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Nutritional Status and Malaria Risk in Children Under Five Years in Owerri Municipality, South Eastern, Nigeria

Uchechukwu M. Chukwuocha[1], Princewill U. Njoku[1], Judith Ezelote[1], Joakin C. Nwaokoro[1], Chimezie C. Iwuala[1]

[1] Department of Public Health, Federal University of Technology Owerri, Imo State, Nigeria
*Corresponding Author: Dr. Uchechukwu M. Chukwuocha, Department of Public Health, Federal University of Technology Owerri, Imo State, Nigeria, Email: chukwuochauchem@yahoo.com

Abstract

Nutritional status of children has been associated with disease conditions leading to morbidity and mortality. This facility based study assessed the relationship between nutritional status and malaria among under-five children in Owerri municipality South Eastern Nigeria. Nutritional status, Malaria status, Haemoglobin level, Serum Iron and Temperature were respectively measured by Z-score, Rapid Diagnostic Test, Hemocue Hb201⁺ analyzer, enzyme immunoassay and digital thermometer. Data was analyzed using descriptive statistics. A total of 200 under five children were involved in the study of which 37% were positive for malaria, 37% were anemic, 38% had iron deficiency, 44% were febrile and 49.5% were hospitalized due to malaria. There was significant association between nutritional status and malaria ($\chi2$=9.254, p=0.002), nutritional status and anemia ($\chi2$=5.552, p= 0.020) as well as nutritional status and hospitalization due to malaria ($\chi2$= 11.691, p=0.001). Malnourishment is associated with malaria risk among the under five children. Reductions in malaria parasitaemia and anemia rates may require improving children's nutritional status. This will reflect on reducing malaria morbidity, progression to severe disease and possible death.

Keywords: Under Five Children, Nutritional Status, Malaria Risk

INTRODUCTION

Malnutrition and malaria in children in developing countries is a major public health concern since they add to the handicap of poor communities especially in Africa. In Africa, the most vulnerable groups are children under five years of age, who have poor immune system to combat invading infections including malaria [1]. Nutritional status is closely tied to immune response to infections, being on one hand an important determinant of the risk and prognosis of infectious diseases and the other hand being influenced by infection [2]. This is a double way synergistic association in which a poor nutritional status contributes to the development and evolution of diseases like malaria, whereas diseases lead to a worsening nutritional status.

Childhood malnutrition is an important indicator of the health of a population [3]. A worldwide analysis recently identified childhood malnutrition as the leading risk factor for the global burden of disease [4]. This burden was highlighted in the Millennium Development Goals by the United Nation (UN) with the aim to reduce by half the number of malnourished children by 2015 [5]. Fifty-six percent of childhood deaths estimated worldwide are attributed to the potentiating effects of malnutrition, with 83% of these arising from mild-to- moderate form rather that the severe form [6]. The physical and cognitive consequences of childhood malnutrition can be long-term effects. It has also been noted that both fetal and childhood malnutrition have a marked repercussion on adult anthropometric outcomes [7]. The manifestation of malnutrition can be witnessed in terms of micronutrients deficiencies (e.g iron deficiency), anemia and anthropometric measurements. Childhood malnutrition also has significant economic consequences. Report suggests that productivity is decreased in individuals who have experienced childhood malnutrition [8].

Malaria on its own has continued to be a serious public health problem with associated morbidity and mortality particularly among under five children and pregnant women, and exacerbating cycles of poverty in poor endemic areas. According to the World Health Organization, there were 212 million new cases of malaria worldwide in 2015 (range 148–304 million) with Africa accounting for 90%, resulting in an estimated 429 000 malaria deaths (range 235 000–639 000) worldwide, most of which occurred in the African Region (92%) [9]. Malaria has the greatest prevalence close to 50% in Children aged 0-59 months in Nigeria of which 42 % are confronted with malnutrition [10]. Generally, malnutrition has been shown to encourage susceptibility to and mortality from malaria [11]. Evidence shows that malnourished children have lower anti-malaria immunity than their nourished counterparts [12-14]. Furthermore, a positive relationship between severe acute malnutrition and malaria has previously also been demonstrated [12]. The Imo River Basin in South Eastern Nigeria is an area of stable malaria transmission with associated morbidity particularly among children [15]. This morbidity may well be associated with various factors which include nutritional status of the children as has been observed in other settings with similar characteristics [16-19].

