Assessment of School-Meal Nutrient Composition and Anthropometry Measurements of Children in Public Primary Schools Operating School-Feeding Programme in Osun State

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ABSTRACT

Background: *The objectives of the study were to evaluate nutrient composition and contribution of the school meals to the children daily nutrient requirements*

Objective*:*

Methods*: Cross-sectional study was conducted among school-children in Osun State Nigeria. Data on socio-demographic variables, household food security and dietary patterns of the children were collected using questionnaires. Height-for-age and body mass index-for-age z-score of the children were determined. The school-meal samples were evaluated for chemical composition, and percentage contributions of the school-meal to the daily nutrient requirements of the children were determined.*

Results*: Household food consumption patterns of the children indicated that 83% depend on starch-based foods, while 72.2% depend on legumes as the main source of protein intakes. For the fruits/vegetables, 71% agreed on regular intakes, while others did not. The protein and energy intakes from the school-meal were 27.12 g/day and 594.05 kcal/day, respectively; and these contributed between 79.78 - 142.76% and 33.0 - 49.5% of the children daily nutrient requirements. The prevalence of underweight and stunting in female children (22.6%, 29.4%) were higher than in male counterparts (21.4%, 28.4%).*

Conclusion*: The school-meals contributed positively to the daily protein and energy requirements of the children. However, prevalence of underweight and stunting was noticed among the school-children. Hence, there is a need to improve on the quantity and quality of the school-meals. This finding may be relevant to health and educational policy makers in Nigeria.*

Keywords: Household food insecurity, School-meal programme, Nutrient composition, Prevalence of malnutrition, School children

INTRODUCTION

School age is a dynamic period of physical growth and mental development of a child, and any signs of nutritional deficiencies during this period may lead to poor health status, high school absenteeism, and inability to cope with school academic programmes (1). Scientific studies have reported that childhood undernutrition imposes significant economic costs on the individuals and nations, and that providing adequate nutrition to the school-age children may have positive effects on their growth patterns and academic performance as well as their long-term productivity as adults (2, 3).

Adequate nutrition is the foundation to proper growth and development in every human; and inadequate access to a balanced diet may result in multiple health complications (4), which in turnsinfluence negatively cognitive development and academic achievement of a child and socio-economic development of a country (5). The prevalence of malnutrition continues to increase, particularly in developing countries and the worst affected were children (6). Malnutritionis a major health challenges among school age children, andit is increasing in many parts of African countries including Nigeria,because of economic restructuring, which has led to increase in the prevalence of household food insecurityamong low-income families (6). Findings have shown that during childhood, several biochemical activities that lead to optimal growth and brain development are going on, and that failures to provide necessary nutrients required for these biochemical activities may lead to stunted growth, poor brain development, diseases and death (7). Epidemiological study has established that poor dietary intakes is one of the major causes of poor health in children, which in turns may leads to school absenteeism, poor academicperformance and productivity of the school-age children (8, 9).

In view of this, several countries in Africa including Nigeria initiated school-meal programmesin order to complement inadequate food intakes at household level, improvingacademic performance and health status of underprivileged school-age children (10).Epidemiological study establishedthat school feeding enhances nutrient and energy intake of children, as well as preventing micronutrient deficiencies, which are widespread among school-age children in developing countries (10, 11). School feeding alleviates short-term hunger, enhancing active learning capacity, school attendance and punctuality among children coming from low-income families (10).

Nutritional status, the efficiency with which the body utilizes food consumed, is an important determinantof growth in children, academic performance and the best indicator of national wellbeing (12) and when nutritional status, particularlyin children, deteriorates, it leads to a viciouscycle of recurring sickness, growthfailure and poor academic performance(10, 11).

In view of this, the present study aimed to evaluate the dietary patterns of school age children at household levels, and determine the nutritional composition and contribution of school meals on daily nutrient requirement of the school age children.

Methodology

Study Location

The study was carried out during third term of 2018/2019 academic year in Osun State, Nigeria. Osun State is situated in South West Nigeria comprises 30 Local Government Areas evenly distributed into three Senatorial Districts.

Study Design and Data Selection Criteria

A cross-sectional study was carried out among school children between the ages of 6 – 14 years in public elementary primary schools operating school feeding programme in Osun State, Nigeria. Children with skeletal deformities and those whose age could not be ascertained were excluded from the study.

Sample Size Determination

The sample size for the study was calculated using the formula below (13).

$$S = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Where:

S = Sample size

X = Z value (e.g. 1.96 for 95% confidence level)

N = Population Size

P = Population proportion (expressed as decimal) (assumed to be 0.5 (50%) – this provides the maximum sample size).

d = Degree of accuracy (5%), expressed as a proportion (0.05); It is margin of error

S = 404 [A non-response rate of 10% was anticipated]

Since anthropometric surveys are designed as cluster samples and not simple random samples, the difference in design has to be corrected for. This is calculated by multiplying the sample size by the design effect (D)(14).For nutritional surveys using cluster sample methodology, the design effect of the cluster samples was doubled, that is, calculated sample size x 2.

