Original Article

Body Fat Distribution and Anthropometric Correlates of Primary School Children in Ilorin Nigeria

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ABSTRACT

Body fats in children determines the nutritional status as well as predict the risk of long-term occurrences of non-communicable diseases such as obesity and type II diabetes mellitus. The body fat changes are mainly influenced by age, sex, genetics and ethnic background. This study describes the body fat distribution of children in the pre-adolescent / early adolescent period in the black ethnic group and their nutritional status using both the direct and indirect methods of body fat measurements. A cross-sectional survey was carried out among 568 public and private primary school children aged between 6-12 years in Ilorin metropolis. Body fat was measured by bio-impedance using Segmental Body Composition Analyzer. Weight and height were measured using a standardized beam balance with an attached stadiometer. Data was analyzed using SPSS v 23. Mean (+SD) of continuous variables were determined. Two means were compared using t test while mean greater than two were compared using ANOVA. Significant p value was < 0.05.

The Mean body fat was highest in the age group 8 – 9 years with a statistically significant difference across the age group ($p < 0.001$). Females had a higher mean body fatwhile private school pupils had a higher body fat than their public-school counterparts($p < 0.001$).The overall mean waist and hip circumference was higher among pupils aged ≥ 10 years ($p < 0.001$). There was significant positive correlation between Age, BMI and waist circumference with body fat ($p = 0.001$).There was a generally low mean BMI for age(<-2SD) across this study population. This study revealed a higher body fat in female pre-adolescent children with corresponding BMI. Private school pupils had higher mean body fat compared to public pupils.Mean body fat correlated positively with BMI, waist circumference and age which shows that such indirect methods are useful tools in determining body fat in children. The existence of malnutrition observed in this study has implication for the health of the school children. A nation-wide survey is advocated to unravel the burden of the disease. Institution of nutritional intervention programs to include regulating the type of feeds allowable in schools is recommended.

Keywords: Anthropometric, Body fat, BMI, Correlates, Hip,Waist circumference,Pre-adolescent

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INTRODUCTION

Body fat is a major component of the body that the body requires to maintain daily physiologic functions. Children as well as adults need a certain amount of fat for the body to function at its best. The fat composition of the body has to be appropriate to maintain a balance as too much or too little fat may result in obesity and other related metabolic conditions.[1]Maintaining normal bodily processes demands a significant amount of body fat. In children generally, Gonadal hormones play a major role in the regulation of body fats and the preadolescent and adolescent years which are the period when the body experience a surge in the hormone and so growth is usually accentuated in children.[2]

Body fat changes are also majorly influenced by age, sex, genetics and ethnic background. Body fats in children also determine the nutritional status as well as predict the risk of long-term occurrences of non-communicable disease such as obesity and type II diabetes mellitus in these children.[3]Globally the double burden of malnutrition, the occurrences of underweight alongside with obesity is on the increase especially in the developing world.[4] The emergence and raising incidence of obesity in this part of the world is also becoming as issue of public health importance. The occurrence of obesity is related to body fat or adiposity of the body's composition.

While more than 149 million children have stunted growth, childhood overweight and obesity are increasing almost everywhere, and suboptimal diets are responsible for one in five (22%) adult deaths globally.[5]Body fat determination can be useful in assessing the double burden of malnutrition which is the current pattern of malnutrition seen especially in the developing part of the world.

Several methods have been developed for the measurement of body fat and these include the direct and indirect methods. The bio-impedance monitor a direct assessment method was developed through research and it can distinguish between lean and fat tissue on the basis of their differential conductance and impedance characteristics.[6]This technique is slightly less accurate than the more sophisticated research tools, but offer an important practical advantage in being simple and cheap to use. Body mass index (BMI), an indirect method basically cannot distinguish between fat and lean tissue or bone, is simple to measure and has been a valuable tool in monitoring trends in body fat but has numerous disadvantages which can lead to misclassifications.[6]

Thepresent study therefore describes the body fat distribution of children in the pre-adolescent period in the black ethnic setting and also their nutritional statususing both direct and indirect method of body fat measurements. This study will determined the mean body fat, BMI, hip and waist circumference of primary school pupils across public and privately owned schools, we determined the correlation (if any) between them. Findings may help to identify early malnutrition as well as those at risk of the consequences of malnutrition especially over-weight and obesity, and also proffers solutions.

