International Journal on Food, Agriculture, and Natural Resources
Volume 03, Issue 01, Page 8-13
E-ISSN: 2722-4066
http://www.fanres.org

Original Paper

The Dietary Pattern and Hemoglobin Status of School-Age Children in Odeda Local Government Area of Ogun State in Nigeria

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Received:14 December 2021; Revised: 11 February 2022; Accepted: 06 March 2022
DOI: *https://doi.org/10.46676/ij-fanres.v3i1.55*

***Abstract*— Iron deficiency is the most common case of micronutrient deficiency in the world and widely known to cause anemia. School-age children are at high risk of micronutrient deficiency due to increased energy expenditure, combined with decreased meal frequency and insufficient maternal attention as well as parasitic infections. This study assessed the dietary pattern and hemoglobin status of school-age children in Odeda Local Government area of Ogun State in Nigeria. Two-hundred-and-twenty-seven (227) children from two schools were recruited for the study. Data on the socio-demographic characteristics of the respondents and consumption pattern were obtained through a semi-structured questionnaire. Anthropometric measurements (height and weight) of the children were determined using standard anthropometric procedures, while anthropometric indices were measured against WHO growth standard. Blood samples of the subjects were collected and analysed for haematological variables (haemoglobin, serum transferrin, and serum ferritin). Data were analyzed using frequency count, percentage, and mean. Research results have revealed that regular consumption of fruits is generally low (6.8%) among respondents. Most of the respondents (61.0%) consume green leafy vegetables on a regular basis, while 54.3% and 46.3% consume meat and fish more than 4 times per week, respectively. The anthropometric measurement of the subjects at baseline shows that 17.2% are severely stunted (HAZ-3SD), 19.5% are moderately stunted (-3SD<HAZ<-1SD), and 39.4% are mildly stunted (‐ 2 SD < HAZ < ‐ 1 SD). The BAZ status record that 14.1% are underweight (BAZ<-2SD), 1.4% are overweight (2 SD > BAZ >1 SD), and 0.8% are identified with obesity (BAZ >2 SD). Biochemical status shows that 54.9% are anemic, while all (100.0%) of the children have adequate ferritin and transferrin status. This study has acknowledged that school-age children in Odeda local government face serious prevalence of anemia associated with causes beyond the lack of iron-rich food sources.**

Keywords* — *hemoglobin, iron deficiency, dietary pattern, school-age children, anthropometric.

I. INTRODUCTION

Micronutrient malnutrition impairs the health and survival of more than 2 billion people worldwide [1]. Globally, all children under 5 years of age are at risk of nutrient deficiency. About 2 billion people are deficient in zinc, two billion others suffer from iron-deficiency anemia, and 250 million people are deficient in iodine [2]. Micronutrient deficiency is the spectra of undernutrition that occurs when the intake of vitamins and minerals is too low [3] to sustain good health characterized by normal physical and cognitive functions [4]. Because such deficiency develops gradually over a long period it is often referred to as hidden hunger [3]. Iron deficiency is the most common micronutrient deficiency in the world to cause anemia [5]. It is also acknowledged to be the bearing factor for impaired physical and cognitive development and suboptimal immune systems in children [6]. Children, pregnant women, women of reproductive age, and adolescent girls are widely affected [7]. The World Health Organization (WHO) report that about two billion people are anemic [8] as a result of hemoglobin concentrations below recommended thresholds [9]. The main causes of anemia are iron deficiency; infectious dis¬eases such as malaria, hookworm infections and schistosomiasis; deficiencies of other key micronutrients including folate, vitamin B12, and vitamin A; or inherited conditions that affect red blood cells (RBCs), such as thalassemia [10]. The prevalence of iron-deficiency anemia (IDA) among preschool children in Nigeria is estimated 69% [11]. Iron-deficiency anemia can be characterized by deficient hemoglobin synthesis, resulting in abnormally small (microcytic) red blood cells containing a small amount of hemoglobin (hypochromic) [12]. As a corollary, blood capacity to deliver oxygen to body cells and tissues will decline.

