

Anthropometric Measurements in Adolescent Students: A Comparison among Three Ethnic Groups Living in North-Central Nigeria

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Abstract

Weight and height measurements together with Body Mass Index (BMI) are commonly used anthropometric measurements for the estimation of relative weight, which has a direct relationship with nutritional status, and for the classification of individuals as underweight, normal, overweight or obese. A randomized cross-sectional study of 1,057 adolescent students from three different ethnic groups living in Katsina-Ala town, North-Central Nigeria, was conducted. The students were aged 10-19 years, and were divided into two age groups: 10-14 years and 15-19 years. The two groups were later separated by gender into male and female subgroups. The One-way Analysis of Variance (ANOVA) was used to assess if the differences observed across the age, gender and ethnic groups were statistically significant. Further statistical testing was carried out using the Tukey-Kramer Multiple Comparisons Test. The results showed extremely significant differences, with P-Values up to ≤ 0.0001 amongst the various groups, in weight, height and BMI.

Keywords: anthropometric measurements, adolescents, body mass index, ethnic groups, Katsina-Ala.

INTRODUCTION/BACKGROUND

Adolescents are tomorrow's adults, making up a very significant proportion of the world's population, and adolescence being an important growth period where tremendous growth and development occurs is an intense anabolic period when requirements for energy and nutrients increase (Guisseppina, 2000; WHO, 2006).

Malnutrition is highly prevalent in developing countries, however, in most of these developing countries, nutrition initiatives have focused on children and women, with the adolescent group more often than not, neglected. This has caused adolescents to suffer from many nutritionally-related health problems later in life (Yetubie *et al.*, 2010). This is due to the fact that the phenomenal growth that occurs in adolescence, second only to that in first year of life, creates increased demands for energy and nutrients. Since nutrition and physical growth are integrally related, optimal nutrition is requisite for achieving full growth potential, and failure to consume an adequate diet can slow or even arrest linear growth (Story, 1992)

Anthropometric indices including height, weight and body mass index (BMI), which is a measure of weight adjusted for height – are simple, ubiquitous, inexpensive and non-invasive surrogate measurements of body fat that have historically been used and form the basis of growth monitoring (Must and Anderson, 2006). BMI is a straightforward measure of the weight-for-height ratio that is applicable throughout human lifespan (Reilly *et al.*, 2000), calculated as weight in kilograms divided by the square of height in meters. It is becoming more and more pertinent to the growth of children (Wikipedia, 2015).

In children and adolescents aged 2-20 years, BMI is calculated in the same way as for adults, however the comparison is not against a fixed threshold, rather it is expressed as a standard deviation score, using age and specific-reference values compared against the percentile for children of the same gender and age (Cole, 1990; Bonthuis *et al.*, 2013; Wikipedia, 2015).

Some epidemiological studies have found anthropometric indices to be related to cardiovascular disease risk factors (Famodu and Awodu, 2009), and dysglycaemia such as impaired glucose tolerance, impaired fasting glucose and type 2 diabetes mellitus (Egbe *et al.*, 2014). Thus when applied to a population, the purpose of anthropometric cut off points is to identify the proportion of people with a high risk of undesirable health state that warrants public health or clinical intervention (WHO Expert Consultation, 2004).

This study aims to establish a baseline reference data, and to observe, if any, ethnic differences amongst residents of the same locality for the group studied, comparing the results observed with previously published data and attempt to explain differences noted if any. Hopefully, the findings in this study will be of benefit in developing new and improving on existing policies and programmes targeted at adolescent nutrition in North-central Nigeria.

MATERIALS AND METHODS.

The study area was Katsina-Ala town located about 126Km away from Makurdi, the Benue State capital, in North Central Nigeria. Katsina-Ala covers an area of 2402 km², with a population of 224,718 at the 2006 census.

The town center is the location of one of the oldest schools in Nigeria – Government College, Katsina-Ala [one of the schools from which subjects for this study were recruited] (Wikipedia, 2014).

