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Dynamics of *Plasmodium falciparum* Parasitaemia and Uncomplicated Malaria among School-Age Children living in Omoku, Southern Nigeria

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Abstract

This cross-sectional study determined the mean parasitaemia and prevalence of *Plasmodium falciparum* malaria parasites among school-aged children in Omoku, Ogba Egbema Ndoni Local Government Area, Rivers State, Southern Nigeria. A total of 200 blood samples were randomly collected through convenience sampling method from the study subjects. Malaria diagnosis was carried out using standard parasitological techniques. The demographic data of the subjects showed that more females, 126(63%), were examined compared with males, 74(37%). Overall prevalence of *Plasmodium falciparum* recorded was 49%. Gender-based prevalence showed that more females were infected 58(29%) with mean parasite density of 16524(1611) parasites/µL of blood than males, 40 (20%) with mean parasite density of 14886(1794) parasites/µL of blood. The difference in prevalence between them was statistically significant ($P < 0.05$). Age-related prevalence showed that those within the age range of 5 to 7 years had the highest prevalence, 48(24%), with mean parasite density of 14909(1244) parasites/µL of blood, followed by those within the age range of 8 to 10 years, 34(17%), with mean parasite density of 11434(1244) parasites/µL of blood, while those within the age range of 11 to 13 years had the lowest prevalence, 16(8%), with mean parasite density of 5067(568) parasites/µL of blood. However, the difference between them was not statistically significant ($P > 0.05$). The prevalence of malaria based on schools attended by the subjects showed that BMA had the highest, 12%, and mean parasite density of 6995(827) parasites/µL of blood, while SIS, and EIS had the lowest percentage of infections, 8%, respectively ($P > 0.05$).The association between mother's level of education, household size and *P. falciparum* parasitized children was statistically significant ($P < 0.05$). In conclusion, malaria is endemic in the study area, and among other interventions, scaling up investment in primary health care is necessary to effectively prevent, detect, and treat malaria in local communities.

Keywords: children, malaria, Nigeria, Omoku, parasitaemia, *Plasmodium falciparum*

1. INTRODUCTION

Malaria is a mosquito-borne parasitic disease which poses public health challenge in Nigeria. Millions of Nigerians are at risk of malaria. Recent report from World Health Organization (WHO) shows that malaria accounted for an estimated 241 million cases and 627000 deaths in 2020 worldwide, of which 96% of the malaria deaths occurred in Africa (WHO, 2022a). Nigeria is leading in terms of global burden of malaria; a preventable and treatable disease. In 2001, Afolabi et al. (2001) reported that malaria was attributed to over 200,000 deaths in children annually in Nigeria. Malaria-associated deaths had increased by 6.9% in recent time in Nigeria from 25% in 2017 to 31.9% in 2020 (Barikuura et al., 2019; WHO, 2018). The marked increase in malaria cases and deaths was partly attributed to disruptions of malaria intervention services during COVID-19 pandemic and newly adopted revised method of estimating malaria mortality (WHO, 2022a). Infants, children under the age of 5 years, pregnant women, naïve adults, and immunosuppressed individuals are more vulnerable to contracting malaria and developing severe disease, particularly *P. falciparum* malaria which can readily progress to severe illness and death within a day (WHO, 2022a).

Nevertheless, in recent years, global efforts to fight malaria have yielded significant reductions in malaria mortality and morbidity in some countries through preclusion of 10.6 million malaria-induced deaths and 1.7 billion malaria cases from 2000 to 2020 (WHO, 2022b). More recently in the year, 2021, China and El Salvador joined the league of certified malaria-free countries (WHO, 2022b). Malaria cases continue to rise across Nigeria and consequently cause illness and deaths, particularly among the high risk group such as children of school age living in poverty and rural areas.

