Original Article

Assessment of Gross Malnutrition among Primary School Children Using Body Mass Index as an Assessment Tool in Abakaliki Metropolis of Ebonyi State, South-East Nigeria

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Abstract

Background: Obesity and overweight are emerging major health problems in developing countries in the background of undernutrition. These have been linked to a substantial increase in mortality and morbidity. **Objectives:** This cross-sectional survey was aimed at determining the prevalence of underweight, overweight, and obesity using body mass index (BMI) in primary school pupils in Abakaliki metropolis of Ebonyi State, south-east Nigeria. **Method:** Eight hundred and four participants aged 6–12 years, from four public and four private primary schools had their weights and heights measured using standard methods. BMI value was calculated for each subject and compared with BMI for age and sex from World Health Organisation (WHO 2007) reference standard. Socioeconomic status was determined using method proposed by Oyedeji. **Results:** Out of 804 subjects, 426 (53.0%) were from public schools, whereas 378 (47%) were from private schools ($P \leq 0.01$). Four hundred and fifteen (51.6%) were males and 389 (48.4%) were female ($P = 0.88$). The prevalence of underweight, overweight, and obesity using BMI were 4.5% and 1.2%, 0% in public schools and 1.1%, 5.0%, and 3.0% in private schools, ($P < 0.001$). The socioeconomic class significantly affected the prevalence of underweight, overweight, and obesity as more subjects with overweight and obesity belonged to upper social class, whereas more underweight subjects belonged to lower social class. **Conclusion:** Overweight and obesity are emerging in a background of undernutrition, showing ''double burden'' of nutritional disorder.

Keywords: *Body mass index, obesity, overweight, primary school children, socioeconomic class, underweight*

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Introduction

Underweight, overweight, and obesity predispose to several diseases. Medical conditions such as diarrheal diseases, tuberculosis, micronutrient deficiencies, and anemia may be associated with being underweight[1,2] whereas hypertension, diabetes mellitus, and lipid disorders are seen more in people who are overweight or obese.[1,2] An ideal body weight requires promotion of balanced diets, increasing household food security, eliminating hunger, treatment of underlying illnesses, and adequate physical activities.

Despite the economic growth observed in developing countries, underweight is still highly prevalent.[3] Nearly half of all deaths in children under 5 are attributable to undernutrition. This translates into the unnecessary loss of about 3 million young lives a year.[1-3] Similarly, an increasing prevalence of overweight, obesity, and its related chronic diseases is also being observed.[2] Childhood obesity has been linked to the premature onset of puberty, it has also been associated with being bullied, which in turn is related to poorer mental health and decreased physical activity.[1-3] Children and adolescents who are overweight are at risk for becoming overweight adults.[1,2] This rising incidence of overweight and obesity along with the persistence of undernutrition

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referred to as the ''Double Burden of Malnutrition'' is now observed among school children.[3]

Although obesity may be defined as excess body fat, overweight is body fat more than the healthy range for sex and age.[4] The fundamental cause of overweight and obesity is a positive energy imbalance between calories consumed on one hand and calories expended on the other hand.[4,5] Diets high in energy density and sedentary life style are the two major environmental factors associated with increased prevalence of obesity.[4,5]

Underweight is a composite index of stunting, wasting, or both.[6] It is the result of food intake that is continuously insufficient to meet dietary energy requirements, poor absorption, and/or poor biological use of nutrients consumed. Opara *et al.*[7] in Uyo studied the prevalence of underweight, stunting, and obesity in school children attending public and private schools in Uyo, Nigeria. The height and weight measurements of 985 children aged 31 – 150 months (2 and half to 14 years) were taken. Body mass index (BMI) was calculated from the data. The results showed that the prevalence of underweight, stunting, and obesity were 27.3%, 17.1%, and 11.1%, respectively, in the private schools and 39.4%, 25.3%, and 0.2% in the public schools. Low maternal income, overcrowding, young age, and use of infant formula feeds in children older than 6 months was associated with the high prevalence of underweight.[8]

The mid-childhood, ages (6 – 12 years), is a period of steady physical growth and cognitive development.[9] During this period, life style, and habits are established.[9] Therefore, health and nutrition at this stage is of critical importance in determining the prevalence of diet-related chronic diseases in adulthood.

