ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

Quality Dietary Intake in Adolescence: Assessment of Macronutrients, Minerals and Essential Amino Acids in School Meals Served in the FCT, North Central Nigeria.

***Eseohe. G Okpebholo[1], Oluwatooyin. F. Oludahunsi[2], Oluwole. S. Ijarotimi [3]**

[1]Department of Nutrition and Dietetics, National Defence College Medical Centre, Central Area, Abuja Nigeria

[2]Department of Food Science Technology, Federal University of Technology, Akure Nigeria

[3]Department of Nutrition and Dietetics, Federal University of Technology, Akure Nigeria

***Corresponding Author**

DOI: https://doi.org/10.51584/IJRIAS.2024.910001

Received: 09 September 2024; Revised: 22 September 2024; Accepted: 26 September 2024; Published: 26 October 2024

ABSTRACT

Energy, Macronutrients, Minerals, and Essential Amino Acids (EAA) were assessed from school meals served to adolescents in government boarding Schools in the Federal Capital Territory of Nigeria. Two Hundred and EightySix (286) secondary school students within the age range of 13-19 years were selected for this study. 56.6% of the students were female and the majority (60.8%) were aged 13-16yrs with average age of respondents as (15.75±1.11) and BMI range (17.4-18.37). Stunting (4.2%) and malnutrition prevalence (28%) were low with the majority of adolescents recorded as normal HFA(95.4%). Protein and energy sources were largely plant based, however, carbohydrates made up (28.03%-31.3%) of daily value which was lower than the RNI for adolescents per day. Protein (53.9% - 83.6%) and Fats (65.6%-158.02%) exceeded the RDA for population consumption and Energy (1070±196.7 (Kcal) intake was less than required. However, individual rations for daily consumption of protein, Energy and Fibre fell short of RNI. Moisture content (54.2-58.3%), ash (3.5-5.1%), fat (9.6-15.15%), protein (5.38-8.0%), crude fiber (0.8-1.3%), and carbohydrate (18.9-21%). Meals contained calcium (57.4-65.0mg), potassium (290-460mg), sodium (1030-1500 mg), iron (10.9-12mg), zinc (6.12-7.72mg), Mg (56.5-58.7mg) vitamin A (2.56-6.5 RAE), and vitamin C (0.024-0.041mg) Vitamin D (8.14-11.63mg) per 100 g of the school meals. Calcium, Vitamin A, Vitamin C and Potassium were recorded as low for Recommended Nutrient Intake. Essential Amino acid (EAA) levels were quite higher than required per 100g of meal assessed for all nine EAA. In conclusion, dietary diversification of meals can be improved upon, to meet intricate adolescent nutrient needs.

Keywords: Adolescent Nutrition in Nigeria, Macronutrient, Essential Amino Acids, Boarding school meals, FCT boarding schools

INTRODUCTION

It is essential that the daily dietary requirements for all nutrients is met, for all individuals according to body needs. In adolescence, the required dietary allowance should be met for more than 80% of the population. Individual minimum intake of macronutrients should be sufficient to meet metabolic demands and maintain the growth process even after nutrient losses in the body system [1] Adolescence is a critical growth period, in which success is largely determined by optimum nutrition intake through diet [2]. However, in developing nations, challenges such as food Insecurity deny individuals, families, feeding institutions the capacity to meet the recommended Daily level of nutrient intake [3]. This in turn has contributed to the scant consumption of high nutrient dense foods such as animal rich protein, fruits and vegetables among the population [4]. Community issues such as Protein-energy malnutrition is still prevalent in Nigeria, same reported in parts of East and Southern Africa, affecting school Age children and school going adolescents [5]. Chronic Protein deficiency,

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

wasting and shrinkage of muscle tissues, oedema and organ failure [6] constitute a nuisance in the growth process and additional protein intake might be beneficial for catch-up growth in chronically malnourished young ones [7].

With the prevalence of malnutrition being curbed in Nigeria, recommendations for child and adolescent nutrition have been put in place by the Federal Ministry of health (2014) regarding dietary guidelines for school-aged children (6-11 years) and adolescents (12-18 years) [8] This is partly to aid growth demands and to initiate healthy dietary patterns in Adolescents. School feeding programs play a major support role in meeting nearly two-thirds of daily calorie requirements, of school going adolescents [9]. With its major challenges related to governance, funding, compliance of local food suppliers, lack of continuous and effective monitoring and evaluation, technicalities, the controlled school feeding programmes run at risk of being less efficient [10] [11].

In adolescence, the Recommended Nutrient Intake (RNI) for daily intake of macronutrients is 45-65% for Carbohydrates, 10-30% for protein and 25-35% for Fats in a daily meal where energy requirement is 2200kcal-2800Kcal/day [12]. Therefore, an adequate diet rich in macronutrients and other key nutrients is recommended by age both from animal and plant sources to prevent the early onset of, deficiency, metabolic and other non-communicable diseases [4]. Ensuring the consumption of nutrient adequate meals requires a healthy combination of both plant and animal food sources [13]. To satisfy the metabolic demand, the dietary protein must contain adequate and digestible amounts of nutritionally indispensable amino acids (histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine), and amino acids that can become indispensable under specific physiological or pathological conditions (conditionally indispensable: e.g. cysteine, tyrosine, taurine, glycine, arginine, glutamine and proline) [14][4]. The UNICEF reported Protein-energy malnutrition was among the top 10 causes of death among children and adolescents, accounting for 225,906 deaths in 2013 [1]. Seeing as Adolescent Malnutrition is a major topic that has a tendency to be overlooked, it is therefore pertinent and timely that this study sheds light on the nutritional status, Quality and Quantity of nutrient Intake of School-going adolescents consuming a generalized and portioned meal in the Federal Capital Territory of Nigeria.

MATERIALS AND METHOD

Sampling

Considering prevalence rate of underweight among Nigerian adolescents as 31% reported in a study [15], and allowable absolute error (Precision) of 5%, Dobson's formula ($\mathbf{n=t^2\frac{(pXq)}{d^2}}$) was used for sample size determination (n =327). 95% confidence interval and a design effect of 1 was used in the study with simple random sampling.

The study population comprised of 286 adolescent respondents attending selected Government public secondary schools with boarding facility, operating a unified feeding meal table across The Federal Capital Territory. The FCT has 21 Government secondary schools with functional boarding facility, located in her six local government areas. Nine (9) of these are located in the three selected local government areas (AMAC BWARI and KUJE LGA). A list provided by the state education board was used to pick out Three (3) of the most populated government secondary Schools with boarding facility, representing each of the three selected local government areas, also running a standard 3-meal school feeding program. This cross-sectional study was conducted in November 2023.

