https://dx.doi.org/10.4314/dujopas.v11i1a.17
ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 11 No. 1a March 2025*

Co-infection of Malaria and Anemia in Children Attending a Tertiary Health Facility in Ilorin, North Central Nigeria

[1]Prosper Chidi Nwachukwu., [2]Mubarak Damilola Abdulkodri., [2]Ayomide Josephine Jeremiah., [3]Blessing Uzoamaka Ejike., [4]Oluwadamilola Oyetunde Ezekiel.,[*2]Ebube Charles Amaechi

[1]Department of Biological Sciences,
Clifford University,
Ihie,
Abia State.

[2]Department of Zoology,
Faculty of Life Sciences,
University of Ilorin,
Ilorin,
Nigeria.

[3]Department of Biology/Microbiology,
Abia State Polytechnic,
Aba,
Abia State,
Nigeria.

[4]Department of Biological Sciences,
Thomas Adewumi University Oko,
Kwara State,
Nigeria.

Email: amaechi.ec@unilorin.edu.ng

Abstract

Malaria and anemia in children continue to pose significant public health challenges. This study aimed to assess the effect of malaria on anemia and to identify co-infection rates among children visiting the General Hospital in Ilorin, Kwara State, North Central Nigeria. Two hundred and eighty blood samples were obtained from outpatients aged 0 to 12 years and were screened for malaria using both thick and thin blood films, which were examined microscopically. The anemia status was assessed by measuring the Packed Cell Volume (PCV). Out of the 280 samples tested, 137 (48.9%) tested positive for malaria, with a higher prevalence noted in females (57.8%) compared to males (46.0%). The age group of 0-3 years showed the highest infection rate (73.1%), while the lowest was observed in the 10-12 year age group. There was a noticeable trend of decreasing infection rates as age increased. Regarding anemia, an overall infection ratio of 43.2% was recorded. The patterns of malaria infection were similar for both gender and age. A significant number of cases (91.2%) showed co-infection for both malaria and anaemia. Malaria continues to be a prevalent infection among children in the region studied and

**Author for Correspondence*

significantly contributes to anaemia in this population. There is a pressing need for public education and the promotion of preventive measures, such as the use of insecticide-treated bed nets, particularly among mothers and caregivers.

Keywords: Anaemia, Children, Ilorin, Outpatients, Packed Cell Volume.

INTRODUCTION

Malaria is a well-known public health infection caused by *Plasmodium* parasites, which are transmitted to humans via the bites of infected female anopheles mosquitoes (WHO, 2021). In 2020, nearly half of the global population was at risk of contracting the disease, with children under five years old, particularly in sub-Saharan Africa, experiencing the highest levels of morbidity and mortality. Although malaria can be treated, prevented, and cured, Africa carries 80% of the world's malaria burden, and Nigeria alone accounts for approximately 29% of this burden (Ibeji et al.,2022). In Nigeria, malaria is responsible for as much as 60% of outpatient consultations and 30% of hospital admissions. It is estimated that malaria contributes to around 11% of maternal deaths, 25% of infant deaths, and 30% of mortality in children under five years old (NMCP, 2015). A recent report from the WHO indicated that Nigeria reported 1.3 million cases of malaria, representing the highest burden among countries (Chukwuekezie et al.,2020). Anemia is another significant public health issue that predominantly affects children under five and pregnant women. This condition arises when the hemoglobin (Hb) level in the blood is lower than what the body requires for optimal physiological functioning (Roberts et al.,2020). Anemia is one of the complications associated with malaria infection, which exacerbates its morbidity and mortality rates. Recent studies have revealed that among children who tested positive for malaria, 9% experienced severe anemia and 54% had moderate anemia, while children who tested negative for malaria showed only 1% severe anemia and 31% moderate anemia (Ibeji et al.,2022). Anemia increases the risk of developmental issues in children under five years, such as cognitive impairment, delayed motor skills, poor academic performance, and weakened immune function, which elevates susceptibility to other infections, as well as overall fatigue and decreased responsiveness (White et al.,2018). Several elements contribute to the risk and onset of anemia in children. The factors leading to anemia can be grouped into socio-demographic, nutritional, and infectious categories (White et al.,2020). Malaria is recognized as one of the primary causes of anemia in children (Eisele et al.,2011; Elechi et al.,2015; Ibrahim et al.,2023). Nigeria is among the African nations with the highest prevalence of anemia in children under five (Aregbeshola et al.,2021). Malaria significantly contributes to childhood anemia, particularly across sub-Saharan Africa. Given that both malaria and anemia affect school-aged children, particularly with respect to morbidity and mortality (Noland et al.,2014), it is essential to determine the level of co-infection in areas where these diseases are endemic. The efficacy of any healthcare program intervention mainly depends on understanding the epidemiological context of the region. There is limited data regarding the co-infection of malaria and anemia among children in the study region; consequently, this current study aims to examine the prevalence of malaria and anemia in children visiting the General Hospital in Ilorin, Nigeria.

