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## Low Prevalence of Anaemia in a Cohort of Pre-School Children with Acute Uncomplicated *Falciparum* Malaria in Nigeria

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**Abstract:** We surveyed for the prevalence of anaemia, by packed cell volume and haemoglobin determinations, in a cohort of 36 pre-school children with uncomplicated *Falciparum* malaria in Sokoto, Nigeria. By packed cell volume, 5 (3.9%) of the children were mildly anaemic, 3 (8.3%) were moderately anaemic and 28 (77.8%) were normal. As indicated by haemoglobin levels, 6.0 (16.67%) of the study children have moderate anaemia while the remaining 30 (83.3%) were normal. There was no incidence of severe anaemia in the study cohort. Comparison of Hb with PCV methods for anaemia detection indicates that the latter is more efficient in detecting prevalence of anaemia in our study subjects. Peak incidence of mild anaemia occurred in the age groups 0-12 and 49-60 months, with the lowest incidence occurring in age group 37-48 months. Peak and lowest incidence of moderate anaemia occurred in the age group 13-24 and 0-12 months, respectively. Haemoglobin levels did not vary significantly among the age groups (ANOVA,  $F = 1.006$ ,  $p = 0.4194$ ). Although all children less than five years of age in this setting are at risk for anaemia, the age group 13-24 months should be especially monitored for anti-anaemia interventions.

**Key words:** Malaria, anaemia, prevalence, pre-school children, Nigeria

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### INTRODUCTION

Malaria is the most important parasitic disease of man (Barnes and White, 2005) and of utmost public health importance. In 2001, malaria was the eighth highest contributor to the global loss of Disability- Adjusted Life Years (DALYs) and second in Africa (Snow *et al.*, 2004). Although four *Plasmodium* species infect humans, severe malaria and malaria-related deaths are almost entirely attributable to *Falciparum* malaria (World Health Organization, 2000a) and children under five years of age are the worst affected. The clinical and epidemiological disease burden of malaria is generally documented in terms of morbidity and mortality (mainly infants, childhood and maternal), with anaemia being one of the important complications. In areas of intense malaria transmission typified by sub-Saharan Africa, approximately three-fourth of pre-school children have anaemia rendering it a common direct and indirect cause of paediatric morbidity and mortality in the region (DeMaeyer Adiels-Tegman, 1985). Acute anaemia, superimposed on a low haemoglobin level, is an important feature in young African children (Ekvall *et al.*, 1998). Anaemia remains one of the most intractable public health problems in malaria endemic countries with serious consequences since severe anaemia is associated with an increased risk of death (Brebin *et al.*, 2001).

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The Roll Back Malaria Initiative (RBM, 2000) has recently proposed using anaemia in pre-school children as one of the indicators of malaria in areas with stable malaria transmission in sub-Saharan Africa. In such settings, targeted delivery of interventions against anaemia to high risk groups may be an appropriate use of limited economic and human resources (Crawley, 2004). Information on prevalence of anaemia in a given setting is important for planning for interventions and prevalence of anaemia has been shown to be a more sensitive indicator to changes in malaria exposure than parasite prevalence in areas with stable malaria transmission (Dolan *et al.*, 1993; Guyatt and Snow, 2001; ter Kuile *et al.*, 2003). The objective of this study was to determine the prevalence and severity of anaemia in pre-school children and identify those requiring emergency anti-anaemia interventions for better patient management.

## **MATERIALS AND METHODS**

### **Study Area**

The study was carried out in Sokoto, the capital city of Sokoto state, between November 2004 and September 2005. The state is located between longitude 11°30', 13°50' east and latitude 4° to 6°0' north, bordered to the north by Niger Republic, Zamfara state to the east while Kebbi state borders most of the south and western parts (Mamman, 2000). The state falls within the Savannah vegetation zone. Rainfall starts late and ends early with mean annual rainfall ranging from 500 to 1,300 mm. The state has three peculiar seasons; the cold dry (December-February), hot dry (October-April) and wet. The wet season begins in most part of the state in May and lasts up to September.

