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Prevalence of Overnutrition using Body Mass Index in Comparison with Bioelectrical Impedance Analysis among Children and Adolescents in Benin, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author SO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AP and AO managed the analyses of the study. Author ND managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To compare the prevalence of overweight and obesity among school children in Egor Local Government Area (LGA) using body mass index (BMI) and bioelectricial impedance analysis (BIA) and determine the ability of body mass index (BMI) to predict body fat mass as measured by bioelectricial impedance analysis (BIA).
Study Design: This was a cross sectional study conducted in Egor Local Government Area of Edo State of Nigeria with1067 children aged 6-18 years recruited from private and public schools. Body mass index was calculated as weight in kilograms divided by the square of height in meters while Body fat was estimated by BIA using a Tanita scale.
Place and Duration of Study: The study took place in selected private and public primary/secondary schools in Egor LGA of Edo State. The study was conducted over a three-month period from October to December 2017.
Methodology: Using multi-stage sampling technique,1067 children aged 6-18 years were

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recruited from private and public schools in Egor Local Government Area in Benin City, Nigeria. Body fat was estimated by BIA using a Tanita scale, whereas BMI was calculated as weight in kilograms divided by the square of height in meters. Data was analyzed using SPSS version 21.
Results: A total of 1067 pupils consisting of 538 (50.4%) males and 529 (49.6%) females were recruited. The overall prevalence of overnutrition by BMI, 13.4% (overweight 9.6% and obesity 3.8%) was comparable to that by BIA which was 12.4% (overweight 5.4% and obesity 6.9%). BMI showed a strong positive correlation with fat mass, and fat mass index especially in females (0.917, 0.907, $p < 0.000$).
Conclusion: The prevalence of overnutrition using BMI and BIA was comparable. The prevalence of obesity is however underestimated with BMI.

Keywords: Over-nutrition; overweight; obesity; prevalence; children; BMI; BIA.

1. INTRODUCTION

"Overnutrition which consists of overweight, and obesity has become pandemic in childhood and adolescence. Overnutrition which was previously considered a problem of high-income countries has become prevalent in low- and medium income countries, especially in urban settings. The worldwide prevalence of obesity has almost tripled since 1975 and most of the world population now live in countries where overweight and obesity kill more people than underweight" [1]. "Approximately 38.2 million children less than 5years were reported to be either overweight or obese in 2019, while over 340 million children and adolescents aged 5-19 years were overweight or obese in 2016" [1]. "Studies show that obesity has increased rapidly in children aged 5 – 19 years in almost all European regions from 1980 to 2016" [2]. "In the United States, since the 1970s the percentage of children and adolescents affected by obesity has more than tripled" [3]. "Obesity varied by race and ethnicity and according to Hales *et al,* 19.3% of US children aged 2-19 years had obesity in 2017-2018" [4].

"Africa has equally experienced a rising trend in overnutrition with a reported increase of 24% in the number of overweight children less than 5years" [1]. Akowuah et al. [5] reported "an overall prevalence of 8.6% and 10.7% of childhood obesity and overweight respectively in Ghana, which is comparable to values reported by other regional studies in Africa" [6]. "The age-adjusted prevalence of overweight and obesity in a systematic review" by Adeloye et al [7] in Nigeria was 20.3% and 11.3% respectively. "A ten-year review of obesity in children reported a prevalence of 7.1% in a hospital-based study [8] while a community study of school-aged children in Southwestern Nigeria reported a 6.6% and 8.9% prevalence of overweight and obesity respectively" [9].

"The target according to World Health Organization (WHO) Global Monitoring Framework for Non-Communicable Diseases (NCD) is to have eliminated childhood overweight and obesity by 2030 as obese children tend to become obese adults" [10]. "For this to be possible overnutrition needs to be assessed and identified early and policies and practices adopted to reverse it."

"Overnutrition is caused by an interplay of genetic, behavioural and environmental factors. The consumption of diets high in fat and a reduction in energy expenditure with a more sedentary lifestyle is by far the major culprit. Overweight and obesity affect all the systems of the body increasing the occurrence of various diseases such as stroke, arthritis, diabetes, cancer and in addition have emotional, mental and social consequences on the health of the individual. It can cause guilt, depression, embarrassment and social isolation" [11].

