

Prevalence of Malaria among Under-5 Children in a Secondary Care Level, Ondo State, Nigeria

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ABSTRACT

Background: Malaria continues to be a leading cause of ill health among children. Globally, this infection remains the major cause of morbidity and mortality especially among the under-five.

Aim: The aim of the study was to investigate and document the prevalence of malaria infection among age groups, genders, birth orders, and blood groups of children who attend a secondary health care level, south-west, Nigeria.

Subjects and Methods: Blood samples of 500 children whose ages ranged between 1 day and 5 years were collected through venipuncture, and these were tested for malaria parasites through the microscopy method, positivity was confirmed by Polymerase Chain Reaction (PCR) test. It was a hospital-based cross-sectional study. The children were recruited from various points of entry into the hospital which included the emergency room, newborn unit, and outpatient department (OPD). Data analyses were done using the SPSS statistical software and p-value < 0.05 was considered significant.

Results: The prevalence of malaria among the neonates (age group 0 to 28 days) was 60.2%, the prevalence of malaria was 49.2% among the infants (aged 29 days to 1 year) while the prevalence was 52.9% among children aged 1 to 5 years ($\chi^2 = 0.004$, $p < 0.05$). The gender prevalence of malaria infection was 30.4% for males and 21.8% for females ($\chi^2 = 0.000$, $p < 0.05$). The prevalence of malaria infection among birth orders showed that children in the first, second, third, fourth, and fifth birth orders are 41.0%, 28.0%, 22.6%, 5.4%, and 3.1%, respectively ($\chi^2 = 0.0210$, $p < 0.05$). Prevalence of malaria among the blood groups are; A⁻ (1.92%), A⁺ (13.41%), B⁻ (1.15%), B⁺ (19.54%), O⁻ (6.51%), O⁺ (51.73%), AB⁻ (0.38%) and AB⁺ (5.36%).

Conclusion: There is a high prevalence of malaria among the children examined in this study, there is therefore the need to intensify efforts to reduce the burden of the infection in the study area, especially among the children.

Keywords: Malaria, Ondo, Prevalence, under-5.

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1. INTRODUCTION

Malaria is an infectious disease caused by the *Plasmodium* parasite. Globally, the infection continues to be a major cause of morbidity and mortality especially among children and pregnant women [1]. The World Health Organization (WHO) reported that approximately 95% of malaria cases and 96% of malaria deaths occur in the African Region in 2021 [2]. Children under 5 alone accounted for about 80% of all these malaria deaths in the Region [2]. In the same report, an estimated 247 million cases and 619,000 deaths occurred globally, and this

suggests that we still have a long way to go to meet the 2030 malaria goals. It was however a relief that the increase in the loss of lives to malaria, which occurred during the COVID-19 pandemic in 2020, had not progressed [2].

Children are mostly affected by severe forms of the disease with death occurring between the ages of six months and five years, they are most vulnerable at this time because of loss of maternally acquired immunity plus the fact that they have not yet developed their own specific immunity to infections [3]. Neonates can acquire the *P. falciparum* infection via the placenta [4] which may result in adverse

perinatal and neonatal outcomes such as still birth, low birth weight, small-for-gestational age babies, and preterm birth.

Reports of the Ghana Demographic Health Survey revealed that malaria is hyper-endemic in Ghana and prevalence ranged from 11.2% to 40.0% with a higher prevalence among children living in rural (37.7%) than in urban (15.0%) areas [5]. The Hohoe Municipal Health Directorate annual report of Ghana (HMHD, 2014) also revealed that malaria is the leading cause of outpatient attendance (28.0%) as well as the leading cause of death (19.4%) [5]. This was also corroborated by Frank *et al.* [6]. The World Malaria Report, 2022 however showed that Democratic Republic of Congo (DRC) registered the highest number of malaria cases in the year 2021 (24.9 million cases) followed by Nigeria (21,600,000 cases) [2]. Nigeria also recorded out-patient clinic visits of over 60% for malaria infection and 30% hospital admissions [7], with south-western Nigeria where Ondo State belongs having the highest prevalence [8]. The current study therefore set out to investigate and document the prevalence of malaria infection among age groups, genders, birth orders, and blood groups of children who were five years old and below attending Mother and Child Hospital, Akure; a major referral center in Ondo State.