MATERIALS AND METHODS

This cross-sectional school survey was carried out among public and private primary school children aged between 6-12 years across the 3 LGA in Ilorin metropolis. Data collection was done between January to June 2017.

Using the Yamane formula[7] (1967), a minimum sample size was calculated allowing for 10% attrition rate, a total of 568 school children aged between 6-12 years from a total number 109,492 pupils. Primary school pupils in both public and private schools in the 3 LGA within the Ilorin metropolis.

A multi staged sampling technique was used to get the desired number of children required for the study from the list of registered schools with the State Ministry of Education. The class register of pupils was gotten through the head teacher via the class teachers, taking into cognizance the class arms and the children's gender.

Body fat was measured by bio-impedance using the ***BC-418MA SECA*** Segmental Body Composition Analyzer. Weight and height were measured using a standardized beam balance with an attached stadio-meter ***(Seca Model 213, USA)*** with the subjects lightly dressed. Body mass index (BMI) was

calculated from weight over height in kg/m². Smoothed centile charts were derived using the Least Mean Square (LMS) method.

Data analysis was done using the Statistical Package for the Social science (SPSS) version 23.0. Categorical variables were reported as frequencies and percentageswhile the mean and standard deviation of normally distributed quantitative variables were determined. Student t test was used in comparing two mean + SD. Analysis of Variance (ANOVA) of mean greater than two was determined.The WHO mean + SD chart was used in reporting malnutrition. Pearson's correlation r was also determined. Significant p is value < 0.05.

Ethical approval was obtained from the Ethics and Research Committee of University of Ilorin Teaching Hospital. A written Permission was also obtained from Kwara State Ministry of Education. Permission was obtained from the school head teacher and class teacher during the field work. In addition, a written informed consent from the parents or guardians of the participants was gotten. Assent was obtained from participants aged Seven years and above.

The authors provided the funds needed for the research.

There is no conflict of interest.

Privacy and confidentiality of data was guaranteed through use of codes and de-identifiers.

RESULTS

Socio-demographic characteristics of Respondents

The mean age of the respondents was 8.95 ± 2.02. There are more pupils recruited from the public schools 324 (57%) in this study. Children aged 10 years and above were in the majority 228 (40.2%) while males were generally more 296 (52.1%) compared with their female counterparts **Table 1.**

Mean Body Fat across the study population

The Mean body fat was highest in the age group 8 – 9 years (Mean ± SD of 50.83 ± 4.30) with a statistically significant difference across the age group **p < 0.001**. Females had a higher mean body fat of 51.54 ± 5.70 compared to the males with a statistical significance **p < 0.001** while private school pupils had a higher body fat than their counterparts in the public schools, this was equally statistically significant **(p = 0.017) Table 2.**

Mean distribution of clinical measurements based on age

The overall mean body fat against age was lower among the 6 – 7years age group (46.68 ± 11.33) while the age group 8 – 9years had a higher (50.83 ± 4.30) mean body fat and the difference was statistically significant **(p < 0.001)**. The overall mean (± SD) waist and hip circumference was higher among pupils aged ≥ 10 years with 62.65 ± 5.038 and 69.00 ± 6.27 respectively which was statistically significant **p < 0.001**. The overall mean (± SD) BMI was higher among pupils aged 6 – 7years (16.20 ± 3.33), with a statistically significant difference **(p = 0.006) Table 3.**

Mean distribution of clinical measurements based on gender

The overall mean body fat of females (51.54 ± 5.70) was higher than in the males (47.27 ± 8.76) and this difference was significant statistically **(p < 0.001)**. The overall mean BMI was also higher for females than males, with a significant difference statistically **(p < 0.001)** However, we found an insignificantly higher mean hip and waist circumference among males 65.17 ± 6.51 (p=0.127).**Table 4.**

Mean distribution of clinical measurements based on type of school

The overall mean body fat for private schools was 50.50 ± 4.72 compared to 48.69 ± 9.08 in public schools and this difference was statistically significant **(p = 0.017)**. The hip circumference was significantly higher in private school students compared to public schools **(p = 0.023).** There was no significant difference in the waist circumference as well as the BMI in both school setting **Table 5.**

Correlation between body fat and other variables

Age, height, weight, BMI and waist circumference correlated significantly and positively with body fat mean **Table 6.**

Figure 1: WHO Mean BMI

The mean BMI for Age percentile was below -2SD for the entire study population.