Body mass index which is calculated as weight in kilograms divided by the square of height in meters is an indirect method of measurement of obesity. It is often used to assess adiposity but it does not differentiate between fat and non-fat components of body mass.

Bioelectrical impedance analysis is a direct method of fat estimation, and so is superior to BMI in this respect. The aim of this study, therefore, is to compare BMI with BIA in the assessment of overnutrition in children in our locale.

2. MATERIALS AND METHODS

2.1 Study Design

This was a cross sectional study conducted in Egor Local Government Area of Edo State of Nigeria.

2.2 Setting

"Egor, which consists of ten political wards has the headquarters in Uselu, and a projected population of 445,095 based on the 2006 census and a projected annual growth rate of 2.8%" [12].

The major occupations of the people include farming, trading and civil service. There are 37 public primary schools, 13 public secondary schools and 143 approved private nursery, primary and secondary schools within the LGA. Egor LGA was chosen because it is centrally located in Benin City and cuts across various socioeconomic strata. The study was conducted over a three-month period from October to December 2017.

2.3 Study Population

One thousand and sixty-seven apparently healthy primary and secondary school children in Egor LGA aged 6 – 18 years were selected by multi-stage sampling technique for the study.

A research team which included the principal investigators and 4 research assistants comprising pre-National Youth Service Corps (NYSC) medical doctors was constituted.

Health talk on the risk of obesity, its prevention, as well as the objective of the study was given to the students of the school by the researchers. Questions on the study were entertained from the children and teachers after the health talk.

2.4 Sampling Technique

Multi-stage sampling technique was employed in the selection of participants. Simple random technique was used to select 3 out of the 10 political wards in Egor LGA. The 3 selected wards have a total of 27 private and 10 public schools. One public and three private schools were selected using simple random sampling technique bringing the total to 3 public and 9 private schools.

The number of pupils to be sampled from each school was determined using the formula:

$$n = a \times b/c$$

where a is the number of children aged 6 – 18 years in each school; b is the sample size of the study (1067) while c is the total number of children aged 6 – 18 years in all the selected schools. The number of children to be sampled from each age group was calculated after obtaining their ages from the class register provided by the school head. The formula $n_1 = a \times b/c$ was used where n_1 is the age sample size; a is the number of each age cohort; b is the obtained sample size from each selected school; c is population of children 6-18 years in each school [13].

2.5 Selection of Subjects

"One arm was picked from primary one and primary two where the 6year olds were found. The register for the selected arm was obtained and a separate list of male and female pupils was generated following which a number was assigned to each pupil, written in a piece of paper and put in a bag. The required number of pupils was randomly picked separately for the bags containing males and females until the sample size was obtained".

2.6 Data Collection

"A questionnaire which was pretested in another school not selected for the study was used to collect information on the sociodemographic characteristic of the subjects and their families and on the presence of any chronic disease. A general examination was performed on the subjects while the anthropometry was measured. A Seca stadiometer (model 214; Seca Corp, Hanover, MD, USA) was used to measure the height to the nearest millimeter following standard procedure. The weight was measured to the nearest 100g with the Tanita body fat monitor/scale model SC-240 which displays the body weight and percentage body fat. The fat mass was calculated from the percentage body fat and body weight. The fat free mass is the body weight minus the fat mass. The fat mass index and the fat free mass index was derived from the fat mass and fat free mass respectively divided by the square of the height.

The socioeconomic class was calculated using the educational status and occupations of the parents as described by Oyedeji" [14].

2.7 Data Analysis

Data was analyzed using statistical package for social sciences SPSS version 21.0 (SPSS for Window Inc; Chicago, IL, USA). Mean, standard deviation, standard error of mean was calculated for quantitative variables such as BIA, BMI and

independent t-test was used for comparison of mean. The significance of each test was set at $p < 0.05$ and confidence level of 95.0% [13].

