

STATISTICAL ANALYSIS OF MALARIA INFECTIOUS DISEASE AND ITS POSSIBLE RISK FACTORS

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ABSTRACT

Malaria is an acute febrile illness marked by a high temperature and headaches that is brought on by parasites called Plasmodium, which people get through the bites of infected female Anopheles mosquitoes (WHO, 2021). Infants, young children, pregnant women, persons with HIV/AIDS, as well as people with low immunity are the most vulnerable populations. Thus, the study examined the statistical analysis of the malaria infectious disease, sex and age categories. The research adopted descriptive and analytical research design. The data was taken from the records of 300 patients at the Badore Primary Health Care Center in Lagos' Eti-Osa LGA, in southwest Nigeria. The data used was separated into risk factors including age, gender, and attendance type and outcome variables like malaria disease diagnosis. The epidemiological tools such as incidence rate, relative risk and attributable risk and Chi-square test of association to analyze the data. The analysis was ran on SPSS v25 and EPI Info v7. The malaria disease is 0.81 times less common among male patients than female, also that malaria among male are not attributed to gender difference (attributed risk (21.62%) < 50.0%). The malaria disease is 1.91 time less common among new patients than followed-up patients. More so malaria cases among reported new patients are not attributed to attendance difference because the attributed risk (47.62%) is less than 50.0%. The age and gender were not significantly associated with malaria infection. Though, the proportion of male affected with malaria disease is less than female.

Keywords: Attributable Risk, Chi-Square Test, Incidence Rate, Malaria Infectious, Relative Risk.

1. INTRODUCTION

Plasmodium parasites, which individuals contract from the bites of infected female Anopheles mosquitoes, produce the acute febrile sickness malaria, which manifests as fever and headaches (WHO, 2021). Two of these parasite species, *P. falciparum* and *P. vivax*, which cause malaria in humans, are the greatest threats, according to the World Malaria Report 2021. The most common and lethal malaria parasite on the continent of Africa is *P. falciparum*. The most common malaria parasite outside of sub-Saharan Africa is *P. vivax* (WHO, 2021).

Plasmodium falciparum, *Plasmodium vivax*, *Plasmodium malariae*, *Plasmodium ovale*, and *Plasmodium knowlesi* are the five main species that can infect humans, with *P. falciparum* being the most dangerous. *P. vivax* also poses a significant risk to people, according to Minwuyelet & Aschale (2021). (Deribew, 2017 and Aikawa, 1988).

The initial signs of malaria, including fever, headache, and chills, can be mild and challenging

to diagnose. They typically show 10 to 15 days after the infecting insect bite. If *P. falciparum* malaria is not treated, it can proceed to severe sickness and death in less than 24 hours.

Nearly half of the world's population would be at danger from malaria in 2020. Infants, young children, pregnant women, persons with HIV/AIDS, as well as people with low immunity going to places with high malaria transmission rates, such as migrant workers, mobile populations, and travelers, are at significantly increased risk of getting malaria and developing severe disease.

According to a 2021 World Health Organization study, the COVID-19 pandemic has negatively impacted malaria services, increasing the number of cases and fatalities.

The World Health Organization (WHO) estimates that there will be 241 million cases of malaria worldwide in 2020 and 627 000 malaria-related fatalities. This amounts to 69 000 more fatalities and approximately 14 million more cases in 2020 than in 2019. Inadequate malaria prevention, diagnosis, and treatment during the pandemic were

responsible for about 27% of these excess deaths (47 000). The circumstance, nevertheless, could have been much worse. In the early stages of the epidemic, WHO had predicted that major service disruptions might potentially cause a probable double-digit increase in malaria mortality in Sub-Saharan Africa in 2020. However, several nations acted quickly to strengthen their malaria programs, preventing this worst-case situation.

The majority of malaria cases and deaths in 2020 will occur in Sub-Saharan Africa, which will continue to bear the brunt of the disease's impact. Children under the age of five account for 80% of mortality in the area.

