Assessment of anthropometric indices, iron and zinc status of preschoolers in a peri-urban community in south east Nigeria

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***Abstract*-- Background: Malnutrition among preschoolers is a major public health problem in Nigeria; with resultant morbidity, poor psychological and intellectual development and mortality.**
Objective: To assess the anthropometric indices, iron and zinc status of preschoolers in Ozubulu, Anambra State.
Methods: Two hundred and forty (240) preschoolers were randomly selected from eight nursery schools. Data were collected using questionnaire, anthropometry, biochemical analysis and a 3–day weighed food intake study. A sub set of 30 children were selected for biochemical analysis and a 3-day weighed food intake study. Serum iron, total iron binding capacity, percentage transferrin saturation and serum zinc were assessed using standard methods. Data from the questionnaire was analysed using descriptive statistics. The anthropometric data was compared with reference standards. The dietary data were analysed with Food Finder version 3.
Results: The prevalence of underweight, wasting and stunting were 1.7%, 11.9%, and 0.8%, respectively. About 66% of the children had low transferrinemia level (percentage transferring saturation <15%). This was more (50%) in the 3 year olds. About 36% of the children had normal (>65µg/dl) zinc status while 63% were deficient (<65 µg/dl). More males (63.6%) had normal serum zinc status than the females (36.4%). The 3 and 5 year olds consumed ≥143.29% and ≥ 155.54% of their FAO/WHO iron and zinc requirements, respectively.
Conclusion: Children's dietary iron and zinc intake were high but probably not bio available. Nutrition education on improving food processing and handling techniques and diversification of diet would help improve zinc and iron status of the preschoolers.

***Index Term*-- Anthropometric indices, Iron and Zinc Status, Preschoolers**

I. INTRODUCTION

Preschool children constitute the most vulnerable group of any community; their nutritional status therefore, is a sensitive indicator of community health and nutrition. Malnutrition among them is one of the major public health problems in many developing countries like Nigeria. The mediate causes of malnutrition (under nutrition and micronutrient deficiencies) include poor quality of food, insufficient food intake, and severe or repeated infectious diseases, or a combination of the three factors [1]. The major outcomes of under nutrition in childhood are morbidity, poor psychological and intellectual development (with serious consequences in adult life) and mortality. Morbidity and mortality are more among the undernourished children who also experience the greatest total burden of the disease [2]. Protein-energy-malnutrition (PEM) which usually manifests early, in children between 6 and 2 months of age is associated with early or late introduction of inadequate complementary foods and severe or frequent infections [3], [4].

Micronutrient deficiencies are the main manifestations of malnutrition besides kwashiorkor and marasmus (protein-energy malnutrition) in developing countries [5]. Micronutrient deficiencies such as iron and zinc deficiencies are veritable public health concerns and major contributors to morbidity and mortality in children in developing countries [6]. This is because of the total or near total absence of foods of animal origin in the traditional diets of these children. Iron and zinc are essential for human growth/development and maintenance of immune system. Iron is needed in production of haemoglobin, psychomotor development, maintenance of physical activity and work capacity and resistance to infection [7]. WHO estimates that iron deficiency anaemia (IDA) affects ¼ of the world population and this is more in preschool children and women particularly in Asia and Africa [8]. In south western part of Nigeria, two separate studies found that 79.1% of 6-24 month olds had iron deficiency (ID) with mean haemoglobin level of less 11.0g/dl and 14.9% had IDA [9], while in the south east, 48.8% of under-fives were iron deficient, 39% were 48 – 60 months old children, 61% of whom were rural dwellers [10].

Zinc deficiency compromises the development of millions of children in developing countries. Zinc is an important component of many enzymes needed for optimal metabolism and body functions [11]. It is an anti-inflammatory and antioxidant agent and also functions in cell mediated immune processes [12]. Zinc intake is closely related to protein intake as a result it is an important component of nutritionally related morbidity worldwide. Deficiency of zinc in children contributes to stunted growth [13] and morbidity from diarrhoea, pneumonia, and malaria [14]. Studies show that the prevalence of Zn deficiency is 24% in 24-48 months olds in rural Bangladesh [15], 28% in east Iran [16] and 46% in an informal settlement in poor peri-urban South African children [17]. In Nigeria, the prevalence of Zn deficiency among under-five children is 20% in 80µg/dl cut-off [18].