2. SUBJECTS AND METHODS

The study was carried out in the Mother and Child Hospital, Akure (MCHA) from February to July 2019. The capacity of the hospital for admission was 100-bed spaces (60 for obstetrics patients and 40 for children). The hospital is a referral centre to all other surrounding primary health centres and private hospitals in the State, ally communities, and neighboring states in the South-West. Akure experiences two weather seasons, which include the rainy season (March to October) and the dry season (November to February), Akure is in the rainforest zone of the southwest geo-political zone of Nigeria with an average annual rainfall of 2378 mm and a temperature ranging from 25.2 °C to 28.1 °C with relative humidity of 80% [1].

2.1. Ethical Clearance and Informed Consent

Approval to conduct the research was obtained from the Research and Ethics Committee of the Hospital and the Ondo State Ministry of Health with approval protocol number OSHREC/29/04/20/270. Written informed consent was obtained from the parents of study subjects as well.

2.2. Enrollment of Study Participants

The children were enrolled in the neonatal intensive care unit (NICU), the children's ward, the emergency Paediatric unit (EPU), and the children's out-patient unit (CHOP). The study was cross-sectional, and the blood sample was collected by venipuncture from 500 children who were between the ages of 1 day and 5 years.

2.3. Socioeconomic Classification

This socio-economic classification was calculated using the parameters earlier described by Oluwafemi [9] which

used parameters such as the income, educational background, and occupation of the parents. There are five socio-economic classes (I to V) that are ranked in descending order and this is the equivalence of income in the 90th, 75th, 50th, 25th, and 10th percentile, respectively. These were then merged into upper socioeconomic status (classes I and II), middle Socio-economic class (Class III), and lower Socio-economic class (classes IV and V).

2.4. Sample Size and Sample Collection

Based on the year 2020 estimated population of Akure, the sample size was calculated using the Raosoft software [10], and a value of 384 was obtained. The sample size was then rounded up to 500 to allow for non-responses. The site of venipuncture was cleaned with cotton wool soaked in methylated spirit; five hundred blood samples were collected for the malaria parasite test while two hundred from the positive samples were randomly selected for confirmation by polymerase chain reaction (DNA PCR test).

Socio-demographic data obtained from the hospital source documents such as age, gender, religion, ethnicity, temperature, presenting complaints, and findings on physical examination were documented. Further information from interviews of the mothers such as birth orders of the children, educational background, and occupation of both parents were entered into the questionnaire; these were then transferred to the Excel sheet while maintaining confidentiality.

2.5. Inclusion and Exclusion Criteria

The inclusion criteria are:

- Children between the ages of 1 day and 5 years
- Children presenting with fever

The exclusion criterion is parental refusal to give consent.

2.6. Malaria Parasite Testing

The microscopy method was used to detect the presence of malaria parasites. Thick blood film was prepared for the purpose of identifying the malaria parasites under the microscope while thin blood films were used to identify the specific species of *Plasmodium*. The films were made on a clean grease-free glass slide and stained with Giemsa stain for 15 minutes [11]. The glass slides were allowed to dry after which oil immersion was added, it was then viewed under the light microscope at ×100 objective lens for the characteristics features of the malaria parasite [12].

2.7. Blood ABO Typing

The blood typing and identification were done for only samples positive for malaria parasite. One or two drops of the blood sample of the participant were mixed with antisera A and B on a white tile, the sample was then checked for agglutination [13]. If there is agglutination, it means the blood reacted to that particular antibody. One or two drops of the anti-D serum were also mixed with one or two drops of the sample to classify it as Rhesus D positive (if agglutination occurred) or Rhesus D negative (if agglutination did not occur).

2.8. Data Analyses

Prevalence for each age group was calculated using the formula:

$$\text{Prevalence} = \frac{\text{Numbers of Positive Samples}}{\text{Total Number Examined}} \times 100 \quad (1)$$

Prevalence between gender and age groups was subjected to Carls Pearson's Chi-Square to test the significant difference at $p < 0.05$. Data analyses were done using the Statistical Package for the Social Sciences (SPSS) version 20.

