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Paediatric Malaria: Associated Symptoms and Risk Factors among Children in Isheri, Alimosho Local Government Area, Lagos State, Nigeria

Okeke, O. A., Imoohi, R. O., Oraneli, U. B., Okeke, C. J., Ubaka, U. A., Imakwu, C. A., Nzeukwu, C. I. and Ndudim G. C.

Nnamdi Azikiwe University, Awka, Anambra, Nigeria

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ABSTRACT

Malaria is a significant health issue, especially in tropical and subtropical regions. Children are particularly vulnerable to malaria due to their underdeveloped immune systems. Although many countries have implemented interventions to control and eliminate malaria, the disease remains a major public health challenge in endemic areas. This study is a cross-sectional survey conducted to determine the prevalence of paediatric malaria and identify associated risk factors in children under 5 years old at the Isheri Primary Health Centre in the Alimosho Local Government Area of Lagos State. The survey was carried out from June to September 2023. Blood samples were collected from 219 children, 44.7% male and 55.3% female. Parasitological analysis was conducted according to WHO standards, and data on associated risk factors and malaria prevention practices were collected through a pretested structured questionnaire. Statistical analyses such as T-test and One-way ANOVA were employed, with significance set at p>0.05. The findings revealed an overall prevalence of paediatric malaria in the study location at 49.3% (n=108), with *P. falciparum* being the main parasite. Males had a 55.1% malaria infection rate, while females had a rate of 40.5%. All malaria-infected children tested positive for the asexual malaria parasite, with parasite density ranging from 2087 to 328000µL-1 and a mean value of 47267 — 80 (95% CI 35244-59292). Children $\leq$ 5years of age (55324 μL^{-1}, 95% CI 29378-81271) had slightly higher asexual parasite density than those > 5 years (44045μL^{-1}, 95% CI 30440-576550). Haematological analysis showed that the infected children had a significantly higher count of neutrophils than the uninfected (p = 0.002). Furthermore, children who did not report experiencing fever and chills had a significantly higher parasite density than those who did (p<0.05). The use of insecticide-treated bed nets (ITN) also had an impact, with children under 5 years of age not using ITNs having a higher parasite density (65390 µL-1, 95% CI 18219-112562) than those who did. The study also assessed environmental risk factors and found that stagnant water and poultry farms did not significantly impact the prevalence of paediatric malaria. The study concluded that improved access to malaria interventions is essential to interrupt transmission, particularly in the at-risk groups, to achieve the United Nations Sustainable Development Goals agenda for health.

Keywords: Paediatric, Malaria, Associated Risk Factosr, Children, Primary Health Centre, Nigeria.

INTRODUCTION

Malaria is a life-threatening blood disease of public importance caused by the protozoan *Plasmodium* parasite (WHO, 2024). WHO reported that an estimated 608 000 deaths occurred globally due to malaria in 2022, a mortality rate of 14·3 deaths per 100 000 population at risk, more than 50% of all deaths occurred in just four countries: Nigeria (31%), the Democratic Republic of the Congo (12%), Niger (6%), and Tanzania (4%) (WHO, 2023).

Infants and children under 5 years of age, pregnant women and patients with HIV/AIDS are more susceptible to developing severe malaria. Of the globally 608,000 deaths in 2022 76 per cent were children under 5 years of age (WHO, 2024; UNICEF, 2024). Malaria is a major public health concern in Nigeria, with an estimated 68 million cases and 194,000 deaths due to the disease in 2021. Nigeria has the highest burden of malaria globally, accounting for nearly 27% of the global malaria burden WHO (2022). Studies have shown that the malaria prevalence rate in children < 5 years in South Eastern Nigeria is high 16.7% to 23.33% (Nwaneli *et al.*, 2020; Okek *et al*., 2021).