Data Collection

A Pretested semi-structured questionnaire was administered to the participants, data on Anthropometry, Age and self-reports on meal pattern, meal skipping, and access to pocket money and interest in the school meals by frequency and types. Demographic data and food frequency data was collected over a period of 2 weeks across the Locations. Anthropometric measurements each representing a local government area, were taken to determine nutritional status of the adolescents as consumers within the research location. Body mass index was calculated using the weight and the height as; Weight (kg)/Height^2(m^2) [16]. The WHO reference table for Body

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

Mass Index and Height-For-Age in adolescents was used to determine stunting across the population group. The WHO growth charts and BMI-for-age charts were used to compute Z-score (weight-for-age, height-for-age and BMI-for-age) according to WHO reference standard [17]. Stunting and underweight (Severe Thinness and Thinness) were calculated as height-for-age and weight-for-age Z-score below -2 Z-score respectively, while overweight was BMI-for-age>2 Z-score and obesity was BMI-for-age >3 Z-score (5-19 years). With the Permission of the State Education Board, the Unified boarding school feeding timetable for government secondary schools was assessed for a 2-day feeding plan, meal pattern and daily dietary consumption. Samples of cooked meals prepared by the school caterers and served to the adolescents, were collected as served for Breakfast, Lunch and Dinner for meals repeated more than 2 times/week on the menu. Food Samples were analysed for macronutrients, micronutrients, energy consumption and Essential Amino Acids using standard methods. Meals were collected wholly at the point of serving the students.

Same portion and size served, weighed and stored in Food-grade bags, Frozen at -10^0C to -18^0C until all meals were collected and ready for analysis. All food samples collected were sorted according to location separately and mixed together into a soft pasty blended mix [18] using a high powered Blender (Century Blender 1000W) and stored in three (3) separately tagged Food freezer bags, cold-chain and on for laboratory analysis. Nutrient analysis was carried out for proximate analysis, and Essential Amino Acids using standard procedures [19] and applied methods [20]. Atwater general conversion factors were used to calculate the energy content of the school meals [21]. The conversion factors used were 4 kcal, 4 kcal, 9 kcal, and 2 kcal per gram of carbohydrates, proteins, lipids, and fiber respectively [21]. The potential contribution of school meals to the RNI of the participants was assessed. The intake of energy and nutrients of the study participants was estimated using a simple proportion. The method used the results of the nutrient and energy content of the foods obtained from laboratory analysis and portion sizes served. Assuming 100 g of cooked moi moi contains Bg of carbohydrate and the portion size consumed by the student is 200 g, then the amount of carbohydrate consumed is: B/100 x 200. Average of the sum of the nutrient and energy intake during the school day (2 day) was noted. The average was then compared with age-specific RNI to estimate the percentage contribution (IOM, 2006 Dietary Reference intakes which is also presented in the Acceptable Macronutrient Dietary References (AMDR).

Inclusion Criteria

All apparently healthy adolescents aged 13 to 19 years attending a Public boarding Secondary School with boarding facility, in three (3) selected districts of the Federal Capital Territory. Presenting a signed Parental informed consent form (aged 13 years and above).

Statistical Analysis

Socio demographic data is presented as descriptive statistics of percentages and frequencies using Statistical Package for Social Sciences (SPSS) software version 21.0. Variables were presented as mean ± (SD), an independent sample t-test was used to compare two means, where appropriate at a level of significance of $p < 0.05$.

Ethical Clearance

Consent forms were given to parents on school visiting day and Ethical clearance was obtained from the Federal Capital Territory State Education Board (SEB) and the National Hospital Ethical Clearance Committee Abuja (NHA/EC/074/2023).

RESULTS

Demographic Characteristics of Adolescents.

The demographic characteristic of the Adolescents is shown in Table 1. There was a total of 286 school-going adolescents in the study, registered as students in one of the three schools with boarding facilities in the selected LGAs of the FCT. 33.9% attended boarding schools in AMAC LGA, (36.01%) BWARI and (30.09%) in KUJE LGA respectively. The highest participation (94.5%) was from the senior secondary school (SSS) while junior

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

secondary was 5.5%. The female adolescent respondents had a higher percentage (56.6%) than male (43.4%) respondents. Age group 13-16 years were the majority (60.8%) of the respondents, while age group (17-19) years were the least (39.2%) respondents as presented in Table 1.

The Mean ± SD of specific variables are; Average Age of Respondents was (15.75 ± 1.11) across the sampled population BWARI LGA had the highest ages of participants, (16.1±1.21) while AMAC LGA and KUJE LGA had the most record for BMI ranges within Normal (18.20 ± 3.29) and (18.37. ±2.50) respectively. The total average BMI across the sampled population was recorded as underweight (<18 BMI).

Table 1 Demographic Characteristics of Adolescents Attending Boarding School Sampled Across Three (3) LGAs in the FCT

SCHOOL	Overall n (%)	AMAC n (%)	BWARI N (%)	KUJE N (%)
Variable	286	97(33.91)	103(36.01)	86(30.09)
AGE				
13-16	174(60.8)	78(27.2)	34(11.8)	62(21.6)
17-19	112(39.2)	19(6.64)	69(24.1)	24(8.39)
SEX				
Male	124(43.4)	51(17.83)	39(13.6)	36(12.6)
Female	162 (56.6)	48(16.7)	64(22.3)	50(17.48)
CLASS				
JSS	16(5.5)	1(0.40)	10(3.40)	5(1.70)
SSS	270 (94.5)	96(33.5)	93(32.5)	81(28.3)
Total	286 (100)			
Mean of Variables observed within the samples by Location				
Age	15.75±1.11	15.51^{a} ± 0.9	16.1^{b} ± 1.21	15.50^{a} ± 1.0
Height(m)	1.67±0.08	1.71^{a} ± 0.08	1.67^{b} ± 0.07	1.63^{c} ± 0.07
Weight(kg)	50.25±9.78	53.21^{a} ± 10.5	48.8^{b} ±10.40	48.9^{b} ± 7.81
BMI	17.77±3.16	18.20^{a} ± 3.29	17.4^{b} ± 3.46	18.37^{a} ± 2.50