3. RESULTS AND DISCUSSION

A total of 1067 children comprising 538 (50.4%) males and 529 (49.6%) females participated in the study giving a male: female ratio of 1:1.About two-thirds of the participants were from the private schools (68.6%). Majority were from the middle socioeconomic class (SEC), followed by those from the upper SEC.

There were more participants from the pre-adolescent group of 6-9 years. The sociodemographic characteristics of the subjects is as shown in Table 1.

Table 1. The socio-demographic characteristics of the pupils

	Public School	Private School	Total
	n=335(%)	n=732(%)	N=1067(%)
Sex			
Male	176(52.5)	362(49.5)	538(50.4)
Female	159(47.5)	370(50.5)	529(49.6)
SEC			
Upper	58(17.3)	300(41.0)	358(33.6)
Middle	155(46.3)	296(40.4)	451(42.2)
Lower	122(36.4)	136(18.6)	258(24.2)
Age group(yrs)			
6-9	145(43.3)	184(25.1)	329(30.8)
10-12	63(18.8)	182(24.9)	245(23.0)
13-15	64(19.1)	184(25.1)	248(23.2)
16-18	63(18.8)	182(24.9)	245(23.0)

SEC = socioeconomic class

There was no significant difference, as depicted in Table 2, between the mean age of male (12.00 ± 3.77 years) and the female pupils (11.99 ± 3.72 years, $p = 0.941$). There was no statistically significant gender difference between the mean weight and height of the subjects.

The mean fat free mass and fat free mass index was statistically higher in males than females, $p<0.0001$.

The BMI, mean percent body fat, fat mass, and fat mass index were higher in females than in males and this difference was statistically significant, $p<0.0001$[13].

Table 2. Mean gender comparison of age and anthropometric indices

Parameter	Male	Female	T	P
Age	12.00±3.77	11.99±3.72	0.074	0.941
Weight_kg	40.46±15.61	41.95±15.82	1.546	0.122
Height_cm	148.06±19.25	146.79±16.63	1.157	0.248
BMI	17.68±3.20	18.67±4.13	4.404	0.000*
Percent_Body_Fat	13.30±5.90	21.26±8.49	17.791	
Fat_Mass	5.45±4.14	9.96±7.56	12.092	0.000*
Fat_Free_Mass	35.01±13.36	31.99±9.79	4.198	0.000*
Fat_Mass_Index	2.42±1.56	4.31±2.90	13.277	0.000*
Fat_Free_Mass_Index	15.24±2.44	14.42±1.95	6.096	0.000*

**p < 0.05*

3.1 Body Mass Index

Table 3 shows a comparison of mean BMI between males and females according to age. The mean BMI for males and females increased with increasing age except at ages 9 and 12 for males and 16 years for females.

Table 3. Mean body mass index of study subjects according to age and gender

Age in years	Male	Mean (Range)	Female	Mean (Range)	t	*p*
6	43	15.19 ± 1.87 (13.0-22.2)	40	15.00 ± 2.05 (12.2-20.8)	0.444	0.66
7	41	15.34 ± 1.61 (12.4-21.6)	41	15.50 ± 1.66 (13.3-20.5)	0.457	0.65
8	42	15.67 ± 1.54 (13.5-20.0)	40	16.00 ± 2.77 (12.9-25.0)	0.675	0.50
9	40	15.46 ± 1.89 (11.0-19.8)	42	16.44 ± 2.90 (12.7-24.4)	1.801	0.08
10	43	16.59 ± 3.16 (13.3-30.1)	39	16.45 ± 2.52 (10.7-22.7)	0.215	0.83
11	40	17.33 ± 2.87 (12.6-25.6)	42	17.03 ± 2.49 (12.3-26.5)	0.501	0.82
12	38	16.96 ± 1.40 (15.2-21.5)	43	18.14 ± 2.54 (14.3-24.5)	2.549	**0.01***
13	42	17.34 ± 1.75 (14.4-22.3)	40	19.71 ± 3.01 (14.4-29.0)	4.378	**0.00***
14	40	18.05 ± 2.63 (14.1-26.8)	42	19.75 ± 2.72 (13.5-27.7)	2.878	0.05
15	46	19.66 ± 2.80 (14.5-26.0)	38	21.97 ± 4.23 (15.5-38.5)	3.006	**0.00***
16	39	20.36 ± 2.12 (16.9-29.2)	43	20.69 ± 3.36 (15.4-34.1)	0.515	0.61
17	41	20.36 ± 3.01 (16.0-32.6)	40	22.23 ± 4.07 (18.3-32.2)	2.358	**0.02***
18	43	21.36 ± 3.88 (16.0-35.8)	39	24.20 ± 4.40 (17.7-40.8)	3.105	3.11
Total	**538**	**17.68±3.20**	**529**	**18.67±4.13**	**4.404**	**0.00**

