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## Nutritional Status and Energy Intake of Adolescents in Umuahia Urban, Nigeria

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**Abstract:** The purpose of this study was to provide information on anthropometry, body composition and energy intake of adolescents South Eastern Nigeria. The participants were 190 apparently healthy adolescent boys and girls aged 15-18 years with equal sex distribution. Participants were subjected to anthropometric measurements viz: height, weight, arm circumference and skinfold thickness. Energy intake was determined from individual weighed inventory for three consecutive days including a week-end day; part of the food sample was subjected to chemical analysis. According to the results, all measurements except BMI and arm circumference had significant differences ( $p < 0.05$ ). Approximately 50% girls and well over 70% boys failed to meet the recommended weight and height standards. Over 20% of the adolescents were thin ( $BMI < 18.5 \text{ kg/m}^2$ ). The prevalence of overweight indicated that about 4% of boys and 2% of girls were at risk of becoming overweight. Similarly the prevalence of stunting was found to be 67.3% and 57.8% for boys and girls, respectively. In addition, body fat percent was significantly higher in girls ( $p < 0.05$ ). The mean intakes for fat, carbohydrate and energy was significantly higher in males compared to females ( $p < 0.05$ ). This research provides information concerning anthropometry, body composition and energy intake of adolescents, South East Nigeria. The result shows that there was under nutrition among the adolescents though the extent was higher among adolescent boys than girls, body composition of the adolescents was equally low. Also protein intake was grossly inadequate in both sexes. Therefore there is a need for improvement in the nutritional status among these adolescents.

**Key words:** Nutritional status, anthropometry, body composition, energy intake, adolescents

### Introduction

Adolescents have been considered to have the lowest mortality among different age groups and have therefore received low priority in terms of nutritional status assessment (Woodruff, 2000). However, because of rapid growth in stature, muscle mass and fat mass during the peak of the adolescent growth spurt, the requirements for some nutrients is as high or higher in adolescent than in any other age group (WHO, 2000). The 2420 kcal required per day by adolescents is the highest energy requirement of any age group (Woodruff, 2000). Poor nutritional status during this period is an important determinant of health status (Deshmukh *et al.*, 2006). Short stature that results from chronic under nutrition is associated with reduced lean body mass and deficiencies in muscular strength and working capacity (WHO, 1995). Another important aspect of health related to nutritional status is body composition (Gamez *et al.*, 1998). Anthropometry is the measurement of certain parameters of the human body and it is frequently used to assess nutritional status as well as growth and development of school aged children and adolescents. (Shetty and James, 1994). It is also the most frequently used tool in public health evaluation and clinical settings; and involves measurements viz: skinfold

thickness, circumferences or various height and weight based indices such as weight-for-height and BMI (Himes, 1991; WHO, 1995). The BMI has been recommended and used to screen for overweight, obesity and thinness among adults and adolescents (Gorstein, 1989; Garrow and Webster, 1985), but it does not differentiate between fat and lean tissue mass. An alternative technique that is simple, inexpensive and non invasive is the measurement of subcutaneous fat thickness or skinfolds at selected sites. Skinfold thickness measured at various sites on the body provides an estimate of the thickness of subcutaneous fat (Onimawo and Cole, 2000).

Many developing countries face an increasing dual burden of under nutrition and over nutrition (Popkin *et al.*, 2001). Anthropometry can thus be used to evaluate either individuals or populations in order to determine the prevalence of over nutrition and under nutrition. The method involves the use of body weight and height scales, skinfold calipers, head and arm circumference tapes. The method has also been used by various authors to determine body composition of various groups (Onimawo and Cole, 2000).

In Nigeria however, only few studies have studied sex differences in the level of under nutrition among

adolescent boys and girls (Ijarotimi *et al.*, 2003; Ijarotimi, 2004; Nwokoro *et al.*, 2006). The present study was carried out with the objective of assessing the nutritional status of adolescents in boarding secondary schools in Umuahia urban.