*JSS-Junior Secondary School; SSS- Senior Secondary School

*Values with superscript across rows are significantly different

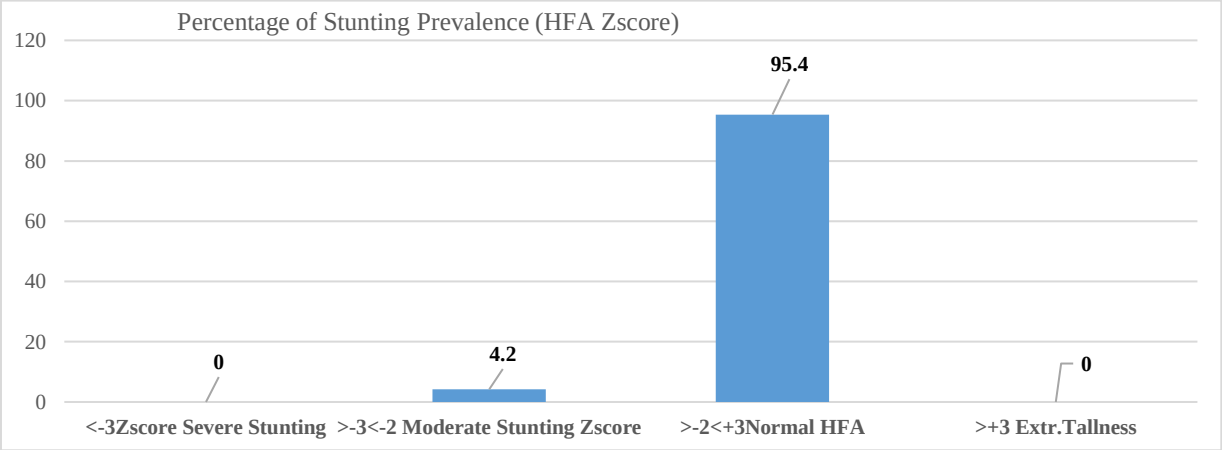

Figure 1 Prevalence of Stunting

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

Prevalence of Stunting (HFA Z-Score) among the Adolescent Participants.

The average rate of stunting across the population was recorded as 12 (4.2 %) Moderate Stunting among the Adolescents attending boarding schools in the Sampled Area.

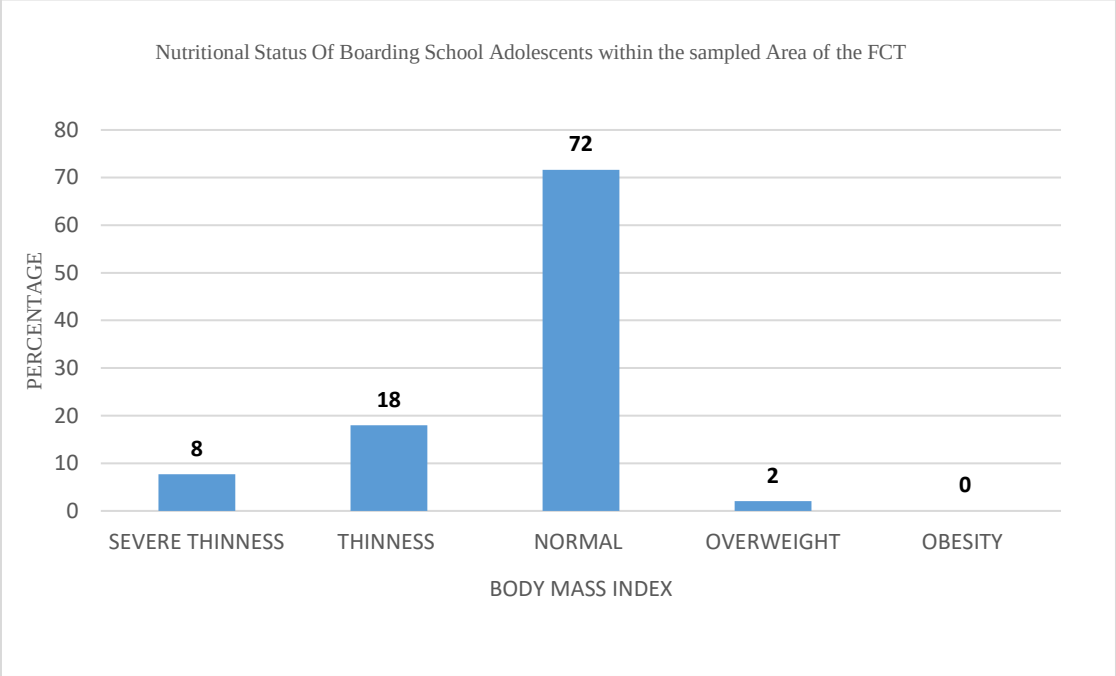

Figure 2 Nutritional Status of the Participating Adolescents.

Nutritional Status of the participating Adolescents (Underweight, Normal Weight, Overweight and Obese Prevalence.)

Prevalence of Malnutrition across the Schools Sampled is shown in Figure 2 and Table 2 as Nutritional Status (BMI) 205 (71.3%) of the sampled population are of Normal weight, 22 (7.6%) severely thin/underweight, 53(18.1%) Thin and Underweight, Overweight 6(2.09%) Obesity 0(0%). Results show that Malnutrition Prevalence was 28% of the total Population (286) Sampled. 34.6% of the Male Population were either underweight or overweight while 23.4% of the female Population were also either Underweight or Overweight.

Table 2. Percentage (%) distribution of BMI of Participating Adolescents by Sex

BMI Severe Thinness Thinness Normal Overweight Obese Malnutrition PREVALENCE (SvThn + Thn + Overweight)					
SEX					
Male (%)	15(12)	26(20.96)	81(65.3)	2(1.61)	-34.6 of Y
Female (%)	7 (4.32)	27(16.6)	124(76.5)	4(2.46)	-23.4 of X
Total Prevalence of Malnutrition 28% of n					

*n is Total Population Sampled

*X is total Female Population Sampled

*Y is total Male Population Sampled

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

Percentage Consumption of each Food Group, by 3.6 Average Quantity (g) of Macronutrients (g/100g) Served/Day by Location.