Following infection with malaria, especially in endemic areas, changes in haematological parameters are likely to be influenced. It affects the haematopoietic physiology at any level affecting the host homeostasis at various fronts resulting in a myriad of clinical presentations (Pinki, 2020). In malaria patients, platelets, eosinophils, RBCs, WBCs, lymphocytes, and Hb levels were significantly low, while monocyte and neutrophil counts were high compared to non-infected patients (Zuberi *et al*., 2024). Haematological alterations associated with malaria infection may vary depending on the following factors: level of malaria endemicity, background hemoglobinopathy, demographic characteristics, and malaria immunity. Thrombocytopenia and anaemia were the two most common observed malaria infections (Awoke and Arota, 2019). In addition to anaemia, platelet reduction is another of the more well-known haematologic changes observed in patients with malaria (Kotepui *et al*., 2015). This study supported that lower platelet counts among patients infected with *P. falciparum* in comparison to those of *P. vivax* were notably important. A report from Nigeria, has shown that haematological alterations associated with malaria are more common in children below 5 years of age with documented higher male prevalence (Okeke *et al*., 2016; Ogbonna *et al.*, 2024). In West Papua, Indonesia, i t has been reported that children with malaria had changes in some haematological markers, with anaemia, low platelet count, white blood count, and lymphocyte count being the most important predictors of malaria infection in the study area (Jiero and Pasaribu, 2021).

The risk factors for malaria transmission differ across the globe. The basic ones are stagnant Water, temperature and humidity, vegetation and land Use: Thick vegetation provides mosquito habitats. Results from Nigeria Malaria Indicator Survey (NMIS) show that the factors associated with the risk of malaria are sleeping under treated mosquito nets, the age of the children, region of domicile in Nigeria (northwest or southeast), types of wall construction material, number of people that make up the household, knowledge about malaria in the last 6 months, availability of health infrastructure, source of drinking water, distance to waste disposal points and window protection (Siko *et al.* 2024; Bayode *et al*., 2024). In 2015 NMIS, a significant correlation was observed between the non-availability or non-use of mosquito bed nets, low household socioeconomic status, low level of mother's educational attainment, family size, anaemia prevalence, rural type of residence and under-5 malaria prevalence (Ugwu and Zewotir, 2020). Also, the presence of streams/rivers, distance from streams/rivers within and travel to rural areas have been identified as significant risks (Awosolu *et al*., 2020).

Determining the risk factors that influence the transmission of malaria in Nigeria is important because the country aims to move from a control phase to an elimination phase, therefore, this study aims to determine the prevalence of paediatric malaria and the risk factors of the infection in Isheri primary health centre in Lagos which is one of the most densely populated city in Africa.

METHODOLOGY

Study Area

This study was done in Isheri in Alimosho LGA (Fig 1), Lagos State, Nigeria. Isheri has a population of 2,047,026 (Lagos State Government, 2019). The population is predominantly Egbados who are either Christian or Islam**.** The latitude of Alimosho L.G.A in Nigeria is 6.61130 and the longitude is 3.29530. Alimosho is located in a city in Nigeria with GPS coordinates 60 361 59.99' N and 30 181 60.00' E. The area comprises of built-up areas of low, medium and high housing densities.

Fig. 1: Map of Lagos State showing Alimosho Local government area highlighted on red.

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Search: (Google map).

Study Participant Recruitment

The study has a total of 219 participants. The selection of the study participants was purposely to include all the children presenting at the Primary Health Centre (PHC) with fibril illnesses.

Study Design

This is a cross-sectional study of children presenting with illness in Isheri Primary Health Centre. All children who presented to the facility for any health-related matter and whose parent(s) gave informed consent in writing, were included in the study.

Ethical Approval

This study was approved by the ethics committee of the College of Medicine, University of Lagos (CMUL/HREC/05/23/1179).

Data Collection

Trained research assistants and microscopists were hired to collect data, perform phlebotomy, and conduct laboratory procedures. Information on demographic details and associated risk factors was gathered using a carefully tested questionnaire from the parents or caregivers.

