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Prevalence and Pattern of Overweight and Obesity in Adolescents Living in Urban and Rural Settings of Enugu State, Nigeria

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Abstract: Cases of overweight and obesity are increasing worldwide. Recently, the application of body mass index (BMI) cut off points for overweight and obesity classifications have been questioned. Bioelectrical impendance analysis (BIA) is a safe, accurate and reliable method for screening overweight and obesity. This study determined the pattern of body weight distribution and the prevalence of overweight and obesity using both BMI percentile and BIA in adolescents living inurban and rural settings of Enugu State, Nigeria. A total of 760 adolescents domiciled in urban and rural areas of Enugu state were recruited for the study. Their body height and weight were measured using standard protocol and BMI was calculated using the formula BMI = Weight (kg)/[Height (m)]^2. The BMI obtained was plotted on the CDC BMI-for-age growth charts to obtain the percentile ranking used for children and adolescent weight classification while body fat percentage was measured using BIA. Body weight distribution was reported according to age, sex and place of domicile.BMI percentile weight categories gave 9.8% and 2.8% prevalence of overweight and obesity respectively in the urban area and 5.2% and 1.1% overweight and obesity prevalence in rural area. Body fat % categorization gave 5.6% and 1.8% overweight and obesity prevalence respectively in urban setting and 4.3% overweight and 1.1% obesity prevalence in the rural area. The prevalence of overweight / obesity was highest in the urban area. This shows that BMI percentile is not a direct measure of body fat % and should be used with caution in the diagnosis of overweight and obesity in children and adolescents. Also the prevalence of overweight and obesity in the study population calls for urgent pediatric public health action to address the situation.

Key words: Adolescents · Overweight · Obesity · Body mass index · Body fat percentage and bioelectrical impendance analysis

INTRODUCTION

Over the years, there has been a change in people's perception about being robust which was earlier seen to be a sign of affluence. This is as a result of increased awareness of the health risks associated with excess fat or obesity [1-3]. Obesity is now one of the major medical problems affecting both children and adults and has been described as a global epidemic [4-10] because it is associated with numerous health problems like cardiovascular disease, type 2 diabetes, certain cancers, [11-16] and increased risk of morbidity and mortality in adulthood [17-20].

The sudden rise in excess fat gain led the American Heart Association (AHA) to call for action to curb consequences of this epidemic [21, 22]. Obesity and overweight are mostly caused by significant decline in physical activities due to increasing use of mechanized transportation and prevalence of labour saving technology in homes and also excessive consumption of high caloric diets,fast foods and canned foods [23-30].

Paradoxically, excessive quest to remain in the healthy fat category, to be fit and also to avoid most of the obesity related disorders/disease have made many people under fat especially among the athletes. However, being under fat is not a medical certificate for good health

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because it also has its own health implications [31] such as infertility, eating disorders, loss of bone mass and density [32].

Various techniques are used to measure body fatness to predict the risk of having the health complications predisposedby abnormal body fat. The use of most of these methods is limited to research settings because of their complexity and cost. The most frequently used tools in public health evaluations and clinical screening is body mass index [33-38]. But, recently, bioelectrical impendance analysis (BIA) has received a great interest as a useful tool in evaluating body fat in both healthy individuals and patients [39-42]. Following the increasing incidence of obesity, the need for accurate measurement of adiposity has become increasingly important not only for the prevention and treatment of most of the obesity related complications but also because of psychosocial complications related to body dissatisfaction which are especially prevalent among adolescents [43]. Though few studies have been done on the prevalence of overweight and obesity in Nigeria, majority of them were limited by design. They used mostly BMI to diagnose overweight and obesity, also, current information about the extent of obesity in developing countries is needed in order to assist policy makers and health planners with setting priorities and for mobilizing and allocating resources to programmes. Hence, this study is therefore aimed at investigating the prevalence of overweight and obesity in adolescents residing in urban and rural settings of Enugu State, Nigeria using both BMI percentile weight category and BIA methods.