Katsina-Ala plays host to several ethnic groups. The most dominant being the Tivs, who are mostly subsistent farmers whose main crops are yams, millet, cassava, soya beans, beniseed, sorghum, maize, and guinea corn, amongst others, most of which form the major components of their staple meals (Orga and Orkes, 2012). Also found in Katsina-Ala is the Hausa ethnic group, a diverse but culturally homogenous people. The Hausas are widely distributed geographically, and have intermingled with many different peoples in Nigeria, as well as in other West African countries. Their staple foods include grains and legumes (sorghum, millet, beans, rice, and maize), and dairy products and very small amounts of meat and dried greenish vegetables (Wikipedia, 2015).

The Igbo ethnic group found predominantly in South-Eastern Nigeria are also found living in Katsina-Ala, Their staple food include yam, (which is a very important staple crop), cassava, maize, plantain and rice, typically consumed with soups and stews made from vegetables such as okra, pumpkin, bitter leaf, and egusi (melon seeds), to which sizeable pieces of fish, chicken, beef or goat meat are added (Wikipedia, 2015).

STUDY DESIGN

One thousand and fifty seven (1057) adolescent subjects (Males: n= 471; Females: n=586), aged 10-19 years were randomly recruited from ten (10) secondary schools in Katsina-Ala town, six (6) of which are public schools, and four(4) of which are privately-owned schools, with one of the schools being exclusively boys and another one, exclusively girls. No special selections were made on body type or degree of overweight.

Ethical approval to proceed with the study was obtained from the Ministry of Health and Human Services, Benue state, Nigeria. Signed informed consent was obtained from the Heads/Principals of the various schools under study, and after detailed explanations of the purpose, objectives and nature of the study, verbal consent was obtained from each of the participants/study subjects, and they were free to withdraw from the study at any point.

STUDY PROCEDURE

Questionnaires were administered to obtain general personal history of each participant. Weight measurements were taken to the nearest 0.1 kg using a weighing scale – Detector PD300DHR Digital-Pro Doc (USA), with the participants wearing light clothing and no shoes. Height was measured to the nearest 0.01m using a Stadiometre Prestige HM0016D (India), with the subject standing erect, without shoes or headgear. BMI was computed using the standard formula – weight in Kg divided by the square of the height in meters (Kg/m²).

STASTICAL ANALYSIS

One-way analysis of variance (ANOVA) was applied to determine the differences in the parameters measured among the various ethnic groups. The Tukey-Kramer test was used for multiple comparisons, as it also accounts for unequal group sizes. The significance level was set at $P \leq 0.05$.

RESULTS

A total of 471 (44.6%) males and 586 (55.4%) females participated in the study. The ethnic representations were Tiv – 527 (49.9%); Hausa – 270 (25.5%); Igbo – 260 (24.6%). All the participants were adolescent students aged between 10-19 years, divided into two years age groups viz: 10-14 years (44.5%) and 15-19 years (55.5%); with the males aged 10-14 years marking up about 22.8% and those aged 15-19 years about 21.8% of the study population; while females aged 10-14 years made up about 21.7%, and those aged 15-19 years about 33.7% of the study population, as shown in Table 1.

*Body Mass Index (BMI) was categorized by WHO standards as follows:

- Underweight: BMI <18.5kg/m²
- Normal: BMI 18.5-24.9kg/m²
- Overweight: BMI 25.0-29.9kg/m²
- Obesity: BMI ≥ 30 kg/m²

TABLE 1: Distribution of study participants by demographic characteristics

<i>N %</i>		
<i>Ethnic Group (10-14 years)</i>	Male	Female
Tiv	6.8	8.4
Hausa	10.4	5.3
Igbo	5.6	8.0
<i>Ethnic Group (15-19 years)</i>	Male	Female
Tiv	11.4	23.3
Hausa	5.6	4.3
Igbo	4.8	6.1

The mean height of all the study participants was 1.563 m with the mean height of the male participants being 1.568m and that of the females 1.559m. The mean weight of all the study participants was 46.17kg, with the mean weight of the male participants being 45.35kg, and that of the females – 46.99kg. The mean BMI of all the study participants was 18.86kg/m², with the mean BMI of the male participants being 18.21kg/m², and that of the females – 19.51kg/m².