3. RESULTS

3.1. The Socio-Demographic Characteristics of Study Participants

Table I revealed the general socio-demographic characteristics of the study participants. Five hundred children whose ages ranged between 1 day to 5 years participated in the study. The results showed that 288 (57.6%) of the 500 participants in the study were male children while there were 212 (42.4%), female children, giving male : female ratio of 1.3:1. Majority of the study subjects were of the Yoruba extraction (80%), while percentages of Igbo and Hausa encountered during the study were 7.6% and 1.4%, respectively. Other minor tribes constituted 11%. The distribution of the study participants according to socio-economic classes showed that 204 children (40.8%) belong to the middle class, 198 (39.6%), and 98 (19.6%) belong to the lower and upper classes, respectively. There were 30 (9.6%) neonates, 195 (39.0%) infants and the remaining 257 (51.4%) of the study participants were older children ≤ 5 years.

TABLE I: SOCIO-DEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS

Characteristics	Frequency	Percentage distribution (%)
<i>Gender</i>		
Male	288	57.6
Female	212	42.4
<i>Socio-economic classification</i>		
Upper class	98	19.6
Middle class	204	40.8
Lower class	198	39.6
<i>Age group</i>		
Neonates (1–28 days)	48	9.6
29 days–12 months	195	39.0
>12 months–5 years	257	51.4
<i>Order of birth</i>		
First	226	45.2
Second	144	28.8
Third	90	18.0
Fourth	30	6.0
\geq Fifth	10	2.0
<i>Ethnicity</i>		
Yoruba	400	80.0
Igbo	38	7.6
Hausa	7	1.4
Others	55	11.0

3.2. Prevalence of Malaria among the Age Groups

Prevalence of malaria infection among age groups of children ≤ 5 years is presented in Table II. The age groups comprise neonates (1–28 days), infants (29 days to 12 months), and older children (>12 months to 5 years). The prevalence of malaria in neonates was 60.2%, 49.2% in infants, and 52.9% among older children. There was a significant difference in the prevalence of malaria infection among the age groups ($\chi^2 = 0.004$, $p < 0.05$).

3.3. Prevalence of Malaria among the Gender and Birth Orders

The results revealed that out of the total 288 male respondents, 152 of them were infected with the malaria parasite while 109 out of the 212 female participants were infected, thus the prevalence of malaria infection was 30.4% for the males and 21.8% for the female subjects (Table III). The result also showed that the prevalence of malaria among the male children was significantly higher than among the female children ($\chi^2 = 0.000$, $p < 0.05$). Prevalence of malaria among birth orders revealed that the prevalence of malaria was 41% among the first birth order, 28% among the second birth order, 22.6% among the third birth order, 5.4% among the fourth birth order, and 3.1% among the fifth birth order (Table IV). The results further showed that the children who belong to birth order 1 were more vulnerable to malaria than other birth orders. There was a significant difference in the prevalence of malaria among the birth orders, ($\chi^2 = 0.0210$, $p < 0.05$).

3.4. Distribution of Malaria Infection among the Blood Groups

The blood group identification was done for only samples positive for malaria parasite. The results in Table V revealed that the highest percentage distribution of malaria (58.24%) was observed among children of blood group O while the lowest percentage distribution (5.74%) was observed among children of blood group AB. However, the percentage distribution of malaria is significantly higher in children whose blood group contained the Rhesus factor (denoted as a positive group) than the blood group without the Rhesus factor (negative blood group). Generally, blood group O positive (51.73%) was noted to be most vulnerable to malaria infection while blood group AB negative (0.38%) was the least vulnerable to malaria.

