Original Research Article

Prevalence of Malaria Parasites among Children from 1 – 15 Years of Age at Bishop Shanahan Hospital Nsukka Enugu State, Nigeria

ABSTRACT

Aim: This study evaluated the prevalence of malaria parasites in children aged 1-15 years at Bishop Shanahan Hospital in Nsukka, Enugu State, Nigeria.
Study Design: The study was a random survey design.
Place and Duration of Study: The study was carried out in Bishop Shanahan Hospital in Nsukka, Enugu State, Nigeria between April and August, 2023.

Methodology: 200 respondents were chosen by a random survey method that used both microscopy and RDT. A semi-structured questionnaire was developed which was used to collect data on demographics such as gender and age of the children.

Results: Microscopy testing revealed that parasitaemia affected 49.0% of the youngsters (i.e. 26.0% + 23.0% ++) while RDT results showed that 54.0% of the children were positive. The prevalence of malaria parasites by RDT and microscopy showed a substantial correlation (P=.00). Male and female children who underwent RDT tested positive in 53.2% and 55.1%, respectively. Additionally, employing microscopy, malaria parasites were detected in 47.7% male and 50.5% female children. Using RDT and microscopy, the prevalence of malaria parasites in children and gender were not substantially correlated (P>.05). 55.9% children between the ages of 1-5 tested positive for RDT, compared to 51.5% of children between 6-10 and 45.5% of children between 11-15. As a result, 51.7% children under the age of 1-5, 45.5% children between the ages of 6-10, and 36.3% of children between the ages of 11-15 had positive microscopy results. Using RDT and microscopy, the prevalence of the malaria parasite in children showed no age-related differences (P>.05).

Conclusion: The studied area has a high prevalence of malaria parasite infection. The control, prevention, diagnosis, and treatment of malaria infection in children under the age of five was advised as the main emphasis of targeted interventions.

Keywords: Parasitaemia; Prevalence; Children; Malaria parasites; Nigeria

1. INTRODUCTION

Although the overall life expectancy is pointing upwards all over the situation, malaria related mortality remains a hidden global scourge. The most common cause of hospital admission in children and in all age group, continuously reducing the population globally is malaria complexity [1]. Malaria is a mosquito-borne disease that kills a significant number of people in Africa every year [2]. The pathology is mainly caused by the *Plasmodium falciparum* parasite and is transmitted to human beings through infected female *Anopheles* mosquito bites [3]. Malarial parasites belong to the genus *Plasmodium*. The only genus in the family Plasmodiidae, order Haemosporida, class Coccidea, and Phylum Sporozoa (Apicomplexa) is *Plasmodium*[4]. The genus contains over 125 species that cause malaria in mammals, reptiles and birds [5], with

five species that cause malaria specifically in man. The species are *Plasmodium falciparum* which is widely distributed, mainly in the tropics; *Plasmodium vivax* which occurs sporadically in different parts of the world; *Plasmodium malariae* which has the widest distribution, extending through the tropics, subtropics and temperate zones, *Plasmodium ovale* which is mainly confined to Central West Africa and some South Pacific islands and *Plasmodium knowlesi* is now recognized as the fifth species of Plasmodium causing malaria in humans. *P. malariae* and *P. falciparum* together account for about 95% of human infections [5].

Malaria is a global public health problem; however, majority of the cases and deaths occur in the tropics and subtropics [6]. Most of the malaria cases occur in African region (90%) followed by the Southeast Asia (7%) and Eastern Mediterranean (2%) regions [6,7]. Malaria remains the leading cause of death in Nigeria with approximate 227,645 deaths in 1990 and 192,284 deaths recorded in 2015 [8]. Because the severity of the attack is constant throughout the year or from year to year, malaria transmission is intense and stable in Nigeria [9]. The degree of endemicity of malaria measured is based on the spleen rate in children aged 2-9 years in their order of severity [10]. When the spleen rate in children is lower than 10%, hypoendemic malaria is present. When children's spleen rates range from 11 to 50%, mesoendemic malaria is present [11].Hyperendemic malaria occurs when spleen rate is 75% in children and > 25% in adults. Holoendemic malaria occurs when spleen rate is >75% in children but very low in adults [12].

