Association of Nutrient Intake Adequacy and Malnutrition among Primary School Children in an Urban Community, Southeast Nigeria-Cross Sectional Descriptive Study

Nkechinyere Godsgift Obichukwu,[1] Clement Chukwudorue Ezechukwu,[1,2] Jacinta Chinyere Elo-Ilo,[1,2] Amalachukwu Okwukweka Odita, [1,2] Lucius Chidiebere Imoh[3].

[1]Department of Paediatrics, Nnamdi Azikiwe University Teaching Hospital, PMB 5025, Nnewi, Anambra State. [2]Department of Paediatrics, College of Health sciences, Nnamdi Azikiwe University, Nnewi Campus, Anambra State. [3] Department of Chemical Pathology, University of Jos, Plateau State, Nigeria..

ABSTRACT.

Background: Nutrient intake adequacy is the bedrock of normal nutritional status among children. Studies have shown the devastating impact of childhood malnutrition despite current interventional strategies. Hence the need to explore the possible association of inadequate nutrient intake and malnutrition among school children. **Objectives:** This study aim to determine the association of nutrient intake adequacy and childhood malnutrition. **Materials and Methods:** Cross-sectional descriptive study carried out on 272 pupils, however 203 of the participants were enrolled for analysis, as 69 of them were excluded since they had mis-report of energy intake. Socio-demographic data was collected using a pretested interviewer administered questionnaire. The adequacy of nutrients present in their immediate past 24-hour dietary recall was analyzed using Nigerian and West African food composition table software. The data was analyzed using Statistical Package of Social Sciences (SPSS) version 25.0 windows with level of significance set at 5%. **Results:** Out of 203 primary school aged children enroll for the analysis, 116(57.1%) were male, with male to female ratio of 1.3:1. Inadequate intake of all macronutrients, vitamin A and calcium were associated with under-nutrition ($p < 0.05$). While inadequate intake of total energy, fat and calcium were associated with overweight/obesity ($p < 0.05$). **Conclusion**: Adequate fortification of routine meals to provide daily requirement of macro and micronutrients, especially vitamin A and calcium, can help mitigate the impact of malnutrition in the sub region.

Keywords: Adequacy of nutrient intake; Childhood malnutrition; School age children; Nnewi.

OPEN ACCESS

***Correspondence**:
Email: : giftedkechi@yahoo.com
Tel: +234-8036736347

***Specialty Section**:
This article was submitted to Clinical, a section of TJMR

Article Metrics:
Submitted: Jan. 2, 2024
Accepted: April 20, 2024
Published: 15 Sept, 2024

***Citation**:
Obichukwu N G, Ezechukwu C C, Elo-Ilo J C, Odita A O, Imoh L C Association of Nutrient Intake Adequacy and Malnutrition among Primary School Children in an Urban Community, Southeast Nigeria-cross sectional Descriptive Study. Trop J Med Res. 2024:23(1);67-78.
10.5281/zenodo.13629506

***Journal Metrics**:
ISSN: p- 1119-0388, e- 2505-0338
Website: www.tjmr.org.ng
E-mail: info.tjmr@gmail.com

***Publisher**: cPrint

Access Code

INTRODUCTION

Malnutrition is defined by World Health Organization (WHO), as deficiencies, excesses, or imbalance in nutritional and or energy intake.[1,2] Malnutrition in primary school children need to be tackled urgently because of divers negative impact on childs' health, growth and physical development like reduced attention span, impaired learning ability, reduced school enrolment, poor academic performance and early school drop – out.[3,4] Adequate nutrient intake is defined as intake of the recommended average daily level of the nutrients based on observed or experimentally determined approximation.[5] The nutrients are grouped into macronutrients- which are, carbohydrate, protein, fat and micronutrients –which are vitamins and minerals.[5] Childhood energy requirement must be satisfied with adequately balanced diet to maintain a normal nutritional status.[5]These nutrients are derived from different food classes present in a child's 24 hour diet. Micronutrients inadequacy is still a problem in school age children in developed world (USA), more so among the malnourished children. Most reported micronutrient deficiencies among these children include vitamins A, D, E, B6, folate, calcium, iron, potassium, zinc, and magnesium.[6] Similar result was noted in studies done among school age children in developing countries, the commonly reported vitamin intake that were lower than Required Daily Allowance (RDA) among these children were vitamin A, B1, B2, B3, B12, folate and beta-carotene.[7,8] There were also suboptimal intake of iron, calcium, zinc, potassium, phosphorus and magnesium.[7,9,10] Studies have shown that childhood inadequate dietary intake of calcium combined with physical inactivity results in overweight/obesity as calcium is known to have anti-obesity effects through inhibition of adipogenesis, increased fat excretion, fat metabolism and apoptosis.[11,12] Osteomalacia and osteoporosis later in adulthood are other complications of inadequate calcium intake. Similar study carried out in Nepal showed that iron and calcium were significantly lower than their respective RDA among the study population.[6] The study also found that calcium intake was positively and significantly correlated with stunting, while iron intake was inversely and significantly correlated to the prevalence of underweight.[6] A study done in Nigeria among school aged children noted a positive linear relationship between nutrient adequacy of child's diet and their nutritional status.[13] Flores et al in a study done among Mexican school age children noted inadequate intake of vitamin, zinc, and calcium among children with under-nutrition, while inadequate intake of energy, zinc, calcium and iron were seen more among children with overweight/obesity.[14] The relationship of inadequate intake of energy and occurrence of obesity may be explained by the theory of hyper-insulinaemia and release of agouti-related protein that usually occur in energy depleted state. This enhances adipose tissue deposition and increases urge for excessive meal intake, which worsens obesity.[15,16] The index study was designed to assess the relationship between adequacy of nutrients (macronutrient and micronutrients) in a child's 24 hour dietary recall and occurrence of childhood malnutrition among school children in Nnewi Southeast Nigeria. The information gotten from this study will be a guide in selecting current interventional strategies, since childhood malnutrition, can be curtailed with preventive measures.[17]