Growth disorders often go unrecognized, and therefore undiagnosed in many developing countries like Nigeria where most government and private hospitals and clinics do not keep adequate birth records of infants. These children are also not routinely weighed and measured for growth monitoring purposes at their health care visits. Some children see a health care professional only for acute care and may not be weighed at all. This may lead to wrong interpretation of growth pattern or velocity of the child and unnecessary or missed referrals. This situation is worst in semi-urban and rural communities where there is poor accessibility to adequate health services and most mothers use the services of traditional birth attendants who lack basic knowledge and training in principles of child growth and monitoring. This community based study assessed the zinc, iron status and anthropometric indices of preschool children (2 – 5years) living in Ozubulu, Anambra state.

II. METHODOLOGY

SAMPLE SELECTION

The study area was carried out in Ozubulu – a semi urban area of Anambra State, Nigeria with an estimated population of 110,000 people. The sample size was calculated based on the percentage (18%) of children who had subnormal nutritional status in southeast Nigeria [19] using the formula by Yamane [20].

$$N = \frac{4p\,(1-p)}{W^2}$$

Where N = total number of children required.

P = proportion of the subjects assumed to have subnormal nutritional status =18%

W = required precision level or probability level = 5% (0.05)

$$N = \frac{4 \times 0.18(1-0.18)}{0.05^2} = 236.16$$

A total of two hundred and forty (240) preschool children were selected using multistage random sampling from eight nursery schools (30 from each school). A sub set of 30 preschoolers was randomly selected from the study sample for a 3-day weighed food intake and biochemical assessment (iron and zinc status).

III. DATA COLLECTION AND ANALYSIS

Ethical clearance was obtained from the government general hospital in the town. Consent and cooperation of the parents whose children were selected to participate in the study was sought from the nursery school heads. Questionnaire, anthropometry (weight and height), biochemical examination (serum Fe, total iron binding capacity, percentage transferring saturation and serum Zn) and a 3 day weighed food intake study were used to collect data. The questionnaire was interviewer administered to the mothers of the children. Descriptive statistics was computed from the questionnaire data using the computer package for Social Sciences version 16. Anthropometric measurements were carried out using the standard techniques and the data generated analysed using the WHO Anthro-plus version 1.0.2 statistical software. The indices derived were compared with WHO reference standards. Serum iron, total iron binding capacity and percentage transferrin saturation and serum zinc of the children were assessed using standard procedures. The results were categorized as normal or sub normal Fe and Zn levels relative to the standard cut offs. The dietary data from the 3-day weighed food intake study were analysed with Food Finder version 3 and the nutrient intake of the children expressed as percentage of the recommended daily intake.

TABLE I

Prevalence of wasting, underweight and stunting among children (sexes and age combined)

	Wt/H		Wt/A		Ht/A	
Category	F	%	F	%	F	%
Severe	5	2.3	1	0.4	-	-
Moderate	21	9.6	3	1.3	2	0.8
Normal	193	87.2	229	95.4	173	72.1
High	2	0.9	7	2.9	39	16.3
Extreme	-	-	2	0.8	26	10.8
Total	221	100	240	100	240	100

Wt/H = weight-for-Height, Ht/A = height-for-age, Wt/A = weight-for-age, F = Frequency, % = percentage

I. RESULTS

The study population consisted of 54.6% boys and 45.4% girls. The anthropometric indices of the children in Table I shows that majority of the children (sexes combined) were within the normal range for weight-for age (Wt/A), weight-for-height (Wt/H) and height-for-age (Ht/A) [95.4%, 87.2% and 72.1%, respectively], however, 9.6% and 2.3% had moderate and severe wasting (Wt/H) respectively.