Tiv females weighed on the average 49.37kg were 1.553m tall and had a mean BMI of 20.49kg/m². Their male counterparts weighed on the average 47.83kg, were 1.588m tall and had a mean BMI of 18.88kg/m². Hausa females weighed on the average 41.20kg, were 1.560m tall and had a mean BMI of 17.75kg/m². Their male counterparts weighed on the average 41.32kg, were 1.534m tall and had a mean BMI of 17.29kg/m². Igbo females weighed on the average 50.40kg, were 1.565m tall, and had a mean BMI of 20.28kg/m². Their male counterparts weighed on the average 46.91kg were 1.581m tall and had a mean BMI of 18.47kg/m². Tables 2, 3 and 4 show the specific distribution of mean height, weight and BMI of all the study participants by ethnic group, age and sex.

TABLE 2: Mean height (in meters) of study participants distributed by ethnic group, age and sex.

<i>Ethnic Group (10-14 years)</i>	<i>Male</i>	<i>Female</i>
Tiv	1.536	1.531
Hausa	1.456	1.570
Igbo	1.519	1.549
<i>Ethnic Group(15-19 years)</i>	<i>Male</i>	<i>Female</i>
Tiv	1.640	1.574
Hausa	1.612	1.550
Igbo	1.643	1.580

TABLE 3: Mean weight (in kg) of study participants distributed by ethnic group, age and sex.

<i>Ethnic Group (10-14 years)</i>	Male	Female
Tiv	42.01	45.35
Hausa	34.97	38.41
Igbo	39.47	47.28
<i>Ethnic Group (15-19 years)</i>	Male	Female
Tiv	53.64	53.38
Hausa	47.66	43.98
Igbo	54.35	53.52

TABLE 4 : Mean BMI (in kg/m²) of study participants ethnic distributed by ethnic group, age and sex.

<i>Ethnic Group (10-14 years)</i>	Male	Female
Tiv	17.77	19.44
Hausa	16.36	17.18
Igbo	16.97	19.56
<i>Ethnic Group (15-19 years)</i>	Male	Female
Tiv	19.99	21.54
Hausa	18.22	18.32
Igbo	19.97	21.00

FIGURE 1: Graph showing height (in meters) of study participants distributed by ethnic groups, age and sex

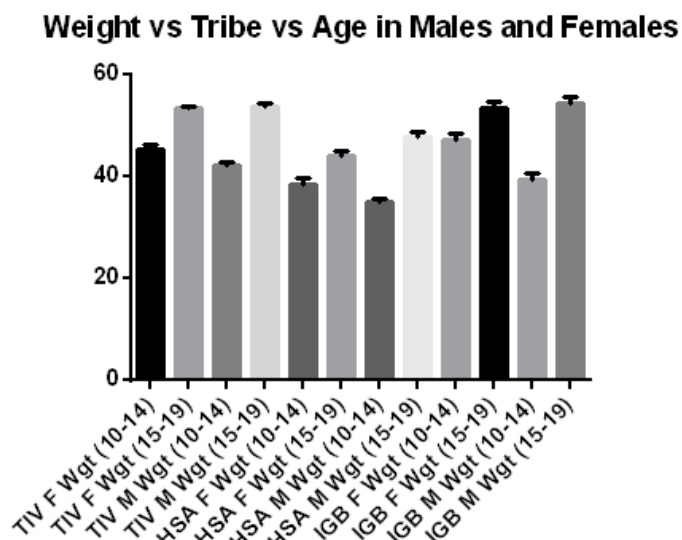
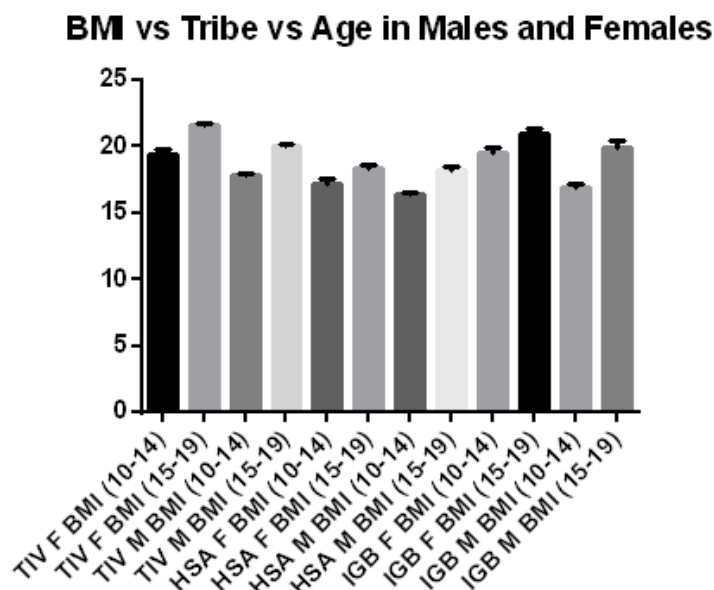