MATERIALS AND METHODS

Study Design

The study was a descriptive, cross-sectional study.

Study Population

The study population comprised of six- to twelve-year-old primary school children in Nnewi Metropolis.

Inclusion Criteria

Six – to twelve-year-old primary school children in Nnewi selected by probability sampling technique and are willing to participate.

Exclusion Criteria

a) Children whose parents/caregivers were not available during periods of data collection.

b) Children with chronic diseases that may impair communication or may contribute to malnutrition.

c) Children whose ages cannot be ascertained.

d) Participants with misreported energy intake, those whose food intake were not present in the food composition table and those whose meal intake cannot be quantified were excluded in the analysis.

Sample Size Calculation

Sample size was calculated using the formulae for cross sectional observational study thus: Minimum sample size $n = z^2Pq/d^2$.[18,19] Where: n= The desired sample size when population is greater than 10,000

Z=The standard normal deviate, usually set at 1.96

P= the proportion in the target population estimated to have a particular characteristic. The prevalence of Normal weight Primary School children in Anambra state is 85.2%, so the prevalence of malnutrition among these children is 14.8%.[20] q=1.0-p ; q=1.0-0.148; q =0.852 d=degree of accuracy desired, set at 0.05 Therefore $n= (1.96)^2x\ 0.148x\ 0.852/\ (0.05)^2$; n= 194 Minimum sample size = 194 Since some children selected for the study could not agree to participate, so a response rate of 80% was allowed. The adjusted sample size (N_s) was = n/0.8. [19]; N_s=194/0.8; N_s= 243 Attrition factor of 10% was accommodated, because some initial respondents could not get to the end of the research. Hence the corrected sample size (N_c) was= 243/0.9 N_c =270 was the corrected sample size. So two hundred and seventy, 6 to 12 year old primary school children in Nnewi that met the inclusion criteria were recruited for the study.

Sampling Technique and Recruitment of Participants

Participants were selected using stratified multistage sampling methods: Data obtained from Nnewi North Local Government secretariat on the list of schools in Nnewi showed that currently, there are 302 primary schools in Nnewi; 30 are government owned schools (public school) while 272 are private schools. The proportion of public school to private school in Nnewi is 1: 9. And the total ratio being 10. So, ten primary schools were selected from 302 primary schools sampling frame in Nnewi metropolis in the proportion of 1:9 (public: private). So, in stage 1 of multi stage sampling, one public and nine private primary schools were selected from the 302 list of the primary schools in Nnewi sampling frame.

The public schools were selected by simple random sampling. That was done by writing the names of the public primary schools separately on different pieces of paper which was folded and put in a sealed bag and shaken. Thereafter one school was chosen randomly from the bag. An individual who was not part of the study was engaged in that selection to avoid selection bias. Also 9 (nine) private primary schools were selected from the sampling frame of the list of 272 private schools in Nnewi using systematic sampling technique of choosing one private school after every 30 private primary schools. So a total of 10 schools were used for the study, one public primary school and 9 private primary schools.[21] Different selection methods were used in selecting the public school and the private schools to allow variety in sampling process and also to ensure all the primary schools in Nnewi were given an equal and fair chance of being selected.

Education Board (ASUBED), Awka. Also, approval was gotten from the Management Board and Approval for the 10 selected primary schools were gotten from the Anambra State Universal Basic Parents Teachers Association (PTA) of each of the selected schools for the study. In stage 2, the number of participants used from each of the selected ten primary schools were determined using a proportionate stratified sampling allocation formulae as follows: [22] The total population of the index school X the total sample Size Sum of the Population of the ten schools selected for the study. For proper representation of different age ranges, the allocated sample size for each of the selected 10 primary schools were equally divided among the six grades of each school (stage 3). The allotted sample size for each grade were also divided equally among the number of classes in each grade (stage 4). Since there were almost equal number of classes in each grade and each class has almost equal number of pupils in the selected schools. Hence the allotted sample size for each grade and class were approximately equal with the proportionate allocation of sample size for each grade and class in the selected schools. The number of participants allotted for each class, were selected by simple random sampling technique using a statistical table of random numbers, until the required participants for each class were selected (stage 5). Number code was given to each of the selected participant. School

record of birth certificate of each enrolled child was used to establish the child's age.

