©NIJRMS
Publications 2023

OPEN ACCESS
ISSN: 2992-5460

NEWPORT INTERNATIONAL JOURNAL OF RESEARCH IN MEDICAL SCIENCES (NIJRMS)

Volume 3 Issue 2 2023

Malaria infection in children below 10 years attending Doka rural Hospital

Mohammed Usman[1], Tense Tangkat[3], Udo S. Monday[4], Udoh J. Queen [4], Ishaya E. Chindo [2], Ezekiel Emmanuel[6] and *Emmanuel Ifeanyi Obeagu[7]

[1]Department of Public Health, University of New Haven, USA.
[2]Department of Medical Laboratory Science, Bingham University Karu, Nasarawa State, Nigeria.
[3] Department of Medical Microbiology, University of Ilorin Teaching Hospital, Ilorin, Nigeria.
[4] Federal School of Medical Laboratory Science, Jos, Nigeria.
[6] Department of Medical Laboratory, Rural Hospital Doka, Kaduna, Nigeria.
[7]Department of Medical Laboratory Science, Kampala International University, Uganda.

ABSTRACT

Despite the huge resources committed to eradicating malaria globally, malaria remains endemic in Africa. Chronic malaria infection may be life-threatening in children due to increased susceptibility to anemia. This study was aimed at determining the prevalence of anemia among malaria-infected children and its possible association with socio-demographic attributes in children. This study is a cross-sectional study involving 225 children under 10 years attending Doka rural hospital. Giemsa-stained thick blood films were examined microscopically. Hematocrit levels were determined using standard methods. Results were analyzed using chi-square statistics to determine the association between malaria infection and anaemia. A total of 204 children representing 80% of the study participants were positive for malaria. The use of insecticide-treated net was low (7%) and did not significantly reduce the risk of infection and anemia. The general prevalence of anemia was 59.2%. There was a significantly higher prevalence of anemia among malaria-positive children ($p<0.000$). Malaria presents a strong factor for developing anemia (OR=15.09; 95% CI=6.43, 35.38; $P<0.0001$). There was no association between malaria parasitemia and gender or season of the year. The prevalence of malaria in Doka is quite high and is strongly associated with anemia. Surprisingly, the use of insecticide-treated nets did not reduce malaria infection. Hence, there is a need for effective malaria prevention schemes which may include education and the inclusion of routine anemia programs when evaluating children for malaria infection.

Keywords: Plasmodiasis, Anemia, Infection, Malaria, Prevalence, Insecticide-treated Nets

INTRODUCTION

Malaria, also known as plasmodiasis, is probably the most popular parasitic disease affecting humans. Although all six species of the genus Plasmodium can infect humans, most malaria-attributable deaths from severe diseases are caused by Plasmodium falciparum. Despite the huge steps taken in other countries of the world to eliminate malaria, Africa remains endemic for the disease. In fact, out of the total 241 million cases of malaria that were reported by

OPEN ACCESS
ISSN: 2992-5460

WHO in 2020 [1], sub-Saharan Africa accounted for about 95% of the burden. Out of this, six African countries, including, Democratic Republic of the Congo, Uganda, Mozambique, Angola, Burkina Faso, and Nigeria accounted for 55% of cases. Malaria endemicity in Nigeria is alarming and affects mostly children aged under 5 years as well as pregnant women when compared to the remaining population group [2]. Malaria is a risk for 97% of Nigeria population accounting for 25% of death in children under five years of age and 11% of maternal death [3]. The transmission of malaria is higher in rural areas compared to urban centers [4, 5]. In rural areas, higher vector density, the presence of thick forests, poor drainage systems, and difficulty in assessing health care are some of the factors that may be responsible for higher infection rates. Additionally, utilization of malaria prevention strategies such as Insecticide Treated Nets (ITN), especially the rural dwellers, is very poor, hence accounting for the high prevalence observed in rural areas compared to their urban counterparts [6].