Thus, the final sample size for the study =1002

Sampling Method

A multi-stage sampling method was used. A list of primary schools in each of the Senatorial Districts was obtained from the State Ministry of Education. Twelve Elementary Primary Schools comprising four primary schools from each of the three Senatorial Districts were randomly selected for the study. The population of pupils to be selected from each school was determined using the Hayling (15) cited by Olayiwola (16). In each of the schools, the allocated population was proportionately divided between each grade, and the total number of students in each section formed the sampling frame in that grade. The allotted sample was then divided according to the number of classes in each grade. In each class, the pupils were selected by simple random sampling techniques using a statistical table of random numbers until the required number for the class was obtained.

Ethical Approval and Consent

Ethical approval was obtained from Ministry of Health and Ministry of Education in Osun State. Permission was also obtained from the various Head Teachers of the selected schools. Written informed consent was obtained from parents/guardians of the selected pupils, and verbal consent from the pupils

Data Collection

Socio-economic, household food security and consumption patterns

The data was collected using structured self-administered questionnaires designed in English language and local language. The questionnaires were administered to the students to take home for their parents. The researchers adequately demonstrated to the students on how to respond to each section of the questionnaire, this was done so that the student mighty assist their parents to fill the questionnaire, particularly those who had no formal education. The students were informed to return the questionnaire in the following school day. The students whose questionnaires were adequately filled were finally recruited for the study. The questionnaire was designed to collect information on the socio-economic status using the parameters described by Boey (17] and household food security status using the parameters described by Coates et al. (18).

Anthropometric Measurements

Weight Measurements: The weights of the children were measured according to the procedures described by WHO (19).All measurements were taken with the children wearing light clothing and without shoes. Each child was weighed using a calibrated standardized digital weighing scale (OMRON BF - 400), with the accuracy of the scale to the nearest 0.1kg. The weight was measured twice and the average value was calculated. To avoid errors in readings, the scale was always set to zero point before each use, and re-checked for accuracy with standard weights after every 20 measurements or whenever the scale was moved from one place to another.

Height Measurements: The heights of the children were measured without shoes with a locally constructed wooden stadiometer placed on a flat surface. The height was measured twice nearest 0.1cm and the average value was calculated.

Nutritional Indices: Body mass index (BMI) and Height-for-age were used to determine nutritional status of the children (19,20).Computed Z scores for BMI-for-age, an index of overweight/obese and height for age, an index of stunting, were used to classify the children into different categories of nutritional status (19). Normal height was defined as height-for-age between -2 and +2 Z score, while stunting was defined as height-for-age less than -2 Z score. Underweight was defined as BMI-for-age less than -2 Z score, while overweight/obese was defined as BMI-for-age more than +2 Z score.

Collections and Determination of Nutritional Compositions of School Meals

Measurement of School Meal Intakes and Collection of Samples

The school meal intake of the pupils was evaluated using direct food weighing methods and chemical analysis for a period of five days. The school had their meal between 11:00 12:00 noon. At each meal, the food served individual pupil was weighed before and after eaten (if there was any leftover); and portion of the food samples were collected, pooled together and analysed for proximate, minerals, amino acid. The actual nutrient intakes of the pupils were calculated using the result of nutrient analyses and the weight of food that was consumed by the pupils.

Chemical Analyses of the School Meals

Proximate Composition

Proximate compositions, that is, moisture content, ash, crude fiber, crude fat and crude protein content of school meal samples were determined using the standard methods (21). Carbohydrate content was determined by difference as follow:

Carbohydrate (%) = 100-(%Moisture + %Fat + %Ash + %Crude fibre + %Crudeprotein)

The gross energy values of the samples were determined (MJ/kg) by using Gallenkamp Adiabatic bomb calorimeter (Model CBB-330-01041; UK).

Mineral compositions

Mineral Compositions: Calcium (Ca), magnesium (Mg), iron (Fe), copper (Cu) and zinc (Zn) were determined using Atomic Absorption Spectrophotometer (AAS Model SP9). Sodium (Na) and potassium (K) in the food samples was determined using flame emission photometer (Sherwood Flame Photometer 410, Sherwood Scientific Ltd. Cambridge, UK) with NaCl and KCl as the standards (21). Phosphorus was determined using Vanado-molybdate method.

Calculation of mineral molar ratios (bioavailability index)

The Na/K, Ca/P, Ca/Mg, [K/Ca+Mg], Phytate: Zn, Ca: Phytate and [Ca][Phytate]/[Zn] molar ratios were calculated as described by Ferguson et al (22).

Amino Acid Compositions

The amino acid profiles of the experimental samples were determined according to the method described by AOAC (21). The experimental samples were digested using 6N HCl for 24 h. Amino acids were determined using the Beckman Amino Acid Analyzer (model 6300; Beckman Coulter Inc., Fullerton, Calif., USA) employing sodium citrate buffers as step gradients with the cation exchange post-column ninhydrin derivatization method. The data were calculated as grams of amino acid per 100 g crude protein of flour sample.