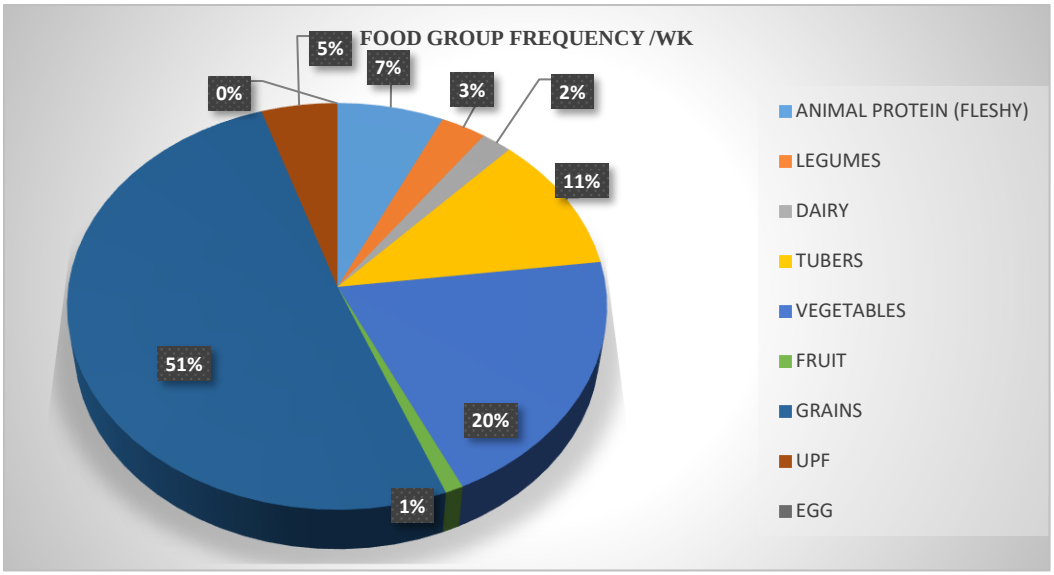

Figure 3: Frequency of Consumption by Food Groups in Meals Served.

Grains and cereals made up more than 50% of the nutrient sources per meal served weekly Vegetables made up 20%, Dairy 2% and Eggs 0%.

Average Weight of Standard Meal Served to Students (Breakfast Lunch and Dinner) for 2 days

Table 3 Weighed (g) portions of a 2 –day Meal as Served

SCHOOL	AMAC	BWARI	KUJE	Mean
MEAL TYPE	(g)	(g)	(g)	±SD
Bread/Tea	105±1.6	110±1.4	100±1.2	105±5.00
Noodles	150±4.3	120±4.7	140±4.4	136±13.20
Jollofrice and Fish	210±2.5	220±2.4	205±2.6	211±7.60
Rice/Stew	100±15.3	180±16.2	200±17	160±52.90
Beans/Pasta/Fish	150±8.6	192±8.9	203±7.5	181±27.90
Cassava mold and Okro	250±9.6	220±8.4	280±6.5	250±30.00

Average weight of meal (2 days) 522g

*Average amount of meal serving to the students for one day recorded as 522g consisting of (Breakfast, Lunch and Dinner) by Location

Table 4: Proximate Analysis of Macronutrients in School Meal Samples by Location

Macronutrient	AMAC	BWARI	KUJE	Mean±SD	P-Value (%)
CHO	18.8	19.0	21.0	19.5±1.03	0.000
PROTEIN	5.38	6.64	8.0	6.56±1.14	0.002
LIPID	6.30	15.15	9.6	13.68±3.58	0.004
FIBRE	1.3	0 .9	0.8	0.98±0.28	0.300

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

ASH	5.1	3.5	3.7	4±0.85	0.180
MOISTURE	54.2	55.8	58.3	56.1±2.06	0.000
MINERALS (mg/100g)					
Calcium	65	61.67	57.4	61.35±3.8	0.001
Sodium	1180	1500	1030	1236.6±240	0.012
Potassium	320	460.0	290	356.6±90.7	0.021
Iron	12	9	10.9	10.63±1.2	0.000
Zinc	7.72	6.6	6.12	6.8±0.82	0.005
Phosphorus	447.1	476.9	357.7	427.2±62.0	0.007
Magnesium	57.9	58.7	56.5	57.7±1.1	0.000
Manganese	5.2	4.5	4.8	4.83±0.35	0.002
VITAMINS					
Vitamin A	6.5	4.1	2.5	4.2±1.27	0.000
Vitamin C	0.03	0.04	0.02	1.94±2.09	0.072
Vitamin D	0.005	0.003	0.004	0.004±0.0	0.005

Significant difference ($p<0.05$) between adolescent groups by Location

Table 5. Contribution of School Meals to the RNI of micronutrients (mg/day)

MICR **(mg/day)**	RNI	**AMAC**	**BWARI**	**KUJE**	Mean ±SD
Calcium	1300	339	321	229.6	296.5±54.7
Sodium	1500	6159	7830	5376	6455±1227
Zinc	11	40.9	34.5	31.9	35.7±5.2
Potassium	4500	1670	2401	1513	1861±444
Iron	15	62.6	46.9	56.9	55.4±7.8
Phosphorus	1250	2333	2489	1867	2229.6±311
Magnesium	410	302	306.4	294.9	301.1±8.4
*Vitamin A	0.9	33.93	21.4	13.05	22.79±10.4
*Vitamin C	75	0.16	0.21	0.10	0.157±0.1
*Vitamin D	0.015	0.0261	0.015	0.021	0.02±0.0

*Values are expressed as percentages of the age specific RNI of the macronutrients provided and expected to be consumed per day. RNI: recommended nutrient intake for Age

*Avg weight of Meal (522g)/day (Table 3)

Table 6. Contribution of School Meals to the RNI of Micronutrients (Percentage%)

MICR RNI%	AMAC	BWARI	KUJE
Calcium	26	24.7	23.04

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

Sodium	410	522	358
Zinc	366.3	313.2	290.4
Potassium	37.2	53	33.64
Iron	417	312.6	379.3
Phosphorus	186.6	199.1	149.4
Magnesium	73.7	74.7	71.9
Vitamin A	3.7	2.37	1.45
Vitamin C	0.21	0.28	0.13
Vitamin D	174	100	140

*Values are expressed as percentages of the age specific RNI of the macronutrients provided and expected to be consumed

Table 7. Shows Macronutrients and Total Energy Consumed Compared with RDA for Age /day (mg/day)

Macro	**RNI (g)**	**AMAC (g)**	**BWARI (g)**	**KUJE (g)**	**Mean±SD (g)**	**P-Value**
CARBOHYDRATE	350	98.13	99.2	109.6	102.31±6.3	0.000
PROTEIN	52	28	34.6	41.8	34.8±6.9	0.050
FAT	50	32.8	79.01	50.1	53.9±23.3	0.796
FIBRE	34	6.7	4.6	4.2	5.16± 1.25	0.001
ENERGY (Kcal)	2200	860	1250	1100	1070.0±196.7	0.010

65-15-20% rule for macronutrient consumption/day/age **(0.65g of carbX2200 ÷ 4 Standard CHO Calories)** rounded up to the nearest 50Kcal

*Average amount of meal serving to the students/day of **522g**/day (Table 3)

*RDA for Ages 14-18 least calories/day at 2200kcal/day

*Acceptable Macronutrient Distribution Ranges.

