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PREVALENCE OF VITAMIN A, ZINC, IODINE DEFICIENCY AND ANAEMIA AMONG 2-10 YEAR- OLD GHANAIAN CHILDREN

Egbi G*[1]

Godfred Egbi

*Corresponding Author's E-mail: gegbi@noguchi.mimcom.org

[1]Noguchi Memorial Institute For Medical Research, College of Health Sciences, University of Ghana, P.O. Box LG 581, Legon, Accra, Ghana.

ABSTRACT

Children are the most nutritionally vulnerable group of society as children are dependants and they are also at a critical stage of the growing process. They need adequate vitamin A, zinc, iron and iodine for their development and school performance. Most often iron deficiency causes anaemia with resultant fatigue and low work capacity. Studies comprehensively assessed dietary intakes of nutrients among Ghanaian children but there is not enough data available on the biochemical assessment of the micronutrient status of Ghanaian children. Therefore, the study provided the first primary data on the prevalence of vitamin A, zinc, iron, iodine deficiency and anaemia among underprivileged 2 – 10 years Ghanaian children in Okwenya village of the Manya-Krobo District. The study was a cross-sectional study carried out among 101 children. Fasting blood sample was collected from each child and used to determine vitamin A, serum zinc and hemoglobin concentration. Urine sample was collected from each of the participants early in the morning and that was used to determine the participant's urinary iodine concentration. Dietary intake data were collected with the 24-hour recalls method on two non consecutive days. Anthropometric data (weight and height measurements) and demographic data were collected on the participants. The prevalence of urinary iodine deficiency and anaemia among the children of Okwenya village was of public health concern. There was high prevalence of low urinary iodine, 93.8% (<100 µg/dl) and anaemia, 72.5% (hemoglobin <11.5g/dl) among the participants. The prevalence of vitamin A deficiency (serum retinol<20µg/dl), low serum zinc concentration <70µg/dl and low hair zinc concentration <70µg/g among the children was 35.6%, 40.5% and 29.9% respectively. There was 22.8% of the participants stunted (short for their age) in the study. This study the first nutritional assessment study in the community showed a high prevalence of low urinary iodine concentration and anemia among the children that were of public health interest. The findings also showed the prevalence of vitamin A deficiency and stunting among the children. From the findings there is the need for a nutritional intervention programme to improve the iodine, anaemia, vitamin A and general nutritional status of the children of Okwenya village.

Key words: Prevalence, deficiency, anaemia status, children

INTRODUCTION

Micronutrient deficiencies (hidden hunger), continue to impose substantial health, economic and social burdens worldwide [1]. Micronutrients deficiencies have public health implications especially in children who require them for various physiological functions [2]. More than 2 billion people including 250 million children worldwide suffer from micronutrients deficiencies like iron, zinc, iodine and vitamin A deficiencies [3]. Among different populations in the world, anaemia is likely the most identified consequence of micronutrients deficiencies suffered by a high proportion of population groups [4]. Within the middle belt of Ghana called the transitional zone, 51% of children were identified as having severe and moderate vitamin A deficiency [5]. Iodine deficiency was found in nine of 27 districts surveyed throughout Ghana [6]. Low zinc serum and hair zinc levels were reported among children in southern and northern Ghana [7, 8]. Data of children under five years of age in Ghana showed that 76.1% of the children had various degrees of anaemia: 23% had mild anaemia (haemoglobin concentration less than 12g/L; 47% had moderate anaemia, haemoglobin concentration < 10g/L and six percent had severe anaemia, haemoglobin concentration < 7g/L [9].

Children are the most nutritionally vulnerable group of a population as they are at a critical stage of the growing process [10]. The nutritional status of children may serve as one of the useful indicators to assess the nutritional and health status of a population. Hence the nutritional well-being of Ghanaian children like other children in any part of the world remains paramount to national aspirations. Knowledge on children's micronutrients status may be required for any nutrition intervention programme to achieve the goal of vision 2020 for global action [11]. This is possible through timely nutritional assessments. Studies have comprehensively assessed the dietary intakes of vitamin A, zinc, iron and iodine of Ghanaian children [5, 6, 7, 8]. However there is not enough data in relation to the biochemical assessment of these micronutrients in children in rural Ghanaian settings. This study therefore provided the first primary data on the vitamin A, zinc, iodine and anaemia status of under privileged children 2-10 years of age in Okwenya village as an initial step towards any nutrition intervention programme.