FIGURE 2: Graph showing weight (in kg) of study participants distributed by ethnic group, age and sex.



FIGURE 3: Graph showing BMI (in kg/m²) of study participants distributed by ethnic group, age and sex.



HEIGHT

In the Tiv ethnic group, there was no significant height difference between the males and the females aged (10-14 years). However, the females aged 15-19 years were significantly taller than the females aged 10-14 years ($p < 0.01$). There was no significant height difference between the females in the 15-19 age bracket and the males in the 10-14 year age bracket. On the other hand, the males aged 15-19 years, were significantly taller than the females aged 10-14 years ($p < 0.0001$) and the females 15-19 years ($p < 0.0001$). They were also significantly taller than the males in the 10-14 year age group ($p < 0.0001$).

In the Hausa ethnic group, there was no significant height difference in both the 10-14 and the 15-19 year age group. However, in the 10-14 year, age group, there were significant differences in height, with the females being significantly taller than the males ($p < 0.0001$). In the 15-19 year age group, the males showed a low level significant difference in height when compared to the females in both the 10-14, and 15-19 year age groups ($p < 0.05$), and a very high significant difference in height, when compared to the males aged 10-14 years, while the females aged 15-19 years were significantly taller than the males aged 10-14 years ($p < 0.0001$).

The Igbo ethnic female group showed similar trends with the Hausa ethnic female group in that, there was no significant height difference in both age groups, while the 10-14 year age groups showed similar trends with the Tiv ethnic group as there was no significant height difference between the males and the females in this age group. Similarly too, the Igbo males aged 15-19 years were significantly taller than the females aged 10-14 years ($p < 0.0001$), the females aged 15-19 years ($p < 0.01$), and the males aged 10-14 years; while the females aged 15-19 years were slightly taller than the males aged 10-14 years ($p < 0.05$).

When the various ethnic groups were compared with each other, the following trends were observed:

- In the 10-14 year age group, there were no significant height differences amongst the females of all the ethnic groups. The Tiv's and the Igbo's in this age group had the closest similarities, as the Tiv males and females showed no significant height differences when compared to the Igbo males and females. On the other hand, Hausa males were significantly shorter than the Tiv females ($p < 0.0001$), Tiv males ($p < 0.0001$), Igbo females ($p < 0.0001$), and the Igbo males ($p < 0.001$), while the Hausa females were slightly taller than the Igbo males ($p < 0.05$), but showed no significant height difference when compared to the Tiv males.

- The 15-19 year age groups showed similar trends as there were no significant height differences amongst the females of all the ethnic groups. Also, there was no significant height difference observed when the Hausa males in this age group were compared to the male and female groups of both Tiv and Igbo ethnicity. The Tiv males were also not significantly taller or shorter than the Igbo males in this age group. However, the Igbo males were significantly taller than both the Tiv females ($p < 0.0001$), and the Hausa females ($p < 0.0001$). The Tiv males exhibited a similar trend, being significantly taller than the Hausa females ($p < 0.0001$), and the Igbo females ($p < 0.001$).

- Amongst the female groups there were no significant height differences in both age groups of the various ethnic groups studied, except for the Igbo females aged 15-19 years, who were slightly taller than the Tiv females aged 10-14 years ($p < 0.05$). On the other hand, all the males in the 15-19 year age group were significantly taller than all the males in the 10-14 year age group across the various ethnic groups, ($p < 0.0001$) in

each case.