Inclusion/ Exclusion Criteria

Children who have or have not had a fever in the last 48 hours, whose parent or guardian have agreed to the terms of the survey in the consent forms, and who are living in Alimosho Local Government Area, were included in the study. Children who did not meet these criteria were excluded from the study. These children were tested for malaria infection.

Malaria Diagnosis

The diagnosis was made using microscopy according to the WHO (2016) manual. One millilitre of venous blood was collected from each participant. Thick and thin blood smears were made on glass slides and stained using 10% Giemsa stain. Each of these specimens was evaluated by two independent microscopists who were unaware of the results obtained by the other. A patient was said to be positive if microscopy demonstrated the presence of malaria parasites.

Haematology Test

The test was done using the blood samples collected inside the EDTA bottle. The haematocrit machine was used to determine the Total White Blood Cell (WBC count), Packed Cell Volume (PCV) and neutrophil levels of the children.

Statistical Analysis

The data was entered and processed in Microsoft Excel 2016 and then imported into statistical software for further analysis. T-test and One-way ANOVA were used to analyze data on sex, age groups, use of ITNs, and symptoms using GraphPad Prism 8. IBM's SPSS (version 20.0) was used to analyze data on prevalence using the Chi-Square test, level of significance was set at $p<0.05$.

RESULTS

Demography of the Study Population

A total of 219 children were sampled; 44.7% and 55.3% were males and females respectively. Children $\leq$5

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years of age constituted 66.2% of the total children sampled (Table 1).

Table 1: Demographic Characteristics of Study Population

Variable	Number sampled (n)	% sampled
Sex		
Male	98	44.7
Female	121	55.3
Age group (years)		
≤ 5	145	66.2
> 5	74	33.8
Total	219	100

Prevalence of Paediatric Malaria

The prevalence of paediatric malaria in the study location was 49.3% (n=108), with *P. falciparum* being the dominant *Plasmodium* species. The prevalence of the infection among male children was 55.1% while 40.5% of female children tested positive for the infection, however, there was no significant difference (p=0.136). Children <5years were more infected with the parasite (53.8%) than those >5years but the difference was not significant (p=0.086) (Fig. 2).

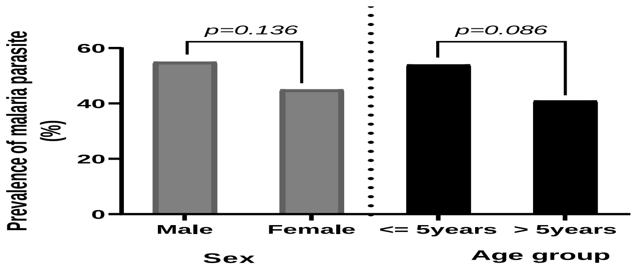

Fig. 2: Prevalence of Malaria Parasite in Study Population in Relation to Sex and Age Groups.

Asexual Parasite Density

The 108 malaria parasite-infected children were all positive for asexual parasites, with the trophozoite stage mostly detected during microscopy. The asexual parasite density ranged from 2087 to 328000µL-1, with a mean value of 47267, 80 (95% CI 35244-59292). The mean asexual parasite density of male children was 51386µL-1(95% CI 32120-70652) and that of the female children was 43071µL-1(95% CI 28194-57947). The difference between the parasite density of male and female children was not significant (p=0.4956). Children ≤ 5years of age (55324 µL-1, 95% CI 29378-81271) had slightly higher asexual parasite density than those > 5 years (44045µL-1, 95% CI 30440-576550). However, the mean difference between age groups was not significant (p=0.4033) (Fig. 3).

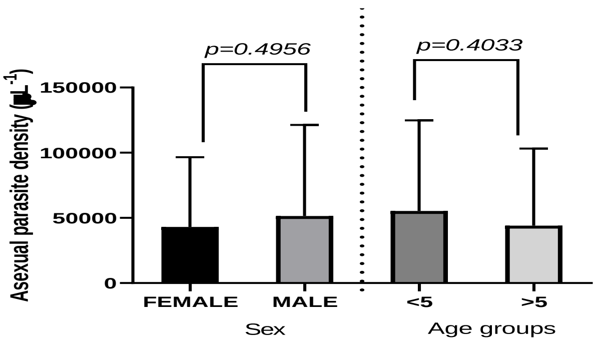

Fig. 3: Asexual parasite Density of Children Sampled.