The vast fadama land of the Sokoto-Rima River system dissects the plain and provides rich alluvial soil and extensive grassland fit for a variety of crop cultivation, hence farming and livestock rearing are the principal activities in the state (Sokoto State Diary, 2003). Other commercial activities are cement and leather production. The leather industrial sites may serve as breeding sites for mosquitoes as most of the wells are uncovered and the water disposal system is poor.

In Sokoto, as in other cities in Northern Nigeria, malaria is hyper-endemic (Molyneaux and Gramiccia, 1980). *Plasmodium falciparum* is the predominant species (Umar and Hassan, 2002). Entomologic inoculation rates have not been determined or published. However, prevalence rates of 20-40 and 10-15% for uncomplicated malaria and chloroquine resistant malaria respectively have been suggested (Personal Communication with Dr. Nma M. Jiya).

### **Study Design and Patients' Recruitment**

Patients for the study aged 2-59 months were recruited as part of a larger study on the therapeutic efficacy of chloroquine for uncomplicated malaria (at the eve of policy change of dropping chloroquine and adopting artemisinin- based combination therapy for first line treatment of uncomplicated malaria) at the outpatients' clinic of the Department of Paediatrics, Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto and the University Health Centre, permanent site. The patients presented with signs and symptoms suggestive of uncomplicated malaria (WHO, 2000a). Other inclusion criteria were: history of fever during the preceding 48 h, *P. falciparum* mono-infection with a parasite density of 1,000-100,000 and verbal or signing of an informed consent form by a parent/guardian of the child to participate in the study.

### **Exclusion Criteria**

The following were excluded; children with sickle cell disease, hyperparasitaemia and jaundice. The study was reviewed and approved by the ethical committee of UDUTH and by Management of the University Health Centre.

Clinical and physical examinations including weighing (in kg), taking of axillary temperature, age and gender were performed and the information entered into proforma data sheets. About 2.0 mL of blood were also taken into EDTA-containing tubes for laboratory diagnosis: parasite species identification, parasite density count and determination of packed cell volume and haemoglobin.

#### **Parasite Specie Identification and Count**

About 20  $\mu\text{L}$  of blood were collected from the EDTA-anti-coagulant bottle and thick and thin films (smears) were made on pre-labelled slides in accordance with the method described by Hendrickse and Mathews (1991). The thin smears were used for the identification of the malaria parasite species based on specie-specific characteristics including staining and morphological features such as the size of the infected red blood cell, chromatin (Maurer's) dot, pattern of ring forms or trophozoites as described by Fleck and Moody (1988). Slides with mixed infections or parasites other than *P. falciparum* were discarded.

#### **Determination of Packed Cell Volume (PCV)**

The micro-haematocrit method as described by Dacie and Lewis (1975) was used and the results expressed as percentage of the packed cell volume.

#### **Determination of Haemoglobin (Hb)**

Haemoglobin was measured using a Hemocue® (Angelholm, Sweden) machine.

#### **Statistical Methods**

All data at the beginning to the end of the study were entered into a database on Minitab 13.03 statistical software (Minitab Corporation, P.A., USA). Mean, Standard deviation and range were calculated for the data; normally distributed continuous data were compared by student's t test or analysis of variance. A p-value of  $<0.05$  was considered statistically significant.

All analyses were performed on Minitab 13.03 (Minitab Corporation, P.A., USA). or Graph pad Instat 3.00 for Windows 95 (Graph pad software, San Diego, California, USA).

## **RESULTS**

#### **Study Population**

A total of 63 children aged 2-59 months were recruited for the study out of which 36 completed the study. The characteristics of the study population are presented in Table 1. Thirty-six children aged 2-59 months were recruited into the study. Mean weight of the study subjects was  $11.0 \pm 4.02$  kg. Males constituted 58.3% (21.0) of the study population and females 41.7% (15.0). At presentation, 28 (77.8%) of the children were febrile (axillary temperature  $> 37.5^\circ\text{C}$ ). The geometric mean parasite density (GMPD) was  $9.048 \pm 87.39 \mu\text{L}^{-1}$  of blood. The mean Haemoglobin was  $10.65 \pm 1.52$  g  $\text{dL}^{-1}$  while the mean packed cell volume (PCV) was  $32.07 \pm 4.42\%$ .