Anaemia affects roughly one-third of the world's population, with sub-Saharan Africa accounting for 67% of the cases. This suggests a possible correlation with malaria infection that is equally rampant in this region. From the mechanistic standpoint, the destruction of infected and non-infected red blood cells resulting in anemia is a common clinical presentation of malaria, especially in vulnerable groups, including children. This makes malaria infection a major public health challenge in low-and middle-income countries such as Nigeria. Two models have been given to explain the cause of anemia in malaria and these include increased destruction and decreased production of red cells [7]. Several studies have reported that in malaria-endemic areas, almost all infected infants and younger children have low levels of hemoglobin [7]. In rural areas such as Doka, malnutrition, illiteracy, and poverty may increase the risk of developing malaria-induced anemia in children. Unfortunately, the potential role of malaria in anemia is insufficiently reported in the northern Western part of Nigeria where the prevalence of malaria is probably high. Therefore, this study was aimed at determining the prevalence of malaria and possible association with anemia among children under 10 years in Doka community of Kaduna state, Nigeria. It also examined the level of association between malaria and socio-demographic features such as age, the use of ITN, gender, and season of the year. This study will provide valuable information that may help caregivers to formulate effective therapeutic strategies based on the predicted risks among children.

Methods

The study was a cross-sectional study conducted among children aged 0-10 years in primary health care of Doka, Kachia LGA, Kaduna state. 255 children that attended the hospital between January to December 2020 were enrolled in the study after obtaining oral informed consent from their parents/guardians. Ethical approval for the study was obtained from the Health Research Ethics committee, Kaduna state ministry of health, Nigeria [8]. The sample size was calculated according to a method described by [8]. Using the prevalence rate of 81.9% according to [9], the sample size of 228 was obtained at a 5% error margin ($p<0.05$). Considering a 10% attrition rate, we expanded the sample size to 255. Using the convenience sampling technique, we enrolled 255 children that attended Doka rural hospital between January to December 2020 [10]. The case records of all the children were reviewed to select cases that meet up with criteria (sickle cell children were excluded). All the demographic data were extracted from the case files. 5 ml of venous blood samples were drawn from each of the participants for hematocrit evaluation. Thick film slides were made, stained using the Giemsa staining technique, and examined using the malaria microscopy method. Hematocrit was estimated using the centrifugation method having considered the age and sex of the participants

Statistical analysis

The data obtained were analyzed using IBM SPSS 11.0 for windows (SPSS Inc. Chicago, USA). Descriptive statistics was done to determine the frequency distributions of all variables. Chi-square statistics were used to test the association between malaria positivity and anemia, sex, use of mosquito nets, and season of the year. The statistical significance level was set at $p<0.05$.

RESULTS

Table 1: Characteristics of the study population

Characteristics	n, %
Ages (years)	

OPEN ACCESS
ISSN: 2992-5460

0-3	7 (2.8)
4-6	238 (93.3)
7-10	10 (3.9)
Gender	
Male	158 (62)
Female	97 (38)
Season	
Rainy	141 (55.3)
Dry	114 (44.7)
Use of mosquito net	
Yes	19 (7)
No	236 (93)

n- number of people

OPEN ACCESS
ISSN: 2992-5460

Table 2: Prevalence of malaria among children based on stratification by age, gender, season of the year and the use of preventive measures.

	Number of malaria positivity (%)	X^2	P value
Overall prevalence of malaria	204 (80)	-	-
Age (years)		5.6	0.05*
0-3	3 (42.9)		
4-6	194 (81.5)		
7 – 10	7 (70.0)		
Gender		0.7	0.40
Male	129 (50.5)		
Female	75 (29.4)		
Season		1.0	0.314
Raining	116 (83.3)		
Dry	88 (77.2)		
Use of Insecticide Treated Nets		0.14	0.95
Yes	15 (79.0)		
No	189 (80.1)		

*-Significant

OPEN ACCESS
ISSN: 2992-5460

Table 3: Prevalence of anemia among malaria-infected children based on stratification by age, gender, season of the year and the use of preventive measures.