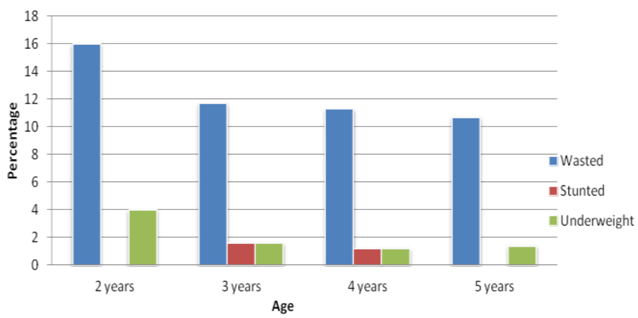

Fig. 1: Prevalence of wasted, stunted and underweight by age

According to age group, wasting (Wt/H) was observed in 16% of the 2 year olds (Fig 1). Stunting (Ht/A) was only seen in 1.6 % and 1.2% of the 3 and 4 year olds, respectively. Four percent (4%) of the 2 year olds and less than 2% of the other age groups were underweight. Using weight-for-age classification 16% of the 2 year olds was obese.

TABLE II
Prevalence of wasting, stunting and underweight among the children by sex

Category	Male	Female
Wasted		
Severe	3 (2.3)	2 (1.8)
Moderate	15 (11.5)	6 (5.5)
Normal	104 (79.4)	89 (81.7)
Overweight	1 (0.8)	1 (0.9)
Obese	-	-
Total	131 (100)	109 (100)
Stunted		
Severe	-	-
Moderate	1 (0.8)	1 (0.9)
Normal	94 (71.8)	79 (72.5)
Tall-for-age	36 (34.4)	29 (26.6)
Total	131 (100)	109 (100)
Underweight		
Severe	1 (0.8)	-
Moderate	2 (1.6)	1 (0.9)
Normal	124 (94.7)	105 (96.3)
Overweight	3 (2.3)	2 (1.8)
Obese	1 (0.8)	1 (0.9)
Total	131 (100)	109 (100)

Figures in parentheses are percentages (%)

TABLE III
Factors that influenced the anthropometric indices of the children

Anthropometric indices	Variables/factors		
	Marital status of mother	Income per month	Meals eaten per day
Wasting			
r - value	-0.002	0.03	0.168
P - value	0.971	0.652	0.012
S/NS	NS	NS	S
Stunting			
r - value	0.018	-0.013	0.022
P - value	0.785	0.846	0.739
S/NS	NS	NS	NS
Underweight			
r - value	-0.003	0.446	0.212
P - value	0.959	-0.022	0.001
S/NS	NS	NS	S

Correlation is significant at $p < 0.05$, S = significant, NS = not significant

In Table III, income, occupation, educational level of mother and child's meal frequency per day were shown to have influence on the nutritional status of the children. The child's meal frequency significantly ($P<0.05$) influenced wasting and underweight among the children.

Table IV shows that the mean serum iron concentration (41.21µg/dl) of the children was below the normal range of 60 - 170µg/dl and the difference between the serum iron concentration of the males and females was not significant ($p>0.05$). However, 20% had iron deficiency (ID) and it was more in males (23.52%) than females (15.38%). ID was more in the 3 year olds than the other age groups. The subjects mean total iron binding capacity (TIBC) of 421.46µg/dl was higher than the normal range (240 - 400µg/dl). The males had better TIBC (426.12µg/dl) than their female (415.46µg/dl) counterparts. More female children had deficient percentage transferrin saturation (%Tsat) than their male counterparts (69.23% and 64.71%, respectively). Deficient %Tsat was seen more in the 3year olds while the more of the 4 year olds had normal %Tsat than the other age groups. There was a significant correlation between serum Fe and %Tsat but statistically no inverse relationship with TIBC.