Iron deficiency with or without anemia is detrimental for human health and child development. Anemia which can result from iron deficiency is estimated to affect one half of the school-age children in developing countries [13]. When people cannot afford adequate amounts of fruits, vegetables, or animal-source foods that contain large amounts of micronutrients, deficiencies usually occur [14]. School-age children are at high risk of micronutrient deficiency [15] due to increased energy expenditure, combined with decreased meal frequency and insufficient maternal attention as well as parasitic infections

[16]. The nutrition status and health of school - age children in developing countries have recently begun to receive more attention after rejecting the assumption of survival during critical period and vulnerability of school-age children [17]. Iron deficiency also obstructs the achievement of school children [13]. In Nigeria, there are few studies in this line of research. Previous studies reporting high levels of anemia recommended the consumption of foods rich in iron. There is need for biochemical assessment to verify claims that most of the children have high levels of anemia. This study therefore assessed the dietary pattern and hemoglobin status of school-age children, in Odeda Local Government area, Ogun State, Nigeria.

Micronutrient deficiencies, other than iron deficiency, can also severely impair hemoglobin status in school-age children who only receive iron supplements. One approximate micronutrient for this is vitamin A, which has been proven important for erythropoiesis, the production of new red blood cells [18]. It is expedient to look into this interaction between vitamin A and iron. A lot of interactions between iron and vitamin A have been reported by previous works. For example, the addition of vitamin A improves the effectiveness of iron supplements in reducing the prevalence of anemia in pregnant women [19]. This effect is similar to the response to iron supplements in the school-age children who are vitamin A deficient and show minute improvement in battling anemia prevalence. When both iron and vitamin A are provided, the prevalence of anemia declines substantially. One important role of vitamin A is to stimulate erythropoiesis, which results in increased hemoglobin concentrations. The rationale behind this notion is not yet clear, but this effect of vitamin A is likely independent of iron status [20]. This is essential because if a subject who has a marginal iron status receives only vitamin A (without iron), iron supply will be further used up by the increased production of red blood cells. Concomitantly, iron status and tissue iron levels fall. This means that other tissues, including the brain, might even become (more) iron deficient. Indeed, a high-dose vitamin A supplement for infants at six months of age is presumed to influence iron status in the following six months. Children who are given iron supplements have higher hemoglobin concentrations, but those without iron supplements have lower hemoglobin concentrations [21]. Iron also affects vitamin A metabolism. Infants who receive iron supplements for six months have a re-distribution of their body vitamin A, with reduced circulation of vitamin A and increased amount of vitamin A [19]. Hence, it appears that the provision of iron or vitamin A alone to subjects with a marginal micronutrient status gives rise to unwanted side-effects in redistribution and metabolic prioritization, which can exasperate pre-existing (marginal) deficiencies. The supply of iron and vitamin A not only prevents these side effects, but also denotes a more effective measure, especially because iron and vitamin A work in high synergy [19].

II. MATERIALS AND METHODS

The study employed a cross sectional survey design. The research was conducted among school-age children attending government owned primary school in Odeda local government, Ogun State. Ogun State is a State in Southwestern Nigeria. Odeda is a Local Government Area and town in Ogun State, Nigeria. The headquarters of the LGA are at Odeda on the A5 highway 7°13′00″N 3°31′00″E. It has an area of 1,560 km² and a population of 109,449 according to the 2006 census.

The local government has 109 schools from three zones. These are: Odeda Zone (Odeda, Osiele, Oluga, Olugbo, Baale Ogun, and Eweje Farm Settelments), llugun Zone (llugun, Olodo, Okiri- Ojule, Apesin, Akonko, Olokemeji, and Kugbajagbe), and Opeji Zone (Obantoko, Adao, Alabata, Opeji, and Obete). Odeda and Ilugun are the two main rural settlements. Odeda zone was chosen for the study. Two-hundred-and-twenty-seven (227) children from 2 schools were recruited for the study.

A. Data Collection

Questionnaire

The data on the socio-demographic characteristic of the caregivers and food frequency pattern of the children were collected using the questionnaire developed in English and translated into the local language, Yoruba. The socio-demographic section had 5 parts. These were information on the care giver (age, sex, education, ethnicity, religious affiliation, marital status, household, employment, and parent income), information on the household (house hold numerical strength, head of household, who decides food purchased, and so on), information on the house and surrounding (toilet type, drinking water source, cooking fuel, and so on), information on home garden (home grown foods), and information on the children. The habitual dietary pattern of the subjects was documented using a 7-day food frequency questionnaire on selected food items [17].