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Sexual Parasite Density in Children Sampled.

Only 2 (0.91%) children (a male-75.19µL-1and and female-93.39µL-1) ≤5 years of age were found with sexual forms of the parasite during microscopy. These sexual forms (gametocytes) were found alongside the asexual forms (Fig. 4).

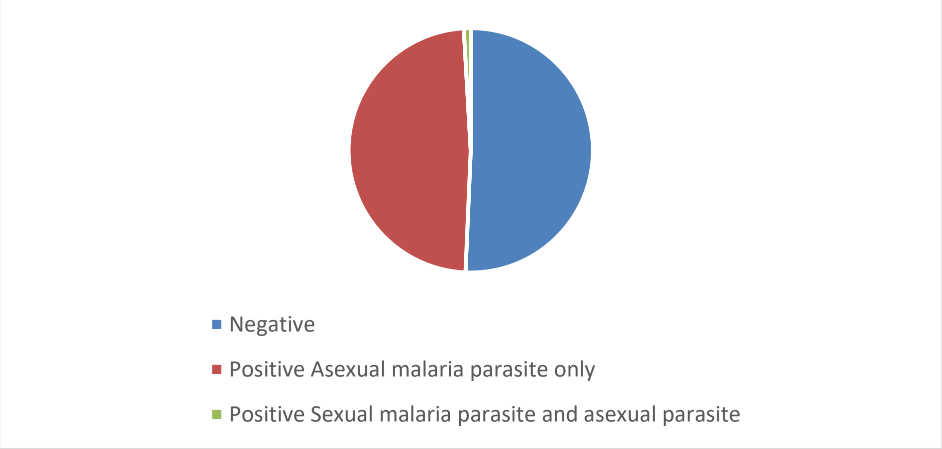

Fig. 4: Sexual Parasite Density of Children Sampled.

Paediatrics Haematology and Malaria Infection

Table 3 shows the haematological profile of malaria parasite-infected and uninfected children. There was no significant difference in the total WBC, PCV, lymphocytes, monocytes and eosinophils of infected and uninfected children but for neutrophils, where a significantly higher ($p<0.05$) count was observed in the parasite-infected children than in the uninfected.

Table 3: Haematological Profile of Malaria-infected and Uninfected Children in the Study.

	Paediatric malaria infection		
Haematology variables	Infected Mean (95% CI)	Uninfected Mean (95% CI)	P value
Total White Blood Cell Count	8118 (7482-8753)	7828 (7616-8037)	0.386
Packed Cell Volume	34.88 (34.35-35.41)	34.82 (34.23-35.41)	0.878
Neutrophils	65.38 (63.26-67.20)	60.57 (58.47-62.68)	0.002*
Lymphocytes	39.92 (34.53-39.32)	37.96 (35.71-40.21)	0.532
Monocytes	2.564 (2.362-2.766)	2.485 (2.275-2.695)	0.589
Eosinophils	1.023 (0.976-1.070)	1.048 (0.9483-1.147)	0.606

* Neutrophil counts of infected significantly higher ($p = 0.002$).

Symptoms Indicators and Malaria Parasite Density

Parasite densities of children who vomited and had stomach aches were higher than those who responded negatively but only the stomach ache was significantly associated ($p<0.0001$) with the presence of high parasite density. It is interesting to note that the parasite density was significantly higher ($p<0.05$) in the children who did not report having fever and chills, compared to those who did report these symptoms as indications of malaria (Table 4).

Table 4: Symptoms in Relation to Parasite Density of Children Sampled.