Human malaria parasites which belong to the phylum *Apicomplexa* are *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae,* and the recent species, *Plasmodium knowlesi* which causes zoonotic malaria. These parasites are transmitted to people mainly through the bites of infected female *Anopheles* mosquitoes. In Nigeria, *Plasmodium falciparum* is the most prevalent species which causes the severest form of malaria with characteristic high levels of parasitaemia (Cheesbrough, 2006). Parasitaemia associated with *Plasmodium falciparum* can exceed 250,000 parasites per microlitre of blood (Cheesbrough, 2006). Malaria is basically characterized with fever, chills, and flu-like illness (CDC, 2022). Basic complications associated with severe *falciparum* malaria are cerebral malaria, haemoglobinaemia, severe anaemia, hypoglycaemia, and complications in pregnancy (Cheesbrough, 2006). Consequently, continued evaluation of the levels of *falciparum* malaria parasitaemia among vulnerable people living in malaria endemic settings is imperative. This becomes necessary to avert likely progression of mild asymptomatic *Plasmodium falciparum* malaria to severe disease, which might have deleterious complications. The socio-economic impacts of malaria are enormous; communities with high malaria parasitaemia have more chronically ill members, resulting in absenteeism from work and school. Repeated malaria attacks among others result in heavy spending on treatment, also affect education of school age children, the amount of food the family can grow, and continuously drain family earnings. Lack of knowledge about malaria, poverty and chronic disease together form a vicious circle, which is difficult to break (WHO, 2010). Among other interventions, malaria can be prevented by proper sanitation, sleeping under well treated insecticide net, and the use of insecticide.

Several reports of recent studies conducted in Rivers State, Niger Delta region of Nigeria, demonstrated marked variations in prevalence rates of *Plasmodium falciparum* parasites among children, pregnant women, and adults residing in different geographical or geopolitical zones (Abah et al., 2017; Wokem et al., 2018; Barikuura et al., 2019; Uzor et al., 2020). These variations might strongly suggest the influence of both human factors and abiotic variables in transmission of malaria parasites. Notably, as malaria curves remain steep in Nigeria, it is pertinent to sporadically evaluate the epidemiology and levels of *P. falciparum* parasite load in susceptible children to avert possible progression to severe disease.

Malariometric indices of school-age children have been studied over the years to determine malaria burden at community levels. An understanding of malaria burden in a given setting is crucial for health planning, policy development, and control interventions. This study, therefore, evaluated the dynamics of *Plasmodium falciparum* parasitaemia and uncomplicated malaria among school-age children in Omoku, Rivers State, Southern Nigeria.

2. MATERIALS AND METHODS

2.1 Study area

The study was conducted in Omoku (5.342ºN 6.656ºE), one of the major towns in Rivers States, Southern Nigeria. It is the headquarters of Ogba/Egbema/Ndoni Local Government Area, and it is bordered by Delta State. The climate of the study area is basically rainy and dry season. The dry season lasts from November to March while the rainy season lasts from April to October every year. Residents are mostly farmers, artisans, and traders, while many are civil servants and indigenous oil company workers.

2.2 Study design

This cross-sectional and community-based study was conducted from April to July in 2022, during rainy season, among children attending various schools in Omoku. The quantitative method of socio-demographic data collection was used through pre-tested structured questionnaire. Some of the data obtained were age, gender, schools' admitted and attending, mother's level of education, mother's occupation, and household size. The inclusion criteria were non-febrile children between 5 and 13 years, with body temperature < 38ºC, being a resident of the study area for a minimum of 6 months, completing the questionnaires, and willingness of caregivers to give written or oral informed consent. Children who recently took antimalarial drugs and those who declined participation were excluded.

2.3 Sample and sampling

The sample size was determined using a previous malaria parasite prevalence of 9.4% according to Oboro et al. (2021) at a confidence interval (CI) of 95% and a precision of 5% following the formula, $N=Z^2P(1-P)/d^2$ for calculating sample size (Naing et al., 2006) which gave rise to a total of 131 subjects. Nevertheless, a simple random sampling was used to select 200 subjects for this study.