- When the female groups were compared to the male groups across the various ethnic and age groups, it was observed that all the males aged 15-19 years were significantly taller than all the females aged 10-14 years at a significance level of ($p < 0.0001$), except for the Hausa males aged 15-19 years, who were significantly taller than Igbo females aged 10-14 years at ($p < 0.01$).

- There was no significant height difference between the Igbo females aged 15-19 years, and the Tiv males aged 10-14 years. However, the Tiv females aged 15-19 years were significantly taller than the Hausa males aged 10-14 years ($p < 0.0001$), and the Igbo males aged 10-14 years ($p < 0.01$). The Igbo females aged 15-19 years were also significantly taller than the Hausa males 10-14 years ($p < 0.0001$).

WEIGHT

In the Tiv ethnic group, there was no significant weight difference between the males and the females aged 10-14 years, and the between the males and the females aged 15-19 years. However when the males and females aged 10-14 years were compared to the males and females aged 15-19 years and vice versa, weight differences were observed, significant in each case at ($p < 0.0001$). A similar trend was observed in the Hausa ethnic group, except for the 10-14 year-old females which was only slightly significant at ($p < 0.05$), when compared to the 15-19 year-old females.

In the Igbo ethnic groups, however, the females aged 10-14 years had significantly higher weight when compared to the males in the same group ($p < 0.0001$), but there was no significant weight difference between the males and females aged 15-19 years in this ethnic group. When the males and females aged 10-14 years were compared to the males and females aged 15-19 years, they all showed weight differences significant in each case at ($p < 0.0001$), with the 15-19 year age group weighing significantly higher than the 10-14 year age groups.

When the weight measurements from the males and females of various ethnic groups aged 10-14 years were compared, it was observed that the Hausa females weighed about the same as the Igbo and Tiv males, but significantly less than the Igbo and Tiv females ($p < 0.0001$), while the Hausa males weighed significantly less than the Tiv males and females ($p < 0.0001$), and the Igbo males ($p < 0.05$) and females ($p < 0.0001$). The Tiv females, on the other hand weighed about the same as the Igbo females but significantly more than the Igbo males ($p < 0.001$), while the Tiv males weighed about the same as the Igbo males, but significantly less than the Tiv males ($p < 0.01$).

In the groups aged 15-19 years, it was observed that the Tiv females weighed significantly more than the Hausa males and females ($p < 0.0001$), and about the same as the Igbo males and females. The same pattern was observed when the Tiv male group was compared with the Hausa and Igbo males and females. However the Igbo males and females weighed significantly more than the Hausa females ($p < 0.0001$), and the Hausa males ($p < 0.001$) and ($p < 0.01$), respectively.

It was also observed that the Tiv females aged 10-14 years weighed about the same as the Hausa males and females aged 15-19 years, but significantly less than the Igbo males and females aged 15-19 years ($p < 0.0001$). The Igbo females aged 10-14 years exhibited a similar pattern as the Tiv females, weighing about the same as the Hausa males and females aged 15-19 years and significantly less than the Tiv males and females aged 15-19 years ($p < 0.0001$). The Hausa females, however, weighed significantly less than the males and females of the Igbo and Tiv ethnic groups aged 15-19 years ($p < 0.0001$).

The Hausa males aged 10-14 years on the other hand weighed significantly less than the Igbo and Tiv males and females aged 15-19 years ($p < 0.0001$), while the Igbo males aged 10-14 weighed significantly less than the Tiv males and females, and the Hausa males aged 15-19 years ($p < 0.0001$), and about the same as the Hausa females aged 15-19 years. The Tiv males aged 10-14 years also weighed the same as the Hausa females aged 15-19 years, but significantly less than the 15-19 year old Hausa males ($p < 0.01$), and the 15-19 year old Igbo males and females ($p < 0.0001$).