	Parasite density in relation to category of symptom response		
Symptom type	Yes Mean (95% CI)	No Mean (95% CI)	P value
Fever	39914 (29403-50426)	82810 (33839-131780)	0.0071*
Chills	36647 (28930-44365)	87337 (38540-136134)	0.005*
Body pain	36146 (24085-48207)	53840 (36029-71651)	0.1596
Headache	42458 (33532-59388)	59292 (39537-79046)	0.2114
Vomiting	54170 (17141-91198)	46460 (33532-59388)	0.6990
Cough	30458 (21854-39314)	50954 (36447-65460)	0.1973
Bitter mouth	12800 (12800-12800)	40640 (30960-50320)	0.4309
Stomach pain	127629 (16309-238948)	40640 (30960-50320)	<0.0001**
Weakness	22807 (3088-42526)	49843 (36754-62931)	0.1920
Body heat	51591 (2156-101027)	46911 (34284-59539)	0.8389

Malaria Parasite Density and the Use of Insecticide-Treated Nets

With the use of ITN generally (Fig. 5), children who do not sleep under ITN (mean value of 53840µL-1,95% CI 36029-71651) had more parasite density than children who sleep under ITN (mean value of 36146µL-1, 95% CI 24085-48207) but the difference was not statistically significant (p=0.1596). When the use of ITN was categorized according to age groups, children ≤5 years of age who do not sleep under ITN (mean value of 65390 µL-1, 95% CI 18219-112562) had higher parasite density than their mates who sleep under ITN (mean value of 45259µL-1, 95% CI 17411-73107). However, the mean difference in the use of ITN for this age group was not significant (p=0.1596). Similarly, children >5 years who do not sleep under ITN (50443µL-1, 95% CI 31078-69808) had higher parasite density than their mates who sleep under ITN (31078µL-1, 95% CI 19603-41297) but the difference was not statistically significant (p=0.1736) (Fig. 6).

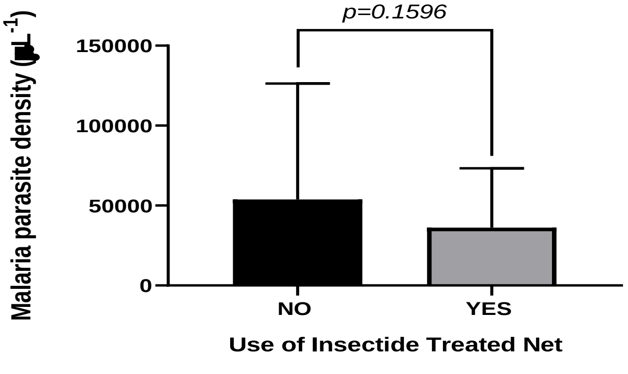

Fig. 5: General Impact of the Use of ITN on Malaria Parasite Density

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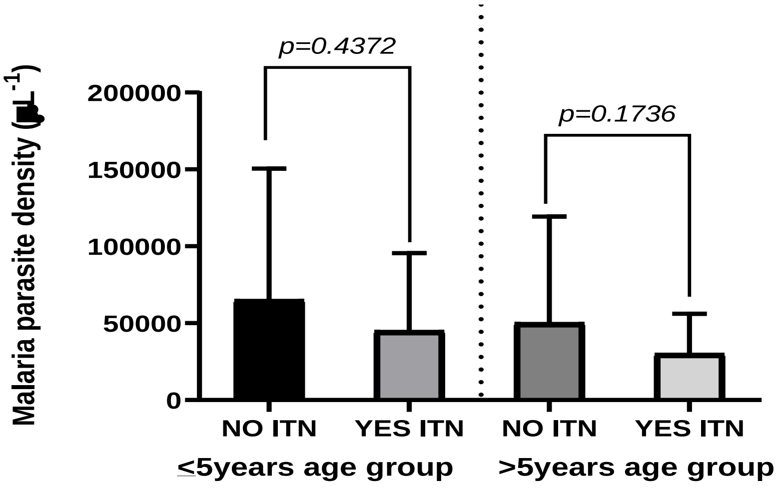