According to Nmadu *et al.*[11], malaria is a major cause of sickness and death among children. It is estimated that more than one million children living in Africa die yearly from direct and indirect effects of malaria infection [12]. Malaria infection was found to be most prevalent among 2-5years old, (29%) while ages 6-10 and 11-15years both had respectively, 17.5% infection of children visiting Gwarinpa General Hospital Life-Camp, Abuja, Nigeria [13]. Malaria is a problem among pupil 1-10 years old especially from age 2 years when their immunity from mothers' starts reducing [12].

Malaria is endemic in Nigeria and the ecology of the Bishop Shanahan Hospital Nsukka, Enugu region supports all-year transmission [14]. It remains among the commonest reasons for admission into the children's emergency ward [15,16]. Even with how high the incidence of malaria is in Nigeria, there is still the potential to miss cases of severe malaria based on clinical signs and symptoms alone [17]. Efforts to reduce the morbidity and mortality of malaria start with an accurate diagnosis of the condition. Therefore, the World Health Organization recommends that a parasitological confirmation of malaria be made before treatment is commenced, unless the resources are unavailable or the turnaround time for the test exceeds 2 hours. Cases with a negative test result may then be reassessed for other causes of fever [18].

According to the Nigeria Fact Sheet published by the US Center for Disease Control and Prevention, malaria is highly endemic in Nigeria with an estimated 53 million cases and 81,640 deaths reported in 2018[19]. Nsukka, where Bishop Shanahan is located, is in Enugu State, which is one of the states in Nigeria with a high burden of malaria. The Enugu State Ministry of Health has implemented various measures to reduce the incidence of malaria, including the distribution of insecticide-treated bed nets, the use of artemisinin-based combination therapy for treatment, and the implementation of indoor residual spraying. However, the prevalence of malaria in Bishop Shanahan Hospital Nsukka specifically would require further investigation and analysis of local data.

Malaria is a preventable and curable disease and yet an estimated one million people in Africa die from malaria each year and most of these are children [20]. According to the Africa Malaria Report from 2003, malaria claims the lives of more than 3,000 African children daily [21]. It is a sickness that primarily affects the underprivileged, who experience lack of access to economic, social, and educational opportunities. It is important for children to understand the effects of malaria and maintain consciousness within their environment. Given the high prevalence of malaria and mortality rate in Nigeria especially among children, accurate diagnosis and proper management of malaria infection are crucial. Also, there is limited study of malaria in this study area and within the age bracket. This makes the research work very essential. The aim of the study is to determine the prevalence of malaria among children from 1 – 15 years at Bishop Shanahan Hospital, Enugu State, Nigeria. The specific objectives of the study include determining the demographic features of children from 1 – 15 years of age that attended Bishop Shanahan Hospital,Nsukka, Enugu State, prevalence of malaria parasite in the children using microscopy, prevalence of malaria parasite in the children using rapid malaria diagnostic test, compare the prevalence of malaria parasite between microscopy and RDT, compare the prevalence of malaria parasite in children relation to gender using RDT and microscopy and compare the prevalence of malaria parasite in the children relation to age category using RDT and microscopy.

2. MATERIALS AND METHODS

2.1 Study Area

Bishop Shanahan Hospital is a private hospital established by Catholic Diocese of Nsukka with the aim of providing health care services to the masses both the poor and the rich, also training nurses and midwives in the field of Health Sciences. It was said to have been established in 1940 under the auspices of the Catholic Church and is owned by the church under the Bishop. This implies that the bishop is the echelon in the hospital's organization chart. It is a missionary hospital in joint partnership with government that delivers excellent medical services. The hospital serves people from both far and wide. Bishop Shanahan Hospital is located at Enugu road, Nsukka, Enugu State, between latitude $6^0$50'59.7''N and longitude $7^0$23'42.6''E.