BMI

BMI measurements in the Tiv ethnic group showed significant differences between the males and females aged 10-14 years ($p < 0.01$), and the males and females aged 15-19 years ($p < 0.0001$), with the females having higher BMIs in both cases. Further comparisons showed that the 15-19 year age groups, (both males and females) had significantly higher BMIs than the 10-14 year age groups ($p < 0.0001$), and that the females aged 15-19 years had significantly higher BMIs than the males aged 10-14 years ($p < 0.0001$). Interestingly however, there was no significant BMI difference between the males aged 15-19 years and the females aged 10-14 years. In the Hausa ethnic group, a very different pattern was observed, where there was no significant difference between most of the groups compared except for the differences observed when the males and females aged 15-19 years were compared to the males aged 10-14 years ($p < 0.001$ and $p < 0.01$), respectively.

The Igbo ethnic group, on the other hand, showed significant differences between the males and the females aged 10-14 years ($p < 0.0001$) – with the females having a higher BMI but no difference in the group aged 15-19

years. When the two age groups were compared to each other, it was observed that the males and females aged 15-19 years had BMIs that were significantly higher than the males aged 10-14 years ($p < 0.0001$). However, between the females aged 10-14 years and the males aged 15-19 years, there was no significant difference, while the females aged 15-19 years had BMI slightly higher than the females aged 10-14 years ($p < 0.05$).

Comparisons of the 10-14 year age groups showed that the Tiv females had significantly higher BMIs than the Hausa males and females and the Igbo males ($p < 0.0001$), and about the same as the Igbo females. The Tiv males, on the other hand, had BMIs not significantly different from the Hausa females and the Igbo males, but slightly higher than the Hausa males ($p < 0.05$), and significantly lower than the Igbo females ($p < 0.001$). The Igbo males had BMIs similar to Hausa males and females, while the Igbo females had BMIs significantly higher than both the Hausa males and females ($p < 0.0001$).

The 15-19 year age groups showed that the Igbo females had BMIs similar to the Tiv males and females, but significantly higher than the Hausa males and females ($p < 0.0001$), while the Igbo males had BMIs not significantly different from the Tiv males and Hausa females, but significantly lower than the Tiv females ($p < 0.01$), and slightly higher than the Hausa males ($p < 0.05$). The Hausa males and females had significantly lower BMIs than the Tiv males and females that ranged from ($p < 0.05$ to $p < 0.0001$).

Other observations made were that the Igbo males and females aged 10-14 years had about the same BMI measurements as the Hausa males and females aged 15-19 years. The Tiv males and females aged 10-14 years also had about the same BMI measurements as the Hausa males and females aged 15-19 years. On the other hand, the Hausa males and females aged 10-14 years had significantly lower BMIs than the Tiv and Igbo males and females aged 15-19 years ($p < 0.0001$). The Tiv males aged 10-14 years had significantly lower BMIs than the Igbo males ($p < 0.001$) and females ($p < 0.0001$) aged 15-19 years, while the Tiv females aged 10-14 years had BMI measurements slightly lower than the Igbo females aged 15-19 years ($p < 0.05$) but not statistically different from the Igbo males aged 15-19 years. However the Igbo males aged 10-14 years had significantly lower BMIs than the Tiv males and females aged 15-19 years ($p < 0.0001$), while the Igbo females aged 10-14 years had BMI statistically similar to the Tiv males aged 15-19 years, but significantly lower than the Tiv females aged 15-19 years ($p < 0.0001$).

DISCUSSION

Adolescence in the second most critical period of growth after infancy, and thus a period of high nutritional requirement to meet the physiological demand for development (PAHO, 2011; Adesina *et al.*, 2012; Manyanga *et al.*, 2014). To achieve this growth, nutritional requirements both for energy, as well as micronutrients demand increase relative to childhood (PAHO, 2011). At the same time, adolescence may represent a window of opportunity during which health problems from earlier in life can be addressed to establish a healthy diet and physical activity that would continue into adulthood (Chandra-Mouli *et al.*, 2005-2006).