Indexes of Protein Nutritional Quality

Protein efficiency ratio (PER): The protein efficiency ratio of the functional complementary foods was calculated according to the equations developed by Alsmeyer (23).

P-PER = -0.468 + 0.454(Leu) - 0.105(Tyr)

Essential Amino Acid Index (EAAI): Nutritional qualities were determined based on the amino acid profiles. The Essential Amino Acid Index (EAAI) was calculated using the method of Labuda (24) according to the equation below:

$$EAAI\ (\%) = \text{n}\sqrt{\frac{100a\ x\ 100b\ \ldots.100j}{av\ x\ bv\ \ldots\ldots.jv}}$$

Where:

n = number of essential amino acids, a, b .....j = represent the concentration of essential amino acids (lysine, tryptophan, isoleucine, valine, arginine, threonine, leucine, phenylalanine, histidine and the sum of methionine and cystine) in test sample and av, bv.....jv = content of the same amino acids in standard protein (%) (egg or casein) *respectively.*

Predicted Biological Value (PBV): Biological Values were computed according to the methods of Oser(25), respectively. The following equation was used for BV determination.
PBV = 1.09 (EAA Index) – 11.7.

Nutritional Index (NI): The nutritional index of the food samples was calculated using the formula below as described by Crisan and Sands(26).

$$Nutritional\ index\ (\%) = \frac{EAAIx\ \%protein\ in\ sample}{100}$$

Fatty Acids Compositions
The lipid extracted from the samples was converted to FAMEs using method described by Joseph and Ackman (27). Oil (25±0.1mg) was weighed and added with 1.5 mL of 0.50 M NaOH in methanol in a 15 mL capped centrifuge tube. The mixture was heated in a water bath (100°C for 5 min) and thereafter cooled at room temperature. Boron trifluoride (BF_3, 12%) in methanol (2 mL) was added to the mixture, reheated in a water bath (100°C, 30 min.), and cooled in running water at room temperature before adding 1mL of isooctane. The mixture was vigorously stirred for 30 s before adding 5.0 mL of sodium chloride solution to facilitate the phase separation. The esterified sample was placed in a refrigerator and left to rest for better phase separation. After collecting the supernatant, another 1.0 mL of isooctane (containing 0.05% B.H.T. as antioxidant) was added into the tube, stirred and the supernatant collected was added to the previous fraction, which was concentrated to a volume of 1.0 mL for later injection into the gas chromatograph. Analysis of methyl esters was performed by a capillary gas chromatograph model Agilent 6890 (USA Agilent Technology) equipped with a split-splitless injector, flame ionization detection (FID) system was used to separate and quantify each FAME component. Two microliters aliquot of the hexane phase was injected in split-mode onto a fused silica capillary column (Omegawax: 30 m x 0.32 mm ID, Supleco, Bellefonte, PA). The injector temperature was set at 200 °C, detector at 230 °C, oven at 120 °C initially, then 120-205 °C for 18 min. The carrier gas was helium and the flow rate was approximately 50 cm/sec. Electronic pressure control in the constant flow mode was used. The internal standard (heptadecanoic acid, C17:0) and calibration standards (NuCheck, Elysian, MN) were used for quantitation of fatty acids in the lipid extracts. The fatty acids reported represent the average of three determinations.

Indexes of lipid nutritional quality
The atherogenicity and Thrombogenicity were calculated using the formulas below
Atherogenicity Index (AI)(28, 29, 30).
(AI) = [C12:0 + (4 × C14:0) + C16:0]/(n-3PUFA + n-6PUFA + MUFA)
Where
PUFA—polyunsaturated fatty acids
MUFA—monounsaturated fatty acids
C12:0—lauric acid, C14:0—myristic, C16:0—palmitic.

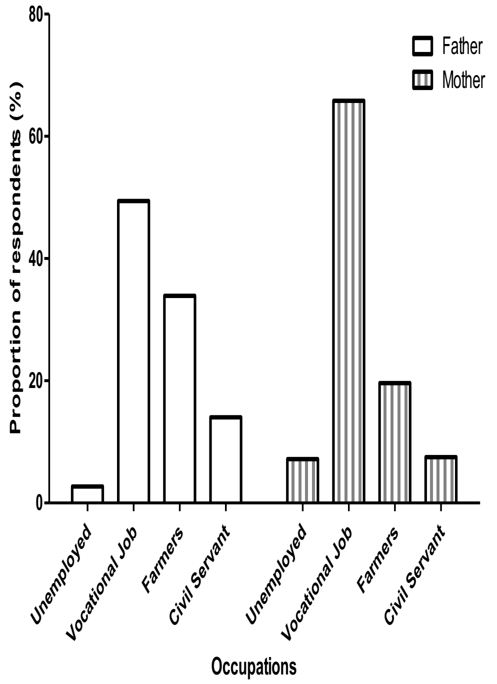
Thrombogenicity Index (TI)(28, 29, 30)
(TI) = [C14:0 + C16:0 + C18:0]/[(0.5 × C18:1) + (0.5 × sum of other MUFA) + (0.5 × n-6PUFA) + (3 × n-3PUFA) + n-3PUFA/n-6PUFA)]