Data Collection

Three research assistants (Health workers) were involved in the data collection after training by the investigator prior to commencement of data collection. The detailed information about the study was given to the parents/caregivers by the researcher before enrolment into the study. During the data collection, the parent/caregiver of the selected participants were met individually after school dismissal for data collection as they come to take their wards home. Pre-tested, standardized, semi-structured, interviewer administered questionnaire was used by the investigator and research assistants to collect relevant information thus: child's age, gender, social economic class(SEC) using Oyedeji's social classification method,[23,24] into upper SEC, medium SEC and low SEC. The research assistants were involved with administration of questionnaires and taking measurements of height and weight of the selected pupils. The height and weight measurement were used to establish each child's nutritional status using the WHO Z scoring system. According to WHO Demographic and Health Survey (DHS), Multiple Indicator Cluster Survey (MICS) and UNICEF joint definition, the clinical diagnosis of different nutritional status were made.[25,26,28] These nutritional status were computed using the WHO Growth reference charts for school age children and adolescents.[27] Prior to the onset of the data collection, the researcher was trained by the Dietician/Nutritionists of Nnamdi Azikiwe University Teaching Hospital, Nnewi on the techniques of accurate measurement/estimation of 24-hour dietary recall using house hold portion sizes of common food models, cups, spoons and food preparation methods/cooking methods. Also details on how to analyze the nutrient content per 100gramme measure of different food groups using the nutritional software app of Nigerian based food classes and West African Nutrient Database was well established.[28,29] Only the researcher was involved in the dietary

recall and analysis of nutrient intake of the participants. Estimated Energy Intake (EEI) from 24hour food recall of each participant was analyzed with Nigerian/West African food calorie software. Also, the Total Energy Expenditure (TEE) was determined using WHO age-appropriate quadratic polynomial regression prediction equation for children. The ratio of EEI: TEE of each participant was used to identify the misreported energy intake (i.e. the over-reporters and under-reporters)24hour food-intake recall of the participants were recorded in 24 hour food diary book. Nutrient content in 100gramme of each of the food classes in the 24hour dietary recall was analyzed using the West African food composition software. The adequacy of the nutrient content of the 24hour meal was assessed using the WHO Recommended Daily Allowance (RDA) of each of the nutrient; thus, macronutrients and the micronutrients.

Dietary Intake Estimation

Dietary intake was assessed using an interactive confrontational questioning of the mother or the primary caregiver of the child using a 24hour food dietary recall diary. The child's immediate 24-hour dietary recall-(quantitation of the size of the child's diet per meal, with frequency of meals per day and the size/content of in-between meals) were estimated by the parents, pupil and older siblings of the pupil 6-7 years if available. Detailed information on the cooking methods/ ingredients used in preparation of the meals, time the food was eaten. The dietary intake estimation of the participants was gotten in the school after dismissal when parents will be available in the school to take their children home. The immediate past 24-hour food intake of each of the participant were recorded using the food diary and was used in analysis of nutrient intake from food groups like vegetables, fruits, beverages, juice, snacks and different types of food preparation.[43,44] Detailed records of food classes and beverages consumed and time of consumption were recorded. Cooking and preparation methods, the quantity of the various ingredients used and the quantity of the meal cooked per time in the immediate past 24 hours were provided by the respondent's parents/ primary caregiver. Portion size of the meal eaten by each participant per time were estimated as accurately as possible by the respondents, parents and older siblings (if available), using common unit sizes, plates, cups in milliliters, ruler, spoons, slices of bread, sizes of stable food models, snacks, different types of household measures were used to ensure quantification of food portion sizes were correctly estimated. This had been

used successfully in large scale study where detailed food and nutrient intakes were required at an individual level.[30,31,34] The recalled dietary intakes were analyzed using food analysis software in international Network of food data system which have software for food density data base version 2.0 that helped to convert food volumes into weight (gramme). It also had software for West African food composition database table that converted the food's weight to calories and also estimated the quantity of different macro and micro nutrients in each 100gramme weight of the meal consumed taking cognizance of the method and ingredients used in preparing the meal consumed. The estimated calories were recorded as Estimated Energy Intake (EEI) of each participant. [32,33] It had been shown that EEI from food diary questionnaire provided valid data.[34] The researcher was well trained by Dietetics/ Nutrition Department of NAUTH Nnewi on the techniques of collecting the 24-hour dietary recall using the food
diary records. Also, on how to analyze the nutrient contents of the recalled diets using the Nigerian and West African food composition database software.[28,29] The dietary intake estimation and analysis of nutrient intake were done by the researcher only to avoid multiple analysis report error. Also, the participants whose energy intake were underreported and over reported, (mis-reporters) were excluded from the final analysis of nutrient intake adequacy. The participants who ate food from a neighbor's/ relatives' house were also excluded from the final analysis of nutrients, because the detailed cooking method could not be ascertained.