METHODS

Study site and population

The study site (Okwenya) is about 120 km from Accra the capital city of Ghana. It is in the Manya-Krobo district. The total population of Okwenya village was estimated at 800 hundred including three hundred children. Major economic activities were farming, pottery and trading. The main crops grown by individual households wee food crops such as maize, cassava, beans, okro and pepper. Few of the households reared goats, cattle and hens. The community relied on pipe born water for drinking and cooking but used stream water for other domestic activities. There was no latrine for the community and domestic waste was disposed in nearby bushes.

Study design

The study was cross-sectional. The participants were children 2 – 10 years of age. A sample frame was constructed for all children 2-10 years of age from every household. One hundred and thirty two children were listed but only 115 consented to participate in the study. Hence convenient sampling technique was used to select the participants. At the time of the sample collection, 101 children (50 boys and 51 girls) offered samples and fourteen children declined to participate even though initially they consented to participate. Biological samples such as blood, hair, stool and urine were collected from the participants for the various biochemical determinations. Questionnaires were used to collect dietary data.

Informed consent and ethical approval

The meeting was organized and the methods and goals of the study explained to the teachers, parents, the chief, elders and the assemblyman of Okwenya village. The district chief executive, medical director and director of education were informed about the study in writing and they gave permission for the study to be carried out. The parents gave written consent for their children to participate in the study. The participants also gave written consent to participate in the study. The researchers obtained Ethical Clearance from the Institutional Review Board (IRB) of the Noguchi Memorial Institute for Medical Research, Legon, after the study was approved by the Scientific and Technical Committee (STC) of Noguchi Memorial Institute for Medical Research.

Measurements

Anthropometry

All anthropometric measurements were made in accordance with World Health Organization (WHO) standards [12]. We took weight measurements in triplicates to the nearest 0.1kg with electronic scale (Precision Health Scale UC-300). The average of the three readings was considered the actual weight of the child. Each child's height was measured with a stadiometer in a standing position as described by WHO standards [12]. Heights were measured in triplicates and to the nearest 0.1cm. The average of the three readings was recorded as the true value.

Biochemical data

The haemoglobin concentration of each participant was determined immediately in the field using a Hemocue Hemoglobinometer (Hemocue AB, Angelhom, Sweden). A qualified phlebotomist collected fasting venous blood (5 ml) by vena puncture early in the morning into eppendorf tubes without anticoagulants. The blood sample of each child was transported on ice-chips to Noguchi Memorial Institute for Medical Research. Each blood sample was centrifuged at 3000g for 15 minutes in the laboratory. Serum aliquots were stored at -80^{0}C until ready to be analyzed. Serum and hair zinc analyses were done by the Atomic Absorption Spectrophotometry (PerkinElmer Atomic Absorption Flame Emission Spectrophotometer Model 3110) at the Ecological Laboratory, University of Ghana, Legon. Urine samples were collected from each child and urinary iodine

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concentrations were determined by the Ammonium Persulfate Digestion method [13]. Serum retinol was analysed with High Performance Liquid Chromatography (HPLC). The cut-off values used for haemoglobin, serum retinol, serum zinc, hair zinc and urinary iodine concentrations were less than 11.5g/dl, 20µg/dl, 70µg/dl, 70µg/g and 100µg/dl respectively.

Dietary assessment

Dietary intake was assessed using the 24 hour recall method on two non-consecutive days. This method estimates the food intake of an individual within the preceding 24 hours [14]. It gives an estimate of the actual food intake of an individual as is recalled from memory. Initially, structured questionnaires were used to collect information on all the foods consumed by each participant at home, school and elsewhere guided by specific probes. Detailed information concerning the description of each food (whether the specified food was fresh, boiled, smoked or steamed) was gathered from respondents. Estimates of portion sizes or amounts in household measures consumed were recorded with prices for purchased prepared foods. Before the 24 recall, market and household surveys were conducted to identify commonly used utensils and measures with their corresponding volumes.

Representative food samples were purchased, weighed and the mean weights calculated to estimate the actual amount of foods consumed by each participant. The total amount of the various nutrients: protein, fat, iron, vitamin C, and energy were calculated based on 100 grams portion of foods using the Food Processor Plus Software, a nutrient database (ESHA, Research Organization) and the Food Research Institute's food composition table [15]. The total amount of protein, fat, iron, vitamin C and energy consumed were compared to the Recommended Dietary Allowances (RDA).

Data analysis

The 101 participants were divided into three age groups as 2-4 years, 5-7 years and 8-10 years when the data was analyzed. There were 50 boys and 51 girls who participated in the study. The anthropometric data was analyzed using Epi-info software version 3.4.1 and the biochemical data was analyzed with SPSS software version 16. Stunting, underweight, and wasting were defined as HAZ, WAZ, and WHZ < -2 Z-Scores respectively. Results were reported as means, proportions and percentages.