This facility-based study therefore sought to determine the relationship between nutritional status and malaria risk among children under five years in Owerri municipality, South Eastern Nigeria.

MATERIALS AND METHODS

STUDY AREA

This study was carried out in Owerri Municipality South Eastern Nigeria located at latitude 5º 28' and 34º 7'N and longitude 7º 1' & 33ºE. Owerri municipality has an area of 58km^2 and a population of 127, 213 of which under five children make up about 11% according to the 2006 census. Majority of people living in the area are traders, artisans and public servants. There is a proportional mix of educated and non-educated people. The climate is tropical with vegetation so degraded that the original natural rainforest vegetation has almost disappeared. The climate, environment and human behavior support the breeding of mosquito vectors ensuring malaria endemicity.

STUDY DESIGN

This is a facility based descriptive cross-sectional study carried out in the Federal Medical Centre (FMC) Owerri, Imo State, Nigeria from May, 2018 to January, 2019. FMC Owerri is a tertiary health facility that serves the entire state and adjoining areas. Among other specialist units, it also has a pediatric unit for childhood illnesses. Prior to the study, the head of pediatrics department was visited by the research team who made their intensions known and obtained his consent. Mothers of children under five years of age attending pediatric clinics were sensitized on the objectives, importance and significance of the study. Informed oral consent was also sought and obtained from these women. The health conditions of the children were examined by medical experts and subsequently these children were followed up.

STUDY POPULATION

The study population consisted of children age under the age of five years attending pediatric clinics at the FMC Owerri, Imo State, Nigeria. Two Hundred (200) children were randomly selected using stratified random sampling. Firstly, they were grouped into 6 strata; each stratum consisted of children within a particular age range. For instance, children between 0 – 9 months, 10 – 19, ……. 50 -59months etc. Secondly, the children in each stratum were selected using balloting. Ballot papers written “YES” and “NO” were picked by the mothers of the children. The mothers represented their children, any mother that picked “yes” had her child selected while those that picked “no”, their children were not selected. This process was used until the required number of children was selected.

LABORATORY AND CLINICAL EXAMINATION

Determination of Malaria Status

Rapid diagnostic tests were done to determine the children's malaria status. These were performed using the malaria *P. falciparium* Antigen rapid kit according manufacturers instruction before antimalarial treatments were administered to the children [20]. The thumb was cleaned with swabs provided and pricked with the lancet to obtained capillary blood. The blood sample was collected using the loop and blotted into a small hole on the rapid test kit labeled the sample part A. Two drops of buffer was added to the buffer part B. The test result was read after 15 minutes.

Determination of Hemoglobin levels for Anemia Status

Hemoglobin levels were measured using Hemocue Hb201$^+$ analyzer according to the methods of Gwerty et al. [21]. Venous blood samples were collected in EDTA bottles. The blood samples in the EDTA bottles were mixed very well by inverting 8 – 10 times before testing. The microcuvette was filled by capillary action on one continuous process to avoid air bubble. Excess blood on the outside of the microcuvette tip was wiped off using tissue and no blood was drawn out while cleaning the microcuvette. The filled microcuvette was placed in the cuvette holder on the analyzer and the cuvette was pushed to its measuring position. After 15 -60 seconds the haemoglobin value of the sample appeared on the screen of the analyzer. Anaemia was defined as haemoglobin level < 11g/L, and severe anaemia was defined as haemoglobin level < 7g/L.