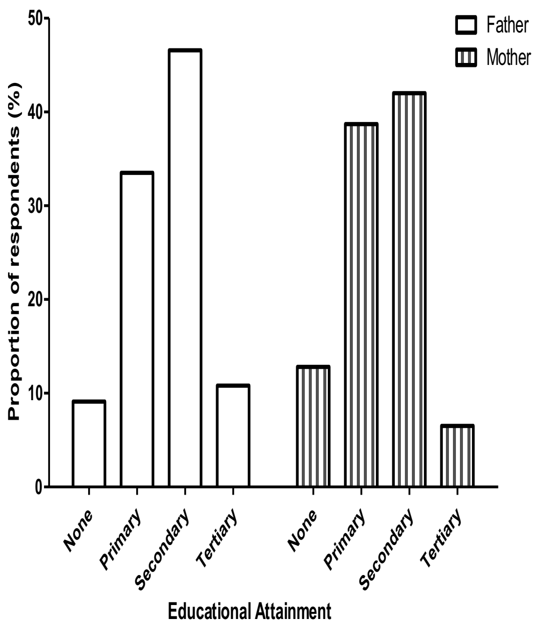
Statistical analysis
Statistical analysis was carried out using IBM Statistical Package for Social Sciences (SPSS Inc. Released 2009. PASW Statistics for windows, Version 18. Chicago: SPSS Inc.) Descriptive statistics, i.e., frequency, percentages, and means (SEM) were used to summarize the variables. Chi-square was used to determine association between categorical variables, while comparison of means between male and female was done using the Student's t test. All tests were 2-tailed and significance was set at P-value less than 0.05.

Results
Socio-Economic,Household Food Security Status and Food Consumption Patterns of the Pupils at Household Level
Socio-economic and household food security status of the pupils' parents in Osun State is

presented in Figure 1. The educational attainment of the pupil parents showed that 11% had non-formal education, while others had formal education ranging from primary (36%), secondary (44%) and tertiary education (9%). The occupation of the parents showed that 5% were unemployed, while some engaged in vocational job (58%), farming (27%) and civil servants (10%). The household food security status of the parents showed that 69% were food secured, while others were food insecure ranging from mildly (17%) to severely household food insecure (14%).

The food consumption patterns of the children at household level are presented in Fig. 2. The food consumption patterns of the children at household levels indicated that over 83% of the children consumed starch-based foods frequently, 16% occasionally, while the remaining children (1%) did not disclose their starch-based food consumption patterns. For the consumption patterns of leguminous-based foods, 72.2% of the children agreed that legumes formed the major source of their protein intakes, while 27% did eat leguminous-based foods occasionally, while others did not disclose their consumption patterns. The fruits/vegetables intake of the children showed that 71% of the respondents frequently consumed fruits and vegetables regularly, while 28% and 1% of the children consumed fruits/vegetables occasionally and did not for the last two months before the study.





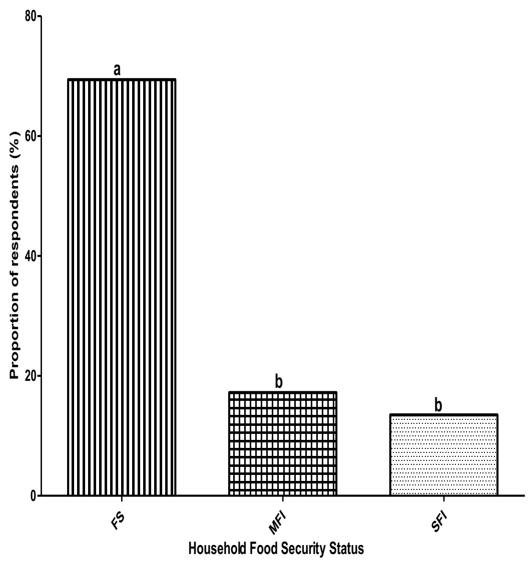


Fig 1: Socio-economic and household food security status of the pupils' parents in Osun State.