4. DISCUSSION

The current study reports an overall prevalence of malaria of 52.2% among children who are five years and below. The result is higher than a report of 15.0% from Ibadan [14], 16.9% from Lagos [15], 41.0% from Jos [16], 16.7% from Nnewi [17], and 27.0% from Maiduguri [18] but lower than reports from Abuja (77.8%), [19] Ogun (70.8%) [20] and earlier report from peri-urban towns of Akure, Ondo State (79.1%) [21]. It is however comparable to the reports of Qureshi *et al.* [22] from India where the authors reported a malaria prevalence of 50.0% and World Health Organization 2022 malaria report of 53.1% in Democratic Republic of Congo [2]. Compared

TABLE II: PREVALENCE OF MALARIA INFECTION AMONG AGE GROUPS OF CHILDREN ≤ 5 YEARS

Age groups	Number examined	No infected	Prevalence of malaria (%)	Chi square χ^2	Degree of freedom df	p-value
Neonates (age 1–28 days)	48	29	60.42	0.004	2	<0.05
Infants (29 days–12 months)	195	96	49.23			
1–5 years	257	136	52.92			
Total	500	261	52.20			

TABLE III: PREVALENCE OF MALARIA INFECTION BETWEEN GENDERS OF CHILDREN ≤ 5 YEARS

Gender	Number examined	Infected	Prevalence of malaria (%)	Chi square χ^2	p-value
Male	288	152	30.4	0.000	<0.05
Female	212	109	21.8		
Total	500	261	52.2		

TABLE IV: PREVALENCE OF MALARIA INFECTION AMONG BIRTH ORDERS IN CHILDREN ≤ 5 YEARS

Birth orders	Total number examined per Birth order	No infected	Prevalence of malaria (%)	p-value
Birth order 1	226	107	41	<0.05
Birth order 2	144	73	28	
Birth order 3	90	59	22.6	
Birth order 4	30	14	5.3	
Birth order ≥ 5	10	8	3.1	
Total	500	261	100	

Note: Birth order: Birth order 1 is the equivalence of the first child; Birth order 2 \equiv second child of the family; Birth order 3 \equiv third child; Birth order 4 \equiv fourth child, etc.

TABLE V: PERCENTAGE DISTRIBUTION OF MALARIA INFECTION AMONG THE BLOOD GROUPS

Blood group	Infected	Malaria distribution (%)	Chi square χ^2	Degree of freedom df	p-value
Group A+	35	13.41	0.000	7	<0.05
Group A–	5	1.92			
Group B+	51	19.54			
Group B–	3	1.15			
Group AB+	14	5.36			
Group AB–	1	0.38			
Group O+	135	51.73			
Group O–	17	6.51			
Total	261	100			

Note: NB: Blood grouping was done for only patients positive for *Plasmodium falciparum*. +Rhesus D positive. -Rhesus D Negative.

to other nations of Africa, the malaria prevalence of 52.2% reported in this study is also higher than the 20.0% reported by Mfueni *et al.* [23] in Angola, 21.0% in Rwanda, and other African countries such as Uganda (16%) [24] and Kenya (3.7%) [25]. Some of the regions with lower prevalence have given reasons for the widespread use of ACTs, compliance with the use of insecticide-treated nets (ITN), Intermittent Preventive Therapy (IPT), and other preventive measures [15].

4.1. Prevalence of Malaria Infection among Age Groups

The prevalence of malaria among the neonates was 60.2% in this study, this result is relatively high compared to the pre-existing knowledge that neonatal malaria is said to be uncommon due to the presence of the fetal haemoglobin in the newborn and maternal Immunoglobulin G which jointly act to impair the cytoadherence of parasitized RBCs in the first few months of life [26]–[28]. The result of the current study is also higher than

the 43.7% earlier reported by Opara and West [29] from Port-Harcourt, Rivers State, south-south, Nigeria, and that of Runsewe-Abiodun *et al.* [30] who reported neonatal malaria prevalence of 24.8% in Sagamu, south-west Nigeria. The prevalence of 60.2% among neonates in this study is however comparable with the reported prevalence of 58.5% in Jos, Nigeria [31]. The similarity between the report from Jos and this study might be due to the sample size and the fact that both centers are referral centers.

Though neonates have a high rate of malaria infection in this study 96.6% of them had low-density parasitemia while none had high density. This is similar to an earlier report by Ceesay *et al.* [32] and Oluwafemi [9] that parasite density was generally lower in infants and younger children compared to older children. The prevalence of malaria among infants aged one to twelve months in the current study was 49.2%, this is higher than the 12%, 21.7%, 3.7%, and 10.2% reported among the Ghanaian, Guinean, Gambian, and Beninese infants, respectively [32], [33]. This

variability in the prevalence of malaria may be due to differences in the transmission intensity and use of preventive measures such as the use of ITN and IPT. On the other hand, the prevalence of malaria among the older children (>1 year to 5 years) in this study was 52.9%, this value is comparable to the 66% reported in Ghana [33].