Method: A total of 780 adolescents who were apparently in good health from both private and public secondary schools in Enugu State were recruited for the study. They included 430 subjects from Urban and 350 subjects from rural areas aged between 10 and 20 years. Urban area here refers to a town with virtually all the trappings of a city: good paved roads, electricity, pipe-borne water and almost all the inhabitants do not engage in subsistence agriculture while rural area refers to a town where most of the inhabitants are unskilled artisans, but still engage in subsistence farming. For descriptive purpose, we first grouped the adolescents in the pooled data into four groups (10-12 yrs, 13-15yrs, 16-18yrs and ≥19yrs).

Height was measured (to the nearest 0.5cm) using stadiometer with the subjects standing on bare feet with head kept erect. Weight was measured (to the nearest 0.1kg) with the subjects on bare feet and with light clothing using an electronic weighing balance calibrated each morning accordingto the manufactures instruction. From the weight and height got, body mass index (BMI) was calculated using the formula; BM = weight (kg)/Height (m^2)·BMI calculated were plotted on CDC BMI- for- age growth charts to obtain a percentile ranking used for children and adolescents. Thinness was defined as BMI/ for-age <5th percentile, Normal BMI-for –age was taken as values ≥5th percentile but = 85thpercentile of the reference data, overweight was taken as 85th to less than 95thpercentile while obesity was taken as BMI ≥ 95 th percentile of first U.S National Health and Nutrition Examination survey (NHANES) 1971-1974 reference data for blacks as approved by the World Health Organization (WHO) [26]. Body fat percentage was measured using hand-held body fat monitor which uses the principle of Bioelectrical impendence analysis (BIA) to determine an individual's body fat percentage, body fat categorization was done using body fat percentage chart.

A hand written questionnaire validated by Nduka U. C. from the Department of Statistics, University of Nigeria, Nsukka was used to solicit information on weight classification of subjects' parents (overweight/obesity) and family history of body fat related complications (Hypertension, diabetes, kidney disease).

Statistical Analysis: To calculate the prevalence, we divided the number of such cases by the number of subjects in that category and multiplied the answer by 100. All data analyses were done using the statistical software SPSS version 18.

BMI Percentile Weight Categories of Urban Subjects: The prevalence of overweight and obesity in urban dwelling boys were 5.0 % each, with those aged 13-15 years and 10-12 years recording the highest prevalence of overweight (6.4%) and obesity (15.8%) respectively. 84.2% of the boys in the study area had healthy weight while 5.8% of the boys were under weight. For the urban girls, a total of 85.1% had healthy body weight, 1.3% were under weight. While, 11.7% and 1.9% were overweight and obese respectively. The highest prevalence of overweight (19.2%) and obesity (3.8%) were recorded in those aged 10-12 years. Altogether, 2.6% of the subjects in urban area using BMI Percentile categorization were under weight, 84.8% had healthy weight, 9.8% overweight while 2.8% were obese (Table 1).

Table 1: BMI percentile weight categories of urban subjects.

	BOYS					GIRLS					TOGETHER				
Age (Years)	N	UW (%)	HW(%)	OW(%)	O (%)	N	UW(%)	HW(%)	OW(%)	O (%)	N	UW(%)	HW (%)	OW(%)	O (%)
10-12	19	5.3	73.7	5.3	15.8	26	0.0	77.0	19.2	3.8	45	2.2	75.6	13.3	8.9
13-15	78	5.1	85.9	6.4	2.6	212	1.4	84.4	12.3	1.9	290	2.4	84.8	10.7	2.1
16-18	22	9.1	86.4	0.0	4.5	69	1.4	90.0	7.2	1.4	91	3.3	89.0	5.5	2.2
≥19	2	0.0	100.0	0.0	0.0	2	0.0	100.0	0.0	0.0	4	0.0	100	0.0	0.0
Total	121	5.8	84.2	5.0	5.0	309	1.3	85.1	11.7	1.9	430	2.6	84.8	9.8	2.8

N, UN, HW, OW and O stand for number of subjects, underweight, healthy weight, overweight and obese, respectively.

Table 2: BMI percentile weight categories of rural subjects.