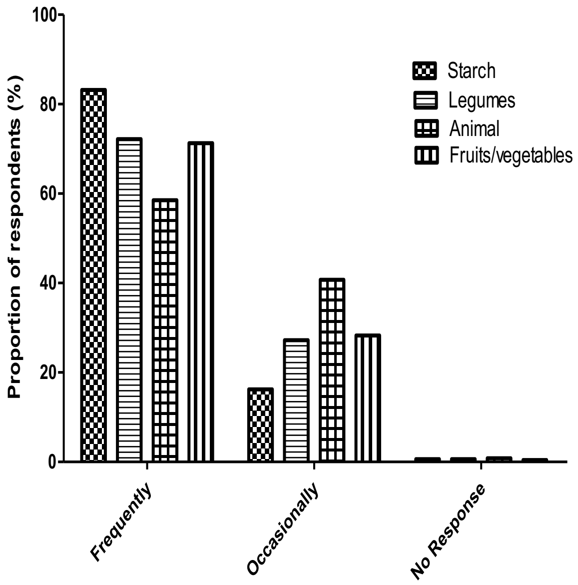


Fig 2. Food consumption patterns of the school pupils at household level in Osun State

Nutrient composition and contribution of school meals to daily nutrient requirements of school children

Nutrient composition and contribution of school meals to daily nutrient requirements of the children are presented in Table 1. The fiber, protein and energy intake per day from the school meals were 5.61 g/day, 27.12 g/day and 594.05 kcal/day, respectively. The nutrient intakes contributed between 22.27 - 28.63%, 79.78 - 142.76% and 33.0 - 49.5% of the daily requirements for fiber, protein and energy value, respectively for the male and female children between the aged 8-14 years. The mineral intake (mg/day) through the school meals were Fe (0.53), Na (6.23), K (0.50), Ca (92.43), Zn (0.28), Mn (0.06), Cu (0.02) and P (1.94), and were lower than recommended daily intake for the children.

The amino acid profile of the school meals ranged between 0.21 for tryptophan and 11.20mg/100g protein for glutamic acid, while total non-essential and essential amino acid composition of the meals were 44.97 mg/100g protein and 31.22 mg/100g protein, respectively. The essential amino acid index (EAAI), calculated biological value (BV) and nutritional index (NI) of the school meals were 50.29%, 43.12% and 13.64%, respectively (Table 2). For the fatty acid composition, the saturated fatty acid (SFA) (44.50%) was higher than polyunsaturated fatty acid (PUFA) (29.36%) and monounsaturated fatty acid (MUFA) (33.86%).The lipid quality indices of the meal showed that PUFA+MUFA/SFA ratio, atherogenicity index (AI) and thrombogenicity (TI) index were 1.421, 0.539 and 0.435, respectively (Table 3).

Table 1. Nutrient composition of school meals and its contributions to the daily nutrient requirements of the school pupils

			Male		Female	
		Actual nutrient intake	4 – 8 years	9 -14 years	4 – 8 Years	9 – 14 years
Nutrient	Proximate (g/100g)	g/day	%RDI met	%RDI met	%RDI met	%RDI met
Fiber	1.69±0.02	5.61	28.63	22.27	33.40	25.05
Protein	8.17±0.11	27.12	142.76	79.78	142.76	79.78
Carbohydrate	11.7±0.04	38.84	29.88	29.88	29.88	29.88
Energy(Kcal)	178.93±7.03	594.05	42.43	33.00	49.50	37.13
Mineral (mg/100g)						
Fe	0.161±0.00	0.53	5.35	6.68	5.35	6.68
Na	1.875±0.02	6.23	0.33	0.28	0.33	0.28
K	0.15±0.01	0.50	0.01	0.01	0.01	0.01
Ca	27.84±0.62	92.43	3.70	3.08	3.70	3.08
Zn	0.084±0.00	0.28	5.58	5.58	5.58	5.58
Mn	0.019±0.00	0.06	4.21	3.94	4.21	3.94
Cu	0.007±0.00	0.02	0.01	0.00	0.01	0.00
P	0.583±0.03	1.94	0.39	0.15	0.39	0.15

Table 2. Amino acid profile (g/100g protein) and predicted nutritional quality of school meals consumed by the pupils in Osun State.

NEAAs		EAAs		RDA
Cystine	1.15±0.00	Leucine	6.65±0.13	3.9
Alanine	3.79±0.04	Lysine	5.65±0.03	3.0
Glutamic acid	11.20±0.11	Isoleucine	4.35±0.03	2.0
Glycine	3.20±0.02	Phenylalanine	3.72±0.02	2.5
Serine	3.99±0.03	Trytophan	0.21±0.00	0.4
Aspartic acid	9.30±0.21	Valine	3.74±0.01	2.6
Proline	3.14±0.30	Methionine	1.25±0.01	1.5
Arginine	6.45±0.22	Threonine	3.38±0.03	1.5
Tyrosine	2.75±0.05	Histidine	2.27±0.01	-
Total	44.97	Total	31.22	-
		BV (%)	43.1	-
		EAAI (%)	50.3	-
		NI (%)	13.6	-

TAA (Total amino acids), TEAAs (Total essential amino acids), TNEAAs (Total non-essential amino acids), EAAI (Essential amino acid index), PER (Protein efficiency ratio), BV (Biological values), NI (Nutritional index)