Anthropometric Assessment

Anthropometric indices are combination of measurements related to body size and composition. The study employed this nutritional assessment to identify whether the research subjects were malnourished or at risk of becoming malnourished. The weights of the children were measured on a digital scale with an accuracy of 0.1 kg. The child was asked to stand on the scale without wearing shoes and with empty pockets [22]. Height was measured by using a stadiometer attached to an even wall. The child was asked to stand with (bare) feet flat and both heels close to each other against the wall. The legs had to be straight, and arms as well as shoulders were level on each side. The child was asked to look straight ahead with the corner of the outer eye parallel to the floor (Frankfurt plane) [22]. Age was calculated from the date of birth and the date of the measurements. The CDC/WHO growth reference curves used in this study were based on biological age (in months), rather than calendar age [17]. The indicators for nutritional status involved BMI for age and BAZ for body mass relative to biologic age. Under-weight/ thinness was determined by having a less than adequate BAZ (z-score < 2 SD). Height-for-age (HA) shows height relative to chronological age. HA is an indicator for group nutritional status and estimates of past and chronic energy undernutrition (shortness or stunting) (z-score < 2 SD) and overnutrition (z-score > 2 SD) [22].

Biochemical Assessment

Samples (10 ml) of venous blood were drawn and divided into a 6-ml serum tube and a 4-ml EDTA - coated tube from non - fasting subjects by a medical technologist and the local government owned clinical nurse. Collected blood samples were thoroughly mixed with the anticoagulant. The blood in the 6-ml serum tube was clotted and centrifuged at 3500 rpm for 10 minutes at room temperature. Both samples were stored at -80°C before undergoing analysis using modified methods [17]. Hemoglobin was measured within 4 hours of blood collection by means of heometer Rapid test kit (Acon laboratory Inc.). Serum ferritin (SF, indicator of iron stores) was determined using Eliza (DNM-9602 Microplate Reader, Bio-Inteco U.K) [21]. Serum transferrin (Tf) was measured using Immunoturbidimetry (Elitech Clinical system). Children were defined as Anemic when hemoglobin (Hb)<11.5 g dL^{-1} <11.9g/dL (5-8 years and 12 years) [9]. Iron deficient was confirmed when serum ferritin<15 µg L^{-1} [14]. Serum transferrin (Tf) 170 mg/L >Tf< 360mg/L [23]. Iron deficient anemia was confirmed when serum ferritin<15 µg $^{L-1}$ Hb < 11.5 g dL^{-1}.

Ethical consideration

Ethical clearance was obtained from the Ogun State Hospital, Ijaye Abeokuta. The purpose of the intervention study was explained and permission to carry out the research was obtained from Ogun State Universal Basic Education Board (SUBEB HQ and SUBEB Zonal), the Primary Schools authority, parents teachers association executives, individual parents, and director of Primary healthcare of Odeda Local Government. Children who gave consent and whose parents or guardians gave consent were recruited for the study. The participants had the right to decline the request if he/she chose to do so. The subjects participated in the study after signing the consent form. As alternative, caregivers could sign the form on behalf of the children.

B. Data Analysis

Descriptive analysis technique was used for quantitative data including socio-demographic information, food frequency pattern, anthropometry, and biochemical data to analyze frequency count, mean, and percentage. The anthropometric indicators were calculated by Nutstat, which was part of Epi info. The biomarkers were compared with WHO cutoff points.

III. RESULTS AND DISCUSSION

This study had limitations. It was only a descriptive study that reported the proportion and severity of anemia in general. The socio-demographic data and food pattern were only examined to gain the background information on confounding factors affecting the children hemoglobin status.

A. Sociodemographic characteristics

The age of 87% caregivers generally fell between 31-40 years. Most of them were married. The fathers without basic education accounted for 24.7% samples, while 27.2% of the mothers did not have basic education. About half of the respondents had 4-6 children per household. Majority of the mothers prepared the household food. The data indicated that the father decided the type of food to purchase for the family, which implied that they were the head of the household. Most of the times fathers decided the amount of money spent on food, and about half of the respondents spent between 2,000 and 10,000 naira on food, with 79.5% families earning 20,000 naira each month. More than half of the caregivers had their house made from concrete or brick and made use of pit as toilets. Sources of drinking water were mainly borehole and well. The average age of the children was 105.9± 27.2 months with 49.0% being female and 51.0% male. The period of deworming of the children was assessed, and all the children were reported to deworm within one year, with majority (72.8%) dewormed within 3 months.