Abakaliki, the capital of Ebonyi State, is a fast developing metropolis. In 1999, about 80% of the state population were rural.[10] Currently, more of the city is urbanized. Many of the inhabitants have migrated from the very rural areas to the metropolis. In this area, various fast food centers are in place with a tendency to a shift in diet toward increased intake of energy-dense food (mainly by the high socioeconomic class) that are high in sugar but low in vitamins, minerals, and other micronutrients. There is also a trend toward decreased physical activity due to increasing sedentary nature of various forms of work, changing modes of transportation where some children are taken to school by cars rather than walking, as well as increasing urbanization. These are linked with obesity and overweight in a background of underweight especially in children in developing countries.[4,5]

Nutritional status is frequently assessed by anthropometry.[11] These include measurement of skinfold thickness, mid-upper-arm circumference, and various height and weight-based indices such as weight for age, height for age, weight for height, and BMI.

BMI is the most widely recommended surrogate measure of adiposity among other indices derived from weight and height.[12] It is given by the formula

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m}^2\text{)}}$$

BMI is generally considered the best way to determine whether an individual is at a healthy weight.[11,12] BMI is commonly used because it is simple, quick, effective, and applies to adult men and women, as well as for children. It is a useful tool for quickly assessing weight classification.[11,12] While it does not directly measure body fat, it is more accurate at approximating degree of body fat than weight alone.[12]

The Centre for Disease Control and Prevention (CDC) growth charts and World Health Organisation define obesity as BMI for age greater than or equal to 95th percentile, overweight as BMI for age between 85th to less than 95th percentile and underweight as BMI for age less than or equal to 5th percentile.[12] It also defines obesity as BMI *Z* score $\geq +2$SD, overweight as BMI *Z* score $> +1$SD but $< +2$SD, whereas underweight is defined as weight-for-age *Z* score of < 2SD and thinness as BMI *Z* score $<$-2SD for age and sex.[13,14] Several studies have been done on obesity and overweight in Nigeria;[12-14] however, only a few have looked at obesity, overweight, and coexisting underweight.[7]

Adequate nutrition is of prime importance in the attainment of normal growth and development and in the maintenance of health throughout life. Children need adequate quantity and quality of food to meet their nutrient requirements. Malnutrition is a wide-spread problem affecting large number of people in developing countries. Vulnerable populations such as school children are susceptible to health problems associated with obesity, overweight, and underweight. This study was therefore done to determine the prevalence and burden of obesity, overweight, and underweight, with the view of planning preventive and interventional strategies targeting the vulnerable groups through promotion of adequate nutrition with life style modification and increased physical activities as well as quality health education implemented in schools. School meal programs should also be encouraged and maintained especially in public schools. These will prevent and reduce the associated diseases or comorbidities later in life.

Subjects and Methods

This cross-sectional study was conducted from April to June 2012 in four public and four private primary schools in Abakaliki metropolis, in Ebonyi State, south-east Nigeria. The state has 13 Local Government Areas (LGAs), with Abakaliki as the state capital. Abakaliki metropolis is made up of two LGAs-Ebonyi and Abakaliki LGAs. There are 22 public (11 in each LGA) and 19 private (9 in one LGA and 10 in the other) primary schools in Abakaliki metropolis giving a ratio of 1.1:1. Using random sampling, two public and two private primary schools were picked in each LGA, based on the ratio of public to private primary schools. In all eight primary schools were used for the study: four public schools and four private schools. Generally, those from low socioeconomic background attend predominantly public schools, whereas a high proportion of those from higher socioeconomic backgrounds attend private schools. Private schools may have limited playground, which will hinder the physical activity of attendees. Lack of physical activity will results to overweight and/or obesity in children. Also they are more likely to be using sweetened drinks and pastries as snacks in school, which will predispose them more to overweight and/or obesity. The total school enrolment in the two LGAs in the metropolis as at 2011 is 16,712.