Table 3. Fatty acid profile of school meals consumed by the pupils in Osun State

Saturated fatty acids	%	Monounsaturated fatty acids	%	Polyunsaturated fatty acids	%
Behenic	0.00	Oleic	26.97±3.01	Arachidonic	0.93±0.00
Caproic	0.00	Erucic	5.02±0.21	Linoleic	12.71±0.41
Caprylic	0.00	Palmitoleic	1.06±0.03	Linolenic	8.72±0.31
Capric	0.00	-	-	-	-
Lauric	14.86±0.22	-	-	-	-
Lignoceric	0.58±0.02	-	-	-	-
Margaric	0.33±0.00	-	-	-	-
Myristic	0.68±0.01	-	-	-	-
Palmitic	14.11±1.11	-	-	-	-
Stearic	13.96±2.01	-	-	-	-
Total	44.52	-	33.1	-	22.4
P/S	0.80	-	-	-	-
AI	0.54	-	-	-	-
TI	0.44	-	-	-	-

PUFA (polyunsaturated fatty acids), MUFA (Monounsaturated fatty acids), SFA (Saturated fatty acids), AI (Atherogenicity index), TI (Thrombogenicity index)

Nutritional Status of the Pupils from public schools The nutritional status parameters of the children are presented in Table 3. The age range of the children was from 6 to 14 years. The mean weights ranged from 20.83±0.24 to 40.00±0.00 for the male and 21.10±0.25 to 44.00±0.02 for the female, while mean heights varied from1.15±0.01 to 1.38±0.00 for male and 1.19±0.01 to 1.43±0.03 for female respondents. The BMI-for-age and height-for-age z-scores are presented in Table 4. The prevalence of underweight and overweight/obese of the children were 22.0% and 6.6%, respectively. Comparatively, the proportion of underweight was higher in female (22.6%) compared to male counterparts (21.4%), however, the proportion of overweight/obese children was insignificantly ($p>0.05$) higher in male (6.8%) than female counterparts (6.4%). The prevalence of stunting was lower in male (28.4%) than in female (29.4%), while overall prevalence was 29.0%.

Table 3. Means weight and height of school-aged children in Osun State.

	Male			Female			Total		
Age	No	Weight (kg)	Height (M)	No	Weight (kg)	Height (M)	No	Weight (kg)	Height (M)
6	54	20.83±0.24	1.15±0.01	67	21.10±0.25	1.19±0.01	121	20.96±0.24	1.17±0.01
7	74	23.54±0.38	1.20±0.01	63	23.63±0.44	1.21±0.01	137	23.58±0.41	1.21±0.01
8	97	24.70±0.40	1.21±0.01	81	24.01±0.40	1.21±0.01	178	24.36±0.40	1.21±0.01
9	80	26.16±0.44	1.26±0.01	82	27.04±0.51	1.27±0.01	162	26.60±0.47	1.26±0.01
10	84	31.64±0.54	1.31±0.01	100	32.47±0.66	1.31±0.01	184	32.06±0.60	1.31±0.01
11	52	34.39±0.88	1.33±0.02	41	36.00±1.30	1.35±0.02	93	35.20±1.09	1.34±0.02
12	58	35.57±0.75	1.37±0.01	59	35.82±0.87	1.38±0.01	117	35.69±0.81	1.38±0.01
13	2	43.50±1.50	1.35±0.00	1	45.00±0.00	1.50±0.00	3	44.25±0.75	1.43±0.00
14	1	40.00±0.00	1.38±0.00	2	44.00±2.00	1.43±0.03	3	42.00±1.00	1.40±0.01
Total	506	27.84±0.30	1.26±0.01	496	28.29±0.34	1.27±0.01	1002	28.07±0.32	1.26±0.01

Table 4. Classification of nutritional status of pupils using BMI-for-age and height-for-age z-scores

Indices	Male		Female		Total		Statistics
	No.	%	No.	%	No.	%	
BMI-for-age (Z -score)							
Severe Underweight	04	0.8	02	0.4	6.0	0.6	Pearson
Moderate Underweight	13	2.6	05	1.0	18.0	1.8	*X* = 5.387
Mild Underweight	91	18.0	105	21.2	196.0	19.6	
Normal	364	71.9	352	71.0	716.0	71.5	df = 5
Overweight	20	4.0	19	3.8	39.0	3.9	
Obese	14	2.8	13	2.6	27.0	2.7	p = 0.371
Total	506	100.0	496	100.0	1002.0	100.0	
Height -for-age (Z -score)							
Normal	362	71.5	350	70.6	712.0	71.1	Pearson *X* = 3.622
Mild stunting	116	22.9	123	24.8	239.0	23.8	
Moderate stunting	22	4.3	13	2.6	35.0	3.5	df = 3
Severe stunting	06	1.2	10	2.0	16.0	1.6	
Total	506	100.0	496	100.0	1002.0	100.0	P = 0.305