Table 1: Socio-demographic characteristics of Respondents

Variables	Frequency	Percentage
School type		
Public	324	57.0
Private	244	43.0
Age groups (years)		
6 – 7	161	28.3
8 – 9	179	31.5
= 10	228	40.2
Mean ± SD	8.95 ± 2.02	
Gender		
Male	296	52.1
Female	272	47.9

Table 2: Mean Body Fat across the study population

Body fats		N	Mean ± SD	F / student t-test	*p* value
Age groups (years)				12.621	**0.001**
	6 – 7	169	46.68 ± 11.33		
	8 – 9	171	50.83 ± 4.30		
	≥ 10	228	50.44 ± 5.33		
Gender				35.009	**0.001**
	Male	296	47.27 ± 8.76		
	Female	272	51.54 ± 5.70		
School type				5.712	0.017
	Public	324	48.69 ± 9.08		
	Private	244	50.50 ± 4.72		

N is the frequency, F= Analysis of Variance ANOVA

Table 3: Mean distribution of clinical measurements based on age

Variables	6 – 7 years	8 – 9 years	= 10 years	F test	*p* value
Body fat Mean ± SD	46.68 ± 11.33	50.83 ± 4.30	50.44 ± 5.33	12.621	**< 0.001**
BMI Mean ± SD	16.20 ± 3.33	14.91 ± 3.78	15.83 ± 4.26	5.176	**0.006**
Waist Circumference Mean ± SD	57.41 ± 4.06	59.88 ± 4.42	62.65±5.038	62.422	**< 0.001**
Hip Circumference Mean ± SD	61.66 ± 4.97	65.45 ± 5.21	69.00±6.273	80.989	**< 0.001**

BMI = Body Mass Index, F = ANOVA

Table4: Mean distribution of clinical measurements based on gender

Variables	MALE Mean ± SD n296	FEMALE Mean ± SD n-272	Student t-test	*p-value*
Body fat	**47.27 ± 8.76**	51.54 ± 5.70	35.009	**< 0.001**
Waist circumference	60.79 ± 4.93	59.72 ± 5.15	6.276	0.103
Hip circumference	66.34 ± 6.14	65.17 ± 6.51	4.893	0.127
BMI (kg/m^2)	13.41 ± 2.24	18.09 ± 3.83	321.010	**<0.001**

n=frequency

Table 5: Mean distribution of clinical measurements based on type of school

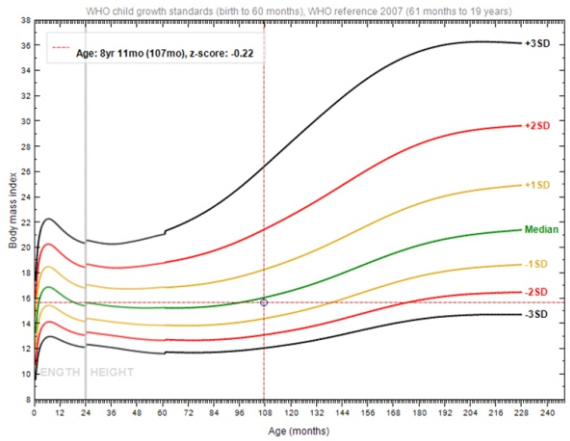
Variables	Public Mean ± SD n=296	Private Mean ± SD n=272	Student t-test	*p-value*
Body fat	48.69 ± 9.08	50.50 ± 4.72	5.712	**0.017**
Waist circumference	60.06 ± 4.78	60.57 ± 5.39	1.396	0.238
Hip circumference	65.26 ± 6.00	66.48 ± 6.71	5.206	**0.023**
BMI (kg/m^2)	15.49 ± 4.54	15.76 ± 2.79	0.687	0.408

n=frequency

Table 6: Correlation between body fat and other variables

Variables	Body Fat Pearson's correlation r	p-value
Age	0.26	**0.001***
Height	0.20	**0.002***
Weight	0.22	**0.001***
Body Mass Index	0.11	**0.001***
Waist Circumference	0.06	**0.026***
Hip Circumference	0.09	0.066

r= correlation coefficient



DISCUSSION

The study revealed that body fat distribution was higher in female pre-adolescent children with corresponding BMI. It also reveals a high burden of malnutrition with undernutrition co-existing with a high body fat. In addition, mean body fat correlated positively with BMI, waist circumference and age which implies that indirect methods are useful tools in determining body fat in children.