The study received approval from the ethical committee of Federal Medical Centre Abakaliki, Ebonyi State. Permission was obtained from Ebonyi State Universal Basic Education Board and individual school authorities. Consent was obtained from parent/guardian of each child studied, whereas assent was obtained from the pupils studied.

The minimum sample size (n) for the subjects was calculated using the formula as cited by Araoye.[15]

$$n = (Z)^2 (P) (Q) / d^2$$

where n is the minimum sample size (where estimated population is >10,000); P, estimated or known prevalence of the variable of interest; d, absolute tolerable sample error; and Z, the fraction of the area under the normal distribution curve. Q can be calculated as

$$Q = 1- P$$

The calculated minimum sample size was 366 in each group (public and private schools). To accommodate possible attritions for incomplete questionnaires, the final sample size for this study was therefore 804. Two public and two private primary schools were used in each LGA, based on the ratio of public to private primary schools in the two LGAs. In all eight primary schools were used for the study: four public schools and four private schools.

A multistage sampling frame was used to select the requisite 804 participants for the study. In the first stage of the sampling, simple random sampling was used to select four private and four public schools out of the 19 and 22 private and public schools, respectively, in the two LGAs in the metropolis. Proportionate sampling was used in the second stage to calculate the number of participants to be selected in each of the four private and four public schools as follows.

Population of the school × calculated sample size (804)

Total population of the eight school studied

In each private school and for each grade, ballots were picked by the research assistants in turn to select the class to be sampled in each grade. This formed the third stage of the multistage sampling. The class to be used in each grade was picked by simple random sampling. For each class, the register was used to exclude those pupils who did not fall within the study age group of 6 – 12 years. Those who fell within the study age group were stratified into males and females and given study proforma to fill and return. Ballots were then picked by all the pupils in the stratum that returned their study proforma. Based on the required number, ballot papers were marked ‘‘yes’’ or ‘‘no.’’ Those that picked a ‘‘yes’’ were included in the study while those that picked a ‘‘no’’ were excluded.

The public school participants had the same sampling methods applied to them to pick the class in the different grades and to select the participants in the different classes.

Information obtained from parents/subjects with a semistructured questionnaire was used to determine the socioeconomic status of parents as well as their medical history. Measurements were taken in the school compound in privacy. Weight and height measurements were made according to standard procedures. Weight was measured to the nearest 0.1 kg using a standard weighing scale with the subject barefooted and wearing only under underpants in a well-screened room. Height was measured with a stadiometer to the nearest 0.1 cm without the shoes. Weight-for-age and height-for-age values were obtained, from where BMI was calculated.

The WHO 2007 BMI Z score for age and sex criteria define underweight as weight-for-age Z score of <2SD and thinness as BMI Z score < -2SD for age and sex,[13,14] whereas BMI Z score for age and sex of between + 1SD and < + 2SD was considered as overweight and ≥ + 2SD as obesity.[13,14]

Socioeconomic stratification was based on methods proposed by Oyedeji.[16] Data analysis was done using statistical packages SPSS version 17.0. Measures of central tendency or dispersion were computed for all quantitative variables such as age, weight, height, and BMI. With respect to continuous variables, means and standard deviations were reported, Student *t* test was used for comparison of arithmetic means, whereas χ^2 test was used for comparison of proportions. Probability value of less than 0.05 was considered statically significant.

Results

Demographic characteristics of the subjects

Out of the 804 pupils, 426 (53%) were in public schools, whereas 378 (47%) were in private schools. In the public schools there were 221 (51.9%) males and 205 (48.1%) females, whereas in the private schools there were 194 (51.3%) males and 18 4(48.7%) females. A comparison of male:female ratio between the two schools shows no statistically significant difference (χ^2 = 0.025, df = 1, P = 0.88), (χ^2 = 149.2, df = 6, P = <0.01), whereas comparison of age between private and public schools was statistically significant [Table 1]. Table 2 shows that majority of pupils that attended private schools belonged to the upper social class. On the other hand, majority of pupils of the lower class attended public schools. This difference was significant (P < 0.001).