2.2 Study Design and Population

The study was conducted from April to August, 2023. It was a random survey design aimed at finding out the prevalence of malaria among children of 1 – 15 years old in the study area. With the presence of signs of severe and complicated *Plasmodium falciparum*-malaria and results from laboratory observations was used to determine the prevalence of *P. falciparum* infection in the study population.The target population was 200 children, within the age range of 1 – 15 attending Bishop Shanahan Hospital, Nsukka, Enugu State, Nigeria.

2.3 Sample Collection

2.3.1 Blood sample collection

Blood samples were collected aseptically into EDTA containers from the children within the selected age by the help of qualified laboratory personnel. 2ml venous blood was collected from each child using a tubing tourniquet tied to the upper arm of the child. After cleaning,

blood samples were collected and emptied into anticoagulant specimen bottles, already labeled with child's name and mixed gently. Samples were analyzed on the same day of collection almost immediately for the presence of malaria parasites. Samples that could not be analyzed same day of collection were stored in a refrigerator.

2.3.2Questionnaire administration

A semi-structured questionnaire was developed for the purpose of this study which was used to collect data on demographics such as gender and age of the children.

2.4Malaria diagnosis

Diagnosis was made using rapid diagnostic tests and microscopy. One milliliter of venous blood was collected from each participant. A rapid diagnostic test was carried out immediately using the Histidine rich protein 2-based SD Bioline Malaria Ag Pf test kit (Standard Diagnostics Inc., USA) according to the manufacturers' instructions. A pair each, of both thick and thin blood smears were made on glass slides and stained using 3% Giemsa stain [22]. Each of these was read by two independent microscopists blinded to the results of the other [22]. A patient was said to be positive if either RDT or microscopy demonstrated the presence of malaria parasites at least 100 microscopic fields [22,23].

2.5Data analysis

Data were coded, entered, cleaned, and analyzed using Chi-square analysis. Descriptive statistics like frequency, prevalence, and mean were manipulated to explain the study participants and to show the malaria prevalence in the study area. Binary logistic regression was used to assess associationbetween socio-demographic and other independent variables with *Plasmodium* infection. Odds ratio (OR) with the corresponding95% confidence interval (CI) was used to determine the strength in association between dependent and independent variables. Associations were considered as significant only if *P* value was less than .05.

3. RESULTS

3.1 Demographic characteristics of the children

Table 1 reveals that 111 (55.5%) of the studied male children and 89 (44.5%) of the examined female children both had malaria parasites. Male children really have a higher malaria prevalence. According to the findings, children between the ages of 1 and 5 (72.5%) and 6 to 10 (16.5%) had the highest rates of malaria infection, while those between the ages of 11 and 15 (11.0%) had the lowest rates. The average age of the kids who went to Bishop Shanahan Hospital in Nsukka, Enugu State, between the ages of 1 and 15 is 4.70. It can be inferred from this that the majority of kids in this age range are still very young. Furthermore, compared to older children, it shows a higher percentage of youngsters under the age of five.

Table 1: Demographic characteristics of children from 1 – 15 years of age attending Bishop Shanahan Hospital,Nsukka, Enugu State, Nigeria

Socio-economic characteristics	Frequency	Prevalence(%)	Mean
Sex			
Male	111	55.5	

Female	89	44.5	
Age			
1 – 5	145	72.5	
6 – 10	33	16.5	
11 – 15	22	11.0	
			4.70

3.2 Prevalence of malaria parasite in children using microscopy and RDT

According to Figure 1, 51.0% of children visiting Bishop Shanahan Hospital were parasite-free, whereas 49% had malaria, which amounted to 26.0% + malaria parasitaemia and 23.0% ++ malaria parasitaemia when the prevalence of malaria parasites was assessed by microscopy.
Figure 2 demonstrates that utilizing a RDT test, 54.0% of children at Bishop Shanahan Hospital tested positive for the malaria parasite, whereas 46.0% did not.