According to the World Malaria Report 2021, four African nations - Nigeria (31.9 percent), the Democratic Republic of the Congo (13.2 percent), the United Republic of Tanzania (4.1 percent), and Mozambique (3.8 percent) - account for just over half of all malaria deaths worldwide (WHO, 2022). The World Health Organization (WHO) has advocated effective vector control and the use of preventive antimalarial medications for the past 20 years in order to lessen the burden of malaria around the world (WHO, 2022).

In order to effectively prevent infection and lessen disease transmission, vector control is a crucial part of malaria control and elimination efforts, according to the World Health Organization (2022). Insecticide-treated nets (ITNs) and indoor residual spraying are the two main therapies (IRS). The distribution of long-lasting insecticide-treated nets (LLINs), the use of indoor residual spraying, and the deployment of artemisinin-based combination treatment (ACT) are all considered essential control measures for this improvement, according to Roll Back Malaria (2008), Griffin et al (2010), and Gahutu et al (2011). Anopheles mosquitoes are becoming more resistant to insecticides, which poses a threat to progress in the fight against malaria worldwide. In the period between 2010 and 2019, 78 countries reported mosquito resistance to at least 1 of the 4 widely used pesticide classes, according to the most recent World Malaria Report. Mosquito resistance to all major pesticide classes was observed in 29 different countries.

Nigeria has a nationwide transmission of malaria; 76% of the population lives in areas with high transmission, compared to 24% in areas with low transmission.

In the south, the transmission season might run all year round, while it only lasts three months or less

in the north. *Anopheles (An.) gambiae* s.s. is the main vector throughout the majority of the nation (USAID, 2020).

According to the 2020 World Malaria Report, Nigeria had the most instances of malaria worldwide (27% of cases worldwide) and fatalities worldwide (23% of deaths worldwide due to malaria) (WHO, 2019).

Between 2016 and 2019, the number of cases increased by 3.5%, from 293 to 303 per 1000 of the population at risk. But at the same time, deaths decreased 16%, from 0.57 to 0.47 per 1000 at-risk individuals (WHO, 2019).

Despite significant regional, rural-urban, and socioeconomic differences, microscopy data from the 2018 Nigeria Demographic and Health Survey (NDHS) reveal that the prevalence of malaria parasitaemia in children under five years of age is 23 percent (down from 27 percent in 2015 and 42 percent in 2010). (NMIS, 2015). The frequency in rural people is 2.4 times higher than in urban populations, ranging from 16 percent in the South and South East Zone to 34 percent in the North West Zone (31 percent versus 13 percent). Prevalence among children in the lowest socioeconomic group is seven times higher than that of the highest socioeconomic group (38 percent versus 6 percent) (USAID, 2020). The 2018 NDHS also revealed that 43% of people slept the night before inside an insecticide-treated net (ITN). (USAID, 2020).

The National Malaria Strategic Plan (NMSP) for the years 2014–2020 will expire in December 2020. But according to the 2019 Malaria Program Review, the new strategy plan's strategic direction for the malaria elimination program won't undergo any substantial modifications (USAID, 2020).

In order to fund health sector initiatives in 13 states of the Federation for five years (2020-2024), the Nigerian government has obtained credits from three multilateral institutions totaling \$364 million from the World Bank, the African Development Bank, and the Islamic Development Bank (USAID, 2020). The main objective of this study is to determine the incidence rate and relative risk of malaria infection reported at Badore Primary Health Care Center in Lagos's Eti-Osa Local Government Area and its association with gender, age, and type of attendance.

2. METHODOLOGY

Here, we adopt Chi-square statistic and the estimation is as follows:

$$X_{cal}^2 = \sum \sum \frac{(f_o - f_e)^2}{f_e},$$

where f_o is the observed frequency, f_e is the expected frequency.

Decision: Reject H_0 if p-value is less than 0.05. We fail to reject if otherwise.