Table 1: Age and gender distribution of study subjects in public and private schools

	Public			Private		
Age (year)	Male (*n*)	Female (*n*)	Total (*n*)	Male (*n*)	Female (*n*)	Total (*n*)
6	40	0	40	59	29	88
7	16	12	28	28	33	61
8	23	20	43	38	29	67
9	22	43	65	27	23	50
10	24	34	58	23	54	77
11	30	34	64	3	16	19
12	66	62	128	16	0	16
Total	221	205	426	194	184	378
	51.9%	48.1%	100%	51.3%	48.7%	100%

Sex/school P = 0.88; age/school P = <0.01

Table 2: Distribution of subjects according to type of school and socioeconomic class

Socioeconomic class	Public schools	Private schools	Total
Upper	75(17.6%)	346(91.5%)	421(52.4%)
Middle	95(22.3%)	30(8.0%)	125(15.5%)
Lower	256(60.1%)	2(0.5%)	258(32.1%)
Total	426(100%)	378(100%)	804(100%)

p = < 0.001

Anthropometric measurements

Table 3 shows distribution of underweight, overweight, and obesity of study subjects according to social class using BMI. Fourteen (3.3%) obese subjects and 42 (10%) overweight subjects were of the upper social class in the social class group. More underweight 24 (9.3%) subjects when compared with overweight six (2.3%) and obesity one (0.4%) were found in the lower class. This was statistically significant (P < 0.001). In all, greater number was found to be within normal range (85.2%).

Table 4 shows the prevalence of underweight, overweight, and obesity in private and public schools using BMI. In the public schools, more subjects were underweight when compared with private schools. On the other hand, more subjects were overweight in private schools, when compared with public schools. Obesity was recorded only in private schools.

The mean BMI values were comparable between male in public and private schools except for subjects aged 6 years as well as 9 and 10 years (P < 0.05) in Table 5. Similarly, in Table 6, females had comparable mean BMI values at ages 7, 8, and 11 years (P = 0.84, 0.13 and 0.34, respectively). Subjects aged 9 and 10 years in private schools had significantly higher BMI values than their counterparts (P < 0.001). However, the mean BMI of female subjects aged 6 and 12 year could not be

Table 3: Distribution of underweight, overweight, and obesity according to social class using BMI

	Social Class Group			
	Upper Class	Middle Class	Lower Class	Total
BMI				
Z score	14(3.3%)	7(5.6%)	24(9.3%)	45(5.6%)
Underweight				
Normal	343(81.5%)	115(92.0%)	227(88.0%)	685(85.2%)
Overweight	42(10.0%)	2(1.6%)	6(2.3%)	50(6.2%)
Obesity	22(5.2%)	1(0.8%)	1(0.4%)	24(3.0%)
Total	421(100%)	125(100%)	258(100%)	804(100%)

χ^2 = 46.85, df = 6

Table 4: Prevalence of underweight, overweight, and obesity in private and public schools using BMI

	Public school	Private school	Total
Underweight	36(8.5%)	9(2.4%)	45(5.6%)
Normal	380(89.2%)	305(80.7%)	685(85.2%)
Overweight	10(2.3%)	40(10.6%)	50(6.2%)
Obesity	-	24(6.3%)	24(3.0%)
Total	426(100%)	378(100%)	804(100%)

χ^2 = 63.7, df = 3, p-value < 0.001

Table 5: Mean body mass index of male subjects by age in public and private schools (public schools:private schools)