4.2. Prevalence of Malaria Infection among Genders

We report that prevalence of malaria was significantly higher among male children than female children. This agrees with previous findings that males are usually more susceptible to infections generally because they are endowed with only one X-chromosome which carries the protection gene compared to females who are doubly endowed with XX-chromosome [33], [34]. This prevalence of males (30.4%) and females (21.8%) was a little higher than the report of Ghana with a prevalence of 21% in males and 19% in females. However, in the cross-sectional survey in Guinea, Gambia, and Benin Republic, with different malaria transmission intensities, [32] the prevalence of malaria infection among gender reported was 47.8% in the male children and 52.3% in the female children in Guinea, 46.2% in the males and 53.8% in the females in Gambia and 46.8% in males and 52.2% in females in the Benin Republic [32]. These values are all higher than the findings in the current study. The reasons for this are not too clear but some of the researchers discovered that females get more exposed to mosquito bites than their male counterparts in the course of doing house chores late in the night and that the sample sizes considered in the different countries were higher than that of this study. The earlier reported prevalence of malaria infection among genders from various other centers in Nigeria was also higher; 46.7% : 53.3% male: female for Port-Harcourt [29] and 50% : 50% in Jos University Teaching Hospital in the north-central of Nigeria [31]. In all of these centers, malaria infection in females seems to be higher than in males which is contrary to the finding in this study. The parasite density count in this study also was significantly higher among female children.

4.3. Prevalence of Malaria Infection among the Birth Orders

In this study, malaria infection decreases with increasing birth orders. Prevalence among the first birth order was the highest (41%), followed by the second birth order with a prevalence of 28%, and the third birth order has a prevalence of 22.6%. The fourth birth order has a prevalence of 5.4% and the lowest prevalence of 3.1% was observed in the fifth birth order. This result agrees with an earlier report from Calabar with a malaria prevalence of 67% in firstborn children [35]. The study from Kenya also reported that malaria is commoner in primigravid and secundigravid women [36]. The higher prevalence of malaria infection in a woman carrying her first pregnancy and her first child may probably be attributable to a sudden change in her body physiology which affects her immunity with a resultant effect of increasing malaria parasitemia both in the mother and her newborn baby [37]. The parasite density counts in the blood of children with birth order 5 and above in the current study was however significantly higher compared

to the density count in the blood of children in lower birth orders.

4.4. Distribution of Malaria Infection among the Blood Groups

In this study, the prevalence of malaria (58.24%) was highest among children belonging to the blood group O. This was a little higher than the 53.8% reported in Minna [38], higher than the 25% reported in Enugu [39], 47.6% in Bayelsa [40], and 53.3% in Warri [41] but lower than the malaria infection of 63.8% reported in Anambra [42]. The possible explanation for the higher prevalence of malaria infection among blood group O could be the absence of blood group antigens on the surface of O group red cells, this gives more room for free receptors and hence higher chances for malaria parasite affinity and attachment. Conversely, in blood groups A, B, and AB, the red cells are covered with their respective blood group antigens and there are fewer numbers of free receptors for malaria parasites to attach to [39]. However, the percentage distribution of malaria is significantly higher among children whose blood group contained the Rhesus factor (denoted as a positive group) than the blood group without the Rhesus factor (negative blood group). Generally, blood group O positive (51.73%) was noted to be most vulnerable to malaria infection while blood group AB negative (0.38%) was the least vulnerable to malaria. High-density parasitaemia was however only observed among children of blood group O positive and completely absent in other blood groups.

5. CONCLUSION

Ondo State, Nigeria, is still among nearly half the population/countries in the Commonwealth that have remained in a malaria-endemic zone. In the study, malaria prevalence increased with increasing age of the children in the study population, prevalence decreased with increasing birth orders and the highest percentage distribution of malaria infection was observed among children who were of the blood group O.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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