TABLE IV
Classification of iron status of the children by sex

			Iron status						
			Deficient		Normal		High		X^2 (P- value)
Sex	F	Mean ± SD Serum iron (µg/dl)	F	%	F	%	F	%	
Male	17	40.62 ± 30.52	4	23.52	6	35.29	7	41.18	
Female	13	42.00 ± 26.86	2	15.38	6	46.15	5	65.0	0.475 (0.789)
Total	30	41.21 ± 28.51	6	20.0	12	40.0	12	40.0	
		Mean ± SD TIBC (µg/dl)							
Male	17	426.12±45.04	-	-	5	29.41	12	70.59	
Female	13	415.46±53.89	-	-	6	46.15	7	53.85	0.889 (0.346)
Total	30	421.46±53.89	-	-	11	36.7	19	63.33	
		Mean ± SD percent Transferrin saturation							
Male	17	9.28 ± 6.59	11	64.71	6	35.29	-	-	
Female	13	9.62 ± 5.2	9	69.23	4	30.77	-	-	0.068 (0.794)
Total	30	9.43 ± 5.93	20	66.67	10	33.33	-	-	

F = frequency, % = percentage

It was also found that 63.33% of the preschoolers had serum Zn lower than the 65µg/dl cut off. The female children mean serum Zn concentration (60µg/dl) was not significantly ($P>0.05$) higher than that of the males (62.52µg/dl). Also there was no significant difference in the mean serum Zn concentration of the different age groups (Table V). However, the 5 year olds had the highest (66.33mg/dl) serum zinc concentration and the 2 year olds the least (52.23mg/dl).

TABLE V
Zinc status of the children according to sex and age group

			Zinc Status				
			Deficient		Normal		X^2 (P- value)
Sex	N	Mean ± SD Serum zinc (µg/dl)	F	%	F	%	
Male	17	62.52 ± 11.72	10	58.82	7	41.18	
Female	13	60.00 ± 11.72	9	69.23	4	30.77	0.344 (0.558)
Total	30	61.42 ± 11.59	19	63.33	11	36.67	
Age							
2 years	3	52.23 ± 9.01	3	100	-	-	
3 years	14	61.13 ± 13.58	9	64.29	5	35.71	
4 years	9	62.79 ± 9.49	6	66.67	3	33.33	
5 years	4	66.33 ± 9.05	1	25.0	3	75.0	4.316 (0.229)
Total	30	61.43 ± 11.59	19	63.33	11	36.67	

F = frequency, % = percentage

The food intake study (Table VI) showed that all the age groups met over100% of their energy requirement except for the 4 year olds who met about 82%. Protein intake of all the groups was below requirement except for the 3 year old who met over 100% of their daily requirement. Zinc and iron intake (mainly from plant sources) of the children were generally high across the age groups except the 2 and 5 year olds who consumed less than 100% of their iron requirement (80% and 98.33%, respectively).

TABLE VI
Mean daily energy and nutrient intake of the children by age group

	Age (years)	Energy (kcal)	Protein (g)	Iron (mg)	Zinc (mg)	Vitamin C (mg)
Mean daily intake	2	1400.81±27.01	13.05±1.26	6.80±0.93	6.62±2.42	26.99±1.15
FAO/WHO/UNU requirement		1250	14.5	8.5	5.5	20
% intake of requirement		112.06	90	80	120.36	134.95
Mean daily intake	3	1464.72±65.77	15.29±9.11	12.18±4.51	7.90±2.12	19.87±8.04
FAO/WHO/UNU requirement		1250	14.5	8.5	5.5	20
% intake of requirement		117.18	105.45	143.29	143.64	99.35
Mean daily intake	4	1273.06±429.71	14.44±2.96	9.05±2.74	7.8±2,84	25.32±11.45
FAO/WHO/UNU requirement		1550	17.5	9	6.5	20
% intake of requirement		82.13	82.51	100.56	120.77	126.50
Mean daily intake	5	1641.97±684.79	14.31±2.08	8.82±1.56	10.11±1.16	37.35±7.11
FAO/WHO/UNU requirement		1550	17.5	9	6.5	20
% intake of requirement		105.93	81.77	98.33	155.54	186.75