Age (yrs)	*n*	Mean ± SD (kg/m²)	*n*	Mean ± SD(kg/m²)	diff	*t*	df	*p*-value
6	40	14.6 ± 1.3	59	15.3 ± 1.3	-0.71	-2.61	97	0.01
7	16	15.4 ± 0.8	28	15.9 ± 1.4	-0.53	-1.39	42	0.17
8	23	16.0 ± 0.9	38	15.5 ± 2.2	0.44	0.89	59	0.38
9	22	15.8 ± 1.4	27	18.0 ± 2.8	-2.24	-3.43	49	< 0.001
10	24	15.8 ± 1.1	23	17.0 ± 2.2	-1.17	-2.35	45	0.02
11	30	16.0 ± 0.9	3	16.3 ± 0.2	-0.26	-0.46	31	0.64
12	66	16.8 ± 1.7	16	17.1 ± 1.7	-0.37	-0.78	80	0.43

Table 6: Mean body mass index of female subjects by age in public and private schools (public schools:private schools)

Age(yrs)	*n*	Mean ± SD	*n*	Mean ± SD	diff	*t*	df	*p*-value
6	-	-	29	16.1 ± 2.1	-	-	-	-
7	12	15.6 ± 0.9	33	15.8 ± 2.0	-0.12	-0.20	43	0.84
8	20	15.1 ± 1.3	29	16.1 ± 2.7	-0.99	-1.54	47	0.13
9	43	15.4 ± 1.2	23	17.4 ± 2.8	-2.01	-4.07	64	0.001
10	34	15.9 ± 1.5	54	12.2 ± 3.0	-2.24	-4.00	86	0.001
11	34	19.9 ± 2.7	16	16.5 ± 1.0	-0.66	-0.95	48	0.34
12	62	17.7 ± 1.9	-	-	-	-	-	-

Table 7: Regression(univariate and multivariate) model(Scott and Jeremy 2005) for predictors of overweight and obesity using BMI

Variable	confidence interval		*p* value	
1. socioeconomic class	univariate	multivariate	univariate	multivariate
-middle class	0.224 - 3.468	0.218 - 3.399	0.857	0.833
-upper class	2.897 - 14.260	2.711 - 13.772	<0.001	<0.001
2. Gender	0.749 - 1.952	0.842 - 1.972	0.436	0.475
3. Age	0.788 - 0.998	0.728 - 1.100	0.047	0.578

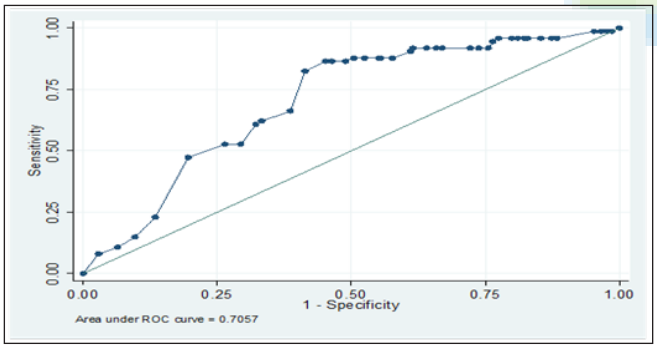

Figure 1: Receiver operating curve for predictor of overweight and obesity using BMI.

compared because there were no subjects of such ages in public and private schools, respectively.

At univariate level, age and social class predicted prevalence of obesity and overweight. But at multivariate level, only social class predicted overweight and obesity. Lower class was used as the reference group.

Figure 1 shows the area under receiver operating curve (ROC) which is 0.71, showing that this is a good model.

Discussion

Underweight, overweight, and obesity are increasing worldwide and are emerging as major risk factors for several chronic diseases.[2] Hence, it is important that countries monitor the nutritional status of children and adolescents. WHO/NCHS recommends the use of BMI percentiles or BMI *Z* score.

In the present study, using BMI *Z* score for age and sex, the prevalence of underweight was 5.6%, overweight 6.2%, and obesity 3.0%. Prevalence of underweight was low and when compared with that of northern (Fulani) Nigerian[17] study, was found to be much lower. The reason could be that the study involved a wider age group, ages (1 – 16 years) compared with 6 – 12 years in the present study. The prevalence of overweight though raised was also lower when compared with other studies.[18,19] The prevalence of obesity in the present study was also lower compared with some Nigerian studies.[7,13] Possible explanations for the presence of overweight and obesity in the present study could be increasing urbanization with life style changes and its lower prevalence when compared with the other studies could be the

high poverty index in Ebonyi State as well as poor socioeconomic status.