Total Energy Expenditure (TEE)

TEE was determined using the WHO sex appropriate quadratic polynomial regression predictive equation of TEE in children and adolescents prepared for the joint FAO/WHO/UNU expert consultation using Child's weight as single predictor of TEE.[35,36] TEE was used to validate the reported energy intake of the participants to determine those whose energy intake was adequately reported, underreported or over reported. That is, the ratio of EEI:TEE of each of the participant if it is within, above or below the 95% confidence interval(CI) of calculated EEI:TEE ratio of the study population using the validation equation. The calculated 95% CI of EEI:TEE ratio of this study was ±1125.24. The over-reporters are the participants whose EEI:TEE ratio is above +1125.24, while under-reporters of energy intake are the participants whose EEI:TEE ratio is below -1125.24 while the adequately reported energy intake are the participants whose EEI:TEE ratio is within ±1125.24.

Validation of Reported Energy Intake

The validation of reported EEI was done using each subject's ratio of EEI:TEE, where each participant was identified as Adequate reporters (AR), Under-reporters (UR) and Over- reporters of Energy intake, when the individuals' estimated EEI:TEE ratio was within, below or above the 95% Confidence limits (CL) of agreement between the two measurements (i.e., EEI and TEE) respectively. The 95% CL was calculated using the standardized equation thus: $95\%CL = \pm 2 \times [\{CV_{wEi}^2/ d\} + \{CV_{wEE}\}^2]$ Where d = number of days of diet assessment, which was one day in present research. CV_{wEI} = the mean coefficient of variation of energy intake, which is 23% in children.[37,38] CV_{wEE} = the coefficient of variation of Energy Expenditure in Doubly labeled water, known to be 8.2% in children.[38,39] The estimated 95% confidence Limits of the estimated EEI and TEE in this research was ± 1125.24.

Adequacy of Nutrient intake

All mis-reporters of estimated EEI (i.e., under-reporters and over-reporters of EEI) were identified and excluded from the final analysis of nutrient intake. Only the participants identified as having adequately reported EEI were used in the final analysis of the association of nutrient intake adequacy and childhood
malnutrition to ensure accuracy and validity of the results obtained. The reported nutrient intake (macronutrients and some micronutrients) of the AR group estimated from their 24hour dietary recall using the Nigerian and West African food composition software table, were analyzed for adequacy using the WHO appropriate age and sex RDA of each of the nutrients (macronutrients and some micronutrient). Each participant was noted to have either adequate or inadequate intake of a given nutrient class if the estimated intake of that nutrient was within or below the age and sex appropriate RDA of the nutrient, respectively. The RDA had

commonly been used for estimating nutrient intake adequacy among school age children.[40]

Quality Assurance

Each day, after the data collection, the questionnaires were reviewed to ensure accuracy. Where responses were missing or ambiguous, the respondent's parent/ caregiver was contacted by phone call to clarify their responses.

Data entry and cleaning

All completed questionnaire and proforma were coded before entry into the SPSS for analysis.

Data analysis

Categorical variables like sex, age groups, parents' socioeconomic class, Adequacy of Nutrient-intake, were tested for association to childhood malnutrition (dependent/outcome variables) using Pearson's Chi-square (and Fisher's exact test where appropriate) for bivariate analysis, and binomial logistic regression for multivariate analysis. Binomial logistic regression analysis was done to control for confounders on the effects of the independent variables on the dependent variables (under-nutrition and overweight/obesity). Odds ratio was used to determine the magnitude of the relationship at 95% confidence level. P-value <0.05 was considered statistically significant.

Ethical considerations

Ethical review was done and approval obtained from the ethics committee of NAUTH Nnewi before commencement of the study. Also, approval for the study was gotten from ministry of Education in Anambra state (Anambra State Universal Basic Education Board- ASUBEB) before commencement of the study. Written informed consents were obtained from the School Parent Teacher Association and written informed assent was gotten from participants' ≥ 7-year-old before enrollment into the study. The parents/care givers of the participants were reassured that the study would cause no harm and there would be no additional discomfort to the child. Children found to be malnourished were referred for appropriate Specialist care.

RESULT

A total of 272 primary school aged children (6-12years) were enrolled into the study, however 203 were used in the final analysis as 69 of the participants had mis-report of energy intake (under-reporters and over-reporters) so were excluded from the study. Of the 203 participants that were analyzed, 116 (57.1%) were males, while 87(42.9%) were females giving a male to female ratio of 1.3:1. The participants aged 6-8years were 111(54.7%), and those 9-12years were 92(45.3%). The participants from upper socio-economic class (SEC) were 42(20.7%) while 60(29.5%) were from middle SEC, and 101(49.8%) were from low SEC. Table1 shows the socio-demographic characteristics of the study participants.