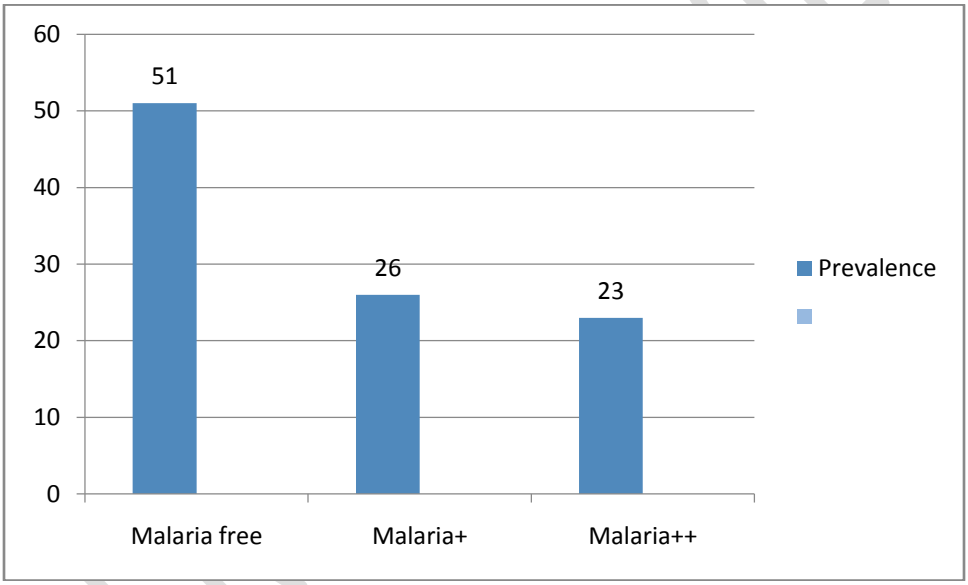

Figure 1: Prevalence of malaria parasite in children from 1 – 15 years of age attending Bishop Shanahan Hospital using microscopy

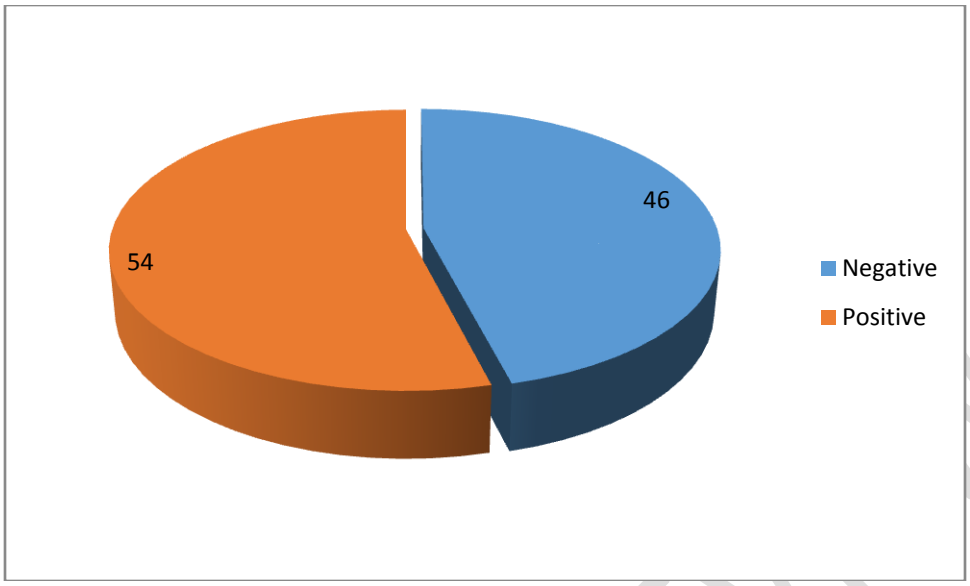

Figure 2: Prevalence of malaria parasite in children from 1 – 15 years of age attending Bishop Shanahan Hospital using rapid malaria diagnostic test

3.3Comparison of the prevalence of malaria parasite between microscopy and RDT

The chi-square test of analysis was used to compare the prevalence of the malaria parasite between microscopy and the fast malaria diagnostic test. The study's null hypothesis is that the independent variables microscopy and RDT have no relationship to one another.Table 2 demonstrates that compared to 46% of children who tested negative for RDT, 51.0% of children tested negative under microscopy. While 54.0% of children tested positive for malaria parasites by RDT, only 49% of children tested positive for the parasites under microscopy, representing 26.0% of + malaria and 23.0% ++ malaria parasitaemia. The null hypothesis, according to which there is an association between the prevalence of malaria parasites under microscopy and RDT, is supported by the Chi-square statistic value of 163.689, which had a probability value (P = 0.00) less than the prescribed alpha level (P = .05). This suggests that the two variables are not related to one another. The Chi-square finding's proposed explanation that the microscopy test was positively linked with the RDT is constrained by the Kendall's tau-b result. The correlation value of 0.813, which was positive and significantly correlated, made this clear.