RESULTS

It was found out that most mothers spent up to ten years in school, while eight percent of the fathers had between 11 – 18 years of formal education (table 1). The mothers who had no formal education were 58%. Majority of the fathers (92.1%) and mothers (99%) were self-employed. There was no mother in Okwenya village that was a salary worker but eight percent of the fathers were salary workers. It was realized that all the fathers who were self employed were into farming whilst the mothers who were self employed were into agriculture, pottery or both. The mean hemoglobin concentration, serum retinol and urinary iodine of the children were 10.9±1.2 g/dl, 22.9±6.8 µg/dl and 40.7±4.1 µg/dl respectively. It was found that 93.8% of the children had low urinary iodine (<100 µg/dl). Six percent, 29%, 66%, 60%, and 70% and of the children had normal urinary iodine, Hb, serum retinol, serum zinc, and hair zinc levels, respectively (Table 2).

The mean z scores of weight-for-age, height-for-age and weight-for-height for boys two to four years old were significantly lower than those for girls ($p<0.0001$) (Table 3). The prevalence of stunting among the children was 22.8% (Table 3). All the children met more than hundred percent of the RDA for vitamin A and total iron (Table 4). Only four percent of the children met at least 80% of the RDA for total zinc. All children met at least 80% of the RDA for vitamin A and no child was able to meet at least 80% of the RDA for energy.

DISCUSSION

This study presented the findings on the prevalence of vitamin A, zinc, iodine deficiency and anemia in two to ten years children at Okwenya village in the Manya-Krobo District of Ghana. This was the first nutritional assessment carried out in the village of Okwenya. The mean urinary iodine concentration (40.7±4.1 µg/dl) coupled with the high percentage of children (93.8%) with low urinary iodine concentration (< 100 µg/dl) was an issue of public health concern. Median urinary iodine levels are used to define the public health severity of iodine deficiency: mild public health problem (50-99 µg/L), moderate public health problem (20-49 µg/L) and severe public health problem (<20 µg/L) [16], but this study reported on the mean urinary iodine concentration and the participants with low urinary iodine levels. Unfortunately there was no available food composition data on the iodine content of local Ghanaian dishes to enable computation of the dietary iodine intake of our participants. Therefore it was not possible for us to explain if the participants met their Recommended Dietary Allowance for iodine. Considering the high prevalence of low urinary iodine concentration among the participants, we suggested that the poor educational background of the mothers possibly influenced their decision to accept media advocacy on the nutritional benefits to be derived from using iodated salt to prepare meals for their families. An earlier study reported on severe and moderate vitamin A deficiency among Ghanaian children [5] whilst in this study there was moderate vitamin A deficiency (serum retinol < 20 µg/dl) among the children. Sixty-six percent of the children had normal serum retinol concentration (20 µg/dl) probably as a result of the high dietary intake of vitamin A rich foods. This was evidenced in the fact that all children met at least 80% of the RDA for vitamin A (table 4). In this study, anaemia was a major health problem confronting the children which supports the findings of some earlier studies in Ghana [9, 17]. Elsewhere (in a different geographical location), other researchers found a similar situation confronting children where majority (81%) of rural children of West Bengal were anaemic [18]. The WHO criteria for assessing the public health significance of anaemia within a population is based on prevalence rates: > 40% constitutes a severe public health concern [19]. Hence in this study it was found that the prevalence rate of anaemia (72%) among children of Okwenya village constituted a severe public health issue for consideration. The causes of anaemia among Ghanaian children may be multi-factorial. It may be linked to inadequate dietary intake of nutrients that promote red blood cells synthesis, high incidence of malaria infections, hookworm infestation, low dietary vitamin C intake, inadequate dietary iron intake and low bioavailability of iron from diets [17]. In the present study we found that the participants had adequate dietary iron intake. They met more than 80% of the RDA for iron. Therefore it is suggested that low bioavailability (even though not investigated) was one of the major causes of anaemia among the participants in the study.

All the participants met at least 80% of the RDA for vitamin A and iron but only 28% of the children met 80% of the RDA for protein, zinc and vitamin C. Surprisingly, we found no participant met 80% of RDA for energy. The nutritional status of the children was discussed in relation to the anthropometric indicators**,** based on the NCHS reference and WHO standards [20]. It was realised that 22.8% of the children were stunted. The children that participated in the study tend to have better nutritional status compared to children in other studies in Malaysia and Oaxaca, Mexico [21, 22].