Determination of Serum Iron Concentration

Serum ferritin was determined using the enzyme immunoassay kit (BIOTEC Laboratories Ltd, UK) according to the manufacturer's manual. Venous blood drawn from the children was centrifuged to obtain the serum. Serum normally contain iron (Fe) attached to proteins transferrin. An enzyme immunoassay kit (BIOTEC Laboratories Ltd, UK) for the determination of ferritin in serum was used to test samples from the children. The assay was based on the principle of a sandwich formed by the serum ferritin, which is detected between two specific monoclonal antibodies directed against two different epitopes on the serum ferritin molecule. The capturing monoclonal antibody was conjugated to biotin, while the second monoclonal antibody was labeled with horseradish peroxidase. The plates had been pre-coated with streptavidin. 20µl of serum and ferritin standards (containing different concentrations of human liver ferritin: 0, 5, 20, 100, 400, l000ng/ml in human protein buffer with gentamycin) were added to all but the blank wells in row A. l00µl of a preparation containing the two monoclonal antibodies to ferritin were also added and the whole incubated at room temperature for 1 hour. The plates were then washed five times with phosphate buffered saline with Tween 20. The chromogen, tetramethylbenzidine (TMB) was mixed in equal volume with the substrate solution containing stabilized hydrogen peroxide and 200µ1 of chromogen-substrate mixture was dispensed into the wells. After incubation at room temperature (29°C) for 10 minutes in the dark, 100µl of IN hydrochloric acid was added to stop the color reaction. Plates were read at an absorbance of 405nm. Absorbance values were converted to their concentration by reading from the ferritin standard (dose response) curve. Serum iron < 60 to 75mcg/dl for children less than 5yrs is defined as iron deficiency.

Measurement of Body Temperature

The children's body temperature were measured with Omron digital thermometer. This was done before any antimalaria treatment was administered to the children. The thermometer was placed in the armpits of the children, the body temperature of the children appeared on the screen after 5 – 10 seconds and was documented for every child. Fever was characterized as an axillary temperature > 37.5 C

Assessment of Nutritional Status

The nutritional status of the children was also assessed in terms of Z-score, using the World Health Organization (WHO) recommended threshold [22], and was classified as nourished and malnourished for the children studied. Height-for-age (stunting), weight-for-height (wasting), and weight-for-age (underweight) Z-scores were calculated based on this recommendation. Children were classified as stunting, wasting, and being under-weight if the Z scores for Height-for-age, weight-for-height, and weight-for-age were, ≤ 2 standard deviation (≤ 2SD). They were categorized as having severe stunting or wasting and being severe underweight if the Z scores for Height-for-age, weight-for-height, and weight-for-age were, ≤ 3 standard deviations ≤ 3SD), respectively. Malnourished was defined as any under-nutrition or the presence of either stunting, wasting or under-weight. Prior to calculating the Z-score, the weight of the children were taken using the spring hanging scale. The height of those aged two years and above was measured using the height measuring ruler calibrated and marked on the wall while the length of children below two years were taken by the aid of a measuring tape. These measurements were made to the nearest 0.1 cm

DATA ANALYSIS

Descriptive method was used to summarize the data characteristics. Frequency distribution tables were constructed for all class variables and were all expressed as the percentage of distribution. Chi-square test was performed at 5% level to test for association between nutritional status and other factors such as malaria, anaemia, iron status and fever. Probability value (*p*) was used to interpret the result. Hence p < 5% was considered significant.

ETHICAL CONSIDERATIONS

Ethical approval was sought and obtained from the research ethics committee of the School of Health Technology, Federal University of Technology, Owerri, Nigeria. Informed oral consent was sought and obtained from study participants after the objectives and protocols of the study were clearly explained to them.