2.4 Blood sample collection and laboratory procedures

Blood samples were collected using venipuncture technique. A 3mL blood sample was obtained from each participant. The blood samples were transferred into ethylenediaminetetraacetic acid (EDTA) tube to prevent the blood from coagulation. Thick and thin blood films were prepared immediately on the same slide to detect and identify malaria parasite species. For thick film, 10µL of blood was spread to cover a diameter of 15mm, while 2µL of blood was used for thin blood film. The thin blood film was fixed in absolute methanol for 2 seconds and air dried. Next, the dried blood films were stained with 3% Giemsa stain solution for 45 minutes at pH 7.2. The stained blood films were examined under x100 oil immersion objective and x10 paired ocular lens of the light microscope by two competent independent microscopists for the presence or absence of malaria parasites. Discrepancy in malaria microscopy result and parasite counts was resolved as reported by

Agomo et al. (2009). Each slide was pronounced negative only when a minimum of 100 microscopic fields have been carefully examined for the presence of parasites (WHO, 2010). Parasite density was estimated using the relative method as the number of parasites per microlitre of blood (WHO, 2010). The level of parasitaemia was classified as described by Adesina et al. (2009).

2.5 Statistical analysis

Data collected were analyzed separately according to gender, age, schools, and other sociodemographics. The statistical analysis was performed using both descriptive and inferential statistics. Data were presented as mean and standard deviation, and percentages (%). Chi squared (χ^2) test was done to test association of variables, and *p*-value of ≤ 0.05 was considered as significant.

3. RESULTS

Gender-related prevalence and density of *Plasmodium falciparum* malaria

Table 1 shows gender-based distribution of mean parasitaemia and prevalence of *Plasmodium falciparum* malaria parasites among infected school children. The female children had higher prevalence of 29% and mean parasite density of 16524(1611) parasites/µl of blood compared with the male children who had a prevalence of 20% and mean parasite density of 14886(1794) parasites /µl of blood. And the difference between them was statistically significant (χ^2=15.440; P<0.05).

Age-related prevalence and density of *Plasmodium falciparum* malaria

Table 2 shows the age-related distribution of mean parasitaemia and prevalence of *Plasmodium falciparum* malaria parasites among infected school children. Those within age group of 5-7 years had the highest prevalence of 24% with mean parasite density of 14909(1244) parasites/µl of blood while those within the age group of 11-13 years had the lowest prevalence of 8% and mean parasite density of 5067(568) parasites/µl of blood, however the association between malaria parasites and age of infected children was not statistically significant (χ^2= 2.802; P>0.05).

School-related prevalence and density of *Plasmodium falciparum* malaria

Table 3 shows the distribution of mean parasitaemia and prevalence of *Plasmodium falciparum* malaria parasites among infected children according to their various schools. Blessed Montessory Academy (BMA) had the highest prevalence of 12% with mean parasite density of 6995(827) parasites/µl of blood. Those who attend Favour Model Academy (FMA) had a total prevalence of 11% with mean parasite density of 6844(892) parasites/µl of blood. The lowest prevalence of 8% of *falciparum* malaria was observed among children of Shiloh International School (SIS) and Ellah International School (EIS) respectively, although the association between malaria parasites and schools attended was not statistically significant (χ^2=2.583; P> 0.05).

Socioeconomic-related prevalence of *Plasmodium falciparum* malaria

Table 4 shows the association between the mother's levels of education, mother's occupation, and the household size of school-age children in relation to the prevalence of *Plasmodium falciparum* infection among the study subjects. School-age children whose mothers' level of education is primary had highest prevalence of *P. falciparum* infection, 21.5%, while those whose mothers' level of education is tertiary had the lowest prevalence of *P. falciparum* infection, 8%. The association between infection with malaria parasite and the levels of the mother's education was statistically significant (χ^2=35.705; P<0.05). Association between mother's occupation and malaria parasite infection shows that children of self-employed mothers had the highest prevalence of 20.5%, followed with civil service, 14.5%, while others without specific occupation had the lowest prevalence of 1%. However, this association was not statistically significant (χ^2=2618; P>0.05). Also school-age children of household size of 5 to 6 persons had the highest prevalence of *P. falciparum* infection, 26%, compared with those of ≤4 and ≥7 household sizes with prevalence of 16.5% and 6.5% respectively. Association between malaria parasite infection and household size of children was statistically significant (χ^2=11.396; P<0.05)