It is worth mentioning the challenges of the study. Some of the children listed initially on the sampling frame declined to participate even though they initially consented to do so. There was no other alternative than to use a convenient sampling approach to obtain 101 participants for the study. Even it was difficult to obtain blood, hair and urine samples from few participants. The participants perceived biological samples were often used for rituals and they did not want to risk their lives. Since it was explained to them in the written consent form that they were free to leave the study at any stage, their decision not to provide biological samples was accepted.

CONCLUSION AND RECOMMENDATION

The study provided useful information on the iodine, zinc, vitamin A and anaemia status of Ghanaian children 2 - 10 years old in Okwenya village of the Manya-Krobo District. The high prevalence of low urinary iodine and anaemia among the children is a matter of concern that needed attention. Also, the level of stunting among the children is of public health concern. Since the findings did not include the causes of anaemia among the children it is recommended that it might be worth investigating the possible causes of anaemia among the children of Okwenya village in a future study. Good dietary practices, public health measures and nutrition intervention measures are needed to improve the iodine status, the anaemia status and the overall nutritional wellbeing of the child population from which the study sample was selected.

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Table 1: Household characteristics of study children

Characteristics	Mother		Father	
	Total number N=101		Total number N=101	
Education level (total number of years in school)	n	(%)	n	(%)
0	58	(57.4)	22	(21.8)
1 – 6	23	(22.8)	38	(37.6)
7 – 10	20	(19.8)	33	(32.7)
11 – 18	0	(0)	8	(7.9)
Occupation				
Unemployed	1	(1)	0	(0)
Self employed	100	(99)	93	(92.1)
Salary workers	0	(0)	8	(7.9)
Number of siblings				
≤ 5	73	(72)		
≥ 6	28	(28)		

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Table 2: Biochemical characteristics of the children

Mean biochemical test values			Children with low biochemical test values			Children with normal biochemical test values	
Index	No. examined	Mean±SD	Cut-off values	(n)	%	(n)	%
Hemoglobin conc. (g/dl)	91	10.85 ± 1.2	Hemoglobin < 11.5g/dl	66	72.5	25	27.5
Retinol conc. (µg/dl)	91	22.87 ± 6.8	Serum Retinol < 20µg/dl	31	35.6	60	64.4
Serum Zinc conc. (µg/dl)	89	84.58 ± 8.9	Serum Zinc < 70µg/dl	36	40.5	53	59.5
Hair Zinc conc. (µg/g)	87	90.13 ± 38.9	Hair Zinc < 70µg/g	26	29.9	61	70.1
Urinary Iodine conc. (µg/dl)	97	40.71 ± 3.6	Urinary iodine <100 µg/dl	91	93.8	6	6.2

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Table 3: Distribution of weight-for-age, height-for-age and weight-for-height z – scores of children according to gender

	Boys	Girls	Children with z score less than -2SD (sexes combined)	
Anthropometric index	Mean ± SD	Mean ± SD	(n)	%
Weight-for-age	-1.7 ± 0.9*	-1.2 ± 0.9*	15	14.9
Height-for-age	-1.5 ± 1.1*	-1.1 ± 0.6*	23	22.8
Weight-for-height	-1.5 ± 0.8**	-0.6 ± 0.5**	11	10.9

*: z-scores (weight-for-age, height-for-age and weight-for-height significantly different for boys and girls; p<0.0001

Table 4: Mean nutrients intake and percentage (%) RDA's met by the children according to age groups and percentage of children who met at least 80% of the RDA's for the nutrients assessed

Nutrient	Mean Nutrients intake according to age group			Percentage (%) RDA met according to age group			
	2-4 yrs (n = 20)	5-7 yrs (n = 38)	8-10 yrs (n =43)	2-4 yrs (n = 20)	5-7 yrs (n = 38)	8-10 yrs (n = 43)	Percentage of children (n = 101) who met at least 80% of RDA's
Energy (kcal)	801.2 ± 163.9	804.7±216.7	751.5±181.3	51.69	42.35	37.58	0.0
Protein (g)	24.6 ± 8.1	23.3±10.5	19.66±5.2	123.0	89.62	70.61	21.8
Vitamin A (ug)	773.8 ± 877.2	657.4±558.6	771±698.4	171.9	109.6	110.14	100
Zinc (mg)	4.3 ± 1.5	4.12±1.9	4.1±2.5	43.0	41.2	41.0	4.0
Iron (mg)	10.9 ± 4.6	10.4±4.1	10.2±3.3	109	104	102	100
Vitamin C (mg)	26.9 ± 22.8	26.4±16.9	27.9±19.7	66.87	58.67	62.0	28.7

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