RESULT

A total of 200 under five children were involved in the study of which 117(58.5%) were males and 83 (41.5%) were females. The classifications for age were such that 61 (30.5%) were less than or equal to 12 months old and 20 (10%) were between 48 -59 months (Table 1.) The health status of the children was also recorded in terms of malaria, anemia, Iron level and feverish occurrence. A total of 74 (37%) tested positive for malaria, and more than that (49%) have been hospitalized due to malaria. Thirty nine percent were anemic, 38% recorded low iron status and 44% were febrile (Table 1).

The Relationship between nutritional status and health assessment parameters among the under five children studied is depicted in Table 2. About 32.4% of the studied under-5s that tested positive for malaria were malnourished. Only 14.3% of the ones without positive malaria status were malnourished. The odd of being malnourished was found to be 2.9 times significantly higher for the malaria positive under-5s compared to that of the malaria negative ones (p =0.002, χ^2 = 9.254). Among the ones found anemic in this present study, 29.5% were malnourished compared to 15.6% found in the non-anemic ones. The odds ratio indicates that the likelihood of being malnourished was 2.2 times significantly higher in for the anemic under-5s compared to the non-anemic ones (p =0.020, χ^2 = 5.552).

For the iron status among the study subjects, the proportion for nourished and malnourished that recorded normal iron status were respectively 81.7% and 15.6%. On the other hand, among the uder-5 children with low iron status 75.3% were non malnourished while 24.7% were malnourished. The odds of being malnourished was found to be 1.2 times higher in the low iron status under-5s studied compared to that of their counterparts with normal iron status. No significant association was found between iron status and nutritional status (nourished and mal nourished) in this study (p ≥ 0.05).

Slight differences were obtained for the nourished and malnourished under five children who were febrile and afebrile. A total of 20.5% of the afebrile ones were malnourished compared to 21.6% found for the febrile. The odds for being malnourished was slightly higher by 1.1 for the febrile than for the afebrile.

On the contrary, significant association was found between the hospitalization status due to malaria and the nutritional status of the under five children in this study (p =0.001, χ^2 = 11.691). The probability of being malnourished was 3.5 times higher among the children hospitalized due to malaria compared to that of the ones not hospitalized due to malaria.

Table 1: Characteristics and Health Status of Children

Characteristics	Frequency (n=200)	Percentage
Gender		
Male	117	58.5
Female	83	41.5
Total	200	100
Age (Months)		
≤12	61	30.5
12 - 23	49	24.5
24 - 35	32	16.0
36 - 47	38	19.0
48 - 59	20	10.0
Malaria Status		
Negative	126	63.0
Positive	74	37.0
Hospitalization		
Non-hospitalized	101	50.5
Hospitalized	99	49.5
Anemia		
Non-Anemic	122	61.0
Anemic	78	39.0
Iron Status		
Normal	124	62.0
Low	76	38
Fever		
Afebrile	112	56.0
Febrile	88	44.0

Table 2: Relationship between Nutritional Status and Health Parameters of Children

Health Parameters	Number studied	Number Nourished (%)	Number Mal-nourished (%)	OR	χ^2	p-value
Malaria Status						
Negative	126	108 (85.7)	18 (14.3)			
Positive	74	50 (67.6)	24 (32.4)			
Total	**200**	158 (79.0)	42 (21.0)	2.9	9.254	0.002
Anemia						
Non-Anemic	122	103 (84.4)	19 (15.6)			
Anemic	78	55 (70.5)	22 (29.5)			
Total	**200**	158 (79.0)	42 (21.0)	2.2	5.552	0.020
Iron Status						
Normal	124	94 (81.7)	21 (18.3)			
Low	76	64 (75.3)	21 (24.7)			
Total	**200**	158 (79.0)	42 (21.0)	1.2	1.224	0.295
Fever						
Afebrile	112	89 (79.5)	23 (20.5)			
Febrile	88	69 (78.4)	19 (21.6)			
Total	**200**	158 (79.0)	42 (21.0)	1.1	0.033	0.863
Hospitalization due to Malaria						
Non Hospitalized	101	92 (91.1)	12 (8.9)			
Hospitalized	99	66 (66.7)	30 (33.3)			
Total	**200**	158 (79.0)	42 (21.0)	3.5	11.691	0.001