## Materials and Methods

**Subjects:** The present study was carried out on 190 adolescents (95 males and 95 females) randomly selected from five boarding secondary schools in Umuahia urban, Abia State Nigeria. The subjects were age 15-18 years. Written informed consent was obtained from all the subjects before commencement of the study.

**Anthropometry:** Each subject was subjected to weight, height, arm circumference and skinfold measurement. Body weight was measured without shoes and in light clothing, with the use of a portable bathroom scale (HANSON MODEL) to the nearest 0.1kg. Height was measured to nearest 0.1cm using a vertical measuring rod constructed with a non stretchable tape firmly attached. Measurement was taken with subjects bare footed, standing erect with feet parallel and heels put together in line with methods of Jelliffe (1966). Arm circumference was measured on the left arm using a non stretchable tape placed firmly round the arm with the arm hanging freely by the side. BMI was calculated as weight in (kg) divided by height in (m<sup>2</sup>). Nutritional status of the subjects was assessed using parameters viz: weight-for-age, height-for-age and BMI. These were compared to available standards (NCHS, 1977). All anthropometric measurements were made by specially trained laboratory technicians.

**Skin fold measurement:** Four skinfolds (triceps, biceps, subscapular, suprailiac) were measured on the left side of the body as described by Lohman *et al.* (1991) using a calibrated JAMAR Medical caliper. Measurements were taken in triplicate to the nearest 0.1mm by the same investigator and the average measurement was used in data analysis. Body density was calculated using equation of Durnin and Rahaman (1967) for boys:

$$Y = 1.1533 - 0.0643 (X)$$

Where Y = density

X = Log (sum of skinfold thickness at four sites (triceps, biceps, subscapular, suprailiac).

While for girls the equation of Durnin and Womersley (1974) was used:

$$Y = 1.1549 - 0.0678 (X)$$

Percentage body fat TBF (%) was calculated from the equations of Siri (1956) as follows:

$$TBF (\%) = \frac{(4.95 - 4.5)}{Y} \times 100$$

Total body fat (kg) was obtained by multiplying percentage of body fat by weight and dividing by 100. Lean Body Mass (LBM) was calculated by subtracting body fat (kg) from body weight (kg).

**Dietary intake:** Individual weighed food inventory was carried out in the school cafeteria during breakfast (07.00-7.30 hours), lunch (14.00-14.30 hours) and supper (18.00-18.30 hours) for three consecutive days inclusive of at least a week-end day. A Salter dietary scale was used to measure individual portion at meal times. Plate wastes were deducted from the original weight of the food. A representative sample of the food was collected and sent to the laboratory for proximate analysis using standard assay procedures (AOAC, 1995). The food samples were analyzed for moisture, fiber, ash, protein and fat. Carbohydrate was calculated by difference. Energy (kcal) was determined using Atwater factors of 4, 4 and 9 kcal/d for protein, carbohydrate and fat, respectively.

**Statistical analysis:** The data generated was analyzed using descriptive statistics such as means, standard deviations, percentages and frequencies. The difference between adolescent boys and girls was determined using students t-test. All data analysis was performed using SPSS statistical package (version 11) and the level of statistical significance for analysis was set at (p<0.05).

## Results

The study population consisted of 190 subjects with equal sex distribution (Table 1). The boys and girls had a mean weight of 56.47±8.64kg and 53.48±6.94 kg; height 167.35±6.29cm and 161.92±5.30 cm; and BMI 19.99±2.56kg/m<sup>2</sup> and 20.50±2.38kg/m<sup>2</sup>, respectively. There were significant differences in all the physical characteristics except for BMI and arm circumference. Over 70% of boys and about 50% of girls had low values for height and weight compared to reference standards. Overall, girls had significantly higher values from skinfold measurements and body fat, while the boys had significantly higher LBM than the girls. The prevalence of underweight using NCHS<-2sd was significantly higher in boys (63.1%) than girls (53.6%) (p<0.05). Similarly, 67.3% of boys and 57.8% of girls were stunted (Table 1) Table 2 and 3 shows the BMI classification of the adolescent boys and girls. The prevalence of thinness (BMI<18.5kg/m<sup>2</sup>) was about 20% in both sexes. The prevalence of overweight was found to be 4% for boys and 2% for girls. None of the study subjects could be classified as obese.