*CHOgx4kcal; PROTgx4kcal; FATgx9kcal *RDA -Acceptable Macronutrient Distribution Ranges for Adolescents. (2020)

Total Energy, Macronutrient (g) and Daily Value consumed relating to Recommended Nutrient Intake/day (RNI)

Table 8. Percentage Contribution of Macronutrients in Meal Consumption by %RNI per day

Macronutrient (%)	AMAC	BWARI	KUJE	RNI
CARBOHYDRATE	28.03	28.3	31.3	45-65
PROTEIN	53.9	66.5	83.6	10-30
FAT	65.6	158.02	100.2	25-35
FIBRE	19.7	13.52	12.3	26-34
ENERGY	39.1	56.8	50	95-100

Values are expressed as percentages of the age specific RNI of the macronutrients provided and expected to be

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

consumed per day.

RNI: recommended nutrient intake

Table 9. Average Values for Essential Amino Acid (EAA) Characteristics (mg/g) of the Served Meals in Boarding Schools Consumed by Adolescents

AA (g/100g)	AMAC	BWARI	KUJE	Mean±SD	P<0.05
**Leucine	10.16	10.66	9.82	10.21 ± 0.42	0.007
Lysine	4.11	4.41	3.9	4.14 ± 0.25	0.082
Isoleucine	3.65	3.8	4.12	3.85 ± 0.24	0.052
AAA					
(PnylA+Tyr)	7.47	7.79	8.6	7.94 ± 0.57	0.002
*Tryptophan	1.09	0.9	0.88	0.95 ± 0.1	0.244
Valine	3.68	3.96	3.8	3.81 ± 0.14	0.080
Threonine	3.25	3.02	2.96	3.07 ± 0.15	0.245
SAA **(Meth+Cyst)**	2.49	2.72	2.41	2.54 ± 0.1	0.468
Histidine	2.34	2.26	2.50	2.3 ± 0.07	0.031
Σ EAA	38.2	39.52	38.99	38.9 ± 0.9	0.051

*Significant difference (p<0.05) between locations

*Limiting Amino Acid

**Abundant Amino Acid

Essential Amino Acids Value in School Food Blended Mix plotted against Values of RNI

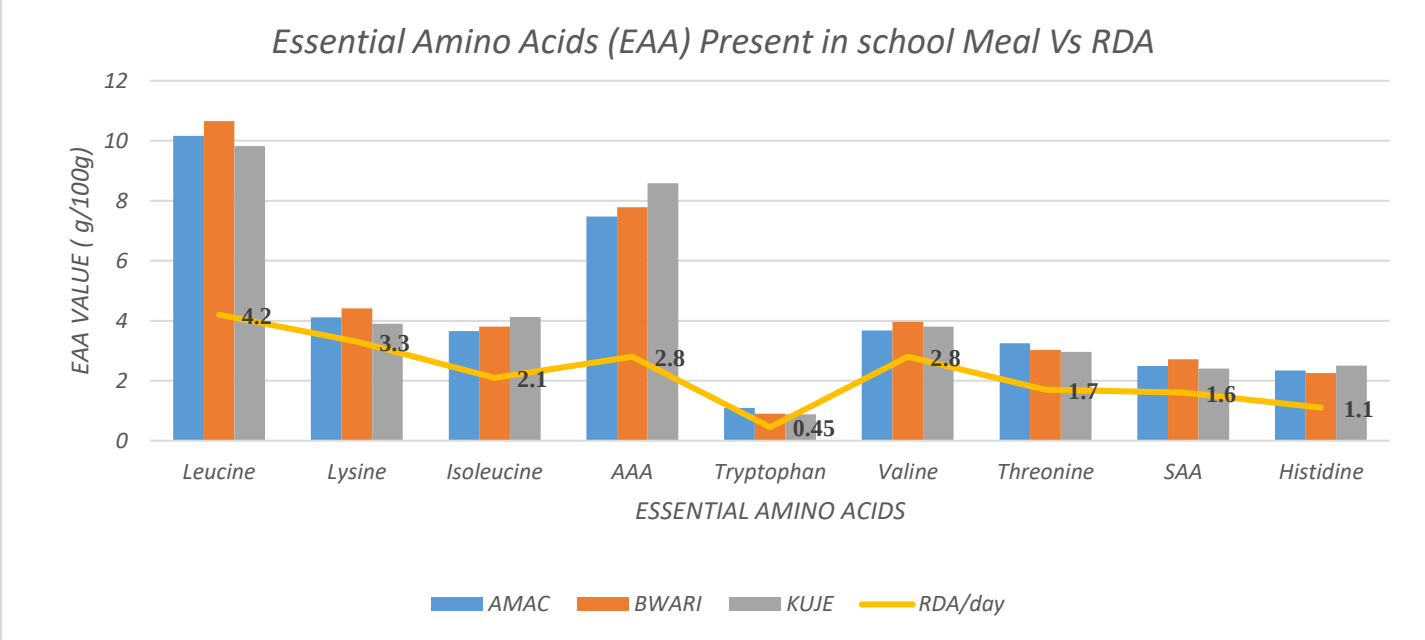

Figure 4. Comparison between Average Daily Consumption of EAA in Boarding School Meals and the RDA for Adolescent Consumption (mg/g/day.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

DISCUSSION

The total average BMI across the sampled population recorded as 17.77±3.16 and prevalence of malnutrition (28%) was similar to adolescent malnutrition in Zaria Nigeria at 25.7% [22]. This relatively implies there are still major problems of malnutrition occurring within the adolescent population in parts of the FCT. This mild prevalence of stunting, overweight and obesity agrees with the findings [23] as seen in parts of East and Southern Africa where further efforts are also being made to tackle Malnutrition in young ages.