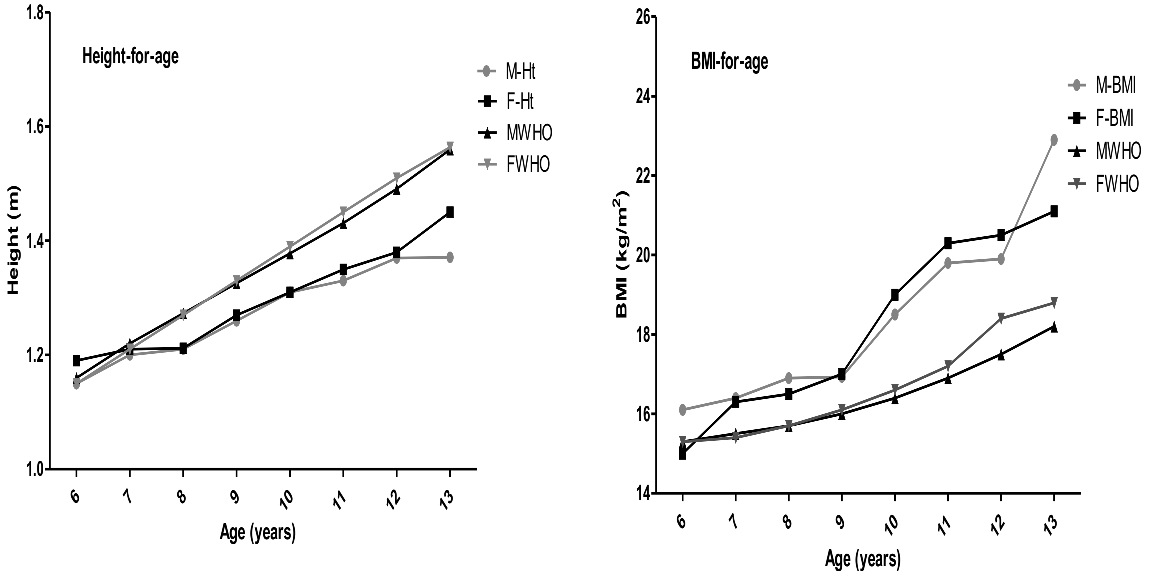


Fig. 3. Comparison between Height-for-age and BMI-for-age of male and female pupils in elementary schools in Osun State and CDC-BMI curves (Cole et al., 2000)

Key: WHO Center for Disease Control; MWHO= CDC 50th percentile BMI for males; FWHOCDC 50th percentile BMI for females; MBMI mean BMI for males in present study; FBMI mean BMI for females in present study

Discussion

Socio-Economic, Household Food Security Status and Food Consumption Patterns of the Pupils at Household Level

The socio-economic status (SES) of the respondents with reference to the educational attainment, occupation and household food security status of their parents showed that majority of the children were within low and medium SES. This finding justified the reason for over four-fifth of the respondents depending on starch-based foods for their daily intakes. However, fruits and vegetables consumption patterns of the children are well encouraged; and this could be attributed to the season of fruits and vegetable, which coincide with the study period. This finding agreed with the reports that formal education and types of occupation play vital roles in determining individual's productivity, food choice, and health wellbeing (31-33). It is well established from the previous study that low socio-economic status could be detrimental to health through the development of household food insecurity(34).

Food insecurity refers to inadequate household access to food due to financial constraints (35). In this study, it could be established that over one-quarter of the children families was food insecure, while the remaining were food insecure. This finding could have some negative implications on the nutritional, health and academic performance of the affected school children. For instance, studies have reported that a food insecure family could compromise dietary intake of the children, hence, leading to high prevalence of malnutrition, school absenteeism, and subsequently poor academic performance(36, 37). This has actually necessitated the needs for school feeding programmes in order to alleviate short-term hunger and enhance learning capacity of underprivileged school children in developing countries, who are persistence influenced by poverty, hunger and malnutrition (38).

It is well established that improving dietary intakes of children could have positive effects on their academic performance, nutritional and health wellbeing (38, 39). High prevalence of malnutrition among school-aged children in Nigeria and other developing countries has been attributed to poor nutritional care or dietary intakes, due to poor socio-economic status of their parents (40)

Nutrient composition and contribution of school meals to daily nutrient requirements of school children

The school meals were able to provide over 20%, 70% and 30% of daily requirements for fiber, protein and energy, respectively for both male and female children (8-14 years). This finding agreed with the aims and objectives of school feeding programme, which was designed to complement dietary intakes of school-aged children at the household level, and thereby improving their nutritional wellbeing, academic performance, and school enrolments (41 - 43). Several reports have also shown that school lunch programme increased the diversity, quality and quantity of nutrient intakes of participating children (44-46).

The mineral composition of the school-meal was generally low and unable to meet the daily requirements of the children. This observation could be attributed to the composition of the school meals, which were characterised with cereals and legumes. This may thus indicate that adequate micronutrient intake could not be achieved through extra meal from school lunch, but it may only be achieved through deliberate supply of micronutrient-dense foods (47). Other studies have reported that African diets are generally characterised with low animal protein, but high in cereals and legumes, which are high in phytate, hence, inhibit the bioavailability of essential minerals like iron, calcium and zinc in foods (48, 49). Besides, epidemiological studies have reported that fruits and vegetables consumption patterns is low in Western part of Nigeria where the present study was conducted (50).The value of phytate/mineral molar ratios, i.e., an index of bioavailability of essential minerals like Ca, Zn, Fe, were within the acceptable levels (51). This implies that non-bioavailability of these minerals, i.e., Ca, Zn and Fe mighty be minimised, and thereby preventing anaemia, deformation of bones and poor cognitive development in children (52).