Table 2: Comparison of the prevalence of malaria parasite between microscopy and RDT

Parameters		**RDT**		**Total**	**Prevalence (%)**
		Negative	**Positive**		**%**
Microscopy	Malaria free children	102	0	102	51.0
	Malaria + children	0	52	52	26.0
	Malaria ++ children	0	46	46	23.3
Total		102	98	200	100
Prevalence (%)		51.0	49.0	100	100
χ=200.00 P =0.00					
Kendall's tau-b value = 0.898 P =0.00					

3.4 Comparison of the prevalence of malaria parasite in children in relation to gender using RDT and Microscopy

The Chi-square test of analysis was used to compare the prevalence of malaria parasite using RDT and microscopy in relation to gender. The study's null hypothesis is that gender and neither RDT nor microscopy are related to one another because they are independent variables. Table 3 reveals that whereas 44.9% of children tested negative for RDT were female, 46.8% of them were boys. In a similar vein, boys made up 53.2% of children who tested positive for RDT, while girls made up 55.1%. The Chi-square statistic value (= 0.072) was low and had a probability value of 0. 788 (>.05), indicating that there was no link between gender and the prevalence of the malaria parasite in children who attended Bishop Shanahan Hospital using RDT. This was better explained by the Kendall's tau-b result (0.019), which demonstrated a lack of connection or, to be more precise, a zero correlation between the research variables. However, the same data also reveals that for microscopic testing, 52.3% of male and 49.4% of female children aged 1 to 15 were malaria-free. As a result, employing microscopy, 21.6% of males and 24.7% of females were found to have ++ malaria parastaemia, whereas 47.7% and 50.5% of males and females, respectively, tested positive for + malaria parastaemia. The Chi-square statistic value (= 0.284) was low and had a probability value of 0.868 (>.05), indicating that there was no link between gender and the presence of the malaria parasite in children who attended Bishop Shanahan Hospital with gender using microscopy. This was better explained by the Kendall's tau-b result (0.033), which demonstrated a lack of connection or, to be more precise, a zero correlation between the research variables.

Table 3: Comparison ofthe prevalence of malaria parasite in children from 1 – 15 years of age attending Bishop Shanahan Hospital in relation to gender using RDT and microscopy

Parameters		**Gender**				**Total**	**Prevalence (%)**
		Male	**Prevalence (%)**	**Female**	**Prevalence (%)**		
RDT	Negative	52	46.8	40	44.9	92	46.0
	Positive	59	53.2	49	55.1	108	54.0
Total		111	100.0	89	100.0	200	100.0
		χ=0.072*P* =0.79					
		Kendall’s tau-b value = 0.019*P* =0.79					
Parameters		**Gender**				**Total**	**Prevalence (%)**
		Male	**Prevalence (%)**	**Female**	**Prevalence (%)**		
Microscopy	Malaria free	58	52.3	44	49.4	102	51.0
	Malaria +	29	26.1	23	25.8	52	26.0
	Malaria ++	24	21.6	22	24.7	46	23.0
Total		111	100.0	100.0	99.9	200	100.0
		χ=0.284*P* =0.87					
		Kendall’s tau-b value = 0.033*P* =0.87					