Daily consumption of food which is largely determined by the school-Unified food table Shows that grains represent more than 50% of the protein sources and food groups served to the adolescents weekly. Vegetables made up 20%, which is also usually paired with the cereal staples as soups. Dairy consumption made up 2% of the meals which was included during breakfast with a teabag and choco mix in water. Eggs (0%) were practically not a regular seen in the diets as well as little meshed pieces of beef and fish served on some days. Fruit was the least consumed on the menu as once/week mainly an orange or depending on what fruits were in season. Diet was not diverse in terms of food type and consumption frequency as over 75% of the menu was being repeated daily or every other day. This is similar to other findings in Tanzania, showing less commitment to foo diversity in school meals [24], stating that boarding school diets are usually monotonous and low nutrient diversity with less animal source proteins Studies on the effects of consuming monotonous rations indicate that repeated presentation of some foods can lead to a persistent decrease in the pleasantness of these foods [24]. The main dishes included Rice, wheat flour noodles, pasta, corn meal (Tuwo) with stews or soups for lunch and dinner. Breakfast included bread and tea, Moi moi (bean pudding) and noodles. Eggs were not served and less than 28g of powdered milk was served in Black Tea bag and cocoa beverage which was served with a portioned 100g of bread twice a week as breakfast. Meat and fish made up about 7% of meals weekly, while grains, tubers and cereals made up for vegetative sources of energy and protein. Dairy consumption is an important aspect of adolescent meal especially for calcium and 50% of the daily consumed protein must be met from animal sources whereas other half must be met from vegetative sources [25]. Several studies have suggested methods of improving Protein quality and Amino Acid presence in foods for children and adolescents who do not consume enough protein. Breakfast Pap (Corn pudding) and Snacks can be enriched with good-quality proteins from soyabean flour or plant dairy products [26].

It is pertinent to note that as alluded, [27] Similar pattern of meals have been observed in school service meals across Nigeria and Africa at Large [28][29]. Adolescents' diet in boarding schools in developing countries is confined with traditional starchy staples, mainly cereals accompanied by legumes and little consumption of animal foods, micronutrient-rich fruits, vegetables, with a tendency to lack quality dietary diversity. Boarding schools' menus in similar studies have been shown monotonous giving adolescents no other food choices, but to eat whatever is provided unlike students who have regular access to other meal options.

Also, an average meal served/day (Breakfast/Lunch/Dinner) was summed at about 522g per day (Table 3). This represented portion sizes of (105±5g) at Breakfast, (211±7.6g) Lunch and (250± 30) respectively, for noodles, jollof Rice and fish and cassava mold with soup. In addition, the meals contained moisture (54.2-58.3%), ash (3.5-5.1%), crude fat (9.6-15.15%), crude protein (5.38-8.0%), crude fiber (0-8-1.3%), and total carbohydrate (18.9-21%) per 100g meal. the meals contained calcium (57.4-65.0mg), potassium (290-460mg), sodium (1030-1500 mg), zinc (6.12-7.72mg), Mg(56.5-58.7mg) vitamin A (2.56-6.5 RAE), and vitamin C (0.024-0.041mg) Vitamin D (8.14-11.63mg) per 100 g of the school meals. Findings in this study indicate that some micronutrient intake such as calcium, potassium, Vitamin A and Vitamin C (23-26%) (33.6-53%) (1.45-3.77%) (<1%) respectively were below the % RNI as seen in Table 6. However, Sodium intake was observed as high (>100%). Similar values have been observed in another study [29][37] with high sodium content in school meals and less values for other important nutrients. Carbohydrates and Energy Intake did not meet the recommended Nutrient Intake daily. This may be due to quantity of meal served as also recorded in school meals served to pupils in Kaduna State [29]. Also, a study in Eastern Nigeria recorded opposite values, with Carbohydrate requirements met and Fat Consumption exceeded similar to this study [30]. The FAO [31] recommends a daily consumption of 0.8g of Protein/kg body weight per day in adolescence. From this study the Average body weight of the participants was 50.25±9.78 Therefore beneficial protein should be consumed at (0.8gx50kg=40g) of protein required per day. This study shows that daily protein consumption from served meals was 34.8±6.9, just lower

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume IX Issue X October 2024

than daily required portion of protein for age per day. Therefore, even though %RNI was exceeded across the location (53.9%-83.6%) it is still important to note that individual protein needs may still not be adequately met. This shortfall can be adjusted for by increasing the quantity of protein rich foods served. The Average total Calorie Intake across the sampled population of the adolescents from the school food alone was Low with a Mean ±SD 1070±196.7 and range of 860-1250kcal, P=0.001 where standard is 2200 -2500 approximate calories/day in adolescents or up to 3000kcal/ day if required, depending on physical activity. This target will only be met, if serving quantity is also adequate at meal time. The presence of individual Essential Amino Acids in the meals, was seen to be higher than RNI scores. This could mean that food combinations are taken into consideration to provide optimum Nutrition. However, it is important to note that quality of protein also depends on its true digestibility. An acceptable Digestible Indispensable Amino Acid Score (DIAAS) should be ≥ 75 in meals with at least 50g of Animal Protein source. Hence the need for inclusion of animal protein foods to cereals and pulses. [32][33][34] Meals majorly consisting of cereals rank low ≤ 50 when eaten alone or in poor combinations and have Lysine (4.14±0.25) and tryptophan (0.95±0.11) as limiting Amino acids as seen from their Low scores per 100g of meal. And are therefore not the best options in food choices for growing adolescents. Over 50% of student meals were cereals, either eaten alone at breakfast (noodles) or eaten with less than 50g of animal protein served.

Table 8 Shows that all three location schools had their highest energy consumption from Lipids, (65.6-158%) of daily calories in their food sources. The use of more fats may also be to improve palatability. This has similarly been reported in other studies [34], where school lunches and dinners were higher in fat and said to improve palatability and acceptance. However, several other studies have presented inconsistent findings per localities, which reported low-dietary-fat intake among adolescents [35]. Adequate intake of fat acts as a source of energy, enhances the absorption of fat-soluble vitamins, and improves hormonal functions [36]. However, a high intake of fat during adolescence is associated with increased risks of overweight/obesity and higher risks of nutrition-related diseases later in life [36]. It is important to note that sodium values (>100%) RNI were very high across the three sampled locations. In other studies, high-sodium, low-potassium diets have been identified as causing a higher risk of cardiovascular disorders [37].