MATERIALS AND METHODS

Study area

This study was carried out using the laboratory of the General hospital Ilorin within the Ilorin metropolis, which serves as the capital city of Kwara State. The metropolis comprises three local government areas: Ilorin East, Ilorin West, and Ilorin South. Geographically, Ilorin is situated approximately between latitudes $8^{o}30'$ and $8^{o}50'$ north of the equator, and longitudes

4º20′ and 4º35′ east of the Greenwich meridian . Ilorin functions as a key transit city linking the southern and northern regions of Nigeria, with a total land area of about 100 square kilometers. The climate in the city is classified as humid tropical, influenced by the prevailing trade winds, and it is characterized by consistently high temperatures throughout the year. Ilorin experiences two distinct seasons: the dry season from October to April, and the rainy season from May to September. The average annual rainfall amounts to 1,200 mm. Most residents in Ilorin lack access to insecticide-treated bed nets and have numerous mosquito breeding sites around their homes, such as discarded items and overgrown vegetation (Amaechi et al.,2018)

Ethical considerations

Before initiating the study, consent was requested and obtained from the parents and guardians of all children involved. The information provided by parents and guardians was kept confidential, and participation was voluntary. The health facility where the research took place granted their consent and approval. The protocol for this study received approval from the State Ministry of Health.

Collection of blood samples

Approximately one milliliter (1 ml) of blood was collected from each participant through venous puncture or finger puncture and placed in an Ethylene Diamine Tetra-acetic Acid (EDTA) container, then mixed thoroughly to prevent coagulation. Each sample container was properly labeled to avoid any mix-up of results. Blood samples were collected between January and July, 2024. The study was basically a hospital based study that was targeted on children between ages 0 to 12 years that manifested symptoms of malaria.

Malaria detection

Malaria was diagnosed through the examination of stained thick and thin blood films at the laboratory of General hospital Ilorin. The technique for slide preparation was based on Cheesbrough (2009). For the thick film, a drop of blood from each sample was placed in the center half of a clean, grease-free microscope slide, followed by spreading to cover the area evenly, approximately 15mm. For the thin film, a spreader was utilized to create a smear along one edge of the slide at an angle of 45 degrees. The slide was then labeled with the subject's serial numbers and left to air dry. The films were fixed using 7% methanol. Slides were stained with 3% Giemsa stain for 30 minutes, rinsed with tap water, and allowed to dry in the air. The stained slides were inspected for malaria parasites under a microscope using a x100 oil immersion objective lens. The detection of any stage of the malaria parasite was recorded as positive, while its absence was noted as negative. Determination of anaemia

The haemoglobin concentration was measured using the Sysmex KX-21 autoanalyser (Sysmex Corporation, Kobe, Japan). Anaemia was classified as a haemoglobin concentration of less than 11 g/dl (Akinbo et al., 2009).

Statistical analysis

Data were analyzed using basic descriptive statistics. The data were entered and assessed using SPSS Version 21, and the chi-square test was employed to determine the significance level.

RESULTS

Prevalence of malaria infection among study subjects based on gender

Gender-wise malaria prevalence revealed that more females (57.8%) than the male (46.0%) counterpart were infected (Table 1)

Table 1: Prevalence of malaria infection from children examined based on gender

Gender	Number examined	Number positive(%)	p- value
Male	139	64 (46.0)	
Female	141	73 (57.8)	0.193
Total	280	137 (48.9)	

Malaria infection was found to be dependent on age with an appropriate significance level ($p< 0.05$). Children 0-3 years of age were the most infected (73.1%) (Table 2)

Table 2: Prevalence of malaria from samples collected from children based on age

Age group (years)	Number examined	Number positive (%)	p-value
0-3	108	73 (73.1)	
4-6	72	31(43.1)	
7-9	63	20 (31.7)	0.002
10-12	37	7 (18.9)	
TOTAL	280	137 (48.9)	

With respect to the sampling months, no significance level was observed, though the month of July recorded the highest infection occurrence (60.0%) while the least occurred in the month of January (31.4%) (Table 3)