Characteristics	Number of anemic children (%)	X^2	P value
Overall prevalence	151 (59.2)		
Malaria results		56.93	<0.000*
Positive	144 (70.6)		
Negative	7 (13.7)		
Age (years)			
0-3	3 (100)	2.42	0.29
4-6	144 (74.2)		
7 – 10	4 (57.1)		
Gender		0.45	
Male	91 (70.5)		0.51
Female	69 (92.0)		
Season	-0.19, 0.003	8.70	0.003*
Rainy	95 (81.9)		
Dry	56 (63.6)		

Table 4 : Prevalence of anemia among malaria-infected children based on stratification by age, gender, season of the year and the use of preventive measures "cont."

Use of Insecticide Treated Nets		0.37	0.54

OPEN ACCESS
ISSN: 2992-5460

Yes	10 (66.7)		
No	141 (74.6)		

*-Significant

A total of 255 children covering 17 major villages from Kachia LGA were enrolled and screened for both malarial infection and anemia. The demographic characteristics of the population are presented in table 1. Most of the study population were children aged 4 to 6 years (238), translating to 93.3% of the sample size while children of 7 to 10 years were 10 (3.9%). The least age range was 0 to 3 years 7 (2.8%). Out of the screened children, 158 (62.0%) were male and 97(38%) were female. The number of participants enrolment is slightly higher during the rainy season (55.3%) than the dry season (44.7%). Finally, 7% of the study population used insecticide-treated nets (ITN) while 93% did not use them. As presented in table 2, we found the prevalence of malaria parasitemia to be 80% (204 out of 255 children were infected). In terms of age, children in the age range from 6 to 7 years had the highest burden of the infection 194 (81.5%) while children between 0 to 3 years have the least burden (3:42.9%). Although more infections were recorded in males (129, 50.5%) compared to females (75, 29.4%), it was not statistically significant (p=0.40). Similarly, the rainy season had a higher infection burden compared to dry season females (116 {83.3%} vs 88 {77.2%}) but the difference was not significant. Surprisingly, this study found no significant difference in the infection rate between the children that used insecticide-treated nets and those who did not use them (79% vs 80.1%, p=0.95)

Table 3 shows the proportion of infected children that came down with malaria. Overall, 151 (59.2%) children were discovered to be anemic. Out of the total 204 children that were positive for malaria, 144 (70.6%) were anemic and this was significantly higher (p<0.000) than the proportion of anemic malaria-negative children 7 (13.7%). Strikingly, 100% of the infected children below 3 years of age developed anemia. 144 of the children within the age range from 6 to 7 years (74.2%) had anemia while those whose age ranges between 7 to 10 years had the lowest prevalence of anemia (4, 57.1%). We found the prevalence of anemia in the rainy season to be significantly higher than in the dry season (81.9% vs 63.6%, p=0.03). Neither gender nor the season of the year was significantly associated with anemia. Lastly, the use of ITN did not significantly reduce the risk of developing anemia (66.7% vs 74.6%, p=0.54).