Association of nutrient intake adequacy and malnutrition.

The prevalence of inadequate intake of the macronutrients were statistically significant among children with under-nutrition when compared with normal nutritional status. Up to 33.8%, 29.3%, 19.7%, and 18.5% of under-nutrition were accounted for by inadequate intake of fat, protein, carbohydrate and energy respectively, $p < 0.05$. The prevalence of inadequate intake of vitamin A and calcium were significantly associated with occurrence of under-nutrition. About 26.2% of the children with under-nutrition were accounted for by inadequate intake of vitamin A, ($p<0.001$), while 16.5% of children with under-nutrition were accounted for by inadequate intake of calcium, (fisher's exact = 0.031) The prevalence of inadequate intake of energy, fat and calcium were significantly associated with occurrence of overweight/obesity. Inadequate intake of energy accounted for 27.4% of overweight/obesity, p for fisher exact test † = 0.002, while inadequate intake of fat accounted for 27.1% of overweight/obesity, p =0.002 and about 29.5% of children with overweight/obesity were accounted for by inadequate intake of calcium, ($p=0.001$). Shown in Tables IIA and IIB. On binary logistic regression, inadequate intake of calcium was significantly associated with occurrence of under-nutrition (OR =592.47, $p < 0.027$) This shows that children that had inadequate intake of calcium were 592.47 times more likely to develop under-nutrition. Furthermore, inadequate intake of calcium was significantly associated with occurrence of overweight/obesity. These were shown in Tables IIIA and IIIB.

Table 1: Socio-demographic characteristics of the selected subjects for the study.

Characteristics	Frequency n=203	Percent(%)
Gender		
Male	116	57.1
Female	87	42.9
Age groups (years)		
6-8	111	54.7
9-12	92	45.3
Socio-economic class		
Upper	42	20.7
Middle	60	29.5
Low	101	49.8

Table IIA: The Relationship Of Nutrient Intake Adequacy And Undernutrition

Variables	Normal Nutritional status n=112(%)	Under-nutrition n = 70(%)	χ^2 (p- value)
Total Energy			**6.2(0.012)***
Adequate	58(51.8)	23(32.9)	
Inadequate	54(48.2)	47(67.1)	
Carbohydrate			**7.0(<0.008)***
Adequate	89(79.5)	43(61.4)	
Inadequate	23(20.5)	27(38.6)	
Protein			**15.6(<0.001)***
Adequate	85(75.9)	33(47.1)	
Inadequate	27(24.1)	37(52.9)	
Fat			**20.85(<0.001)***
Adequate	93(83.0)	36(51.4)	
Inadequate	19(17.0)	34(48.6)	
Vitamin A			**2.53(<0.001)***
Adequate	67(59.8)	23(32.9)	
Inadequate	45(40.2)	47(67.1)	
Iron			**1.71(0.124)**
Adequate	62(55.4)	33(47.1)	
Inadequate	50(44.6)	37(52.9)	
Zinc			**2.37(0.124)**
Adequate	69(61.6)	35(50.0)	
Inadequate	43(38.4)	35(50.0)	
Calcium			**4.93(0.026)***
Adequate	11(9.8)	1(1.4)	
Inadequate	101(90.2)	69(98.6)	

**Statistically significant,* χ^2 *=Chi square*

Table IIB: The Relationship Of Nutrient Intake Adequacy And Overweight/Obesity

Variables	Normal Nutritional status	Overweight/obesity	χ^2 (p- value)
Normal	**n=112(%)**	**n = 21(%)**	
Total Energy			**10.0(0.002)***
Adequate	58(51.8)	3(14.3)	
Inadequate	54(48.2)	18(85.7)	
Carbohydrate			**0.67(0.413)**
Adequate	89(79.5)	15(71.4)	
Inadequate	23(20.5)	6(28.6)	
Protein			**0.001(1.00)**
Adequate	85(75.9)	16(52.4)	
Inadequate	27(24.1)	5(47.6)	
Fat			**9.75(0.002)***
Adequate	93(83.0)	11(52.4)	
Inadequate	19(17.0)	10(47.6)	
Vitamin A			**0.053(0.819)**
Adequate	67(59.8)	12(57.1)	
Inadequate	45(40.2)	9(42.9)	
Iron			**2.11(0.146)**
Adequate	62(55.4)	8(38.1)	
Inadequate	50(44.6)	13(61.9)	
Zinc			**1.44(0.23)**
Adequate	69(61.6)	10(47.6)	
Inadequate	43(38.4)	11(52.4)	
Calcium			**11.54(0.001)***
Adequate	11(9.8)	8(38.1)	
Inadequate	101(90.2)	13(61.9)	

Statistically significant, χ^2 =Chi square

Table IIIA: Adjusted odds ratio of nutrients among children with under-nutrition.