Table 1. Gender-based distribution of mean malaria parasitaemia and prevalence of *Plasmodium falcparum* malaria parasites among school age children in Omoku

Gender	No. Examined(%)	No. Infected(%)	Mean (SD) Parasites /µl	*P*
Female	126 (63)	58(29)	16524(1611)	< 0.05
Male	74 (37)	40(20)	14886 **(**1794)	< 0.05
Total	200(100)	98(49)	31410	

SD: standard deviation; Note: We calculated *P* values using χ^2 test

Table 2. Age-related distribution of mean malaria parasitaemia and prevalence of *Plasmodium falciparum* malaria parasites among school age children in Omoku

Age(years)	No.Examined(%)	No. Infected (%)	Mean(SD) Parasites /µl	*P*
5-7	86(43)	48(24)	14909(1244)	NS
8-10	70(35)	34(17)	11434(1813)	NS
11-13	44(22)	16(8)	5067(568)	NS
Total	200(100)	98(49)	31410	

NS: not significant; SD: standard deviation; Note: We calculated *P* values using χ^2 test

Table 3. Distribution of mean malaria parasitaemia and prevalence of *Plasmodium falciparum* malaria parasites among school age children in Omoku according to their various schools

Schools	No. Examined (%)	No. Infected (%)	Mean(SD) Parasites /µl	*P*
FMA	40(20)	22(11)	6844(892)	NS
BMA	40(20)	24(12)	6995(827)	NS
CPS	40(20)	20(10)	6306(786)	NS
SIS	40(20)	16(8)	5595(781)	NS
EIS	40(20)	16(8)	5670(231)	NS
Total	200(100)	98(49)	31410	

NS: not significant; SD: standard deviation; Note: We calculated *P* values using χ^2 test ; Abbreviations: FMA;Favour Model Academy.BMA;Blessed Montessory Academy CPS;Community Primary School; SIS; Shiloh International School. EIS; Ella International School

Table 4. Association of sociodemographic characteristics and prevalence of *falciparum* malaria parasites among school age children in Omoku

Variables	No. Examined (%)	No. Infected (%)	*P*
Mother's Education			< 0.05
Primary	54(27)	43(21.5)	
Secondary	81(40.5)	39(19.5)	
Tertiary	65(32.5)	16(8)	
Mother's Occupation			NS
Self-employed	84(42)	41(20.5)	
Trader	37(18.5)	15(7.5)	
Farmer	21(10.5)	11(5.5)	
Civil Service	52(26)	29(14.5)	
Others	6(3)	2(1)	
Household size			< 0.05
≤4	83(41.5)	33(16.5)	
5-6	102(51)	52(26)	
≥7	15(7.5)	13(6.5)	

NS: not significant; Note: We calculated *P* values using χ^2 test

4. DISCUSSION

The overall prevalence of 49% observed in this study suggests the level of malaria endemicity in the study area. This high prevalence of *falciparum* malaria infection agrees with other earlier studies which reported high prevalence of malaria in Nigeria (Abah et al., 2017; Ozuogwu et al., 2020; Uzor et al., 2020). This corroborates the fact that malaria is still endemic in Nigeria (WHO, 2022a). However, the prevalence rate found in this study is lower compared with the prevalence of 63.3%, 55%, and 69.4% earlier reported by Abah and Temple (2015), Otu et al. (2020), and Wokem et al. (2018) in Bayelsa State, Cross River State, and Rivers State in Niger Delta, Nigeria respectively. Although, more recently, Omonijo et al. (2021) reported a relatively lower prevalence of 16.98% and 16.83% among school-age children in Oye and Ikole Local Government Areas of Ekiti State, Southwestern Nigeria respectively. Also, in the previous year, a significantly low prevalence of 9.4% of malaria infection was reported among children less than five years in Rivers State (Oboro et al., 2021). The differences in trend of prevalence rates may be attributed to changes in season and locations where the studies were conducted. Transmission of malaria parasites may be influenced by myriad of factors ranging from environmental to climatic factors among others that enhance the bleeding of malaria parasites arthropod vector, *Anopheles* mosquito.