CONCLUSIONS

Even though Overweight and obesity is not highly prevalent in this location, it still stands that a continuous effort needs to be made with the prevention and management of Malnutrition. Diet in boarding schools was monotonous comprising mainly of cereal-legume meal with low intake of animal source protein foods and low –to- no consumption of eggs. The only vegetables consumed were due to soups that needed to be eaten with the staple carbohydrate meals. There is a need to ensure the school meals continue to meet up to 33% of all daily Nutrient Intake. This will meet the standard for dietary diversity and reduce the impact of meal monotony, hence improving meal participation of the students. The Recommended Nutrient Intake on macronutrients was not met for all macronutrients, exceeding recommended levels for some. Therefore, a continuous monitoring of adolescents' dietary intake and nutrition status is key in preventing adolescents' malnutrition in the short term and diet-related diseases in the long term. Finally, Common challenges faced by the school authority and food service suppliers should be tackled squarely by the Government. Financial allocations should be re-evaluated, to meet the need for proper food storage and Logistics as diets are shaped by the interactions of food supply chains, food environments, and consumer behavior. School caterers should get better regular trainings on food hygiene and better methods of food preparation as suits this growing population. Other challenges identified by school feeding systems include delay in ration delivery, poor-quality food provision, unhygienic cooking environment inadequate amount of food allocated for the academic year, expensive supplies from local farmers and food supplies, lack of necessary storage facilities, and lack of training in sanitation and hygiene for cooks are similarly identified with this study and require special mitigating interventions.

RECOMMENDATIONS

Nutritional level of meals and portion sizes may be improved upon especially with regards to minerals and Vitamins, through better dietary diversity. Low levels of dietary protein insufficiency should be sustained. The Federal and State Governments need to throw in more effort with regards to monitoring and evaluating the

Children and Adolescent school Feeding Programmes. Several Challenges encountered such as Lack of major food storage facilities have prevented the sustained consumption of more animal protein foods which have even better protein quality. Food supplies made to the school premises should be subsidized so that children can have quality and quantity requirements as needed. The prevalence of other health challenges co-existing with undernutrition and obesity such as dental carries, early Diabetic Onset in the Young, Anaemia, and other micronutrient deficiencies should be assessed periodically among this age group, as to avoid the acute or chronic effect on wellbeing and appetite of the adolescents.

ACKNOWLEDGMENTS

The department of Food Science and Technology, Akure Ondo State Nigeria, The National Hospital Abuja. The State Secondary Education Board and The NARICT LAB Ahmadu Bello University Zaria are acknowledged. Thanks are due to the staff and students of the participating schools in all three Local Government Areas of the Federal Capital Territory Abuja.

REFERENCES

1. UNICEF. The State of the World's Children 2019. Children, Food and Nutrition: Growing Well in a Changing World New York: UNICEF; 2019.
2. UNFPA, 2022, Review of Adolescent and Youth Policies, Strategies and Laws in Selected Countries in West Africa
3. Mekonnen, D.A., Trijsburg, L., Achterbosch, T. et al. (2021) Food consumption patterns, nutrient adequacy, and the food systems in Nigeria. Agric Econ **9**, 16 (2021). https://doi.org/10.1186/s40100-021-00188-2
4. de Vries-ten Have, Judith J., Adedotun Owolabi, A., Steijns, J., Kudla, U., and Melse-Boonstra, .A., (2020**)** Protein intake adequacy among Nigerian infants, children, adolescents and women and protein quality of commonly consumed foods. 2020 Jun; 33(1): 102–120. Published online 2020 Jan 30. doi: 10.1017/S0954422419000222 PMCID: PMC7282859PMID: 31997732
5. Mulu Birru G, Eshete Tadesse S, Hassen Abate K, Mekonnen TC, Genetu Chane M. Malnutrition in School-Going Adolescents in Dessie Town, South Wollo, Ethiopia. J Nutr Metab. 2021 Jan 7;2021:4898970. doi: 10.1155/2021/4898970. PMID: 33520306; PMCID: PMC7817239.
6. Khan Alamgir, Khan Salahuddin, Ahmad Aftab Jan, Manzoor Khan, (2017) Health complication caused by protein deficiency October 2017 1(1):1-2. DOI: 10.35841/aajfsn.1000101
7. WHO/FAO/UNU (2007) Protein and Amino Acid Requirements in Human Nutrition; Report of a Joint WHO/FAO/UNU Expert Consultation WHO Technical Report Series no. 935. Geneva: WHO. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (2005)
8. National policy on the health and development of adolescents and young people in Nigeria: 2020-2024.
9. Oyedokun O. (2024) Nigeria plans massive investment in school meals to reach 20 million children by 2025. February 20, 2024. School feeding programme guide. School Meals Coalition.
10. Ogunode NJ, Abubakar M (2022) National Home Grown School Feeding Programme (NHGSFP) in Nigeria:Achievement, Problems of Implementation and way Forward. Pindus Journal of Culture, Literature, and ELT ISSN: 2792 – 1883 Volume 8 https://literature.academicjournal.io
11. Kent DJ., (2023). Stakeholders' perceptions on the nutritional and educational impacts of National Home Grown School Feeding Programme on pupils of rural public primary schools in Ebonyi State, Nigeria. Education 3-13, 1-12. doi: 10.1080/03004279.2023.2229863
12. Acceptable Macronutrient Distribution Ranges (AMDRs) for Adolescents (2020). [Summary Report of the Dietary Reference Intakes. nationalacademies.org.www.nationalacademies.org/our-work/summary-report-of-the-dietary-reference-intakes. Accessed July 13, 2020.]
13. Mathai JK, Liu Y & Stein HH (2017) Values for digestible indispensable amino acid scores (DIAAS) for some dairy and plant proteins may better describe protein quality than values calculated using the concept for protein digestibility-corrected amino acid scores (PDCAAS). Br J Nutr 117, 490–499.
14. Rutherfurd SM, Fanning AC, Miller BJ, et al. (2015) Protein digestibility-corrected amino acid scores and digestible indispensable amino acid scores differentially describe protein quality in growing male rats. J Nutr 145, 372–379.