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Table1: Mean anthropometric, body composition and nutritional status indicators of the adolescents

| Parameters                 | Males       | Females     | p-value |
|----------------------------|-------------|-------------|---------|
| Age (yrs)                  | 16.27±1.08  | 16.29±1.06  | 0.895   |
| Weight (kg)                | 56.47±8.64  | 53.48±6.94  | 0.01*   |
| Height (cm)                | 167.35±6.29 | 161.92±5.30 | 0.00*   |
| Arm circumference (cm)     | 23.5±1.95   | 23.82±2.07  | 0.273   |
| BMI (kg/m <sup>2</sup> )   | 19.99±2.56  | 20.50±2.38  | 0.172   |
| Triceps (mm)               | 6.36±1.30   | 11.19±3.70  | 0.00*   |
| Biceps (mm)                | 4.89±0.93   | 7.01±2.65   | 0.00*   |
| Subscapular (mm)           | 8.38±1.36   | 10.91±2.75  | 0.00*   |
| Suprailiac (mm)            | 7.67±1.59   | 10.41±2.88  | 0.00*   |
| Ø 4 SF (mm)                | 27.35±4.09  | 39.66±11.03 | 0.00*   |
| Body fat (%)               | 16.56±1.88  | 23.02±3.87  | 0.00*   |
| Body fat (kg)              | 9.43±2.39   | 12.54±3.34  | 0.00*   |
| Lean body mass (kg)        | 46.51±7.75  | 40.98±5.31  | 0.00*   |
| Nutritional indicators     |             |             |         |
| Underweight % (<-2sd NCHS) | 63.1        | 53.6        | 0.00*   |
| Stunting % (<-2sd NCHS)    | 67.3        | 57.8        | 0.00*   |

\*Significant difference (p<0.05) between boys and girls, Σ 4 SF (mm), sum of 4 skinfolds

Table 2: BMI classification of adolescent boys

| BMI (kg/m <sup>2</sup> ) | No of subjects | % Contribution | Grade            |
|--------------------------|----------------|----------------|------------------|
| <16.00                   | 5              | 5.26           | Grade 3 thinness |
| 16.00-16.99              | 7              | 7.37           | Grade 2 thinness |
| 17.00-18.49              | 9              | 9.47           | Grade 1 thinness |
| 18.50-24.99              | 70             | 73.68          | Normal           |
| 25.00-29.99              | 4              | 4.21           | Grade 1 obesity  |
|                          | 95             | 100            |                  |

Source: Ferro-Luzzi *et al.* (1992)

Table 3: BMI classification of adolescent girls

| BMI (kg/m <sup>2</sup> ) | No. of subjects | % Contribution | Grade            |
|--------------------------|-----------------|----------------|------------------|
| <16.00                   | 3               | 3.15           | Grade 3 thinness |
| 16.00-16.99              | 4               | 4.21           | Grade 2 thinness |
| 17.00-18.49              | 13              | 13.68          | Grade 1 thinness |
| 18.50-24.99              | 73              | 76.84          | Normal           |
| 25.00-29.99              | 2               | 2.10           | Grade 1 obesity  |
|                          | 95              | 100            |                  |

Source: Ferro-Luzzi *et al.* (1992)

Table 4: Macronutrient intake from three days weighed inventory

| Parameters             | Males          | Females       | p-value |
|------------------------|----------------|---------------|---------|
| Energy intake (kcal/d) | 2683.12±113.91 | 2333.60±94.57 | 0.000*  |
| Protein (g)            | 54.43±7.94     | 51.49±9.56    | 0.067   |
| Fat (g)                | 43.69±3.84     | 47.05±9.99    | 0.006*  |
| Carbohydrate (g)       | 518.92±27.67   | 425.5±26.68   | 0.000*  |

\*Significant difference (p<0.05) between boys and girls

A comparison of the mean energy and macronutrient intake is shown in Table 4. The mean intake for carbohydrate, fat and energy were significantly higher in the males compared with females. About 80% of the adolescents met two third of the RDA for energy. Similarly, more than 50% girls and less than 25% boys met two third of the RDA for protein.

