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***PLASMODIUM FALCIPARUM* PARASITEMIA WITH ANEMIA IN CHILDREN UNDER  
FIVE YEARS AT A TERTIARY HEALTH CENTER IN SOUTH-WEST, NIGERIA**

## PLASMODIUM FALCIPARUM PARASITEMIA WITH ANEMIA IN CHILDREN UNDER FIVE YEARS AT A TERTIARY HEALTH CENTER IN SOUTH-WEST, NIGERIA

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### ABSTRACT

#### Introduction

Malaria is a major public health disease, and severe malaria with anaemia could be life-threatening. A focused study on malaria with anaemia will provide information which may help in mitigating this problem among the population in sub-Saharan Africa. The objective of this study is to determine the prevalence of *Plasmodium falciparum* parasitemia in relation to anaemia among children under 5 years in a tertiary health center in South-West, Nigeria.

#### Methods

The study was conducted at the Paediatrics Emergency Unit of the Federal Medical Centre, Owo, Ondo State in Nigeria, over a three-month period. Ethical approval was obtained and informed consent was taken from the caregivers. One hundred children below the age of five years were randomly selected for the study. Blood sample was obtained from the children for thick and thin smears for malaria parasite identification and estimation. Packed red blood cell volume was estimated using the microhematocrit method.

#### Results

Only 93 children had complete data, which were analyzed. There were 48 females and 45

males, and the age range for the patients was from 11 hours to 59 months with a mean age of 24.6 months. Eighty-four (90.3%) of the children had *Plasmodium falciparum* parasitaemia while 55 (59.1%) were anaemic. Only 2(2.6%) of the children with anaemia did not have malaria. Using multivalent analysis, malaria parasitemia was found to be associated with anaemia ( $P = 0.036$ ) in these children, but there was no significant association between age, gender and malaria with anaemia.

#### Conclusion

Malaria in children is closely associated with anaemia irrespective of the age or gender.

**Keywords:** Malaria; *Plasmodium falciparum*; Anaemia; Children; Nigeria

### INTRODUCTION

Human malaria is a major health problem in tropical developing countries and it is the major parasitic disease of humans.<sup>1,2</sup> It is a protozoan disease caused by the parasite of the genus *Plasmodium*.<sup>3</sup> The disease is transmitted through the bite of infected adult female Anopheles mosquitoes. Five species of *Plasmodium* cause malaria in humans: *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae*, and *P. Knowlesi*.<sup>3</sup> Some other *Plasmodium* species like *P. cynomolgi* and *P. simium* can

also infect humans under natural conditions but are not established causes of human malaria.<sup>3</sup>

Malaria accounts for an estimated 250 to 500 million febrile illnesses and causes about a million deaths annually.<sup>1</sup> It is estimated that up to 40% of the world's population live in the malaria endemic zone and are thus at risk of developing the disease. Most of the recent increases in the cases of global malaria incidence come from countries in the African Region.<sup>1</sup>

Presently, 29 countries account for 96% of malaria cases globally. Nigeria takes the lead with 27% despite the consistent interventions at reducing malaria endemicity in the country.<sup>1</sup>

Severe malaria is multi-syndromic and often manifests as cerebral malaria, severe anaemia and respiratory distress.<sup>3</sup> Mortality is high if severe malaria is not promptly and effectively managed. The distribution of severe malaria syndromes varies by age across transmission intensities, influenced mainly by changes in community-level immunity patterns.<sup>4-6</sup> Most severe cases and deaths occur in children younger than 5 years and in pregnant women.<sup>1</sup> The percentage of total malaria deaths in children aged under 5 years was about 77% in 2020 and the malaria mortality rate (i.e. deaths per 100 000 population at risk) increased from 13 in 2019 to 15 following the COVID-19 pandemic in the year 2020.<sup>1</sup> Nigeria also accounts for the highest rate of mortality among the 29 countries with high mortality rates from malaria.<sup>1</sup>

*P. falciparum* malaria can be much more acute and severe than malaria caused by other *Plasmodium* species, and it is the prevalent specie found in Nigeria as well as in tropical Africa.<sup>3,7</sup> Although *P. vivax* can cause serious and fatal illness, by far the largest fraction of deaths directly attributable to malaria are caused by severe complications of *P. falciparum* infection.<sup>3</sup> Complications arising from *P. falciparum* malaria include cerebral malaria, severe anaemia, respiratory failure, renal failure, and severe malaria of pregnancy.