The essential amino acids in the school meals were adequate to provide daily requirements of the school children, except for phenylalanine, tryptophan and methionine. It is evident that for brain to function adequately, it requires essential amino acids like tryptophan, tyrosine, histidine, and arginine (53), which were present in appreciable amount in the school-meal. Study has reported that depletion of these amino acids could interfere with the brain functions (54), hence, academic performance of school children. The essential amino acid index (EAAI), calculated biological value (BV) and nutritional index (NI) of the school meals were comparatively lower than recommended values for EAAI (70%), BV (70%) and NI (20%) (25,55). These results imply that the nutritional quality of the school meals was low, and this could be attributed to the composition of the school meals, which were mainly plant-based. Plant-based foods are usually low in quality proteins (56), hence, poor biological value when compared to that of animal-based meals. This observation agreed with the report of Abizari (56), who also reported that the biological value of school lunch in Ghana was low due to poor composition of the school meals, which were mainly plant-based with low animal protein sources.

The total polyunsaturated fatty acid (PUFA) and monounsaturated fatty acid (MUFA) of the school meals was higher than saturated fatty acid (SFA), while PUFA+MUFA/SFA ratio was > 1. This observation implies that the meals contain lesser amount of saturated fatty acid compared to polyunsaturated fatty acid, and this is highly beneficial to the health of the children. Scientific studies reported that regular consumption of meals with PUFA/SFA ratios higher than 0.45 reduce formation of blood cholesterol, and the risks of cardio-vascular disease(57-61). The atherogenicity index (AI) and thrombogenicity (TI) index values of fat in the school meals were less than recommended value (<1.0), and this indicates the quality of the oil used to prepare the school meals. The relationship between total saturated fatty acids (pro-atherogenic) and unsaturated fatty acid (anti-atherogenic) indicate the quality of the oil in the foods(61,62). Hence, the fatty acid in the school meals may not lead to arteriosclerosis formation in the children or any associated health challenges at adulthoods. Recent epidemiological study has linked prevalence of obesity and hypertension among children to the high-saturated fatty acid intakes (63).

Nutritional Status of the Pupils

The age of the children ranged from 6 to 14 years. In this present study, it was observed that for both male and female pupils the mean weight and height increased with age. This observation was similar to previous studies from Nigeria (64-66). The overall mean of BMI values in this study was generally lower than what reported by Ahmad (66), but comparable to those of the 50th percentile values from the CDC-2000 BMI charts (Fig 3b). The variance in BMI values that was observed in this present study compared with other similar studies could be attributed to socio-cultural, ethnicity and geographical locations differences.

The BMI-for-age z-scores of the children showed that the prevalence of underweight was higher in female than male counterparts, in contrary, the prevalence of overweight/obesewas insignificantly (p>0.05) higher in male than female counterparts. This finding was in line with the reports of Igbokwe (67) and Ahmad (66), but not in conformity with Kimani-Murage et al. (68) and Reddy et al. (69). Evidence has shown that at early adolescence age, fat gain usually occurs in both boys and girls, but as the age increases it ceases and it may even temporarily reverse in boys, while it continues throughout female adolescence (70). The female adolescent lay down fat as a natural part of the ontogeny of their sexual and reproductive physiology, whereas the males gain proportionately more muscle mass rather than fat (66, 71, 72).The prevalence of stunting among the study populationshowed that the proportion of stunted female pupils was more than that of male counterparts. The prevalence of stunting among the respondents in this study was higher when compared with the report of Igbokwe(67), lower than those of the 50th percentile values from the CDC-2000 height-for-age charts (Fig 3a), but comparable to that of Senbanjo(73). The variance between the prevalence of stunting in this present study and that of other previous studies could be attributed to variation in socio-economic status and geographical locations. For instance, Senbanjo (73) documented low prevalence rates of wasting, stunting and underweight in a rural community in Southwest Nigeria, while Igbokwe (64) reported high prevalence of stunting among adolescents in Enugu, an urban centre.

Conclusion

The findings established that the school-meals contributed positively to the daily nutrient intakes of the children in terms of protein and energy value. However, the prevalence of underweight and stunting was noticed in the community particularly among female pupils than male counterparts. Hence, there is a need to improve on the quantity and quality of the school-meals. This finding may be relevant to health and educational policy makers in Nigeria.

Acknowledgements

We are grateful to the Director of Ministry of Health, Ministry of Education, Head Teachers of schools and the pupils in Osun Sate for their supports.

Conflicts of interest: There was no Conflict of interest.

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