**Discussion**

WHO (1995) stated that adolescence is a period of increased nutritional requirements. Mukhopadhyay *et al.* (2005) also stated that adolescent anthropometry varies significantly worldwide. The basic objective of

anthropometric assessment is to provide an estimate of the prevalence and severity of malnutrition. The information collected can then be used for the formulation of health and developmental policies. Information regarding the nutritional status of adolescents in South East Nigeria is scarce. Using weight and height indices, the boys in this study were significantly taller and heavier (p<0.05) than the girls. The higher body weight and height values of boys is supported by the fact that at this age i.e. (15-18 years), boys usually have a larger body build, grow to a larger structure and also continue to grow faster than the girls even after adolescence (Barbara, 1984; Goran, 1998). The higher body weight of boys is further supported by data from their food intake measurements. Similar trends were also observed by (Nwokoro *et al.*, 2006; Shamssain, 1991; Didia and Ogunranti, 1986). Arm circumference is generally associated with a specific and relative risk of malnutrition and is widely used as an indicator of thinness (Waterlow, 1992). The prevalence of low arm circumference was similar for both sexes. The prevalence of low arm circumference showed that together with been underweight and stunted, the adolescents also showed low fat and muscle reserve. From the result, it also appeared that the prevalence of underweight and stunting was lower in girls than in boys. The prevalence of stunting in the adolescents was 57.8% among girls and 67.3% among boys with an overall prevalence of 62.5% in both sexes. A similar trend in the prevalence of stunting in developing countries was reported by kurz and Johnson-Welch (1994). However, the report of WHO Consultation on nutritional status of adolescents noted 45% stunting among girls and 20% among boys with an average of 32% in both sexes (WHO, 1998).

The mean BMI was 19.99kg/m<sup>2</sup> for boys and 20.50 kg/m<sup>2</sup> for girls. The value obtained for both sexes corresponds to mild thinness on the BMI reference data (Ijarotimi *et al.*, 2003). Using the classification of BMI ranges (Ferro-Luzzi *et al.*, 1992), the result reflects that over 70% (both sexes) of the adolescents had normal weight. More than 20% were underweight, while 4% and 2% boys and girls respectively, were overweight. The BMI did not reflect an obese group of adolescents. The mean BMI of the adolescents in this study is in accordance with studies carried out in other parts of Nigeria (Ijarotimi *et al.*, 2003; Cole *et al.*, 2002; Nwokoro *et al.*, 2006; Onimawo and Ukegbu, 2005; Osisanya *et al.*, 2002). Deshmukh *et al.* (2006) reported the prevalence of overweight (BMI = 25kg/m<sup>2</sup>) to be 2.2% and this is in line with results of this study. The skinfold measurements from all sites were consistently higher in girls than boys (p<0.05). Low skinfold thickness was previously reported among Nigerians (Onimawo and Cole, 2000; Watson and Etta, 1975). Triceps skinfold thickness was reported by Jelliffe (1966) to serve as an indicator on