3.5 Comparison of the prevalence of malaria parasite in children relation to age category using RDT and microscopy

The Chi-square test of analysis was used to compare the prevalence of the malaria parasite using RDT and microscopy in relation to age. The study's null hypothesis states that the independent variables age and microscopy, as well as RDT and age, are not related to one another.According to Table 4, the age ranges of the children that tested negative to RDT were 1 to 5, 6 to 10, and 11 to 15 years old, respectively. In a similar vein, the RDT revealed good results in 55.9% of young children (1–5), 51.5% of kids (6–10), and 45.5% of kids (11–15). The prevalence of the malaria parasite in children being treated at Bishop-Shanahan Hospital had no association with age or was not connected with age, according to the Chi-square statistic value (= 17.886), which was relatively low and had a probability value of 0.212 (>.05). The Kendall's tau-b result (-0.043), which indicated a weak negative correlation or, more precisely, portrayed a negative correlation between the research variables, provided a more comprehensive explanation for this.Therefore, 51.7% of children between the ages of 1 and 5, 45.5% of children between the ages of 6 and 10, and 36.3% of children between the ages of 11 and 15 tested positively using microscopy, accounting for 27.6% of children between the ages of 1 and 5, 27.3% of children between the ages of 6 and 10, and 13.6% of children between the ages of 11 and 15. Additionally, 24.1% of children between the ages of 1 and 5, 18.2% of children between the ages The Chi-square statistic value (= 2.851) was low and had a probability value of 0.583 (>.05), indicating that there was no link between age and the presence of the malaria parasite in children who were patients at Bishop Shanahan Hospital with gender using microscopy. This was more explained in the result of the Kendall's tau-b (-0.078) which showed the non-existence of correlation or rather portrayed a zero correlation between the study variables.

Table 4: Comparison ofthe prevalence of malaria parasite in children from 1 – 15 years of age attending Bishop Shanahan Hospital in relation to age using RDT and microscopy

Parameters		**Age (years)**						**Total**	**Prevalence (%)**
		Freq.	**Prevalence (%)**	**Freq.**	**Prevalence (%)**	**Freq.**	**Prevalence (%)**		
		1 – 5		**6 – 10**		**11 – 15**			
RDT	Negative	64	44.1	16	48.5	12	54.5	92	46.0
	Positive	81	55.9	17	51.5	10	45.5	108	54.0
Total		145	100.0	33	100.0	22	100.0	200	100
χ=17. 886 *P* =0.21									
Kendall's tau-b value = -0.043 *P* =0.21									
Parameters		**Age (years)**						**Total**	**Prevalence (%)**
		Freq.	**Prevalence (%)**	**Freq.**	**Prevalence (%)**	**Freq.**	**Prevalence (%)**		
		1 – 5		**6 – 10**		**11 – 15**			
Microscopy	Malaria free	70	48.3	18	54.5	14	63.6	102	51.0
	Malaria +	40	27.6	9	27.3	3	13.6	52	26.0
	Malaria ++	35	24.1	6	18.2	5	22.7	46	23.0
Total		145	100.0	33	100.0	22	100.0	200	100
χ=2.851*P* =0.583									
Kendall's tau-b value = -0.078*P* =0. 58									

4. DISCUSSION

From the findings of the study, there was high prevalence of malaria infection among children between ages 1 and 15 years in the study area. Out of the 200 children examined, 49% of children tested positive of malaria parasites under microscopy accounting for 26.0% of malaria+ and 23.0% malaria ++. This is not similar to previous study in Bayelsa State, Nigeria where a higher proportion of 63.3% was reported [24]. The fact that almost half of the population 49.0% of children tested positive to malaria indicates a significant burden of the diseases in the hospital although 23.0% of children testing malaria++ typically suggesting a more severe malaria which can lead to complications such as anaemia, respiratory distress, organ failure, and even death requiring prompt and aggressive treatment.

An average proportion (54.0%) of children who tested positive under RDT suggests a high prevalence of malaria in the surveyed sample. The high number of malaria positive cases may indicate limited access to healthcare facilities, diagnostic tools, or treatment options in the affected area. This could be due to various factors such as remote locations, lack of resources, or inadequate healthcare infrastructure. According to Ali *et al.* [23] and Bhutta *et al.*[25], the high number of malaria positive cases may suggest that preventive measures against malaria, such as insecticide-treated bed nets or indoor residual spraying, are not effectively implemented or utilized in the community. This may contribute to the high disease burden among children. This is in line with the findings of Chessed *et al.*[26], that the higher prevalence rates (59%) among children could indicate a higher level of malaria transmission in the environment. That is, the concentration of malaria vectors or breeding sites that pose a greater risk to children may be location specific.