Estimation of Incidence rate, relative risk (RR) and attributable risk (AR) are:

$$\text{Incidence rate} = \frac{\text{subject with } dx * 100}{\text{subject with } dx + \text{subject without } dx}$$

$$\text{Relative risk(RR)} = \frac{\text{Incidence of } dx \text{ among subject A}}{\text{Incidence of } dx \text{ among subject B}} = \frac{I_A}{I_B}$$

Note that dx implies occurrence of disease.

$$\text{Attributable risk (AR)} = \frac{I_A - I_B}{I_A} * 100$$

Decision: RR = 1 “no association”, RR > 1 “positive association” and RR < 1 “exposure is protective”.

Also, the descriptive and analytical research design are used in examine the record of the patients that visited the Badore PHC Centre due to sign and symptoms observed in their body. The data was extracted from the record of Badore Health Centre at Eti-Osa, LGA with sample size of 300 participants that was subjected to malaria test was taken from the record. Hence, the study based upon

the effect of malaria on sex and age, taking patients who are either cured or diagnosed with malaria sickness/symptoms. Anyone who does not fulfil the condition(s) of being a patient in the health Centre are not included in the study.

The data is a secondary data then, chi square technique and epidemiological tools were used to analyze the data with the aid of Epi-Info version 7 and Statistical Package for Social Sciences (SPSS) version 25.

3. RESULT

From the 300 participants that visited the health centre, male diagnoses of malaria are less common than female diagnoses (**table1**). Where 15.3% of those subjected to malaria test were under the age of 28 days, 4.0% were between the ages of 29 days

and 11 months, 2.0% were between the ages of 12 months and 59 months, 9.0% were between the ages of 5 and 9 years, 6.0% were between the ages of 10 and 19 years, and 63.7% were over the age of 20 when they were identified.

Table 1: Respondent Bio-Data

Bio Data	Category	Freq.	Percentage	Remark
Gender	Male	116	38.7	%of male < %of female diagnosed for malaria
	Female	184	61.3	
	Total	300	100.0	
Age group	0-28 days	46	15.3	%of ages 20years above diagnosed for malaria is more than other
	29 days -11 months	12	4.0	
	12 months-59 months	6	2.0	
	5-9 years	27	9.0	
	10-19 years	18	6.0	
	20 years or more	191	63.7	
	Total	300	100.0	
Malaria Diagnose	No	204	68.0	%of positive test for malaria infection is less than none
	Yes	96	32.0	
	Total	300	100.0	
Types of attendance	New	208	69.3	%of new > follow-up
	Follow-up	92	30.7	
		300	100.0	

Hypotheses Statement

1. Ho: The gender difference does not have significant influence on malaria infection

Ha: The gender difference have significant influence on malaria infection

Table 2: Cross tabulation gender and type of diagnosis

			Malaria Diagnosis		Total
			Yes	No	
Sex	Male	Count (%)	43(44.8%)	73 (35.8%)	116(38.7%)
	Female	Count (%)	53(55.2%)	131(64.2%)	184(61.3%)
	Total	Count (%)	96(100.00	204(100.0%	300(100.0%)

Chi-square statistic = 2.226, DF = 2, P-value > 0.05

Estimation of Incidence rate, Relative risk and Attributable risk of malaria cases by gender

Incidence of malaria cases among male is $43/96 \times 100 = 45$ per 100

Incidence of malaria cases among female is $53/96 \times 100 = 55$ per 100

Relative risk (RR) is $45/55 = 0.81$ (malaria disease is 0.81 times less common among male patients than female)

Attributable Risk (AR) is $(I_e - I_n) \times 100 / I_e = (45 - 55) \times 100 / 45 = -23.26\%$

This implies that malaria cases among males are not attributed to gender difference since attributed risk (-23.26%) is less than 50.0%.

Interpretation:

According to the study presented in Table 2, of all the patients diagnosed with malaria, 44.8% were men and the remaining 55.2% were women. According to descriptive statistics, women are more likely than men to have malaria.