Variable	odds ratio	95%CI	p-value
Energy	0.020	0.000-2.155	0.101
Carbohydrate	0.655	0.009-45.696	0.845
Protein	1.717	0.013 – 229.321	0.829
Fat	0.010	0 .000 – 1.037	0.052
Vitamin	0.069	0.001-5.700	0.235
Iron	12.197	0.324-458.937	0.177
Zinc	0.210	0.002-28.080	0.532
Calcium	592.472	2.046-17160.0	0.027*

**Statistically significant, CI = Confidence Interval*

Table IIIB: Adjusted odds ratio of nutrients among children with overweight/obesity.

VARIABLES	Odds ratio	95%CI	P-value
Energy	0.36	0.05-2.57	0.308
Carbohydrate	0.80	0.06-10.67	0.867
Protein	0.09	0.004– 2.03	0.130
Fat	0.14	0 .01 – 1.84	0.136
Vitamin	1.16	0.08-16.09	0.913
Iron	1.79	0.06-51.83	0.735
Zinc	0.01	0.00-23.49	0.256
Calcium	0.05	0.003-0.74	0.030*

**Statistically significant, CI = Confidence Interval*

DISCUSSION

This study was aimed to determine the adequacy of macro- and some micro- nutrient intake and its association with malnutrition among six-to-twelve-year-old primary school children in Nnewi. Children

with under-nutrition experienced significant inadequate intake of all macronutrients, vitamin A and calcium. This result was similar to the findings by Flores *et al* in a study done among Mexican school age children[14] Wong *et al* in a study done in Malaysia [41] and studies done among school aged children in developing countries as collated by Ochola *et al*.[42] The result was also in agreement with the findings of Agdeppa *et al* in a study done in rural poor community of Filipino.[43] In contrast, Andrea *et al* in a study done in Oklahoma USA noted excess intake of macronutrients, zinc, vitamin A among school children.[44] The noted difference may be because the index study used 24 hour dietary recall and WHO RDA cut off to estimate nutrient intake adequacy and only the researcher was involved in 24 hour dietary recall and analysis of nutrient intake of the study population to avoid recall bias, this was not same with the study by Andrea *et al*. Furthermore, mis-reporters of energy intake were excluded before the analysis of nutrient intake adequacy in this study. Moreover, children with under-nutrition in this study were majorly from low SEC (56.3%), as low SEC homes are more prone to household food insecurity, so will have higher tendency of inadequate nutrients in their meals. This study have shown that intake of diets rich in macronutrients, vitamin A and calcium should be advocated for in Paediatrics practice to limit the devastating impact of malnutrition in school age children. From this study, overweight/obese children have significant inadequate intake of total energy, fat and calcium. This result was in consonance with the findings by Flores *et al* in a study done among Mexican school children[14] and Hassapidou *et al* in a study done in Greece.[45] In contrasts, El-Gazzar *et al* in a hospital based study done in Cairo- Egypt reported higher intake of macronutrients and micronutrients among overweight/obese 6-12 year school children.[46] This noted differences may be because of different methodology adopted, as the index study used multi-stage sampling method, also mis-reporters of energy intake were excluded from this study before the final analysis of nutrient intake of the study population. Inadequate intake of total energy, fat and calcium among overweight/obese children in this study could be because overweight/obese children have more tendency to withhold the actual size of their meal intake so as not to be seen as gluttons. Also, this could have resulted from the drive to lose weight by these children, thereby limiting their nutrient intake which can be encouraged by the parents/caregivers. Meanwhile, the practice of fasting and reduced energy intake has been implicated in worsening of overweigh/obesity, as this leads to a state of hyper-insulinaemia that drives glucose and fatty acids into the adipose tissue causing increased adipose tissue deposition, hence reduced circulatory metabolic substrate which will stimulate hunger and increased drive for food intake. Moreover there is release of agouti related protein during fasting/ negative energy balance that triggers a state of hyper-phagia and increased drive to eat, thereby worsening overweight/obesity.[15,16].

The strength and Limitation of the Study

The strength of this study stems from the fact that the misreporters of energy intake were identified removed from the final analysis. The limitation of the study stems from the fact that the 24 hour dietary intake was recalled and not gotten on real time. There could be some recall bias, but this was taken care of by identifying and removing misreporters of energy intake from the final analysis.

CONCLUSION

This study has shown that proper provision of adequate macronutrients and micronutrients will limit the increasing prevalence and complications of childhood malnutrition. Also, this research identified the nutrients whose inadequate intake was associated with occurrence of childhood malnutrition. Furthermore, this study has shown that there is need to improve on both macro and micro nutrients content of daily meal intake of school children to curb the devastating impact of childhood malnutrition in the sub-region.

Acknowledgement

We sincerely appreciate our research assistants, the parents/caregivers of the participants and above all the school heads and the school teachers, for their full support and assistance during the data collection.