** P < 0.05*

3.1.1 Prevalence of overweight and obesity based on BMI

Table 4 shows age and gender specific prevalence of overweight and obesity according to BMI in males and females.

The overall prevalence of overweight according to BMI was **9.6%** (12.3% for females and 6.9% for males) and was statistically higher in females (χ^2= 9.030, *p*=0.003). The overall prevalence of obesity according to BMI was **3.8%** (5.3% for females and 2.4% for males) and was statistically higher in females (χ^2= 5.974, *p*=0.015).

3.1.2 Prevalence of overweight and obesity based on percentage body fat

Table 4 shows age and gender specific prevalence of overweight and obesity according to percentage body fat.

The overall prevalence of overweight according to percentage body fat was 5.4 % (6.0% for females and 4.8% for males) and there was no statistically significant difference between males and females. (χ^2= 0.768, *p*=0.381). The prevalence of obesity according to percentage body fat was 6.9% (7.2% for females and 6.7% for males) and there was no statistically significant difference between males and females. (χ 2 =0.100, p=0.752).

Table 4. Age and gender specific prevalence of overweight and obesity according to BMI and BIA

	Over Weight (OW)						Obesity (OB)					
BMI												
Age group (years)	**Male OW (n)**	**%**	**Female OW (n)**	**%**	**χ^2**	***p***	**Male OB(n)**	**%**	**Female OB(n)**	**%**	**χ^2**	***p***
6 – 9	12(166)	7.2	10(163)	6.1	0.158	0.691	4(166)	2.4	12(163)	7.4	4.360	0.037
10 – 12	10(121)	8.3	16(124)	12.9	1.389	0.239	4(121)	3.3	2(124)	1.6	0.735	0.391
13 – 15	11(128)	8.6	21(120)	17.5	4.371	0.037	1(128)	0.8	4(120)	3.3	2.042	0.153
16 – 18	4(123)	3.3	18(122)	14.8	9.914	0.002	4(123)	3.3	10(122)	8.2	2.780	0.095
Total	**37(538)**	**6.9**	**65(529)**	**12.3**	**9.030**	**0.003**	**13(538)**	**2.4**	**28(529)**	**5.3**	**5.974**	**0.015**
Percentage body fat												
6 – 9	3(166)	1.8	7(163)	4.3	1.726	0.189	13(166)	7.8	4(163)	2.5	4.853	0.028
10 – 12	13(121)	10.7	9(124)	7.3	0.910	0.340	8(121)	6.6	13(124)	10.5	1.172	0.279
13 – 15	3(128)	2.3	6(120)	5.0	1.250	0.264	5(128)	3.9	11(120)	9.2	2.840	0.092
16 – 18	7(123)	5.7	10(122)	8.2	0.596	0.440	10(123)	8.1	10(122)	8.2	0.000	0.985
Total	**26(538)**	**4.8**	**32(529)**	**6.0**	**0.768**	**0.381**	**36(538)**	**6.7**	**38(529)**	**7.2**	**0.100**	**0.752**

Overweight and obesity in the study was defined as BMI equal to and above the adult equivalent for overweight and obesity of Cole et al. chart [15]. Overweight/overfat and obese respectively as defined by set criteria based on percentage body fat [16]

The overall prevalence of overnutrition using BMI and percentage body fat is 13.4% and 12.4% respectively.

3.1.3 Prevalence of overnutrition according to socioeconomic strata

As observed in Table 5, there was a statistically higher prevalence of overnutrition in the subjects from higher SEC in comparison with other socioeconomic classes. Similarly, females had a statistically higher prevalence of overnutrition.