Fig. 6: Malaria parasite Density and the Use of ITN in Age Groups

DISCUSSION

Malaria remains a prominent and ancient disease which has been profiled and studied. Nigeria bears a higher burden of malaria in the African region despite the various gains in control and the quest for elimination. The study is on paediatric malaria, the associated symptoms and risk factors that influence persistence and continued transmission in childhood**.** The results showed high malaria prevalence in this community. This supports the report of the World Health Organization (WHO, 2022) and Nigeria Malaria Indicator Survey (Siko *et al.*, 2024), which stated that malaria remains a major public health problem worldwide, particularly among children. A higher prevalence (72%) has been reported in the Northern part of Nigeria by Umma *et al.* (2017). A prevalence of 25% of children less than 5 years has equally been reported in Akure, Nigeria. In 2018 a survey involving a weighted sample size of 10,185 children who were tested for malaria using a rapid diagnostic test (RDT) in Nigeria showed that the proportion of children 6–59 months of age that had malaria fever positive was 35.5% (3418/10,185), (CI: 33.9–37.1). Kebbi State had the highest (77.7%, CI: 70.2–83.5), followed by Katsina State (55.5%, CI: 47.7–63.1) and the Federal Capital Territory (FCT), Abuja (29.6%, CI: 21.6–39.0) (Obasohan *et al.*, 2020).

The moderate prevalence rate compared with other studies may be because the PHC is situated in the heart of Lagos. Also, the Government of Lagos State is implementing free Malaria programme where malaria diagnosis using Rapid diagnostic Tests (RTDs) and treatment is provided free for all ages; children, pregnant women, adult men, women and the elderly (https://lagosministryofhealth.org › malaria-control-progr).

Sex prevalence in this study showed that the male children had a higher prevalence of malaria than their female counterparts but without any significant difference. Both sexes (males and females) were equally affected, which could be due to exposure to the parasite in terms of geographical differences, poor socio-economic conditions and variation in malaria prevention and control interventions in these regions. Similar findings were reported by Millicent *et al*. (2015) and Inah *et al*., 2017), however, different studies have reported varying prevalence, some indicating higher prevalence for male children while others reported higher prevalence in females (Okiring *et al*., 2022; Jennifer *et al.*, 2016).

Although malaria affects all age groups, the age group 0-5 years had the highest prevalence. This high prevalence compared with other age groups could be attributed to their vulnerability due to immature immune systems (Mbishi *et al.,* 2024) and their inability to adequately protect themselves from mosquito bites if not provided for by their parents. The high prevalence recorded in this age group was also reported by Edogun *et al.* (2017) who recorded a prevalence of 48.4 % in children aged 1-5 years.

This study confirms that haematological abnormalities considered hallmarks of malaria infection are common and more pronounced in *P. falciparum* malaria infection, probably due to the higher levels of parasitaemia found in these patients. Leucocytosis was frequently seen in the malaria-infected children but no significant difference in WBC was found between the two groups. These findings are comparable with other studies (Roy *et al.*, 2019; Kini & Chandrashekhar, (2016). which reported no significant difference in WBC between the malaria-infected and non-infected groups. In contrast, other studies have demonstrated leucopaenia (Kotepui *et al*., 2020 or leucocytosis (Mensah, 2020). According to Kotepui *et al.* (2020), the total leukocyte count is affected by malarial infection at the baseline. Also, children with malaria in this study had significantly higher neutrophil counts compared to the non-malaria-infected children. Clinical data has shown that the number of circulating neutrophils is high in patients with acute uncomplicated malaria (Babatunde, K. & Adenuga, O. 2022; Aitken *et al.,* 2018).