DISCUSSION

Despite the huge investment made by both the government and various donor agencies to end malaria globally, plasmodiasis still poses a serious threat of public health importance with a high mortality rate mostly among children in Sub-saharan Africa [10]. In the northern part of Nigeria, the level of education is relatively low, and people are often uninformed about malaria prevention and control measures, putting them at a higher risk of malaria burden. Thus, this study focused on determining the burden of malaria and its possible correlation with anemia, the season of the year, and the use of insecticide-treated nets among children attending Doka rural hospital. This study found that 204 participants were positive for malaria, representing 80% of the study population (table 2). This data is similar to the 81.9% prevalence recorded in a study conducted by Oladeinde and colleagues in 2012 [9] in Okada, the southern part of Nigeria but higher than the 75.7% documented by [11]. The variation in the prevalence rates could be attributed to the differences in geographical location, environmental factors, lifestyles, and knowledge of malaria prevention and control among many others. While the 75.7% prevalence was observed in Benin city, an urban center that may have better access to prevention and control devices, the current study was conducted in rural settings with high levels of illiteracy and limited access to quality health care. There was no significant difference in malaria burden between the rainy and dry seasons (p=0.31), suggesting that the infection pattern is constant throughout the year. This is in sharp contrast to observation from an earlier study [12], conducted in Bolifamba, Cameroon which documented a seasonal variability in the infection rate. There are several possibilities that may explain this discrepancy [13]. First, lifestyle may dictate infection patterns in different geographical settings. For instance, during the dry season in the northern part of Nigeria, hot weather may encourage children to spend more time outdoors and become exposed to the vector for an extended period, hence raising the infection rates to comparable levels in the rainy season [14]. Additional mechanisms that may justify why malaria parasitemia was not different between the two main seasons can be explained using a molecular approach. As a survival mechanism, the parasite may trigger epigenetic programs that allow them to survive the dry season and increase its transmissibility [15]. To gain better insight into this hypothesis, molecular studies may reveal differential expression of certain survival and infectious genes [16]. In the ambit of seasonal malaria transmission,

OPEN ACCESS
ISSN: 2992-5460

understanding the apparatus that maintains the parasite reservoir during dry seasons may inform control interventions to reduce vector density and transmission [17].

Age has been proposed as a risk factor for malaria infection. As documented by [9], we found significantly higher ($p<0.05$) infection rates in children between the ages of 4 to 6 (144; 60%) compared to other age groups under study. This finding could probably be due to the fact that the children in this age range are usually allowed to play freely in villages with little or no restrictions, thereby exposing them more to the vector. Considering gender, although more males were infected compared to females (50.5% vs 29.4%), there was no significant difference in malaria prevalence between males and females, suggesting a sex uniformity in the pattern of infection [18]. This finding is in concordance with previous studies which established that malaria prevalence is homogenous in distribution between males and females [3, 13]. In malaria-endemic areas, the most common prevention and control measures are the use of barrier systems such as insecticide-treated nets. In the current study, the use of insecticide-treated bed nets was generally low (7%) in the study population compared to the proportion who did not use them (93%). Although there was a slight reduction in the number of children infected with malaria among those that used insecticide nets, the difference was insignificant ($p=0.54$). Considering the population under study, factors such as inconstant or use of expired nets might partly contribute to this observation. This finding suggests that Kachia residents may require the allocation of increased physical control devices to reduce the malaria burden [19, 20, 21, 22].

Malaria is a major risk factor for anemia, especially in young children [18-22]. Generally, the prevalence of anemia among the study population was 59.2%, higher than the 47.3% recorded by [11]. It is worth mentioning that several factors may contribute to the pathogenesis of anemia which may account for the disparities in prevalence seen in different studies. For instance, the age range of the study populations may be attributed to the risk of anemia. Moreover, the low economic status of participants in the current study may predispose them to malnutrition and may be responsible for this increased anemia frequency. Specifically, out of the 204 malaria-positive children, 144 of them representing 70.6% were found to be anemic. Compared to the anemia rate among malaria-negative children (13%), the difference was statistically significant with a p-value of 0.000. Interestingly, we found the odd ratio to be 15.09 ($P<0.000$), providing strong evidence that malaria infection is a risk factor for anemia. Similarly, there was a significant difference (p-value 0.000) between the frequency of anemia during the rainy season compared to the dry season 95 (81.9%) vs 56 (63.6%). This finding was an endorsement of the previous study that found a similar pattern [9]. The slight increase in malaria burden during the rainy season may be a factor for this observation. In addition, evidence exists that the dry season is accompanied by hemoconcentration which may increase hemoglobin and hematocrit levels [14]. Similarly, serum ferritin levels were found to reduce in the rainy season [15], suggesting that the high risks of anemia during the rainy season may not be solely dependent on the malaria infection.