B. Dietary Pattern

The most popular food consumed by the children on a weekly basis was white amala, followed by eba and boiled yam, while pounded yam is consumed occasionally. Also, rice and cereal were regularly consumed by the children, while bread was occasionally consumed. The legumes occasionally consumed were moinmoin, akara, and beans. The consumption of fruits among the children was relatively low (6.8%). This was presumed to result from the seasonality of fruits and data collection during fruits off-season. Green leafy vegetable was consumed regularly by more than half of participants (61%). Meat and fish consumption among the children were high and commendable at 54.3% and 46.3%. Both consumed meat and fish more than 4 times per week. This was contrary to Bello et al. [24] where children were found to eat less protein rich food, which in fact are important for child’s growth and development. The snacks consumed regularly by the children were biscuit and chin-chin. This study also agreed with Bello et al. [24] documenting the majority of pupils having snacks regularly, at least 4 to 5 times in a week. To some extent, this infers that snacking has a positive influence on the pupils’ nutritional status. To that end, Adamu et al. [25] observed that most of the upper primary school pupil who were underweight had snack once in a day, whereas those with normal weight or overweight were at risk of becoming overweight due to excessive snack in a day. The result of this study gave a clearer picture of the diet pattern of school children in the rural setting. It agreed with a study conducted on school-age children in Nigeria Afolabi et al. [26], which revealed that children in the urban areas had poor eating habits compared with their rural counterparts. The majority of the subjects grew food on their own. By contrast, those who did not grow their own vegetables gave reasons ranging from the ability to afford food, no access to arable land, and the lack of money to purchase seeds. The high consumption of some foods, such as cassava, yam based food, livestock, and green leafy vegetables may be associated with the report claiming that majority of the children were raised in families growing their own vegetables.

C. Anthropometric Assessment

The anthropometric measurement in Table 1 shows that 17.2% participants are severely stunted (HAZ, -3SD), 19.5 are moderately stunted (-3SD<HAZ<-1SD), and 39.4% are mildly stunted (－2 SD < HAZ <－1 SD). Figure 1 shows the height-for-age by sex of the children. The BAZ status demonstrates that 14.1 are underweight (BAZ<-2SD), 1.4 % are overweight (2 SD > BAZ >1 SD) and 0.8% are obese (BAZ >2 SD). Figure 2 shows the body mass index -for age by sex of the children. Similar studies in Nigeria by Vivian [27] and Akinlade et al. [28] reported contradicting values for underweight at 24% and 28.5%, respectively. Adanna et al. [29], Idris et al. [30] and Danjin [31] reported stunting at 9.9%, 10.5%, 22.5% respectively. This finding does not cohere with the report from Ogunnaike et al. [32] who documented stunting at 70% and underweight at 25% in Ogun State, Nigeria. This study is, however, similar to reports from NNHS 2018 [33], which reported stunting at 35.1%, while a contradicting value is documented for underweight at 25.6% in Ogun State.

Table 1. Participants' anthropometric status

	Number	Frequency	Percentage (%)
Severely stunted (HAZ <-3SD)	*227*	38	17.2
Moderately stunted (-3SD <HAZ <-2 SD)	*227*	43	19.5
Mildly stunted (-2 SD < HAZ <-1 SD)	*227*	87	39.4
Underweight (BAZ <-2 SD)	*227*	31	14.1
Overweight (2 SD > BAZ >1 SD)	*227*	3	1.4
Obese (BAZ >2 SD)	*227*	2	0.9

All values are given as n (%). HAZ: Height－for－age z score. BAZ: BMI－for－age z-score