Table 3: Frequency of occurrence of malaria among children based on the months of collection

Month	Number examined	Number infected	p-value
January	35	11 (31.4)	
February	36	15 (41.7)	
March	39	19 (48.7)	
April	35	16 (45.7)	0.521
May	44	22 (50.0)	
June	41	24 (58.5)	
July	50	30 (60.0)	

Prevalence of anaemia among the study subjects

The prevalence of anaemia in the study population was accessed based on the World Health Organization classification of haemoglobin (Hb) < 11.0g/dl. Of the 280 samples that were examined for anaemia, 125 (44.6%) were anaemic (Table 4). The result indicates that anaemia was not sex dependent as there was no significant difference in infection ($p> 0.05$). nevertheless, more females (47.5%) were more infected than the males (41.7%).

Table 4 : Prevalence of anaemia in children based on gender

Gender	Number examined	Number infected (%)	p-value
Male	139	58 (41.7)	
Female	141	67 (47.5)	0.743
TOTAL	280	125 (44.6)	

There was no significant difference in the prevalence of anaemia in children with respect to age. All age groups were at risk of developing anaemia as a result of complicated malaria parasite infection. Nevertheless, children 0-3 years of age had the highest rate for anaemia (66.7%) while the older age group 10-12 years had the lowest prevalence of anaemia (13.5%) (Table 5)

Table 5 : Prevalence of Anaemia in children based on age

Age group (years)	Number examined	Number infected (%)	p-value
0-3	108	72 (66.7)	
4-6	72	28 (38.9)	
7-9	63	16 (25.4)	0.391
10-12	37	5 (13.5)	
TOTAL	280	121 (43.2)	

Relationship between malaria and anaemia co-infection among the study subjects
There was a positive correlation between malaria and anaemia with a greater number (91,2%) having malaria and anaemia while those having anaemia without malaria infection was significantly low (8.8%) (Figure 1)

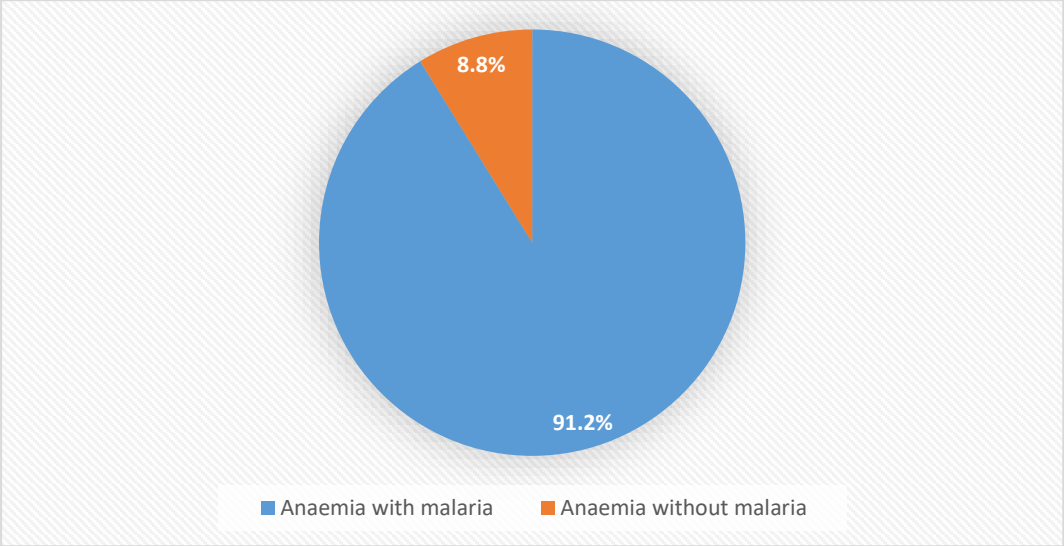

Figure 1 : Association between Malaria and Anaemia in children.