Also, the aforementioned table revealed that (p-value > 0.05) gender differences are not a risk factor for malaria cases recorded at the Badore Primary Health Center in Eti-Osa LGA.

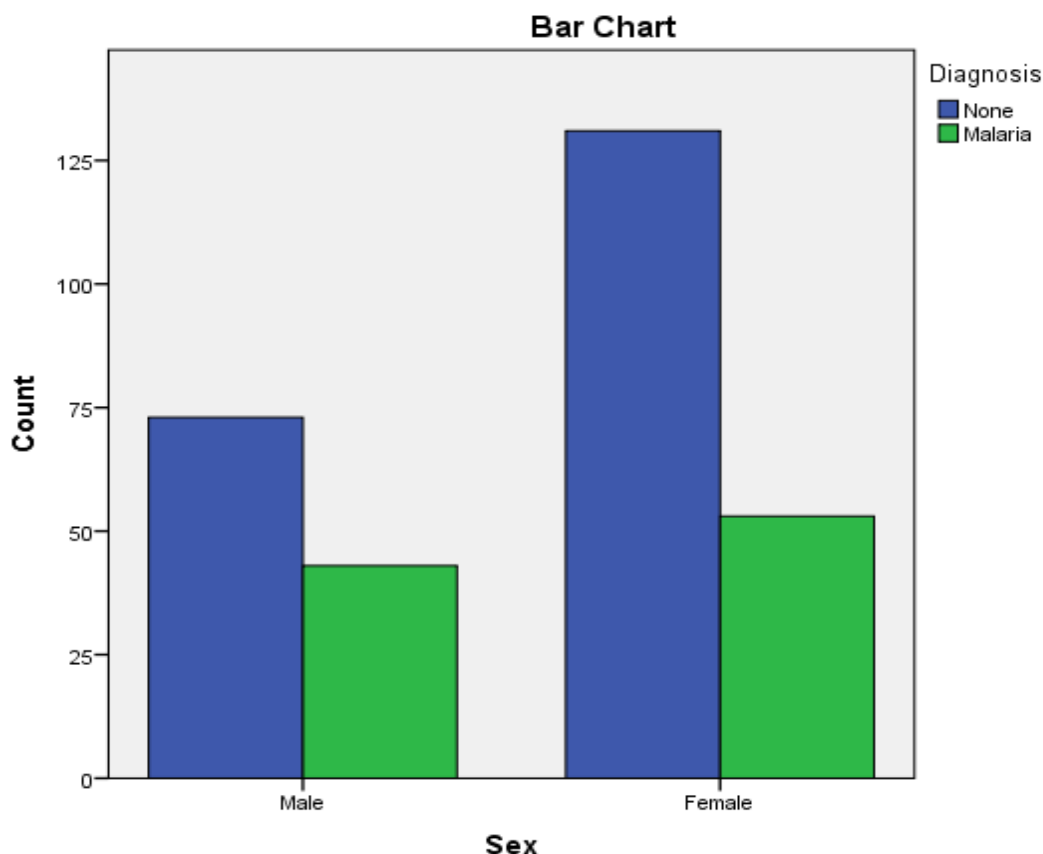


Figure 1: Bar chart for patients diagnosed for malaria with gender difference

2. Ho: The age is not a significant factor to influence malaria infection

Ha: The age is a significant factor to influence malaria infection

Table 3: Cross tabulation of age and malaria diagnosis

			Malaria Diagnosis		Total
			Yes	No	
Sex	0-28 days	Count (%)	29(14.2%)	17(17.7%)	46(15.3%)
	29 days -11 months	Count (%)	11(5.4%)	1(1.0%)	12(4.0%)
	12 months-59 months	Count (%)	5(2.5%)	1(1.0%)	6(2.0%)
	5-9 years	Count (%)	18(8.8%)	9(9.4%)	27(9.0%)
	10-19 years	Count (%)	9(4.4%)	9(9.4%)	18(6.0%)
	20 years or more	Count (%)	132(64.7%)	59(61.5%)	191(63.7%)
	Total	Count (%)	204(100.0%)	96(100.0%)	300(100.0%)

Chi-square statistic = 0.007, DF = 1, P-value > 0.05

From the table above, prevalence of malaria cases in age 20 years above is more than prevalence in all other age categories. While prevalence of malaria cases in under five years (18.7%) is more than all other age groups except age 20 years above. This implies ages under five years and 20 years above are more prone to malaria disease than other age groups.