	BOYS					GIRLS					TOGETHER				
Age (Years)	N	UW (%)	HW(%)	OW(%)	O (%)	N	UW(%)	HW(%)	OW(%)	O (%)	N	UW(%)	HW (%)	OW(%)	O (%)
10-12	11	9.1	81.8	9.1	0.0	11	9.1	72.7	18.2	0.0	22	9.1	77.3	13.6	0.0
13-15	108	2.8	92.6	4.6	0.0	80	1.3	862	10.0	2.5	186	21	89.9	6.9	1.1
16-18	58	10.3	87.9	1.7	0.0	71	8.5	88.7	0.0	2.8	129	9.3	88.3	0.5	1.6
≥19	2	50.0	50.0	0.0	0.0	9	0.0	88.9	11.1	0.0	11	9.1	81.8	9.1	0.0
Total	179	6.1	89.9	3.7	0.0	171	4.7	86.5	6.4	2.3	350	5.4	88.3	5.2	1.1

N, UW, HW, OW and O stand for number of subjects, underweight, healthy weight, overweight and obese, respectively.

Table 3: Body fat percentage categories of urban subjects

	BOYS					GIRLS					TOGETHER				
Age (Years)	N	UW (%)	HW(%)	OW(%)	O (%)	N	UW(%)	HW(%)	OW(%)	O (%)	N	UW(%)	HW (%)	OW(%)	O (%)
10-12	19	5.3	78.9	15.8	0.0	26	7.7	84.5	3.9	3.9.	45	6.7	82.2	8.9	2.2
13-15	78	3.9	84.5	7.7	3.9	212	2.4	92.4	4.3	0.9	290	2.8	90.3	5.2	1.7
16-18	22	9.1	77.3	13.6	0.0	69	5.9	91.3	1.4	1.4	91	6.6	87.9	4.4	1.1
≥19	2	0.0	100.0	0.0	0.0	2	0.0	100.0	0.0	0.0	4	0.0	100.0	0.0	0.0
Total	121	5.0	82.6	9.9	2.5	309	3.6	91.5	3.6	1.3	430	4.0	89.0	5.4	1.6

N, UF, HF, OF and O stand for number of subjects, under fat, healthy fat, over fat and obese, respectively.

Table 4: Body fat percentage categories of rural subjects

	BOYS					GIRLS					TOGETHER				
Age (Years)	N	UW (%)	HW(%)	OW(%)	O (%)	N	UW(%)	HW(%)	OW(%)	O (%)	N	UW(%)	HW (%)	OW(%)	O (%)
10-12	11	27.3	63.6	9.1	0.0	11	18.2	81.8	0.0	0.0	22	22.7	72.7	4.6	0.0
13-15	108	0.9	94.4	3.8	0.9	80	2.5	91.2	6.3	0.0	188	1.6	93.1	4.8	0.5
16-18	58	6.9	89.7	3.4	0.0	71	1.4	91.5	2.8	4.2	129	3.9	90.7	3.1	2.3
≥19	2	0.0	100.0	0.0	0.0	9	11.1	77.8	11.1	0.0	11	9.1	81.8	9.1	0.0
Total	179	4.5	91.0	3.9	0.6	171	3.5	90.0	4.7	1.8	350	4.0	90.6	4.3	1.1

N, UF, HF, OF and O stand for number of subjects, underfat, healthy fat, over fat and obese, respectively, n = 780.

BMI Percentile Weight Categories of Rural Subjects: Table 2 shows that obesity was not prevalent in rural-dwelling boys, while 3.7% were overweight, 89.9% had health weight and 6.1% were under weight. The highest number of overweight boys was recorded in those aged 10-12 years (9.1%) while those aged ≥ 19 yrs had the highest prevalence of underweight (50.0%). As much as 6.4% of the girls in the rural area were overweight, 2.3% overweight, 4.7% underweight while 86.5% had healthy weight. Irrespective of sex, 5.4% of the subjects in rural area using BMI categorization were under weight, 88.3% had healthy weight 5.2% over weight while 1.1% were obese.