Overnutrition was not significantly associated with the age group, type of school and maternal education of the subjects.

Table 5. Association between overnutrition and sociodemographic characteristics using BMI

SEC	Overnutrition(n)n (%)	Normal n (%)	X	P-value
SEC				
Upper	65(18.2)	293(81.8)		
Middle	49(10.9)	402(89.1)	10.513	0.005
Lower	29(11.2)	229(88.8)		
Gender				
Male	50(9.3)	488(90.7)		
female	93(17.6)	436(82.4)	15.782	0.000
Age group				
6-9	38(11.5)	291(88.5)		
10-12	32(13.1)	213(86.9)	1.841	0.606
13-15	37(14.9)	211(85.1)		
16-18	36(14.7)	209(85.3)		
Type of School				
Private	116(14.6)	676(85.4)		
Public	29(10.5)	246(89.5)	0.600	0.439
Maternal Education				
None	15(11.2)	119(88.8)		
Primary	20(10.9)	164(89.1)		
Secondary	52(11.0)	419(89.0)	1.500	0.682
University	56(20.1)	222(79.9)		

Table 6. Sex-related correlation between BMI and various body fat indices

	n	r	F-value	*p-value*	R^2
BMI vs PBF					
Male	538	0.386	94.006	0.000	0.149
Female	529	0.871	1653.812	0.000	0.759
BMI vs FM					
Male	538	0.777	816.202	0.000	0.604
Female	529	0.917	2777.76	0.000	0.841
BMI vs FMI					
Male	538	0.658	409.538	0.000	0.433
Female	529	0.907	2436.493	0.000	0.822
BMI vs FFMI					
Male	538	0.867	1624.874	0.000	0.752
Female	529	0.828	1147.284	0.000	0.685

There is a positive correlation between BM1 and various body fat indices as shown in both males and females in table 6 ($p < 0.000$). BMI showed a strong positive correlation with fat mass, and fat mass index especially in females (0.917, 0.907, $p < 0.000$).

BMI = Body mass index
PBF= percentage body fat
FM=Fat Mass
FMI = Fat mass index
FFMI = Fat-free mass index

Table 7. Mean gender comparison of age and anthropometric indices

		N	Mean	Std. Deviation	*p*-value	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
BMI	6 - 11 yrs	493	16.00	2.427		15.79	16.22	10.7	30.1
	12 -18 yrs	574	20.04	3.626		19.74	20.34	13.5	40.8
	Total	1067	18.17	3.720	.00	17.95	18.39	10.7	40.8
Percent_Body_Fat	6 - 11 yrs	493	16.39	6.539		15.81	16.97	.0	99.0
	12 -18 yrs	574	18.11	10.104		17.28	18.94	5.0	55.3
	Total	1067	17.31	8.679	.00	16.79	17.84	.0	99.0
Fat_Mass	6 - 11 yrs	493	4.84	3.095		4.57	5.12	.0	25.8
	12 -18 yrs	574	10.13	7.549		9.51	10.75	1.4	51.8
	Total	1067	7.69	6.481	.00	7.29	8.08	.0	51.8
Fat_Free_Mass	6 - 11yrs	493	23.50	5.822		22.98	24.02	.3	43.3
	12 - 18 yrs	574	42.12	8.386		41.43	42.81	25.6	64.2
	Total	1067	33.52	11.818	.00	32.81	34.22	.3	64.2
Fat_Mass_Index	6 - 11 yrs	493	2.71	1.476		2.58	2.84	.0	14.0
	12 - 18yrs	574	3.92	3.026		3.67	4.16	.7	27.5
	Total	1067	3.36	2.508	.00	3.21	3.51	.0	27.5
Fat_Free_Mass Index	6 - 11 yrs	493	13.28	1.417		13.15	13.40	.1	21.0
	12 - 18yrs	574	16.17	1.959		16.01	16.33	12.0	28.3
	Total	1067	14.83	2.253	.00	14.69	14.97	.1	28.3

Table 7 is a description of the statistical analysis between 6-11 yrs and 12-18 yrs old subjects and various anthropometric variables. The mean of all the variables (BMI,percent body fat, fat mass, fat free mass,fat mass index and fat free mass index) were statistically significantly higher in children aged 12-18 years than in children 6-11 years.