DISCUSSION

Malaria is a recognized public health issue, and anemia is a significant complication associated with malaria infections that contributes to morbidity and mortality among children, as investigated in Ilorin, north-central Nigeria. For effective management and adequate surveillance, it is crucial to have precise epidemiological data. The results from this study indicated that 137 out of 280 children (48.9%) visiting a primary healthcare facility in Ilorin tested positive for malaria. This prevalence is comparable to the 50.6% malaria infection rate found in children at a specialist hospital in Yola (Kunihya et al., 2016). A higher prevalence of 62% was reported by Isa et al. (2022) in Yola as well. The results from this study may be linked to inadequate control measures in the region, such as the lack of use of insecticide-treated bed nets in households and blocked drainage systems that create breeding grounds for the mosquito vectors, among other issues. Female participants (57.8%) showed a higher infection rate than their male counterparts (46.0%), and this difference was statistically significant (P >

0.05). This disparity might be due to varying levels and patterns of exposure to mosquito vectors. In terms of age, the group of subjects aged 0-3 years exhibited the highest infection rates. This pattern of infection could be related to background immunity, suggesting that younger children possess lower immunity that develops with age. This finding contrasts with the observations made by Noland et al. (2014), who reported higher infection rates among children aged 5-9 years in Abia and Plateau States.Factors such as socio-demographics, nutritional status and the proper utilization of malaria preventive measures may affect the pattern of infection among the study population (Ajibaye et al., 2025). The monthly analysis showed that July had the highest infection rate (60.0%), coinciding with the peak of the rainy season in the region, which creates more breeding sites that allow for an increase in mosquito populations. It is well-established that malaria transmission in north-central Nigeria peaks during the rainy season (Olayemi et al., 2011). The rate of anemia among children infected with malaria parasites was determined to be 44.6%, marking a significant public health concern based on the WHO threshold of over 40% (WHO, 2015). This finding aligns with the research by Aregbeshola et al. (2021), who reported a 67% prevalence of anemia in Nigeria. Female children exhibited higher rates of anemia than males, likely due to established malaria infections. Other factors that might have contributed to females having higher anemic condition include genetic variations and immunity status.The association between malaria infection and anemia was statistically significant ($P < 0.05$) (Fig 1). A study by Kiggundu et al. (2013) indicated a higher anemia prevalence (68.7%) among children with malaria parasites. Other related studies suggested that improvements in hemoglobin levels may correlate with a notable decrease in mosquito exposure among children utilizing malaria prevention measures (Oladeinde et al., 2021). To mitigate this issue, it is important to provide insecticide-treated bed nets, deliver proper health education and awareness to the community, and conduct regular environmental clean-up initiatives to maintain cleanliness and reduce mosquito breeding sites.

CONCLUSION

The majority of subjects in this study were co-infected with malaria and anemia, highlighting a positive correlation between both infections and their consequent impact on morbidity and mortality in the area.

ACKNOWLEDGEMENTS

Gratitude is expressed to the hospital management and ethical committee. We thank the study participants for permitting us to conduct our assessment.

REFERENCES

Ajibaye,O.,Rahman,S.A.,Aina,O.O.,Ujuju,C.,Agomo,C.O.,Akindele,S.,Abiodun,O.,Uzoka,T.V.,Ogbulafo,N.,Oroge,O.,Garba,R.,Ekholuenetale,M.,Maxwell,K.,Awosanya,R.A.,Adekola, M.A.,Ilesanmi,B.B.,Ajayi,A.,Oresanya,O.,Tibenderana,J.K. and Olukosi,A.Y. (2025). Prevalence and factors associated with childhood malaria and anaemia in Osun State, Nigeria: a baseline household malariometric study. *Malaria Journal* (2025) 24:11

Akinbo, O. F., Omoregie, R., Mordi, R., and Okaka, C. E. (2009). Prevalence of malaria and anaemia among young children in a tertiary Hospital in Benin City, Edo state. *Fooyin Journal of Health Science,* 1(2) : 81 – 84.

Amaechi,E.C.,Okore,O.O.,Ubiaru,P.C.,Ejike,B.U.,Ihemanma,C.A.,Egwu,O.,Ibrahim, A.B., Bello, B.O. and Oyeniyi, M.R. (2018). Status of falciparum malaria and associated

knowledge amongst febrile patients attending Cottage hospital Ogidi-Oloje, north central Nigeria. *Animal Research International*, 15(3): 3101-3111.