Adolescents are estimated to make up approximately 20% of the world's population (UNFPA, 2003), and because of the negative health outcomes associated with the double burden of malnutrition (over weight and underweight), it is especially important to fully understand its prevalence and associated factors in school-aged adolescents (Manyanga *et al.*, 2014), for obvious reasons, thus, the need for additional information on the nutritional status of this particular age group and targeted strategies for improvement of existing nutritional problems is evident, as information about the nutritional status of adolescents is a prerequisite for the development of appropriate policies and programs to improve their nutrition (PAHO, 2011).

Accurate estimates of the prevalence and understanding of the factors associated with unhealthy weight is essential because of the importance of adolescence and the potential negative impacts of unhealthy weight in adulthood (Manyanga *et al.*, 2014). Therefore, it is necessary to monitor prevalence rates and weight trends among children and adolescents at different levels – international, national and subnational (Lazzeri *et al.*, 2008). However, this subject has been largely ignored both as a subject of scientific research and as a target of public health and nutritional programs in developing countries (PAHO, 2011; Manyanga *et al.*, 2014), hence the need for this study.

Anthropometry which is one of the most basic tools for assessing nutritional status, whether over- or under-nutrition (Mei *et al.*, 2002) was used in the present study, estimating the height, weight and body mass index as the basic anthropometric parameters and the results have been extensively presented in the appropriate section.

There were several significant findings in the study which showed a trend which is both alarming and worrisome and calls for immediate public health intervention to prevent the potential negative impact of unhealthy weights and nutrition in adulthood, which for many of the subjects of this study, is in the very near future. These findings include the alarming prevalence of undernutrition/underweight, overnutrition/overweight and obesity among the various ethnic groups studied.

TIV ETHNIC GROUP

The prevalence of underweight adolescents in the TIV ethnic group was about 9.3%, that is about 1 in every 10,

being more prevalent among the males (13.5%) than the females (6.9%), showing that the TIV male adolescents were two times as likely to be underweight as their female counterparts.

The rate of overweight and obesity on the other hand stood at 9.7% (about 1 in 10 adolescents), being more prevalent in this case among the females (11.6%) than the males (6.3%), also showing that the TIV female adolescents were twice as likely as the males to be overweight or obese, with 1.9% obese prevalence rate (2.1% males and 1.8% females).

About 81% however were found to be within the normal weight spectrum, which is, about 8 out of every 10, and evenly distributed across the genders, 80% males and 81.5% females.

HAUSA ETHNIC GROUP

The prevalence of underweight adolescents in this group was 41.5% that is about 4 of every 10, being evenly distributed among the males (41.4%) and females (43.6%). The rate of overweight and obesity stood at 3.3%, about twice the number of females (4.95%) than males (2.4%), with 0.7% obese prevalence rate (0% obesity among the males). While this may seem to be a good trend on the part of obesity, the underweight trend however, requires urgent intervention.

55.2% of the adolescents here were found to be within the normal weight spectrum, slightly above half of the population, evenly distributed, with the males at 56.2% and the females at 53.5%.

IGBO ETHNIC GROUP

The Igbo ethnic group recorded the highest prevalence of overweight and obesity (13.5%), with the obese group at 4.2%. The females were several times more overweight (14.7%) and obese (6%) than the males (1.8% in each case).

Interestingly, the underweight prevalence in this group was almost the same (14.6%) as the overweight/obesity prevalence in the same group, with the males being twice as likely to be underweight (20%) as the females (10.7%). A good percentage of adolescents in this group (though slightly less than the TIV group but much higher than the Hausa group) however, were found to be in the normal weight spectrum, about 71.9%; with about 76.4% males and about 68.7% females, showing a fairly even distribution.

CONCLUSION

Based on the findings of this study, we recommended that appropriate public health interventions be carried out urgently, which should include development of appropriate policies and programs to improve nutrition amongst adolescents to prevent future outbreak of nutrition-related metabolic epidemic in adulthood as epidemiological studies have found anthropometric indices to be related to cardiovascular disease risk factors (Famodu and Awodu, 2009), and dysfunctions of glucose metabolism (Egbe *et al.*, 2014).

We also recommend that similar studies be carried out among other ethnic groups across Nigeria to provide the necessary information, thereby generating the required data needed to formulate policies to combat nutritional inadequacies among adolescents and children.

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