4. DISCUSSION

The overall prevalence of overnutrition obtained from this study using BMI, which is an indirect method of assessment of overnutrition, is comparable with the prevalence obtained using BIA, a direct assessment tool of overnutrition. This finding further buttresses the usefulness of BMI as a reliable tool for the assessment of overnutrition in children. No study, to the best of the Researchers' knowledge has reported a similar finding for comparison with this study. It was however, observed that the prevalence of the components of overnutrition, overweight and obesity, obtained from this study using BMI and BIA was different. BMI tended to underestimate obesity which is in consonance with previous studies that have observed the inability of BMI to adequately differentiate body mass composition. A review of literature on the diagnostic value of BMI in the measurement of adiposity by Javed et al [17] showed that BMI has a high specificity (0.93) and a lower sensitivity (0.73). This implies that about a quarter of children who are obese will be missed when BMI is used in assessing excess adiposity, as shown in this study where the prevalence of obesity was lower than that obtained using BIA. This finding indicates that in the assessment of obesity using BMI in a clinical setting some obese children may be categorized as overweight.

The prevalence of obesity (3.8%) as measured by BMI in this study is similar to that obtained by Adam et al [18] in Nigeria, and Deren et al [19] in Ukraine. Higher prevalence was reported by Karki in Nepal [20] and Ismail et al in Tanzania [21] (7.1% and 6.7% respectively). The different prevalence rates obtained from these studies can be attributed to the different factors associated with obesity which vary from country to country and from region to region. A Review of articles on the factors associated with obesity in adolescents by Narciso et al [22] showed a significant association between obesity and factors such as ingestion of sugar-sweetened beverages, skipping of breakfast, increased screen-time, lower socio-economic class and having a parent who is obese. The presence of these enumerated factors differs in magnitude between communities, countries and regions. While obesity is associated with the lower socioeconomic class in developed countries, the reverse is the case in developing countries [23].

This study has equally observed a higher prevalence of obesity among children from high socioeconomic class in comparison with those from a lower socioeconomic class. A few factors have been attributed to this observation. Children from a high socioeconomic background are more likely to have access to high caloric diet and drinks which have been associated with obesity. Energy saving recreational activities such as video games, increased watching of TV which are sometimes accompanied by snacking are more affordable by children from a high socioeconomic class. Small family size, tertiary parental educational status and higher household income, (attributes found more commonly with families from high socioeconomic class) have been associated with the development of obesity [24]. Trekking to school which is a form of exercise is more common with children from low socioeconomic class which can contribute to a lower incidence of obesity.

Contrary to the finding of this study obesity was associated with a lower socioeconomic class in Mauritius [25] which is a developing country. This difference was attributed mainly to two factors. Refined cereals, full-cream milk, dairy products, and high fat protein sources which provide high calories were cheaper when compared to whole grain cereals, low fat milk and dairy products, which were low in calories. Children from low socioeconomic class were more likely to afford these calorie-dense diets which promote obesity. It was also observed that children from families of high socioeconomic status spent more time in physical activities in school which reduced the tendency to obesity.

The mean BMI and the prevalence of obesity were significantly higher in females than their male counterparts which is similar to the observation by Keane et al [26]. Maruf et al [27] however, reported a significantly higher mean BMI in males aged 2-6 years, and in females aged 11-14years and 15-18 years. There was no significant gender difference in the prevalence of obesity across all age groups.The increased prevalence of obesity in females can be attributed to the hormonal effect of estrogen which leads to the deposition of fat, particularly in