Aregbeshola, B.S., Onifade, O.M. and Awuviry-Newton, K. (2021). Prevalence and correlates of anaemia among children aged 6 to 59 months in Nigeria. *World Nutrition*, 12:58-74

Cheesbrough,M. (2009). *District Laboratory Practice in Tropical countries (Part 1)*, Second Edition, Cambridge University Press, London. Pp 253-328

Chukwuekezie, O., Nwosu, E., Nwangwu, U., Dagunro, F., Onwude, C., Agashi, N., Ezihe, E., Anioke, C., Anokwu, S., Eloy, E., Attah, P., Orizu, F., Ewo, S., Okoronkwo, A., Joseph, A., Ikeakor, I., Haruna, S. and Gnanguenon, V.(2020). Resistance status of *Anopheles gambiae* (s.l.) to four commonly used insecticides for malaria vector control in south-east Nigeria. *Parasites and Vectors,*13:152

Eisele, T. P., Miller, J.M., Moonga, H.B., Hamanza, B., Hutchimson, p. and Keating, J., (2011). Malaria infection and anaemia prevalence in Zambia's Luangwa district: An area of near – insecticide treated mosquito net coverage. *American Journal of Tropical Medicine and Hgyiene, 84 (1) : 152 – 157.*

Elechi, H.A., Rabasa, A. J., Muhammad, A.A., Bashir, M. F., Bukar, L.M. and Askira, U. M.(2015). Predictive indices of empirical clinical diagnosis of malaria among under five febrile children attending paediatric outpatient clinic. *Annals of Tropical Medicine and Public Health*, 8 (2): 28- 33.

Ibeji, J.U., Mwambi, H. and Iddrisu, A. (2022). Spatial variation and risk factors of malaria and anaemia among children aged 0 to 59 months; a cross- sectional study of 2010 and 2015 data sets. *Scientific reports, 12: 11498.*

Ibrahim, A. O., Bello, I. S., Ajetunmobi, A. O., Ayodapo, A., Afolabi, B. A., & Adeniyi, M. A. (2023). Prevalence of asymptomatic malaria infection by microscopy and its determinants among residents of Ido-Ekiti, Southwestern Nigeria. *Plos One*, *18*(2), e0280981.

Isa, H., Bashir, M., and Adedeji, B. A. (2022). Malaria prevalence and anaemia status of children attending a health facility in Yola. *Journal of Advances in Microbiology, 22 (8) : 25 – 31.*

Kiggundu, V.L., O Meara, W.P., Musoke, R., Nalugoda, F.K., Kigozi, G., Baghendaghe, E., Lutalo, T., Achirnge, M. K., Reynolds, S. J., Makumbi, F., Serwadda, D. and Gray, R.H. (2013). High prevalence of malaria parasitaemia and anaemia among hospitalized children in Rakai, Uganda. *PLOS One*, 1- 7.

Kunihya, I.Z., Samaila, A.B., Nassai,I.,Sarki,A. and Haruna,M.Y. (2016). Prevalence of malaria infection among children attending specialist hospital Yola, Adamawa State, Nigeria. *Journal of Medical and Biological Science Research*,2(8):136-142.

National Malaria Control Program (NMCP) (2015). Monitoring and Evaluation Plan 2011-2015.http://www.sante.gouv.bj/documents/PNLP/Plan_S&E-2011-2015.pdf

Noland,G.S.,Graves,P.M.,Sallau,A.,Eigege,A.,Emukah,E.,Patterson,A.E.,Ajiji,J.,Okorofor,I.,Oji,O.U.,Umar,M.,Alphonsus,K.,Damen,J.,Ngondi,J.,Ozaki,M.,Cromwell,E.,Obiezu,J.,Eneiramo,S.,Okoro,C.,McClintic-Doyle,R.,Oresanya,O.,Miri,E.,Emerson,P.M.,Richards Jr,F.O.(2014). Malaria prevalence, anemia and baseline intervention coverage prior to mass net distributions in Abia and Plateau States, Nigeria. *BMC Infectious Diseases*, 14;168

Oladeinde, B.H., Omoregie, R., Olley, M., Anunibe, J. A., Onifade, A. A., and Olademde, O. B. (2012). Malaria and Anaemia among children in a low resource setting in Nigeria. *Iranian Journal of Parasitology,* 7 (3): 13-37.

Roberts,D.J.,Matthews,G.,Snow,R.W.,Zewotir,T. and Sartorius,B.(2020). Investigating the spatial variation and risk factors of childhood anaemia in four sub-Saharan African countries. *BMC Public Health*, 20:126.

Roland, L.A., Kenny, S. L., Klinkenberg, E., Akoto, A.O., Boakye, I ., Barnish, G ., and Donelly, M. G. (2006). Malaria and Anaemia in two communities of Kumasi, Ghana: a cross-sectional survey. *Malaria Journal, 5: 15.*

White, N.J. (2018). Anaemia and malaria. *Malaria Journal*, 17 : 1-17.

WHO (2015). The global prevalence of anaemia in 2011. World Health Organization. https//iris.who.int/handle/10665/177094

WHO (2021). World Health Organization. *World malaria report* 2021.