Plasmodium falciparum was the only malaria parasite species detected and identified in this study which is similar to reports from other recent studies among school-age children in Nigeria (Abah et al., 2017; Ifebi et al., 2020; Nwaneli et al., 2020). This further validates the fact that *P. falciparum* is the most prevalent and virulent malaria parasite in Nigeria, occasionally implicated for children's morbidity and absenteeism from school. In this study, there was a significant association between gender and malaria prevalence among school-age children with females having higher prevalence than males. Females had a prevalence of 29% and mean parasite density of 16524 parasites per micro litre of blood than the males with a prevalence of 20% and mean parasite density of 14886 parasites per micro litre of blood. Though there is no available scientific evidence linking malaria prevalence to gender. The reason for this finding may be due to the fact that majority of the population sampled were female participants.

It was observed in this study that the age of a child was an independent determinant of a child's malaria status. School children between 5 to 7 years, and those between 8 to 10 years were more at risk of malaria infection compared with children between 11 to 13 years. This trend on age-related prevalence corroborates with the study conducted 8 years earlier in a community in Bayelsa, Southern part of Nigeria (Abah & Temple, 2015). This may suggest the fact that younger children may not have either partial or naïve immunity making them more susceptible to malaria infection. However, Nwaneli et al. (2020) reported higher prevalence rate in older children than younger children in a study conducted in Southeast Nigeria. The researcher hypothesized that it might be due to the short term effect of focused malaria control measures on younger children in the study population.

The report of this study shows that school attended by a child has no significant effect on the child's malaria status. Prevalence of *P. falciparum* infection in this study shows a significant association between socioeconomic statuses of the family and a child's malaria infection status. This finding may suggest a linear relationship exist between level of education, standard of living, and malaria parasitaemia.

5. CONCLUSION

This study observed high prevalence of malaria infection caused by *Plasmodium falciparum* parasite. These findings provide evidence-based facts for strategic policy decision and implementation on effective malaria treatment, control and eradication in the affected region in particular and Nigeria at large. The State Ministry of Health in collaboration with the region's Primary Health Care unit should carry out a door-to-door health education and promotion interventions which may significantly reduce malaria burden on school children in the study area.

REFERENCES

Abah, A., Awi-Waadu, G., Nduka, F., & Richard, A. (2017). Malaria infection and socioeconomic status of some residents of Port Harcourt metropolis, Rivers State, Nigeria. *Journal of Applied Science and Environmental Management*, *21*(2), 299-304.

Abah, A.E., & Temple, B. (2015). Prevalence of malaria parasite among asymptomatic primary school children in Angiama community, Bayelsa State, Nigeria. *Tropical Medicine and Surgery*, *4*(1), 203-207.

Adesina, K.T., Balogun, R.O., Babatunde, A.S., Sanni, M.A,, Fadeyi, A.,& Aderibigbe, S. (2009). Impactof malaria parasitaemia on haematologic parameters in pregnant women at booking in Ilorin, Nigeria. *Trends in Medical Research*, *4*(4), 84-90.

Afolabi, B.M., Ezedinachi, E.N.U., & Fatumbi, B.S.(2001). Roll back malaria: The story so far. *WHO Newsletter*, 16, 6-7.

Agomo, C.O., Oyibo, W.A., Anorlu, R.I., & Agomo, P.U. (2009). Prevalence of malaria in pregnant women in Lagos, South-West, Nigeria. *The Korean Journal of Parasitology, 47*(2), 179-183.

Barikuura, D.F., Ngozika, W.C., & Obioma, A. (2019). Immune-based investigation of tumour necrosis factor-alpha (TNF-α), interlerleukin-1beta (IL-1β), interleukin-6 (IL-6), interleukin-10 (IL-10) among pregnant women infected with *Plasmodium falciparum* in Port Harcourt. *Journal of Medical Microbiology and Immunology*, *3* (1), 1-12.