#### **Prevalence of Anaemia**

According to the WHO (2000b) method, taking 30% as cut off point for anaemia, 5 (3.9%) of the children were mildly anaemic, 3 (8.3 %) were moderately anaemic and 28 (77.8%) were normal. There was no incidence of severe anemia in the study subjects (Table 2).

As shown in the Table 3 only 6.0 (16.67%) of the study children have moderate anaemia while the remaining 30 (83.3%) have normal haemoglobin levels. Comparison of Hb with PCV method for anaemia detection indicates that the latter is more efficient in detecting prevalence of anaemia in our study subjects.

Table 1: Characteristics of a cohort of pre-school children with uncomplicated *Falciparum* malaria in Sokoto

Characteristic	
No. who completed follow-up	36.00
Mean age±SD (in months)	28.64±18.20
Mean weight±SD (kg)	11.00±4.02
No. of males (%)	21.00 (58.30)
No. of females	15.00 (41.70)
No. febrile (≥37.5°C)	28.00
Geometric mean parasite density±SD ( $\mu\text{L}^{-1}$ )	9048±87.39
Range	(1440-39,200)
Mean Haemoglobin±SD (g dL <sup>-1</sup> )	10.65±1.52
Range	(7.00-12.70)
Packed cell volume (%)±SD	32.07±4.42
Mean axillary temp±SD (°C)	37.85±0.68
(Range)	(36.50-39.60)
Proportion with ring forms/trophozoites	94.40%

Table 2: Prevalence of anaemia by PCV in a cohort of pre-school children with uncomplicated *Falciparum* malaria in Sokoto

Degree of anaemia	Classification*	Number (%)
PCV 25-29	Mild	5.00 (13.9)
PCV 21-24	Moderate	3.00 (8.3)
PCV ≤20	Severe	0.00 (0.00)
PCV ≥30	Normal	28.00 (77.8)
Total		36.00 (100)

\*Classification of anaemia by packed cell volume according to WHO (2000b). PCV = Packed Cell Volume

Table 3: Prevalence of anaemia by Hb in a cohort of pre-school children with uncomplicated malaria in Sokoto

Degree of anaemia	Number (%)
Severe (Hb ≤5g dL <sup>-1</sup> )	0.00 (0.00)
Moderate (<7g dL <sup>-1</sup> )	6.00 (16.67)
Normal (10-14g dL <sup>-1</sup> )	30.00 (83.33)
Total	36.00 (100)

Values in parentheses are percentages

Table 4: Age-specific malarionometric variables in a cohort of pre-school children with uncomplicated malaria in Sokoto

Age group (Months)	No.	Mean weight (kg)	Mean temp (°C)	Mean Hb (g dL <sup>-1</sup> )	GMPD ( $\mu\text{L}$ )
0-12	11	7.60±1.70	37.6±0.60	10.70±1.40	3.896±0.45
13-24	8	8.73±1.90	37.9±1.10	9.80±2.20	3.845±0.29
25-36	6	11.70±1.10	38.1±0.50	11.10±1.40	3.999±0.39
37-48	5	13.16±2.60	38.0±0.60	11.40±0.50	3.513±0.15
49-60	6	17.80±0.60	37.9±0.70	10.60±1.20	3.620±0.15

Age group classification based on WHO (2000a). No. = Number of individuals per age group, GMPD = Geometric mean parasite density (log<sub>10</sub> transformed), Hb = Haemoglobin, Temp. = Temperature (axillary)

### Age-Specific Malarionometric Variables

Mean weight increased as age increased, age group 0-12 months had the least mean body weight (7.6±1.7 kg), while age group 49-60 months had the highest mean body weight (17.8±0.6 kg). Age group 13-24 months had the least mean Hb value 9.8±2.2 g dL<sup>-1</sup> while age group 37-48 months had the highest mean Hb value (11.4±0.5 g dL<sup>-1</sup>). Haemoglobin levels did not vary significantly among the age groups (ANOVA, F = 1.006, p = 0.4194) (Table 4). Peak incidence of mild anaemia (as indicated by PCV) occurred in the age groups 0-12 and 49-60 months, with the lowest incidence occurring in age group 37-48 months. Peak and lowest incidence of moderate anaemia (as indicated by PCV) occurred in the age group 13-24 and 0-12 months, respectively (data not shown).