The findings of this present study reflect a higher prevalence of underweight in public school (8.5%) compared with private schools (2.4%). This pattern is similar, though lower than that reported by Opara *et al.*[7] in Uyo (39.4% in public and 27.3% in private schools). The Uyo study involved a wider age group two and half to 14 years. This may explain the high prevalence of underweight in that study. The 2008 Nigeria Demographic Health Survey (NDHS) reported prevalence for underweight as 23%[20] in children younger than 5 years. This prevalence was based on weight-for-age as against BMI used in the current study. Also their target group was under 5 in contrast to the target group of the current study. It may be more appropriate for the NDHS to use the more universally accepted BMI and to cover a wider age range to make for easier comparison with studying, within and outside the country.

The prevalence of underweight in the present study was comparable to South African studies by South African Vitamin A Consultative Group (SAVACG) 9.5%[21] and National Food Consumption Survey (NFCS) 10.3%,[22] although in Nepal area of south-east Asia the prevalence of underweight was reported as 54.1%, India 45.5%, and Bangladesh 44.7%.[23] This higher prevalence of underweight in these studies could be attributed to poverty, low socioeconomic status, and tropical climate that create an environment conducive for the emergence and propagation of communicable diseases. It can further be attributed to the poor social services and poor health services in developing economies, as reported by other authors.[24,25]

Overweight in children and adolescent are worrisome as the affected children are likely to become obese adults.[18,19] Overweight individuals are at more risk for morbidity and mortality associated with obesity. In the current study, overweight was noted more in private (10.6%) than in public (2.3%) schools. Socioeconomic disparities likely underlie these differences. There were no obese subjects in public schools but a prevalence rate of 6.3% was noted in private schools (mainly females). The trend is similar to, though lower than the study reported by Opara *et al.*,[7] where obesity was more prevalent in private schools (11.1%). The reason could be that Abakaliki, Ebonyi State, is a much younger and developing metropolis with higher poverty index of 73.6% when compared with 53.7% in Uyo, Akwaibom State.[26]

BMI values in the participants increased with age as expected. In this study, the BMI values for males in private schools were higher than those of their counterparts in public schools when matched for age and sex. Similarly, females in private school also had higher BMI values than their counterparts in public schools. In all, females had higher values when compared with males.

The BMI of female subjects aged 6 and 12 years were not obtained in the present study because there were no subjects of such ages in public and private schools respectively. For those aged 6 years in public schools, the possible explanations could be that, these children who are likely to come from lower socio-economic class are seen by their parents to be too young to be enrolled into schools while females aged 12 years in private were not recorded possibly because pupil in private school and likely to come from upper socioeconomic class and are enrolled earlier into school; therefore, complete their primary education before 12 years of age.

Conclusions

Malnutrition is a wide-spread problem affecting large number of people in developing countries. Undernutrition has negative implications for academic performance, increased susceptibility to infection, whereas overweight/obesity has immediate implications such as poor body image, bullying, stigma. Obese subjects are more likely than their peers to develop cardiovascular disease, type 2 diabetes, hepatic steatosis (a fatty liver), sleep apnea, high cholesterol, and asthma. Overweight and obesity have also been found to be evolving at the background of undernutrition. Vulnerable populations like school children are highly susceptible. Socioeconomic class significantly affected the prevalence of malnutrition. These nutritional disorders if unattended to will lead to high morbidity and mortality.

Recommendation

Promotion of adequate nutrition with life style modification through quality health education should be implemented in schools whereas school meal programs should be encouraged especially in public primary school where the prevalence of underweight was found to be higher.

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Conflicts of interest

There are no conflicts of interest

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