Furthermore, the current study found that 100% of children below 3 years of age with malaria develop anemia. In addition to the possible inheritance of maternal malnutrition, this remarkable phenomenon may reflect a poor immune response against malaria parasites in this group. Among malaria parasite-infected children, the use of ITN was found to reduce the prevalence of anemia (66.7% vs 74.6%), although it was not significant ($p=0.54$). The slight improvement in hematocrit level may be associated with the commensurate reduction in infection rates among children using the malaria prevention device. There was no significant difference ($p=0.51$) in the anemia risk between malaria-infected males and females, consistent with the literature [16].

CONCLUSION

In conclusion, our study allows us to establish a direct relationship between malaria and anemia among children in Doka, the northern part of Nigeria. Our study found the prevalence of malaria infection to be 80% out of which 70.6% of the children were anemic. We also observed that residents of the Kachia local government do not have access to the use of insecticide-treated nets for malaria control which is strongly responsible for the high prevalence, and this would be drastically reduced with the intervention of treated insecticide mosquito nets. Our findings suggest that effective policy interventions to control malaria-associated mortalities should focus on increased access to insecticide-treated nets, massive awareness programs, and the destruction of vectors. Lastly, caregivers should consider anemia screening as part of the workup for children that present with malaria.

Acknowledgements

We would like to appreciate the parents/guardians of our study participants and all caregivers who worked with us to retrieve patient information from their case files.

Author Contributions

All the authors were fully involved from conceptualization of the work to the completion of report and gave their approval for the manuscript.

OPEN ACCESS
ISSN: 2992-5460

Conflict of interest

All authors declare no competing interests.

Funding

This research received no external funding.

Data availability

All the data used to support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