Stomach ache was significantly associated with high parasite density. Aches and pains all over the body (especially the back and abdomen), and an abnormally large spleen can be associated with malaria infection in children (https://kidshealth.org › parents › malaria), however, the relationship between malaria and gastrointestinal disturbance remains unclear (Sey *et al.*, 2020). In some children, fever is usually continuous and may be very high (40°C) from the first day while many children will have only flulike respiratory symptoms at presentation, with mild cough and cold (https://emedicine.medscape.com › 998942-overview). Other studies have reported that the majority of children under the age of five years had malaria coexisting with fever and cough which are known to be leading causes of febrile illnesses (Kiemde *et al.*, 2018; **Abdul-Azeez *et al*., 2020**).

Also, the parasite density of children without fever and chills as symptoms of malria was significantly higher ($p<0.05$) than those with the symptoms. This could be asymptomatic malaria infection or subclinical malaria, which refers to malaria parasites in the blood without symptoms (Das *et al*., 2015). It is highly prevalent in endemic areas of Sub-Saharan Africa, where only a small percentage of individuals exhibit clinical symptoms (Njama-Meya *et al*., 2004; Chourasia *et al.,* 2017). This situation may delay malaria elimination and control programs in Nigeria.

The usage of Insecticide Treated Net (ITN) is an important tool to control malaria but it was not significantly associated with malaria parasite density in the survey. Similarly, a survey of malaria in children aged between 6 and 59 months in a program setting (Teh *et al.,* 2021; Abdella *et al.,* 2009) reported that mosquito net utilization was not associated with clinical malaria. Also in Haiti analyses revealed that ITNs did not significantly protect against clinical malaria (Laura *et al.*, 2017). Children who do not use ITN had a higher malaria burden however the mean difference in the use of ITN was not significant. Many studies have reported that the use of ITNs was significantly associated with malaria prevalence and parasite density, according to them those who did not use ITNs regularly reported a high occurrence of malaria infection with a high parasite density, as compared to those who used ITNs daily (Fana *et al*., 2015; Okeke *et al.*, 2016; Abossie *et al.*, 2020; Debash *et al.*, 2022).

The lack of association between the use of ITNs and parasite density may be due to mosquito resistance to insecticides and the widespread use of older ITNs (Shah *et al*., 2020). Another reason may be the age of the participants which is below 5 and above 5 years. In Guinea, school-aged children (5–10 years) used ITNs less than those under 5 years of age, similar to observations in other countries (Russell, *et al.*, 2015). Also in an interaction between ITN use and age (2–42 months of age versus 42–80 months) in determining the risk of febrile malaria, it was found that the ITNs did not protect older children (Bejon *et al.*, 2009). Other reasons why the use of ITNs may not be associated with parasite density in the study area may be the presence of larval sites and inappropriate use of the nets, in households (Obala *et al*., 2015). Other may include heat or hot night temperature, low mosquito activity, lack of space for hanging, phobia for chemicals, preference for other preventive methods, lack of knowledge on preventive effects of ITNs and cultural beliefs as identified by Ajegena and Oti (2020).

Insecticide Treated Nets (ITNs) have been demonstrated to effectively reduce illness and death from malaria infections. Their coverage and proper utilization remain moderately low in many parts of sub-Saharan Africa (Apinjoh *et al.*, 2015). According to the CDC, ITNs are highly effective because they capitalize on mosquito behaviour (which involves seeking out human hosts) and, when combined with potent insecticides, significantly reduce malaria mosquito populations. The insecticides kill and repel mosquitoes, thereby decreasing the number of mosquitoes that enter homes and attempt to feed on people indoors. The CDC emphasizes that with high community coverage, the number and lifespan of mosquitoes will decrease, affording protection to all community members, whether they use a bed net or not (https://www.cdc.gov › malaria › php › public-health-strategy › insecticide-treated-nets).

CONCLUSION AND RECOMMENDATIONS

The study found a high prevalence of malaria infection among the group, with a higher incidence seen in male children. Children living in the study area infected with *P. falciparum showed* significant changes in their blood parameters, with the neutrophil count being the most commonly affected. Interestingly, utilization of insecticide-treated bed nets (ITNs) was not linked to lower parasite density. As a result, stakeholders should focus on uncovering the reasons behind this to enhance our efforts in fighting malaria within the region.

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