150)
17	20.4±3.01 (150)	21.6±3.37 (150)
18	20.7±3.73 (150)	23.6±2.14 (150)
19	20.9±1.45 (150)	24.0±5.00 (150)

Results are mean ± standard deviation, number in parentheses = number of subjects. Mean BMI values differ significantly ($p<0.05$) between males and females for all age groups.

Table 2: Percentage Distribution of Female Subjects According to BMI – Range Classification in Kano metropolis (June – August, 2007)

	Age (Yrs)						
BMI Range Class	**13**	**14**	**15**	**16**	**17**	**18**	**19**
<15.5 (Grade – 3 – underweight)	36.0	13.0	4.6	4.6	1.3	-	-
15.5 – 16.9 (Grade – 2 – underweight)	31.0	22.0	14.6	10.0	4.0	4.6	2.0
17.0 – 17.9 (Grade – 1 – underweight)	13.0	23.0	18.6	15.0	4.0	6.6	2.6
18.0 – 22.9 (Normal)	18.0	38.0	54.0	58.6	61.3	60.0	65.3
23.0 – 27.9 (Grade – 1– overweight)	1.30	2.0	6.0	10.0	23.3	24.0	28.0
28.0 – 38.9 (Grade – 2 – overweight)	0.70	2.0	2.2	1.80	6.1	4.8	2.1
≥ 39.0 (Grade – 3 – overweight)	-	-	-	-	-	-	-

Table 3: Percentage Distribution of Male Subjects According to BMI Range classification in Kano metropolis (June – August, 2007)

	Age (Yrs)						
BMI Range Class	**13**	**14**	**15**	**16**	**17**	**18**	**19**
<14.5 (Grade – 3 – underweight)	14.6	25.3	6.6	4.0	-	-	-
14.5 – 15.9 (Grade – 2 – underweight)	19.3	20.0	6.6	8.6	6.0	3.3	4.7
16.0 – 16.9 (Grade-1-underweight)	17.3	14.6	20.6	10.0	7.3	6.0	4.0
17.0 – 20.9 (Normal)	42.0	37.3	52.0	60.0	60.0	55.3	50.0
21.0 – 25.9 (Grade – 1 – overweight)	6.8	2.8	12.6	15.3	22.7	32.0	36.0
26.0 – 36.9 (Grade – 2 – overweight)	-	-	1.6	2.1	4.0	3.4	5.3
≥ 37.0 (Grade – 3 – overweight)	-	-	-	-	-	-	-

DISCUSSION

The result of this study on the variation of BMI with age and sex (Table 1) agrees with earlier reports (Atiku *et al.,* 1997). In the past, the World Health Organization made no specific recommendations for adolescent anthropometry, but advocated the National Centre for Health Statistics (NCHS) of the United States reference data for younger children (WHO, 1983), which include standard deviations (SD) and percentiles of height and weight through the adolescent years. Body mass index was recommended as the basis for anthropometric indicators of thinners and overweight during adolescence (Bauer and Maffeis, 2002). Using this criterion, Must *et al.* (1991a) recommended BMI – for – age cut-off values for adolescents considered at risk of overweight as $\geq$ 85th percentile and thinness or low BMI – for – age as $\leq$ 5th percentile of the BMI data for the whole US population. While the use of these cut-off values may appear appropriate, but the possibility of under-or over estimation of adolescents outside the US population at risk of malnutrition cannot be ignored. The use of local reference data to take into account differences in dietary habits would be a better option than comparison with international standards. In addition, growth differences among groups (adolescents in this instance) are related to nutritional status, socio economic levels, degree of industrialization/urbanization. For individual adolescents, growth may be limited by factors such as prolonged undernutrition, infection and chronic disease.

The use of different BMI – range classification on the basis of sex (Tables 2 and 3) reflects earlier reports which indicated the variation of BMI with sex during adolescence (Must *et al.,* 1991a, Atiku *et al.,* 1997). From age 15 through to 19 years more than fifty percent of the subjects both males and females (Tables 2 and 3) fell in their respective normal BMI – range category.

This observation indicates that these normal BMI – range categories appear to be an entry point or cross – over point into the normal BMI – range category of 18.50 – 24.99 for adults later in life. With increase in age, percentage distribution of subjects in the grade-3- underweight categories decreases. It is therefore possible for these subjects to cross into the normal BMI – range category for adults later in life. In the grade – 1 – overweight category, the percentage distribution of subjects increases with increase in age. A reasonable proportion of these subjects may remain in the normal BMI – range of adults. In line with earlier reports which indicate that in many countries there will be few adolescents with BMI $\geq$ 30 (Hoffmann *et al.,* 1988), relatively few subjects were found in the grade – 2 – overweight category and none in the grade – 3 – over weight category.

In conclusion, it is suggested that this proposed categorization be subjected to further verification on a larger sample size, and preferably of a widespread nature in terms of location of sample. Variations in bodymass, subcutaneous fatness and total body fat in adolescents are significantly associated with variations in blood pressure and blood levels of lipoproteins, glucose and insulin in many populations of developed countries (Lin *et al,* 2002). Further studies in the local population ought to take these variations into account.

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