DISCUSSION

The present study recorded a significant relationship between nutritional status and malaria; with an indication that malaria has a positive association with malnutrition among the under-fives. Malaria positive under five children were 2.9 times more likely to be malnourished than the ones that are not positive for malaria. Similarly, in South-Central Ethiopia several wasted children were found to be more likely to have malaria than non-wasted children [23]. A study in North central Nigeria showed high likelihood of malaria in acutely malnourished children than healthy ones [24]. Evidences from Congo [25] and Rwanda [26] respectively have also depicted the relationship between malnutrition and malaria risk. The likely explanations for this pattern of association between malaria and nutrition include the immune suppressive effect of severe malaria, loss of appetite to food, and low level of income or poverty which also influences nutritional patterns.

However, in contrast to the findings in the present study, a study carried out in preschool children in Senegal revealed that wasted children had lower risk of having malaria [13]. Also, no association was found between wasting and malaria among children in a previous study in south west Ethiopia [27]. A possible reason for the conflicting results is the differences in the definition criteria of malaria disease. While these studies solely defined malaria based on parasitemia, the present study used parasitemia criterion and other symptoms such as fever and anemia. Whatever is the case, it is important to understand that malnutrition makes children vulnerable to infections. On the other hand, infection has adverse effects on nutritional status. While suppression of immunity has been the cause of reduced resistance to infection in the humoral and cell mediated immunity, it also affects bactericidal activities of phagocytes and complements formation [2].

Childhood anemia is also of public health concern especially in child nutritional pattern. The present study recorded a significant difference in the occurrence of anemia among nourished and malnourished under five children. This study found that the odds for being malnourished were 2.2 times significantly higher among the anemic under five children compared to that of the non-anemic ones. A report in parts of Southern Nigeria observed a higher prevalence for anemia among malnourished preschool children [28]. It has also been reported that children under five years during their growth have the greatest physiological demands for nutrients and are at higher risk of anemia. Another previous study found corroborating results, of which the odd of malnourishment was 2.1 times higher in the anemic than the non-anemic [29]. This high ratio may be an indication that the diet of these under 5 children is not adequate as they may lack access to good and adequate diet.

Malnourishment in the study children was not significantly associated with low iron status. This is in contrast with a study conducted in Kenya where high prevalence of iron deficiency was associated with malnutrition among preschool children [30]. This discrepancy can be explained based on study subjects. In our study, malnourished children with low iron status were children who have stopped breast feeding. They were toddlers who fed on varieties of food, but this food may lack iron supplements. It could be as a result of inability of their parents to provide food with the required amount of iron supplement. Also malnourished children with normal iron status were seen still breast feeding and were acquiring iron from their mother's breast milk. But their malnourishment may be as a result of their parents' inability to give them food with lacking in the nutrient.

Furthermore, fever was not significantly associated with nutritional status among the studied under five children. This may be as a result of malnutrition not being directly responsible for symptoms like fever. Rather malnutrition aggregate existing illness which manifest itself with fever and other symptoms.

However, hospitalization due to malaria was associated with nutritional status among under five children in this study. It should be expected that since malnutrition worsens infections such as malaria, this may lead to increased incidence of hospitalization especially among under five children whose immune system are still developing.

CONCLUSION

This study revealed that nutritional status can be associated with malaria risk in children under five years of age in South Eastern Nigeria. This risk can further manifest with anemia as well as hospitalization of children due to malaria. This situation could also be the same in other poor malaria endemic parts of the World where under five morbidity and mortality are high. Improvement of nutritional status of under five children would therefore help in reducing morbidity and mortality due to malaria and its complications.

Conflict of Interest

None declared

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None declared

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