## DISCUSSION

The study subjects enrolled for this study were children under 5 years of age (2-59 months) with uncomplicated *P. falciparum* malaria from an area of intense malaria transmission all year round with a peak in the rainy season. This group is of greatest interest not only because most studies exclude them but also because they are the ones at highest risk of illness and death (Bloland *et al.*, 1998).

This study recorded overall prevalence of anaemia between 16.7-22.2% (mild anaemia 13.9%, moderate anaemia 8.3%). No incidence of severe anaemia was encountered. Thus prevalence of anaemia in this study was lower than that reported by Mannir (2006) of 29% in Katsina, Nigeria. An earlier study conducted in Sokoto, Nigeria (Umar and Hassan, 2002) found a prevalence rate of anaemia of 64% (44% moderate, 20% severe) in children with malaria from a hospital mostly attended by patients of comparatively low economic status. This present study encountered a lower incidence of anaemia. May be the low incidence was because the teaching hospital is frequented by people of higher economic status and are better nutritionally. Although the association between malaria and undernutrition is complex improved nutrition lessens the severity of malaria episodes and results in decrease in malaria deaths (Bremner *et al.*, 2004; Caulifield *et al.*, 2004) and poor socioeconomic background has been identified as causing multiple difficulties in getting access to better health care (Gallup and Sachs, 2001; Lawrence *et al.*, 2004). Difficulties in access to proper health care appear in forms of transport fees, hospital admission fees, drug costs and traditional beliefs. These factors tend to edge out the poor in the competition for better medical attention.

Anaemia has frequently been associated with malaria. In areas of transmission of malaria in Africa, different degrees of anaemia exist. In areas of intense transmission, severe anaemia is the primary presentation of serious malarial disease among children (especially less than 2 years). Malarial anaemia associated with both high and low density parasitaemia has been well described (Kitua *et al.*, 1997; Newton *et al.*, 1997).

The pathogenesis of anaemia is multifactorial particularly among disadvantaged children. The malaria associated with *P. falciparum* is quite complex and poorly understood (McElroy *et al.*, 2000). Malarial anaemia may result from direct destruction of parasitized erythrocytes (Abdalla *et al.*, 1980). However, the degree of anaemia that often develops in parasitaemic individuals cannot be accounted for solely by haemolysis of parasitized erythrocytes (Miller *et al.*, 1994). Immune-mediated destruction of non-parasitized erythrocytes (via binding of complement factor) and decreased deformability followed by splenic removal are other mechanisms and may contribute more to anaemia than destruction of parasitized erythrocytes (Weatherall and Abdalla, 1982; Dondorp *et al.*, 1999). A third aetiology may be inadequate bone marrow response due to persistent low grade parasitaemia (Clark and Chandhri, 1988).

Studies among non-immune or semi-immune populations outside of Africa have found statistically significant levels of mild anaemia in *Falciparum* malaria patients (Rajanasthien *et al.*, 1992; Pevin *et al.*, 1982; Das *et al.*, 1999). Malaria triggers an imbalance in RBC destruction and production, which frequently leads to anaemia, but there is still no comprehensive understanding of the relative contributions made by extravascular or intravascular haemolysis.

In a detailed study of 20 children with acute haemolysis due to *Falciparum* malaria in Tanzania, Ekvall *et al.* (2001) found that the change in the Hb concentration was linearly related to maximum parasitaemia. Balance studies between loss of blood Hb, increase in plasma Hb and appearance of Hb in the urine indicated that extra vascular clearance of red cells was the predominant mode of erythrocyte clearance. Most subjects showed minor signs of intravascular haemolysis. Hence the mechanism of acute *Falciparum* induced anaemia in children involves extra vascular erythrocyte clearance, normal erythrocyte senescence and other forms of acute haemolysis.

All forms of malaria are accompanied by some degree of Hb loss. Malaria specific interventions could be channelled to children with malaria especially if they are anaemic. Such interventions include Insecticide Treated Nets (ITN), chemoprophylaxis, prompt effective treatment of infections, deworming and improved agricultural and feeding practices. Although all children less than five years of age in this setting are at risk for anaemia, the age group 13-24 months should be especially monitored for anti-anaemia interventions.

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