peripheral adipose tissues. Reduced physical activities in comparison to males may also be a contributory factor. Ahmad et al [24] however, reported higher prevalence of obesity in males with no statistical gender difference in the mean BMI. This was attributed to higher consumption of energy containing foods and drinks in males in contrast to females who exhibit a more restrictive dietary habit. Globally, the prevalence of obesity was higher in males in a vast majority of high income and upper middle-income countries. This was absent in lower middle income and low income countries, to which Nigeria belongs. Shah et al [28], in a bid to proffer reasons for gender difference in the prevalence of obesity, proposed the influence of sociocultural beliefs and practices and sex related biological differences.. Females tended to have more body fat post-partum with a resultant decrease in calorie intake which favours a lower BMI in females. Secondly, females have a higher serum leptin level which leads to reduced appetite and a higher energy expenditure with a resultant decrease in BMI. Thirdly, eating preferences in females tend towards intake of smaller and healthier meals to large portions of calorie dense foods characterized by a feeling of fullness and physical performance. Fourthly, girls tend to have shorter sleep duration, less physical activities and watch more television. This point, however tends to favour the development of obesity in females. The degree to which these various factors play out in different communities and regions will greatly determine the direction in gender-based prevalence of obesity.

Though body mass index was highly correlated with fat mass and fat mass index in both males and females it was higher in females than males. This finding compares with that of Wanghi et al [29] in the Democratic Republic of the Congo.

There was also a high correlation between body mass index and fat free mass index in both males and females but was slightly higher in males than females. The above findings are in consonant with the study of Freedman et al [30] where there was a higher correlation between fat mass and BMI in girls in comparison to boys where a higher correlation between fat free mass and BMI was obtained. This implies that body fat contributes more to BMI in females in contrast to males where fat free mass has a greater contribution. This is further corroborated by the finding of a higher mean fat free mass in males than females while females had a higher mean fat mass than males both in this study and that of Freedman's et al. [30].

4. CONCLUSION

The overall prevalence of overnutrition obtained from this study using BMI, is comparable with that obtained using BIA. This finding further buttresses the usefulness of BMI as a reliable tool for the assessment of overnutrition in children in poor resource settings.

ETHICAL APPROVAL AND CONSENT

Ethical clearance was obtained from the Ethics and Research Committee of the University of Benin Teaching Hospital (ADM/E22/A/VOL.VII/1348). Written permission was obtained from the Education Authority of the Egor LGA, written informed consent was given by the parents/guardians while verbal permission was given by the school heads.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. WHO – overweight and obesity fact sheet 2021.
   Available:https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
   Assessed on 6th of April, 2022.
2. Nittari G, Scuri S, Sagaro GG, Petrelli F, Grappasonni I. Epidemiology of Obesity in Children and Adolescents. Teamwork in Healthcare, edited by Michael Firstenberg, Stanislaw Stawicki, IntechOpen, 2020.
   DOI:10.5772/intechopen.93604.
3. Fryar CD, Carroll MD, Ogden CL. Prevalence of overweight, obesity, and severe obesity among children and adolescents aged 2-19 years: United