IV. DISCUSSIONS

The percentage (11%) of wasted children in the study area was higher than that found in another community (Aguata) in the same state [21] but lower than that found in south eastern Nigeria where wasting was 22% [22]. Wasting reflects body proportion and it is sensitive to acute growth faltering [23] usually caused by insufficient energy intake and/or repeated infection. It is therefore not surprising that wasting was observed more (16%) in the 2 year olds than the age groups. This is because within this age bracket (6 – 24 months) when the negative effect of improper complementary feeding (inadequate complementary food and infrequent feeding) of children is most felt. Underweight which is the most commonly used nutritional indicator for defining malnutrition in developing countries was low in the study population according to WHO [23] criteria. This showed a decline from what was observed in a similar study by Okorigwe & Okeke [21]. The level of stunting was also low among the children; this is surprising because many studies have reported high prevalence of stunting in developing countries recently. Marital status of the mothers, their occupation and income and the child's meal frequency affected the children's anthropometric indices. The effect of the child's meal frequency on wasting and underweight was significant ($P<0.05$). Although the energy intake of most the children were above the recommended daily intake, their protein intake was below the requirement. This might have contributed to the observed wasting and underweight in the children.

About 20% (more males than females) of the children studied had low serum iron of <60 µg/dl and more than half had high (>400 µg/dl) total iron binding capacity (TIBC) and low (<15%) percentage transferrin saturation (%Tsat) [63.33% and 66.67%, respectively]. The low serum iron or ID observed in this study supports the findings of other studies [9], [10]. However, the percentage of affected children in this study was lower than those found in south west and south east Nigeria [9], [10]. The low serum iron could be a function of the source of iron in the diets of the children rather than inadequate intake. This is because the result of weighed food intake of the children showed that except for the 2 year olds, who met about 80% of their daily iron requirement, the other age groups met over 100% of their requirement. This finding was in line with an earlier study on nutrient intake of 3 year olds in a rural community in Anambra state which found that the children consumed more than 100% of their daily iron requirement [24]. The main sources of iron for these children were foods of plant origin which has been shown to have poor iron bio availability due to the form of iron and the presence of inhibitors such as phytate, oxalic acid and polyphenols. Other factors that could have contributed to low serum iron were absence or low proportion of iron-rich foods of animal origin in the meals of the children. Vitamin C enhances iron absorption from plant foods and result of this study showed that the daily intake of the children was high but their serum iron was low. This could be a function to separate consumption of foods rich in the two nutrients. A direct relationship was observed between serum iron and %Tsat in this study but there was no inverse relationship with TIBC statistically. This association between these parameters of transferrinemia was observed by other researchers in their studies with children [25], [26].

The mean serum zinc (61.42µg/dl) of the children studied was below the WHO cut off of 80µg/dl used in a study in Nigeria [18]. The children's mean serum zinc was also lower than the 65 µg/dl cut off used in other studies to define zinc deficiency in children [27], [28]. Low serum or plasma zinc is normally associated with dietary intake. Serum zinc decreases when dietary intake is low that homeostasis cannot be established [29], however, in this study, daily dietary Zn intake was higher than the recommendation. It might be that other factors other than depletion could have been responsible for the low serum level. Such factors as meal time of the day (diurnal variation), stress, infection, hypoalbuminemia [30], [31] and low bio availability from plant sources [13] could have affected the serum level.

V. CONCLUSIONS & RECOMMENDATIONS

Wasting was considered a public health problem among preschoolers in Ozubulu. Low serum Fe concentration and %Tsat of <15 observed in this study could be as a result of the sources and consequently the form of iron in the diets of the children. Zinc status of the children could also have been affected by poor bioavailability. Any intervention plan for this community should be local custom and resource specific. Nutrition education programmes targeted at mothers and women of child bearing age on the importance of Zn and Fe and dietary diversification (inclusion of animal products) of meals for preschoolers and improved food processing/handling could be of help. Also routine Fe and Zn supplementation and inclusion in national food fortification programme as medium would be a long term strategy to prevent the deficiency these micronutrient among preschool children.

A similar study should be carried with other age groups in the community.

VI. SCOPE AND LIMITATIONS OF STUDY

The study area is a peri-ubran community made of made up large village groups. It has a population of about 110000 people. Preschool children were selected from all the villages.

Differences in nutrient composition of foods in food tables due specie and /or soil type of the area may have affected the calculation of nutrient intake of the children. Secondly, the children's inability to accurately account for the snacks eaten outside the home was another source of error.

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