Authors Contribution

CCE, NGO and JCE Conceptualization and design of the study, NGO data collection and Write-up,

AOO and LCI Data analysis and review. All authors were involved in the writing and revision of the manuscript. The authors read, approved the final manuscript and agreed to be accountable for all aspects of the work.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee.

REFERENCES

1. Malnutrition fact sheet. WHO 2020 (Cited 2020 June 10th) Available from:https://www.who.int>/news …/malnutrition.
2. Definition of malnutrition by Merriam-Webster Dictionary. (Cited 2021 April 20th) Available from:http://www.merriam-webster.com>…
3. Field AE, Cook NR, Gillman MW. Weight status in childhood as a predictor of becoming overweight or hypertensive in early adulthood. ObesRes 2005;13:163–169.
4. Saluja N, Bhatnagar M, Garg SK, Chopra H, Bajpai SK. Nutritional Status of urban primary school children in Meerut. J Epidemiol 2009;8:1–4.
5. Consultation of a joint report of FAO/WHO/UNU expert. Human energy Requirement. 2004. (Cited 2022 April 21st) Available from: https://www.intake.org>resource.
6. Mcginnis JM, Gootman J, Kraak VI. Food and Nutrition Board on children youth and food Marketing to children and youth, threat or Opportunity. (Cited 2022 August 20th) Available from: www.nap.edu.
7. Barugahara EI, Kikafunda J, Gakenia WM. Prevalance and risk factors of nutritional anaemia among female school children in Masindi District, Western Uganda. Afri J food Agric Nutr Dev 2013;13:7679–7692.
8. Sempolis CE, Canducci E, Ricci E, Gualdi-Russo E. Nutrient intake in 5-17 year old African boys and girls in a rural district of Kenya. Nutr Hosp. 2011;26:765–774.
9. Mehta B, Grover K, Kaur R. Nutritional Contribution of midday meal to dietary intake of school children in Ludhiana district of Punjab. J Nutr food sci 2013;3:183.
10. Arini HR, Hadju V, Thomas P, Ferguson M. Nutrient and food intake of Indonesian children under 5 years of age: A systemic Review. Asia Pacific Journal of public health. 2022; 34: 25-35.
11. Pannu PK, Calton EK, Soares MJ. Calcium and Vitamin D in obesity and related chronic disease. Adv food Nutr Res 2016;77:57–100. Dio:10.1016/bs.afnr.2015.11.001.
12. Ishmail MS. Can Dietary Calcium consumption be beneficial in body weight loss Regimen? Merit Res J Med Sci 2016;4:282–289.
13. Hassan A, Onabanjo OO, Oguntona CB.Nutritional Assessment of school age children attending conventional primary and integrated Quranic Schools in Kaduna. Res J Med Sci 2012;6:187–192.
14. Flores M, Macias N, Rivera M, Barquera S, Hernandez L, Gracia-Guerra A *et al.* Energy and nutrient intake among Mexican school aged children, Mexican National Health and Nutrition Survey 2006. Salud Public Heal Mex. 2009;51:1606–1616. doi: 10. 1590/s0036-36342009001000009.
15. Morton GJ, Meek TH, Schwartz MW. Neurobiology of food intake in health and disease. Nat Rev Neurosci 2014;15:367–378. doi: 10. 1038/nrn3745.
16. Ludwig DS, Friedman MI. Increasing adiposity: consequence or cause of overeating. JAMA 2014;311:2167–2168. Dio: 10. 1001/jama.2014.4133.
17. Epstein LH, Goldfield GS. Physical activity in the treatment of childhood overweight and obesity: current evidience and research issues. med.sci Sport Excerc 1999;31:S553–9.doi:10. 1097/00005768-199911001-00011.
18. Singh S, Yadav ST, Mishra P, Mittal A, Kumar R, Singh J. An Epidemiological Study