Malaria is a major cause of anaemia in endemic areas and is often a common reason

for blood transfusion, especially in children and pregnant women.<sup>8,9</sup> In the tropics, poverty, nutritional deficiencies (especially iron deficiency), intestinal helminth infections, poor housing systems, overcrowding, inadequate water facilities and poor hygiene which often go concomitantly with haemoglobinopathies and other childhood diseases, all contribute variably to anemia.<sup>2,10-13</sup> These same factors also inadvertently contribute to the higher morbidity from malaria in some African regions. The objective of this study is to determine the prevalence of *Plasmodium falciparum* parasitemia in relation to anaemia among children under 5 years in a tertiary health center in South-West, Nigeria.

## METHODS

### Study Area

The study was conducted at the Federal Medical Centre (FMC), Owo. The FMC serves the people of the town and its environs. Owo is a town in Ondo State, Southwest Nigeria, situated at latitude 7.20°N and longitude 5.59°E with a population of about 276,574. The town is located at an elevation of 0 feet above sea level and has a tropical wet and dry (savanna) climate. It receives about 195.27 millimetres (7.69 inches) of precipitation with an average of 284.21 rainy days annually. The people are mostly farmers and traders.

### Study Population

One hundred children under the age of 5 years who presented with fever were randomly selected from the Paediatrics Emergency Unit of the Hospital. Children who were afebrile, had trauma or burns, or are known to have chronic illness were excluded from the study.

### Ethical Consideration

Ethical approval was obtained from the Ethical Committee of the hospital (FMC/OW/380/VOL.LXIII/165) and informed written consent was obtained from the parents or caregivers of the children enrolled in the study.



### Sample Collection

Blood samples of less than 1 millilitre (mls) were obtained from each child for malaria parasite identification and estimation through aseptic means. Thick and thin blood films were made for parasite identification and estimation. Packed cell volume estimation was done by the microhematocrit method.

### Preparation of Blood films, Staining and Examination

Thin smears of blood of about 12mm were made on clean, grease-free glass slides and fixed with methanol after drying. Thick films were also made on clean, grease-free glass slides. Both thick and thin smears were stained using a 1:10 dilution Giemsa stain for 10 mins. The stain was carefully washed off the slides with clean water and left to air dry, then examined microscopically using an oil immersion lens for malaria parasites.

Both malaria parasites and white blood cells (WBC) were counted in each microscopic field with the aid of a tally counter with different assigned keys for parasites and WBCs. More than 100 parasites in 200 counted WBC or less than 99 parasites with 500 WBCs were taken as the cutoff. The result was recorded as the number of parasites per 500 fields.

The parasite density was calculated using the following formula.<sup>14</sup>

Parasite/ $\mu$ L of blood =

$$\frac{\text{Number of parasites counted} \times 8000 \text{ WBCs}/\mu\text{L}}{\text{Number of WBCs counted}}$$

### Packed Cell Volume Estimation

The Packed Cell Volume (PCV) was estimated using the microhematocrit method. Whole blood measuring about 5mls was collected from the patients into sterile anticoagulated (EDTA) sample bottles, from which at least two capillary tubes for each patient were filled to approximately  $\frac{3}{4}$  of the tubes and sealed with plasticine. The tubes were spun in a balanced microhematocrit centrifuge at 13,000rpm for 5 minutes. The hematocrit value for each child was read off in percentage using the microhematocrit reader. According to the World Health Organization (WHO), anaemia

in children is classified as mild with haemoglobin of 10.0 to 10.9 g/dl, while moderate anaemia is a haemoglobin of between 7.0 and 9.9 g/dl and severe anaemia is a haemoglobin of less than 7.0g/dl.<sup>14</sup> Haemoglobin of 11.0 g/dl and above is considered normal.<sup>15</sup> Hematocrit level expressed in percentage (%) is defined as three times the value of haemoglobin.