nutritional status in man. Onimawo *et al.* (2004) also pointed out that it is useful in assessing degree of malnutrition. Judging from the values obtained, only about 50% of the adolescents met the recommendations. Using triceps skinfold thickness values, the adolescents were undernourished. Nnayelugo *et al.* (2000) reported triceps skinfold of 6.05mm and 5.29mm for adolescent boys aged 13-15 and 16-19 years respectively, this compares well with results of this study. Percent body fat was significantly higher in girls than boys. The higher body fat in girls could be attributed to the fact that adolescent girls tend to lay down more subcutaneous fat layer than boys during the growth spurt at puberty (Osisanya *et al.*, 2002; Chumlea *et al.*, 1981). The percent body fat reported by Cole *et al.* (2002), Onimawo and Ukegbu (2005) on female adolescents and Osisanya *et al.* (2002) on male adolescents are identical to that of this study. However, compared with that of Ijarotimi *et al.* (2003), our subjects were heavier, taller and had higher percent body fat than theirs. Moderate percent body fat values should range between 19-24% for males and 26-29% for females (Slaughter *et al.*, 1988). In as much as our results for body fat compared well with studies by other Nigeria authors, the values obtained for both sexes was low compared to standards (WHO, 1995). Again the subjects in this study had lower BMI and body fat compared to their American counterparts, but showed higher body fat values than Indian adolescents reported by Deshmukh *et al.* (2006) and Mukhopadhyay *et al.* (2005). Furthermore, the LBM of the boys was significantly higher than the girls. The high LBM and low TBF (%) of the boys may be due to the fact that boys generally build more muscle mass have a larger skeleton and deposit less fat than adolescent girls (Heald and Gong, 1999). In addition, BMI was highly and significantly correlated with TBF (kg) and LBM (kg) in both sexes and ( $r = 0.579$  and  $r = 0.802$ ) and ( $r = 0.595$  and  $r = 0.746$ ) ( $p < 0.05$ ) for boys and girls for TBF (kg) and LBM (kg), respectively. The correlation of BMI with TBF (kg) is in line with reports by Osisanya *et al.* (2002) ( $r = 0.75$ ,  $p < 0.05$ ) and Cole *et al.* (1997) ( $r = 0.83$ ,  $p < 0.05$ ). This also confirmed findings by Onimawo *et al.*, 2004 and Norgan and Ferroluzi (1982) that BMI and body fat are better predictors of obesity than body weight alone, as well as suitable measure of adiposity. Again, the study further showed that BMI and height are more related particularly in boys at late adolescence. The relationship between BMI and height is negative ( $r = -0.034$ ) during late adolescence in girls in this study. This is probably because of the early onset of puberty in girls whereby the height of girls is usually more than the boys' till 13 years, after which the boys would then grow taller (Anand *et al.*, 1999; Rao *et al.*, 1984). There was no correlation between BMI and energy intake. The mean total protein appeared sufficient for the

females, although the quality was quite low. The adolescents generally consumed a higher percentage (over 80%) of energy from carbohydrate foods, as compared to that obtained by (Cole *et al.*, 2002; Onimawo and Ukegbu, 2005; Oguntona *et al.*, 1987). Of note is also the fact that carbohydrate was still higher in this study when compared to adolescents studied by Nnayelugo *et al.* (2000) and Ene-Obong (1993). A higher proportion of energy derived from carbohydrate is typical of foods consumed by adolescents in Nigeria which are mainly starchy foods like rice, yam, cassava flour, bread, Abacha (tapioca) and plantain. Protein and fat contributed 9% and 8%, respectively to total energy intake of girls. Protein was obtained mainly from beans and bean products like akara (bean balls) and moin-moin (bean pudding). Vegetable oil and palm oil used for making soup and stew served as their source of fat. High dense foods such as margarine or butter, meat and milk are sparingly or never there in the diet of the adolescents. The study subjects generally consumed less fat and Nigerian diets are known to contain little fat (Cole *et al.*, 1997). Though, less fat consumption helps to prevent overweight and to avoid cardiovascular heart diseases which are common among men and women in developed countries, some intake of fat is essential for life. It was recommended by DRI (2002) that 55-60% of total calories should come from carbohydrate, 10-20% from protein and less than 30% from fat. The adolescents in this study thus had excess carbohydrate intake, fat intake was minimal but protein intake was grossly inadequate especially in the boys and this is indicated in their body composition variables. The low protein intake and poor source of protein in the adolescent meals could be attributed to the fact that proteinous foods are usually very expensive especially in developing countries. It is also worthy to note that the economic hardship in the country may also be said to contribute to the low protein intake of students feeding both at home and in the boarding schools since they rely sole on their parents who are barely managing to survive.

**Conclusion:** The nutritional status and energy intake of adolescents in Umuahia is poor. The low values for anthropometry and body composition obtained from this study suggest that there is need for improvement in the nutritional status of these adolescents. Also, more attention needs to be done to address the issue of adolescent malnutrition.

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