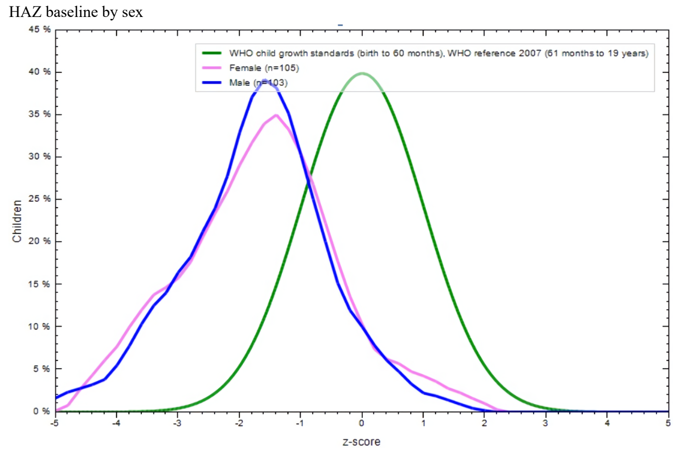

Fig 1. The height-for-age by sex of the children

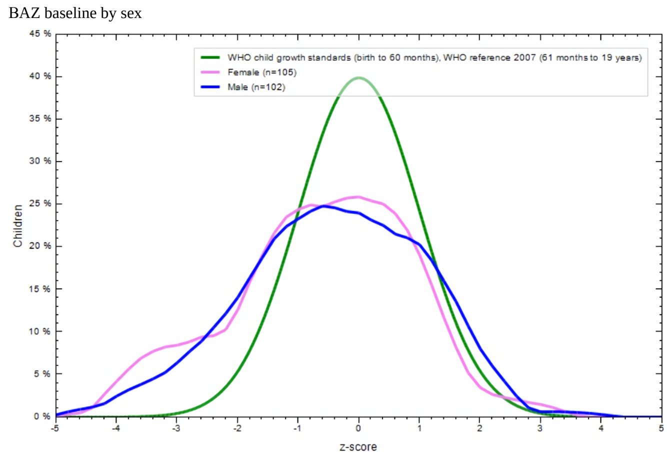

Fig 2. BMI-for age by sex of the children

D. Biochemical Assessment

The prevalence of anemia (Table 2) is marked at 54.2% as evidenced by hemoglobin status (<11.5g/dl for 5-11 years; 11.9g/dl for 12 years). There was no record of iron deficiency based on serum ferritin controlled by c-reactive protein and transferrin. A total of 227 children hemoglobin status were analysed. Kuku-Shittu [34] reported that iron deficiency was more prevalent in the Southwest areas of the country when compared with data from other parts of the country. To contrast, Quadri et al. [35] reported anemia at 16.3%. Aregbeshola [36] highlighted the prevalence of anemia in Nigeria at 67%, while Bello-Manga [37] underscored 40.3% prevalence of anemia in Northwest Nigeria. Some driving factors identified include the consumption of cereal-based diets which are low in bioavailable iron, worm infestation, and hemoglobinopathies (inherited blood disorders). The level of anemia in this study may have resulted from the lack of iron or the intake of iron which is not easily absorbed by the body, such as vegetables subject to chelation by oxalates, phytates, and other anti-nutrients. Vitamin A has been proven essential for erythropoiesis, the production of new red blood cells. Unfortunately, the vitamin A status of children in this study was not assessed. Presumably, the children with adequate hemoglobin also had sufficient vitamin A since they had adequate ferritin. This could be the result of consuming food rich in vitamin A food, such as vegetable, fish, and meat.

The protein content of apple snail measured in this study was 19,11%. A study by [32] reported lower protein content in apple snail (*Pila ampullacea)* at 10,67%. Higher protein content may result from different environmental factors and treatment before analysis. In [32], flesh and shells were separated and dried in an oven at 60^{o} C for 24 hours, while in this study only flesh and shells were separated by boiling for 3 minutes without any drying process. As in [50], protein content decreased with each addition of drying time and temperature because heating could damage amino acids in protein. This is supported by [57] who point out that extensive heating at excessive temperature causes protein to be denatured.

Table 2. Participants'' hemoglobin status

	Number	Frequency	Percentage (%)
Anemia (Hb <11.5 g/dl: <11.9g/dl)	*227*	123	54.2
Mild Anemia (10-11.4g/dl; 10-11.9g/dl)		99	80.5
Moderate Anemia (8-9.9g/dl)		21	17.1
Severe Anemia (<8g/dl)		3	2.4

IV. CONCLUSION

Consumption of leafy vegetable, meat, and fish are very high, while that of fruits is found very low among the children. Majority (86.4%) of the subjects grow food on their own, which includes green leafy vegetables. Their access to orange as the source of vitamin C is believed to be substantial indicator for their adequate ferritin and transferrin status. The prevalence of anemia is slightly above average of the children's population despite adequate serum ferritin and transferrin. This may be due to infectious and inflammatory disorders, the prevalence of genes for thalassaemia, vitamin A deficiency, and deficiencies of folic acid and vitamin B12. The school-age children come from families with low socio-economic status, which explains why they manage their own home garden. This allows extensive access to food sources that should improve their hemoglobin status. This study has confirmed that Odeda local government, Ogun State is an area with high prevalence of anemia be due to extraneous causes beyond the lack of iron rich food sources.

ACKNOWLEDGMENT

I appreciate my team of supervisors for their dedication and commitment toward the successful completion of this research.

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