### Data Management and Statistical Analysis

A data collection form designed for this study was used to extract patients' data. Data entry, cleaning and analysis were done using Statistical Package for Social Sciences (SPSS) (IBM, Chicago, Illinois) version 25.0. Categorical variables were presented as frequency and percentages. Fisher's exact test was used to assess the association between malaria infection status and anaemia status. It was also used to assess malaria parasitaemia levels and anaemia variables. Logistic regression analysis was used to determine the independent predictor of anaemia.  $P < 0.05$  was accepted as significant.

## RESULTS

### General Characteristics

A total of 100 children under the age of 5 years were recruited into the study. Seven of these children had incomplete data entries and thus were excluded from the final analysis, thus only data from 93 children were analyzed in this study.

### Age and Sex Distribution

There were 48 females and 45 males, and the age range for the patients was between 11 hours and 59 months with a mean age of 24.6 months (Table1).

**Table 1: Demography**

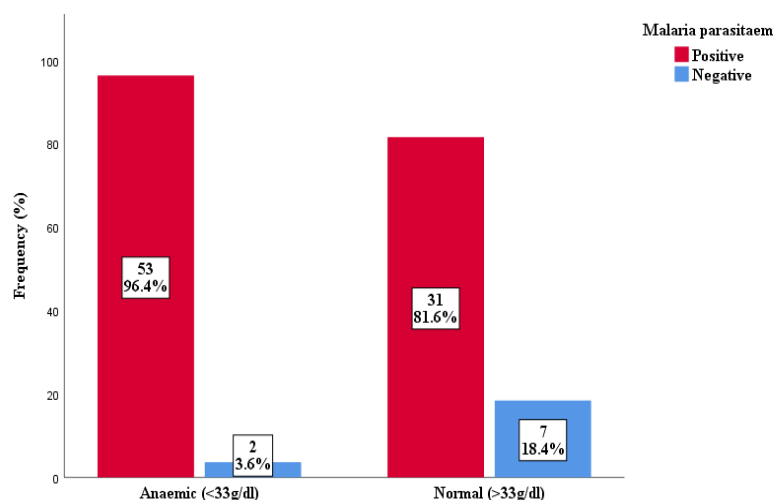
	Frequency (Percentage %)
<b>Age (Months)</b>	
<12	27 (29.0)
12-23	15 (16.1)
24-35	16 (17.2)
36-47	18 (19.4)
48-59	17 (18.3)
<b>Gender</b>	
Male	45 (48.4)
Female	48 (51.6)

### **Malaria Parasitemia and Categorization of Packed Cell Volume Estimates**

Of the 93 children, 84 (90.3%) had varying levels of *Plasmodium falciparum* parasitemia (Table 2) while 55(59.1%) had anaemia. 36(38.7%) of the children had mild anaemia with hematocrit levels between 24-32% while 10(10.8%) had moderate anaemia with a hematocrit level of 18-23%. Those with severe anaemia with a hematocrit level of less than 18% were 7(7.5%) (Table 3). Two (2.2%) of the children who had anaemia did not have *Plasmodium falciparum* parasitaemia (Fig 1). In two of the children with anaemia, the anaemia was not related to malaria as they were negative for *Plasmodium falciparum* parasitaemia; hence the variation in number between 53 in table 2 and 55 in table 3.

### **Association between Packed Cell Volume and Malaria Parasitemia**

There was a significant association between malaria parasitemia and anaemia in this study ( $P= 0.018$ ), Fisher's exact value was 5.620 (Fig1) but no association was found with the different age groups in months and gender on multivariate analysis (Table 4).