of Malnutrition Among Under Five Children of Rural and Urban Haryana. 2016;10–3. doi: 10. 7860/JCDR/2016/16755.7193.
19. Araoye MO. Research Methodology with statistics for Health and social sciences. Nathadex publications,saw-mill,Ilorin, 2nd Edition 2008:115-122.
20. Nwabueze AS, Ilika LA, Azuike EC, Nwabueze NC, Obi KM, Onebunne ME *et al*. Assessment of Nutritional status among primary school pupils in rural and urban area of Anambra State. Eur J Prev Med. 2015;3:34.
21. Bardara ME, Livingstone L, Alison E B. Biomarkers of Nutritional Exposure and Nutritional Status, Markers of the Validity of Reported Energy Intake. J Nutr Suppl 2003;133:895s-920s.
22. Propotionate stratified sampling method.(Cited 2022 October 15th) Available from:www.oxfordreference.com>view>auth...
23. Oyedeji GA. Socio-economic and cultural background of hospitalized children in Ilesha. Niger J Paediatr 1985;12:111–117.
24. Oseni TA, Odewale AM. Socio-economic status of parents and the occuerence of pelvic inflammatory disease among undergraduates attending Irrua Specialist Teaching hospital, Irrua Edo state, Nigeria.Niger postgrad Med J 2017;24:114–120.
25. De Onis M, Onyangwo AW, Borghie E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school aged children and adolescents. bull world Heal Organ 2007;85:660–667. doi: 10. 2471/BLT.07.043497.
26. Tracking progress on child and maternal nutrition-a survival and development priority. 2009. (Cited2018 July 20th) Available from: http://www.unicef.org/publications/files/tracking-progress-on-child-and-maternal-nutrition-EN-110309.pdf.
27. WHO Growth Reference data for 5-19 years. (Cited 2020 August 31st) Available from: https://www.who.int> tools> growth…
28. West African Food Composition Table. (Cited 2018 July 25th) Available from: www.fao.org/docrep/015/.../i2698b00.pd... I.
29. Calories of over 100 Nigerian based foods. (Cited 2018 July 20th). Available from: www.fitsNigeria.com.
30. Walker JL, Ardouin S, Burrows T. The validity of dietary assessment methods to accurately measure energy intake in children and adolescents who are overweight or obese: A systematic review. Eur J Clin Nutr 2018;72:185–97.
31. World Health Organisation food safety publication [Internet](Cited 2019 September 15th). Available from: www.who.int/food safety/publications/chem/guidelines-chem-contam.pdf
32. International Network of food Data systems(INFOODS) [Internet](Cited 2019 September 20th). Available from: http://www.fao.org/infoods/index_en.stm.
33. FAO/INFOODS food Composition Databases. [Internet](Cited 2019 November 20th). Available from: www.fao.org/infoods/infoods/tables-and-databases/faoinfoods-databases/en/.
34. Carlsen MH, Lillegaard TL, Karlsen AI, Blomhoff R, Drevon CA, Andersen LF. Evaluation of energy and dietary intake estimates from a food frequency questionnaire using independent energy expenditure measurement and weighed food records. Nutr J. 2010;9:37–46.
35. Mgbagbeola DD, Tosin FI, Adetokunbo ST. Prevalance and determinants of diarrhoea among infants in selected primary health centers in Kaduna North local Government area, Nigeria. Pan African Med J 2017;28:109.
36. Energy Requirement of children and adolescents, Background paper prepared for the joint FAO/WHO/UNU Expert Consultation on energy in human nutrition. [Internet](Cited 2020 January 20th) Available from: www.fao.org>
37. Nelson M, Black AE, Morris JA, Cole TJ. Between and within subject variatin in nutrient intake from infancy to old age: Estimating the number of days required to rank dietary intake with desired precision. Am J Clin Nutr 1989;50:156–67.
38. Living stone MB, Black AE, Robson P J, Coward JM, Wallace MC, Kinley MC,*et al.*

An Evaluation of the sensitivity and specificity of energy expenditure measured by heart rate and the Goldberg cut-off for energy intake:basal metabolic rate for identifying misreporting of energy intake by adults and children: a retrospective analysis. Eur J Clin Nutr 2003;57:455–63. doi: 10.1038/sj.ejcn.1601563

39. Black AE, Cole TJ. Within and between-subject variation in energy expenditure measured by doubly-labelled water technique: Implications for validating reported dietary energy intake. Eur J Clin Nutr. 2000;54:386–94.
40. Sophie O, Mosibo PK. Dietary Intake of School children and Adolescents in Developing Countries. Ann Nutr Metab 2014;64:24–40.
41. Wong HJ, Moy FM, Nair S. Risk factors of malnutrition among preschool children in Terengganu , Malaysia : a case control study. BMC Public Health 2014;14:785-795.
42. Ochola S, Masibo PK. Dietary Intake of School Children and Adolescents in Developing Countries. Annals of Nutrition and metabolism 2014;64:24-40. dio:10.1159/000365125
43. Agdeppa AI, Denney L, Toledo MB, Obligar VA, Jacquier EF, Carriquiry AL *et al*. Inadequate Nutrient intakes in Fillipino School children and adolescents are common among those from rural areas and poor families. Food Nutr Res 2019;63:3435–58.
44. Andrea HR. Macronutrient and micronutriet intake of children in Oklahoma child care centers, USA. Public Heal Nutr 2016;19:1498–505.
45. Hassapidou M, Fotiadou E, Maglara E, Papadopoulou SK. Energy intake,diet composition,energy expenditure and Body fatness of Adolescents in Northern Greece. Obesity 2006;14:855–862.
46. El-Gazzar HH, Saleh SM, Khairy SA, Marei AS, Elkelany K, Alsoda MF. Relationship between dietary and obesity among primary school aged children in Cairo Governorate. J med sci 2019;2:42–53. dio: 10. 4103/JMISR.JMISR_19_19.