Table 5: Weight classification of subject parents overweight/obese

	Urban N (percent)	Rural N (percent)	Total N (percent)
Father	40(5.1)	35(4.5)	75(9.6)
Mother	85(10.9)	78(10.0)	163(20.9)
Both	81(10.4)	45(5.8)	126(16.2)
None	224(28.7)	192(24.6)	416(53.3)

Table 6: subjects' relatives suffering from hypertension, diabetes and kidney diseases

	Urban N (percent)	Rural N (percent)	Total N (percent)
Hypertension	24(3.1)	23(2.9)	47(6.0)
Diabetes	37(4.7)	31(4.0)	68(8.7)
Kidney disease	6(0.8)	1(0.1)	1(0.9)

Body Fat Percentage Categories of Urban Subjects: Obesity was prevalent in only boys aged 13-15 years (3.8%) in the urban area using body fat percentage categorization while over fat was most prevalent at ages of 10-12 years (15.8%). Among the urban subjects, 5.0% of the boys were under fat, 82.6% had healthy fat, 9.9% over fatand 2.5% obese, for the girls, 3.6% were under fat, 91.5% had healthy fat, 3.6% over fat while 1.3% were obese. Obesity and under fat were more prevalent in girls aged 10-12 years (3.9%) and 13-15 years (4.3%) respectively. Collectively, 4.0% of the subjects in this area irrespective of sex were under fat, 89.0% had healthy fat, 5.4% over fat while 1.6% were obese (Table 3).

Body Fat Percentage Categories of Rural Subjects: Table 4 shows that 91.0% of the boys in the rural area had healthy fat, 4.5% were under fat, 3.9% over fat and 0.6% obese. Only 0.9% of the boys aged 13-15yrs were obese in this area while the over fat was more prevalent at 10-12 yrs (9.1%.), similarly, only girls aged 16-18 yrs (4.2%) were obese in this area with the over fat being more prevalent for girls ≥ 19 years (11.1%). A total of 90.0% of the girls in this area had healthy fat, 3.5% under fat, 4.7% over fat and 1.8% obese. Altogether, out of 350 subjects categorized using body fat percentage in this area, 4.0% were under fat, 90.6% had healthy fat, 4.3% over fat and 1.1% obese.

Weight Classification of Subject Parents Overweight/ Obese: Table 5 shows subjects genetic disposition. From the results, 75 subjects (9.6%) have overweight/obese father, 163 subjects (20.9%), have overweight/obese mother: 85 of this subjects (10.9%) were from urban area while 78 subjects (10.0%) were from the rural area. The Table also shows that 126 subjects have both parents overweight/obese while 416 have none of their parents overweight/obese.

Subjects' Relatives Suffering from Hypertension (HBP), Diabetes and Kidney Disease: A total of 47 subjects (6.0%) have relatives suffering from HBP, 24 of these subjects (3.1%) were from the urban area while 23 (2.9%) came from rural area. Sixty eight subjects (8.7%) have relatives suffering from diabetes while only 7 subjects (0.9%) have relatives who suffered or are still suffering from kidney disease (Table 6).

DISCUSSION

Worldwide, obesity trends are serious public health concern and in many countries threatening the viability of basic care delivery [14] and has been adjudged by the World Health Organization as having reached pandemic proportion [21].

BMI classification of overweight and obesity has been controversial and investigating whether the accepted BMI cut off points are appropriate for identifying increased health risk is an important challenge for the health system.

One of the major findings in the present study is that there is a large discrepancy between BMI percentile and BIA -defined adiposity status. This study shows that BMI percentile weight classification over diagnosed overweight and obesity in the subjects compared with body fat % measured with BIA. In urban area, it was 9.8% vs6% overweight and 2.8% vs 1.6% obesity; thereby predicting almost fifty percent increase in overweight and obesity respectively while in the rural area, it was 5.2% vs 4.3% overweight and 1.1% vs.1.1% obesity. This shows that BMI is not a direct measure of body fatness. A sizeable proportion of the subjects were misclassified by BMI percentile criteria. This poses serious health consequences on the population, as intervention may be misapplied. BMI is calculated from an individual weight which includes muscle and fat. As a result some individual´s may have high BMI but not have a high body fat%. This agrees with reports from previous studies carried by [6, 15 and 2] and also reinforces the statement made by Goodman *et al.* (2000) [29] that error in BMI is significant due to its inability to differentiate between body fat and lean mass.