15. Abubakar, H.A., Shahril, M.R. & Mat, S. Nutritional status and dietary intake among Nigerian adolescent: a systematic review. BMC Public Health 24, 1764 (2024). https://doi.org/10.1186/s12889-024-19219-w
16. WHO, (2024) https://www.who.int/tools/growth-reference-data-for-5to19-years/indicators/bmi-for-age
17. FANTAPROJECT, (2013), BMI and BMI-for-Age Look-Up Tables for Children and Adolescents 5–18 Years of Age and BMI Look-Up Tables for Non-Pregnant, Non-Lactating Adults ≥ 19 Years of Age Revised January 2013
18. Ana Paula, Lança,, Diez-Garcia Rosa Wanda and Alceu Afonso (2017) Blenderized feeding formulas with nutritious and inexpensive foods August 2017 Revista de Nutrição 30(4):525-534 30(4):525-534
19. AOAC (2000) Official Methods of Analysis of the Association of Official Analytical Chemists International 17th edition, section 45.3.04 (AOAC Official Method 960.48, Protein Efficiency Ratio), section 45.3.05 (AOAC Official Method 982.30, protein Efficiency Ratio, Calculation Method) section 45.3.06 (AOAC Official Method 991.29; True Protein Digestibility of Foods and Food Ingredients, Rat Bioassay), section 45.4.04 (AOAC Official Method 988.15, Tryptophan in Foods and Food and Feed Ingredients), section 45.4.05 (AOAC Official Method 985.28, Sulfur Amino Acids in Food and Feed Ingredients, Ion-Exchange Chromatographic method: Extension to Processed Foods). Gaithersburg, Maryland: Association of Official Analytical Chemists International
20. Ijarotimi OS, Keshiro OO. Determination of Nutrient Composition and Protein Quality of Potential Complementary Foods Formulated from the Combination of Fermented Popcorn, African Locust and Bambara Groundnut Seed Flour. Polish Journal of Food and Nutrition Sciences. 2013; 63(3):155-166. DOI: 10.2478/v10222-012-0079-z
21. WHO/FAO. [Internet] Food energy - methods of analysis and conversion factors. Report of a technical work shop, FAO Food and Nutrition Paper - 77. Rome, 2003.
22. Okpebholo E.G., James D.B, Anigo K. M, Ajike S.O (2020) Relationship between Nutritional Status, Sweetened Foods Consumption and Prevalence of Cariogenicity with Associated Level of Risk in Adolescents- Case of Sabongari LGA Zaria, Kaduna State Nigeria International Journal of Research and Innovation in Applied Science (IJRIAS) | Volume V, Issue II, February 2020|ISSN 2454-6194 www.rsisinternational.org Page 1
23. Rachael Menezes, Megan Deeney, Stephanie V. Wrottesley, Natasha Lelijveld (2022) Nutritional status of school-age children and adolescents in eastern and southern Africa: A scoping review. Nor. Afr. J. Food Nutr. Res. 2022; 6 (14): 218-234. https://doi.org/10.51745/najfnr.6.14.218-234
24. Nicholaus C, Martin HD, Kassim N, Matemu AO, Kimiywe J. (2020) Dietary Practices, Nutrient Adequacy, and Nutrition Status among Adolescents in Boarding High Schools in the Kilimanjaro Region, Tanzania. J Nutr Metab. 2020 Jun 29;2020:3592813. doi: 10.1155/2020/3592813. PMID: 32685204; PMCID: PMC7350084.
25. Erkan, T. (2008). Nutrition in Adolescents. In Adolescent Health II (p. 73).
26. Hyelsinta LK, Ebere EC, Kwary MI, et al. (2017) Quality evaluation of DUBLA, a traditional snack produced from wheat and soybean blends. Semin Ser 8, 60–64. [Google Scholar]
27. Abizari A., Ali Z. Dietary patterns and associated factors of schooling Ghanaian adolescents. Journal of Health, Population and Nutrition. 2019;8:1–10.
28. Ayogu Rufina N. B., Paul E. Eme ,Vivien C. Anyaegbu, Henrietta N. Ene-Obong, and Uche V. Amazigo (2018) Nutritional value of school meals and their contributions to energy and nutrient intakes of rural school children in Enugu and Anambra States, Nigeria 2018; 4: 9.Published online 2018 Feb 21. doi: 10.1186/s40795-018-0216-0
29. Zailani Halliru Olumuyiwa Adeyemi Owolabi, Abdullahi Balarabe Sallau [2] (2023) Contribution of school meals to the recommended nutrient and energy intake of children enrolled in the National Homegrown School Feeding Program in Zaria, Nigeria Oct;30(7):471-476. doi: 10.1016/j.arcped.2023.07.004. Epub 2023 Sep 11. (2023) Oct;30(7):471-476.
30. Anyika , J.U. Uwaegbute A.C,. Olojede and J.U. Nwamarah1 Pakistan Journal of Nutrition 8 (10): 1596-1602, (2009) Nutrient Intakes of Adolescent Girls in Secondary Schools and Universities in Abia State of Nigeria ISSN 1680-5194 Asian Network for Scientific Information
31. FAO2013 Dietary Protein Quality Evaluation in Human Nutrition: Report of an FAO Expert Consultation. FAO; Auckland, New Zealand: 2013
32. Suri DJ, Tano-Debrah K & Ghosh SA (2014) Optimization of the nutrient content and protein quality of

cereal–legume blends for use as complementary foods in Ghana. Food Nutr Bull 35, 372–381. [PubMed] [Google Scholar]

33. Hoppe C, Mølgaard C & Michaelsen KF (2006) Cow's milk and linear growth in industrialized and developing countries. Annu Rev Nutr 26, 131–173.
34. Dimina, L., Rémond, D., Huneau, J.-F. and Mariotti, F. (2022). Combining plant proteins to achieve amino acid profiles adapted to various nutritional. Nutr., 8 (809685), 1–11. https://doi.org/10.3389/fnut.2021.809685.
35. Desalegn., T, Gebremedhin., S, Stoecker., BJ, (2022). Successes and challenges of the Home-grown School Feeding Program in Sidama Region, Southern Ethiopia: a qualitative study. Journal of Nutritional Science, 11 doi: 10.1017/jns.2022.77
36. Chaves, V.M.; Rocha, C.; Gomes, S.M.; Jacob, M.C.M.; da Costa, J.B.A., (2023) Integrating Family Farming into School Feeding: A Systematic Review of Challenges and Potential Solutions. Sustainability 2023, 15, 2863. https://doi.org/ 10.3390/su15042863 (2023). Mdpi basel Switzerland.
37. Yang Q, Liu T, Kuklina EV, Flanders WD, Hong Y, Gillespie C, Chang MH, Gwinn M, Dowling N, Khoury MJ, Hu FB. Sodium and potassium intake and mortality among US adults: prospective data from the Third National Health and Nutrition Examination Survey. Archives of internal medicine. 2011 Jul 11;171(13):118391. (Source:https://nutritionsource.hsph.harvard.edu/salt-and-sodium/)