1. World Health Organization, 2023. *Malaria prevention and treatment.* Geneva, Switzerland: WHO.
2. Oyewole IO, Ibidapo AC. Attitudes to malaria, prevention, treatment and management strategies associated with the prevalence of malaria in a Nigerian urban center. African Journal of Biotechnology. 2007;6(21).
3. Noland GS, Graves PM, Sallau A, Eigege A, Emukah E, Patterson AE, Ajiji J, Okorofor I, Oji OU, Umar M, Alphonsus K. Malaria prevalence, anemia and baseline intervention coverage prior to mass net distributions in Abia and Plateau States, Nigeria. BMC Infectious Diseases. 2014;14(1):1-3.
4. Hay SI, Guerra CA, Tatem AJ, Atkinson PM, Snow RW. Urbanization, malaria transmission and disease burden in Africa. Nat Rev Microbiol. 2005; 3:81- 90.
5. Omumbo JA, Guerra CA, Hay SI, Snow RW. The influence of urbanization on measures of Plasmodium falciparium infection prevalence in East Africa. Acta Trop. 2005; 93:11-21.
6. Oladimeji KE, Tsoka-Gwegweni JM, Ojewole E, Yunga ST. Knowledge of malaria prevention among pregnant women and non-pregnant mothers of children aged under 5 years in Ibadan, South West Nigeria. Malaria journal. 2019 Dec;18(1):1-2.
7. White NJ. Anaemia and malaria. Malaria journal. 2018;17(1):1-7.
8. Charan J, Biswas T. How to calculate sample size for different study designs in medical research?. Indian journal of psychological medicine. 2013; 35(2):121-6.
9. Oladeinde BH, Omoregie R, Olley M, Anunibe JA, Onifade AA, Oladeinde OB. Malaria and anemia among children in a low resource setting in Nigeria. Iranian journal of parasitology. 2012;7(3):31.
10. Afolabi BM, Sofola OT, Fatunmbi BS, Komakech W, Okoh F, Saliu O, Otsemobor P, Oresanya OB, Amajoh CN, Fasiku D, Jalingo I. Household possession, use and non-use of treated or untreated mosquito nets in two ecologically diverse regions of Nigeria–Niger Delta and Sahel Savannah. Malaria journal. 2009;8(1):1-0.
11. Akinbo FO, Omoregie R, Mordi R, Okaka CE. Prevalence of malaria and Anemia among young children in a tertiary Hospital in Benin City, Edo state, Nigeria. Fooyin Journal of Health Sciences. 2009;1(2):81-4.
12. Nkuo-Akenji T, Ntonifor NN, Ndukum MB, Kimbi HK, Abongwa EL, Nkwescheu A, Anong DN, Songmbe M, Boyo MG, Ndamukong KN, Titanji VP. Environmental factors affecting malaria parasite prevalence in rural Bolifamba, South-West Cameroon. African journal of health sciences. 2006;13(1):40-6.
13. Singh R, Godson II, Singh S, Singh RB, Isyaku NT, Ebere UV. High prevalence of asymptomatic malaria in apparently healthy schoolchildren in Aliero, Kebbi state, Nigeria. Journal of vector borne diseases. 2014;51(2):128.
14. Srai SK, Bomford A, McArdle HJ. Iron transport across cell membranes: molecular understanding of duodenal and placental iron uptake. Best Practice & Research Clinical Haematology. 2002;15(2):243-59.
15. Rodrigues PC, Ignotti E, Hacon SS. Association between weather seasonality and blood parameters in riverine populations of the Brazilian Amazon. Jornal de Pediatria. 2017; 93:482-9.
16. Imoru M, Shehu UA, Ihesiulor UG, Kwaru AH. Haematological changes in malaria-infected children in North-West Nigeria. Turkish journal of medical sciences. 2013;43(5):838-42
17. David Ekene Nwele, Ikechukwu Oliver Onyali, Milliam Okwudili Iwueze, Michael Okpara Elom, Ogbonna Elom Sabastian Uguru. Malaria Endemicity in the Rural Communities of Ebonyi State, Nigeria. Korean J Parasitol 2022; 60(3): 173-179.
18. Ugwu, O. P.C., Nwodo, O. F.C., Joshua, P. E., Odo, C. E., Bawa, A., Ossai, E. C. and Adonu C. C. (2013).Anti-malaria and Hematological Analyses of Ethanol Extract of Moringa oleifera Leaf on Malaria Infected Mice. International Journal of Pharmacy and Biological Sciences,3(1):360-371.
19. Ugwu O.P.C.(2011).Anti-Malaria Effect of Ethanol Extract of *Moringa oleifera* (Agbaji) Leaves on Malaria-induced Mice. University of Nigeria Nsukka.

OPEN ACCESS
ISSN: 2992-5460

20. Ugwu Okechukwu P.C., Nwodo, Okwesili F.C., Joshua, Parker E., Odo, Christian E. and Ossai Emmanuel C. (2013). Effect of Ethanol Leaf Extract of Moringa oleifera on Lipid profile of malaria infected mice. Research Journal of Pharmaceutical, Biological and Chemical Sciences, 4(1): 1324-1332.
21. Ugwu OPC, OFC Nwodo, PE Joshua, CE Odo, EC Ossai, B Aburbakar (2013). Ameliorative effects of ethanol leaf extract of *Moringa oleifera* on the liver and kidney markers of malaria infected mice. International Journal of Life Sciences Biotechnology and Pharma Research,2(2): 43-52.
22. Enechi OC, CC Okpe, GN Ibe, KO Omeje and PC Ugwu Okechukwu (2016). Effect of Buchholzia coriacea methanol extract on haematological indices and liver function parameters in Plasmodium berghei-infected mice. *Global veterinaria*, 16 (1): 57-66.

Mohammed Usman, Tense Tangkat, Udo S. Monday, Udoh J. Queen, Ishaya E. Chindo, Ezekiel Emmanuel and *Emmanuel Ifeanyi Obeagu (2023). Malaria infection in children below 10 years attending Doka rural Hospital. ***NEWPORT INTERNATIONAL JOURNAL OF RESEARCH IN MEDICAL SCIENCES (NIJRMS) 3(2): 55-63.***