However, the advantage of using BMI is that height and weight are variables readily available and easy to measure [33]. But it is important to remember that weight and height changes that occur during growth results in substantial (50%) increase in BMI, further complicating the interpretation of this index among children and adolescents

The prevalence of overweight and obesity obtained in this study is significantly lower than the 10.7% prevalence reported by Chigbo and Aja, (2011) [21] who studied pregnant women in Southeast Nigeria, 20% overweight and 5% obesity obtained in two villages in south-western Nigeria by Durazo-Arvizu *et al*., (2008) [24] and also 53.3%overweight and 21% obesity prevalence recorded in Northern Nigeria by Wahab *et al*. (2011) [18]. Our figures are also lower than 17.2% and 4.2% overweight and obesity respectively obtained by Puepet *et al*. (2002) [13] who studied Nigeria adults in Jos. The lower prevalence of overweight and obesity in the present study when compared with previous studies carried out in Nigeria using adult population may be due to the younger age group of the subjects because obesity increases with age [4, 6 and 8].

Significantly, more subjects in the urban setting had higher prevalence of overweight and obesity compared with their rural counterparts. This is probably because of the high consumption of fast food, canned and backed foods in this area. These food types have been associated with greater energy intake and glycemic load and poor nutritional quality which cause higher body fatness [24 and 27]. Poti *et al*., (2014) [12] proposed that fast foods have high total energy, total fat and saturated fat and also lower fibre content. The obesegenic effects of dietary fats have been attributed to its high energy density and palatability which leads to passive over consumption. The high efficiency of dietary fat storage, which leads to a more positive energy balance and a weaker metabolic feedback system of appetite control for fat, leads to greater energy consumption and fat accumulation [30]. In the rural populations of Southeast Nigeria, the diet consists mainly of traditional high fibre foodstuff and complex carbohydrates (Chigbu and Aja, 2011) [21]. Carbohydrate overfeeding studies found the presence of homeostatic control that quickly increase carbohydrate oxidation in response to overfeeding and that subsequently balance dietary carbohydrate intake with oxidation [30].

In addition, it could also be due to significant decline in physical activities especially in the urban area due to the use of mechanized transportation and greater prevalence of laboursaving technologies in homes [4]. Overweight and obesity are results of caloric imbalance due to few calories expanded for the amount of calories consumed. Increased physical activity enhances the ability to increase 24 hours fat oxidation in response to increasing intake of fat in the diet and thus help in reducing positive fat balance and ultimately weight gain. Hence, it was shown by Hansen *et al*., (2007) [30] that adjustment in fat oxidation is accelerated by an increased level of exercising in man.

It is worrisome to realize that this high prevalence of overweight and obesity is expected to increase especially in urban areas due to considerable increase in sedentary lifestyle and the "crazy" demand for fast food. Popkin (1994) [1] has called attention to the nutrition transition in developing countries or shift from traditional diet or lifestyles to the western diet (diets high in saturated fats, sugar and refined food) and the combination of reduced level of physical activity and increased stress. The feared outcome of the nutritional transition are increased level of obesity and chronic and degenerative diseases. Hence, the need for urgent measures to save the magnitude of its occurrence in the near future and more so considering the fact that some subjects have parents who are overweight and or obese and also have obesity related complications like hypertension, diabetes and kidney disease (as shown in Tables 5 and 6) which are hereditary [22 and 37].

CONCLUSION

This study shows that BMI Percentile does not measure body fat accurately. Hence it is recommended that caution should be taken when BMI percentile is used in clinical and scientific research as diagnostic tool for overweight and obesity. Also, there is need for immediate public health interventions to reduce overweight and obesity prevalence in Enugu state.

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