Fisher exact value= 5.620,  $p=0.018^*$

**Fig 1:** Proportion of Malaria Parasitemia in Anaemic and Non-Anaemic Children

NOTE: Normal = Normal Packed Cell Volume

**Table 2: Malaria Parasite Density among the Children who had Malaria+ Anaemia**

Malaria Parasite Density	Anaemic (n=53)	Non-anaemic (n=31)	F	p-value
<1000/ul	45(64.3)	25(35.7)		
1000-9999	1(50.0)	1(50.0)	0.307	0.858
≥10,000	7(58.3)	5(41.7)		

F=Fisher exact test

**Table 3: Prevalence and Classification of Anemia in the Children**

Classification	Haematocrit Value (%)	Frequency (Percentage)
Severe Anaemia	<18	7 (7.5%)
Moderate Anaemia	18 -23	10 (10.8%)
Mild Anaemia	24 -32	38 (40.9%)
Normal Haematocrit	≥33	38 (40.9%)
Total	-	93 (100%)

**Table 4: Multivariate Logistic Regression Showing Independent Predictors of Anaemia**

	Odd ratio (95% CI)	p-value
<b>Age (Months)</b>		
<12	1	
12-23	1.23 (0.64-1.89)	0.53
24-35	1.53 (0.78-4.74)	0.42
36-47	1.84 (0.56-3.90)	0.34
48-59	2.43 (0.65-3.83)	0.11
<b>Gender</b>		
Male	1	
Female	1.81 (0.59-2.14)	0.71
<b>Malaria Parasitemia</b>		
No	1	
Yes	3.99 (1.03-7.41)	<b>0.036*</b>

## DISCUSSION

This study was undertaken to investigate *Plasmodium falciparum* parasitemia anaemia among febrile children at the study hos Federal Medical Centre (FMC), Owo, Nigeria. The prevalence of malaria parasitemia among the children with fever who presented at the Pediatrics Emergency unit of the study hospital was 90.3%. This is similar to a report from a hospital-based study in Anambra, South-East, Nigeria which reported a prevalence of 94.6%.<sup>16</sup> Similar studies from Southern Nigeria reported lower prevalence rates between 70% and 82%.<sup>4,9</sup> A previous nation-wide survey on malaria in Nigeria has stated that the prevalence of malaria varies in different regions and could be above 90%, especially in rural communities.<sup>7</sup> The differences in the prevalence rates of malaria across different regions may be due to various factors such as seasonal variation in malaria endemicity, geographical location, targeted population and variations in malaria prevention and control interventions among other reasons.<sup>1,3,7</sup>

There was a significant association between malaria parasitemia and anaemia in this study ( $p < 0.018$ ). Using multivariate logistic regression, malaria was found to be an independent predictor of anaemia with a p-value of 0.036. Thus, control of malaria which must include prevention, timely diagnosis and treatment of children with malaria will

undoubtedly impact positively the reduction of cases of anaemia in these children.

The prevalence of anaemia (59.1%) in these children is close to the prevalence of 54.1% reported from Plateau State, higher than 47.3% from Okada in Edo State, but lower than 76.9% found in children from Abia State, and 74% to 88.2% from Burkina Faso.<sup>5,8,9</sup> Nutritional and immunity status vary from one child to another across the various geographical locations which could explain differences in the prevalence of anaemia found.<sup>9,12,17</sup>

Using multivariate logistic regression, the age of these children and their gender were not found to be predictive of anaemia in our study. This differs from the report from a study in Zambian children which found a relationship between the female gender and the development of anaemia in children with malaria.<sup>13</sup> An association has also been found between malaria and anaemia in infants aged less than one.<sup>18</sup> However, a study from Kano in Northern Nigeria found no significant difference in the prevalence of malaria among different age groups and gender.<sup>10</sup>

Although 70(75.2%) of the children involved in this present study had a malaria parasite count less than 1000/ul, a majority (85%) had anaemia, but the severity of anaemia was mild in 40.9% of the patients. Some studies done on the pathogenesis of anaemia in malaria have established that malaria infection causes

hemolysis of infected and uninfected red blood cells and causes dyserythropoiesis in the bone marrow thus resulting in a rapid depletion of red blood cells.<sup>2</sup> Thus, a mild level of malaria parasitemia could result in a more severe level of anaemia in children.<sup>2-3</sup>

The scope of the study did not cover data on previously confirmed diagnoses of malaria in the study group. Also, their genotypes and nutritional statuses were unknown. These unknown variables could be associated with chronic anaemia in these children.

## CONCLUSION

Malaria is closely associated with anaemia in the children involved in our study and the level of parasitemia did not necessarily translate to the severity of anaemia.

## Acknowledgements

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