Centres for Disease Control and Prevention.(2022). *Malaria* https://www.cdc.gov/parasites/malaria/index-html

Cheesbrough, M. (2006). *District laboratory practice tropical countries*, *part 1* (2nd ed.). Cambridge University Press.

Ifebi, E.A., Nwaneri, D.U., & Ibadin, M.O. (2020). Current state of malaria endemicity in Egor South-South region, Nigeria. *West African Journal of Medicine, 37*(6), 612-618.

Naing, L., Winn, T., & Rusli, B.N. (2006). Practical issues in calculating the sample size for prevalence studies. *Archives of Orofacial Sciences*, *1*, 9-14.

Nwaneli, E.I., Eguonu, I., Ebenebe, J.C., Osuorah, C.D.I., Ofiaeli, O.C., & Nri-Ezedi, C.A. (2020). Malaria prevalence and its socio demographic determinants in febrile children: A hospital-based study in a developing community in South-East Nigeria. *Journal of Preventive Medicine and Public Health, 61*(2), 173-180.

Oboro, I.L., Bob-Manuel, M., Chijioke-Nwauche, I.N.,Maduka, O., Kasso, T., Awopeju, A.T.O., Paul, N.I., Yaguo-Ide, L.E., Ogoro, M., Siminalayi, I.M., Abam, C.I., Nte, A.R., Nduka, F.O., Obungu, O.K., & Nwauche, C.A. (2021). Prevalence of malaria among children under five years in the Niger Delta region of Nigeria. *Asian Journal of Pediatric Research*, *5*(4), 10-17.

Omonijo, A.O., Omonijo, A., Okoh, H.I., & Ibrahim, A.O. (2021). Relationship between the usage of Long-Lasting Insecticide-Treated Bed Nets (LLITBNs) and malaria prevalence among school-age children in Southwestern Nigeria. *Journal of Environmental and Public Health*. Doi: 10.11551202118821397

Otu, A.A., Udoh, U.A., Ita, O.I., Hicks, J.P.,Ukpeh, I., & Walley, J. (2020). Prevalence of Zika and malaria in patients with fever in secondary healthcare facilities in South-eastern Nigeria. *Tropical Doctor, 50* (1), 22-30.

Ozuogwu, J.C., Imakwu, C.A., Ekeleme, J.E., Okeke, O.P., Amana, G.U., Eziuzor, S.C., & Ogbodo, J.C. (2020). Prevalence of falciparum malaria in relation to age, gravidity, trimester, blood group and genotype. *Asian Journal of Pregnancy and Childbirth, 3*(4), 1-7.

Uzor, C.A., Eze, N.C., & Nduka, F.O.(2020). Occurrence of malaria and intestinal helminthes among students from selected secondary schools in Port Harcourt area of Rivers State,

Nigeria. *Journal of Environmental Science Current Research, 3*, 017. https://www.heraldopenaccess.us/openacess/occurrence-of-malaria-and-intestinal-helminths
Wokem, G.N., Nnadi, E., Azuonwu, O., & Okafor, A. (2018). Effect of malaria on selected liver function profiles of children in Port Harcourt, Rivers State, Nigeria. *International Journal of Tropical Disease and Health*, 31(4), 1-8.
World Health Organization. (2010). *Basic Malaria Microscopy part 1; Learner's guide* (2nd ed.). WHO, Geneva.
World Health Organization (2018). *Malaria.* https://www.who.int/news-room/fact_sheets/detail/malaria
World Health Organization (2022a). *Malaria.* https://www.who.int/news-room/fact-sheets/detail/malaria
World Health Organization. (2022b). *Malaria fact sheets: Commonwealth leaders recommit to ending malaria and neglected tropical diseases*. WHO, Geneva. https://www.who.int/news/items/23-06- 2022- commonwealth-leaders-recommit-to-ending-malaria