In this study, there was significant difference between the result of microscopy and RDT with regards to comparison of the prevalence of malaria infection under microscopy and rapid malaria diagnostic test. The higher prevalence rate in RDT compared to microscopy suggests that RDT may be more sensitive in detecting malaria parasites. This could indicate that microscopy may be less efficacious, leading to a relative under-diagnosis and potentially inadequate test methods in the study context. Malaria RDTs reported comparable sensitivity and specificity to microscopy in several other studies [27,28] who stated that the difference in prevalence rates between microscopy and RDT highlights the variability in diagnostic techniques and their ability to accurately detect malaria infections. This raises concerns about the consistency and reliability of diagnostic methods used in different settings, which can impact the effectiveness of disease surveillance and control efforts. However, Andrade *et al.*[29] recorded higher prevalence rate (66.3%)detected by RDT suggests the need for more accurate and accessible diagnostic tools for malaria. RDTs are relatively easy to use and provide rapid results, making them suitable for resource-limited settings.

The difference in prevalence rates between males and females suggests potential gender-specific vulnerabilities to malaria. The higher prevalence among females in both microscopy and RDT could indicate differences in exposure or susceptibility to infection. The variation in prevalence rates between males and females may also reflect differences in access to healthcare services. It is possible that females have better access to diagnostic testing and treatment, leading to higher detection rates.This present study confirms with the findings of Ezeigbo *et al.*[24] that females were more infected than males, but differs from the results of Benisheikh *et al.*[30] and Umaru and Uyaiabasi[31] who reported higher prevalence rate in males than their female counterparts.

This varied finding may be explained by Okonko *et al.*[32] and Marotta *et al.*[33] who stated that there is no scientific evidence to prove higher prevalence being related to gender as susceptibility to malaria infection which is not influenced by gender. This implies that malaria infection depends on the person's exposure to infectious bites of mosquito vectors.

The varying prevalence rates between different age categories suggest potential age-specific vulnerabilities to malaria. The higher prevalence rates among younger age groups (1-5 years) compared to older age groups (6-10 years and 11-15 years) in both microscopy and RDT could indicate differences in exposure, immunity, or susceptibility to infection. According to Geldsetzer*et al.*[34], the lower prevalence rates among older age groups could be attributed to acquired immunity from previous exposure to malaria. As individuals age, they may develop partial immunity to the disease, leading to lower infection rates. However, variations in prevalence rates between different age categories may also reflect differences in healthcare-seeking behaviour. It is possible that younger children have better access to diagnostic testing and treatment, leading to higher detection rates. This is similar with the findings of Alessandro and Lorenzo [35]. The differences in malaria prevalence between age categories could be influenced by variations in vector exposure and protective measures. Younger children may spend more time outdoors or have less access to protective measures such as bed nets or insect repellents, increasing their risk of malaria infection.

5. CONCLUSION

From the result of this study, it may be concluded that the prevalence of malaria parasite infection is high in the studied area. The association between malaria prevalence in microscopy and RDT provides valuable information for improving diagnostic accuracy, guiding test selection, allocating resources, and enhancing surveillance systems for malaria control and management. The usefulness and reliability of RDT kits for malaria diagnosis in the absence of expert microscopy is also re-enforced. To ascertain the variation in the prevalence rate, the study did not extend its study period to the dry season and only took into account one hospital, despite the fact that it is a referral center.

ETHICAL APPROVAL

An introductory letter was collected from the Department of Zoology and Environmental Biology in the Faculty of Biological Sciences, University of Nigeria, Nsukka. With the letter, ethical approval was obtained from the Ethical Committee Bishop Shanahan Hospital to undertake the study. Informed permission and consent of the Head of the Laboratory Unit, laboratory attendants, haematologists and trained nurses of the health facilities were solicited to enable prompt recruitment of the study subjects.

Consent

As per international standards, parental written consent has been collected and preserved by the author(s).

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