States, 1963-1965 through 2015-2016. Health E-Stats; 2018.
4. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of obesity among adults and youth: United States, 2015–2016. NCHS Data Brief. 2017;288:1–8
5. Akowuah PK, Kobia-Acquah E. Childhood Obesity and Overweight in Ghana: A Systematic Review and Meta-Analysis. Journal of Nutrition and Metabolism 2020:1907416
6. Adom T, Kengne AP, De Villiers A, Puoane T. Prevalence of overweight and obesity among African primary school learners: a systematic review and meta-analysis. Obesity Science& Practice 2019;5(5):487-502.
7. Adeloye D, Ige-Elegbede JO, Ezejimofor M, Owolabi EO et al. Estimating the prevalence of overweight and obesity in Nigeria in 2020: a systematic review and meta-analysis. Annals of Medicine 2021;53(1). Available:https://doi.org/10.1080/07853890.2021.1897665
8. Oluwayemi IO, Oyedeji OA. A ten-year review of childhood obesity in a teaching hospital, South West Nigeria. Nigerian Journal of Clinical Practice 2021;24:841-6.
9. Adeniyi FO, Fagbenro GT, Olatona FA. Overweight and obesity among school-aged children and maternal preventive practices against childhood obesity in select Local Government Areas of Lagos, Southwest, Nigeria. International Journal of MCH AIDS 2019;8(1): 70-83.
10. World Health Organization (WHO).Non-Communicable diseases and mental health."Target 7:Halt the rise in obesity"; 2017
11. The National Institute of Diabetes and Digestive and Kidney Diseases.2019. Available:https://www.niddk.nih.gov/health-information/weight-management/adult-overweight-obesity/health-risks. Assessed on 10 April 2022.
12. Population and Housing Tables, Edo State Priority Table Vol.1. National Population Commission; 2006.
13. Oriaifo S, Abiodun P, Atimati AO, Nwaneri D. Determination of overnutrition using mid-upper arm circumference in comparison with bioelectrical impedance analysis in children and adolescents in Benin, Nigeria. Journal of Health Research; 2019.
14. Oyedeji GA. Socio-economic and cultural background of hospitalised children in Ilesha. Nigerian Journal of Paediatrics. 1985;12:111-117.
15. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. British Medical Journal. 2000;320:1240-1253.
16. McCarthy HD, Cole TJ, Fry T. Body fat reference curves for children. International Journal of Obesity. 2006;30:598-602.
17. Javed A, Jumean M, Murad MH, Okorodudu D, Kumar S, et al. Diagnostic performance of body mass index to identify obesity as defined by body adiposity in children and adolescents: A systematic review and meta-analysis. Pediatric Obesity. 2015;3(10):234–244.
18. Adam VW, Isah JA. Prevalence and comorbidities of childhood overweight and obesity among school aged children in an urban settlement in Benin City, Nigeria. Nigerian Journal of Paediatrics. 2017:44:7-13.
19. Deren K, Nyankovskyy S, Nyankovska O, Luszczki E, Wyszynska J, et al. The prevalence of underweight, overweight and obesity in children and adolescents from Ukraine. Scientific Reports. 2018;8:3625.
20. Karki, A., Shrestha, A. Subedi, N. Prevalence and associated factors of childhood overweight/obesity among primary school children in urban Nepal. BMC Public Health. 2019;19:1055.
21. Ismail N, Festus K, Jane W, Vincent O. Prevalence of overweight and obesity among Primary School Children Aged 8-13 years in Dar es Salaam City, Tanzania. Advances in Preventive Medicine. 2016:1-5.
22. Narciso J, Silva AJ, Rodrigues V, Monteiro MJ, Almeida A, et al.Behavioral, contextual and biological factors associated with obesity during adolescence: A Systematic Review. 2019;14:4.
23. Adetunji AE, Adeniran KA, Olomu SC, Odike AI, Ewah-Odiase RO, Omoike IU, et al. Socio-demographic factors associated with overweight and obesity among primary school children in semi-urban areas of mid-western Nigeria. PloS One. 2019;14(4).
24. Ahmad A, Zulaily N, Shahril MR, Syed Abdullah EFH, Ahmed A. Association between socioeconomic status and obesity

among 12-year-old Malaysian adolescents. PLoS ONE. 2018;13(7):1371.
25. Waqia Begum Fokeena, Rajesh Jeewon. Is There an Association between Socioeconomic Status and Body Mass Index among Adolescents in Mauritius? The Scientific World Journal 2012; 2012.
26. Keane E, Kearney PM, Perry IJ. Trends and prevalence of overweight and obesity in primary school aged children in the Republic of Ireland from 2002-2012: a systematic review. BMC Public Health. 2014;14**:**974.
27. Maruf FA, Aronu U, Chukwuegbu K, Aronu AE. Influence of gender on prevalence of overweight and obesity in Nigerian school children and adolescents.Tanzania journal of Health Research. 2013; 15(4):1-6.
28. Shah B, Tombeau Cost K, Fuller A, Birkin CS. Sex and gender differences in childhood obesity: contributing to the research agenda. BMJ Nutrition, Prevention & Health. 2020;3(2):387-390.
29. Wanghi GI, Lytle L, Buhendwa. Body Mass Index Correlates with Body Fat Percentage in Children and Adolescents in the Democratic Republic of the Congo: A cross sectional study. African Journal of Health Sciences. 2021;34(1).
30. Freedman DS, Wang J, Maynard LM, Thornton JC, Mei Z, et al. Relation of BMI to fat and fat free mass in children and adolescents. International Journal of Obesity. 2005;29:1-8.

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