This present studyassessed body fat in black pre-adolescent children in Nigeriawhile majority of the previous studiesassessing body fat in children using direct method was carried out more among adolescentCaucasian, Asians and more recently in South Africa.[8–12]Body fat measurement shows that the mean body fat increased significantly across the different age group while females had higher mean body fat than the males. These findingsare in tandem with previous studies where females were found to have higher body fat than males.[13]

Female students were found to have more body fatcompared to males in thepre-adolescent children studied. Similar gender differences have been reported in other studies conducted among children in Africa and outside of Africa.[14–16] Other studies, have reported the gender difference in percent body fat mass and attributed it to the natural differences in fat distribution between males and females, particularly during adolescence.[17–19] A similar trend was seen among South African youngsters, where female students were more likely to be overweight or even obese.[20]These findings emphasize the importance of focusing on females when developing preventive strategies like lowering dietary fat and energy intake and encouraging more women to participate in sports and other physical activities. Fourteen out of the 20 children in the study population had lots of body fats, this is particularly so among children older than 8years. Obesity decreased with decreasing age, according to this study, which iscomparable to similar studies in Zimbabwe and Africa, wheresimilar results were observed.[19,,21-25]

Mean body fat was found to be higher in private schools' attendees than children in public schooland was statistically significant. Mean BMI in the two school types werehowever similar.Children in private schools had higher BMI classifications than children in the public schools and this was statistically significant.That pupils from private schools are expected to be from a higher socio-economic background andmostly living a sedentary life style thus can have the propensity of increased body fat and BMI.It could also be as a result of their accessibility to more food especially unhealthy, sugary foods and snacks to these children which is usually not monitored. In some cases, this may be due to the availability of fast food at schools' shops. According to research conducted by Temple in South Africa, 70% of students bought no healthy food and 73% bought two or more unhealthy items from school shops, which supports this claim.[26] Researchers in South Africa found that the availability of fast food and street vendors to schoolchildren in urban areas contributes to obesity.[27]

Mean Waistcircumference and Hip circumference increased significantly with age, male had a higher mean Waist and Hip circumference than females but was not significantly different.Mean BMI was not significantly different across age categories but was significantly higher in females than in males.

The overall mean BMI for Age Percentile for the entire study population was 15.65± 3.89, which was below -2SD is below the 50 percentiles for age and this reflects wastingmalnutrition(undernutrition) in the study population.

Body fat correlated positively and significantly with age, height, weight, BMI and waist circumference. The children's body fat mass, waist circumference, BMI for age percentage, and hip circumference were found to have positive correlation and this shows that such indirect methods are usually tools in determining body fat in children. BMI is a simple and low-cost surrogate for body fatness in elementary school students, regardless of age and sex. The strength of the link between BMI and percent Body Fat appears to get stronger as children get older, according to the study's long-term findings. This study did not just reveal the important relationship between direct body fat assessment with indirect methods available, it also reveals the fat distribution pattern as well as its importance in determining the nutritional status of the study population who were pre-adolescent children in the North central part of Nigeria.

CONCLUSION

The study revealed that body fat distribution was higher in female pre-adolescent children with corresponding BMI.Private school students had higher mean body fat compared to the students in public schools. There is a high burden of malnutrition especially the undernutrition co-existing with a high body fat.Mean body fat correlated positively with BMI, waist circumference and age which implies that indirect methods are useful tools in determining body fat in children. Theexistence of the two forms of malnutrition observed in this study has implication for the health of the school children.

RECOMMENDATIONS

Intervention program must be instituted to improve nutritional status of the children with under-nutrition as well as to check the rising trend of excessive body fat in the form of obesity which has implication for the risk of long-term conditions like Type II diabetes and hypertension.

It is imperative that elementary schools implement more active programs to combat the increasing trend of the double burden of malnutrition.

A comparable nation – wide investigation should be carried out in Nigeria to determine the entire magnitude of this hidden burden of the disease.

Improving on nutrition education, encouraging the government on promoting school feeding in school children, regulating type of food that are sold or given to school children should be advocated for.

Sport and exercise should be encouraged in schools especially in the private schools where there's a growing trend of overweight and obesity in this class of children.

Limitation

Dietary pattern as well as the degree of physical activities was not assessed.

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Conflict of Interest

Nil

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