It was concluded in the above table that age is not a determinant factor of malaria disease since p-value 0.935 is more than 0.05 level of significance. According to figure 1 above, female patients are more afflicted by the disease than male patients when it comes to those with a malaria diagnosis.

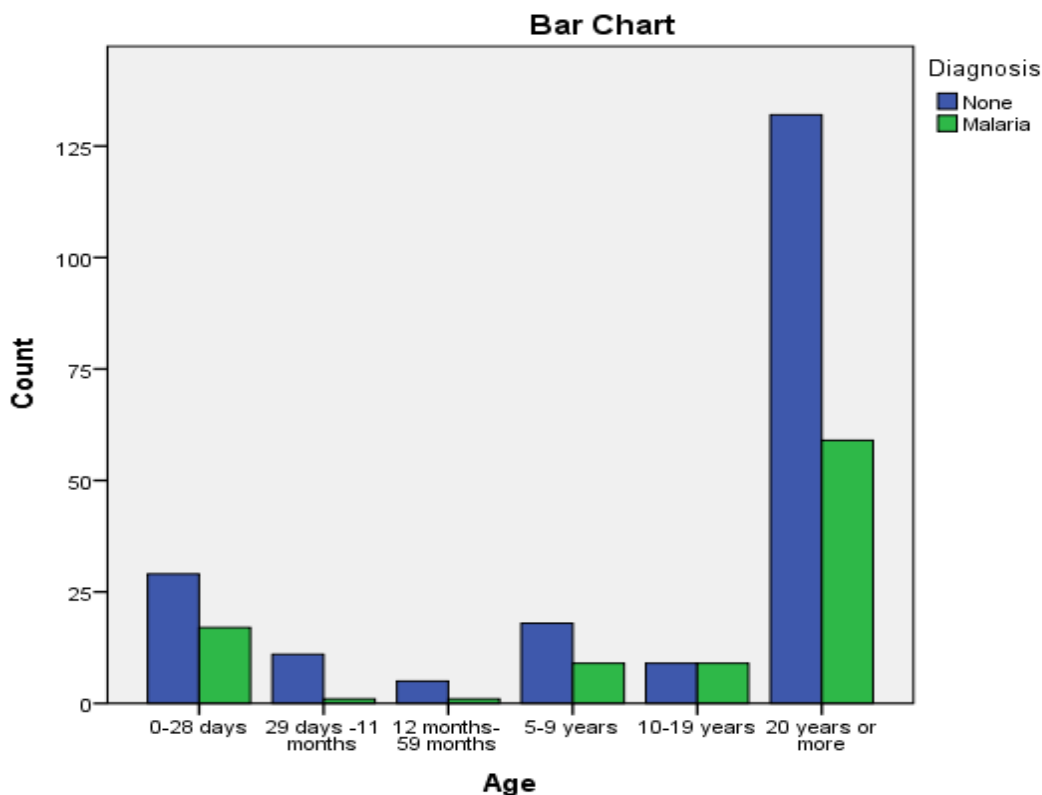


Figure 2: Multiple bar-chart of age group and malaria infection

Interpretation:

The graph above reveals the malaria infection according to patients' age distribution. It was found that patients in the ages 20 years and above were

more affected by malaria infection than others. While patients in the ages 0-28 days were the next that was affected by the malaria infection.

Table 4: Cross tabulation malaria infectious disease and type of diagnosis

			Malaria diagnosis		Total
			No	Yes	
Type of attendance	New	Count	145	63	208
		% within Malaria diagnosis	71.1%	65.6%	69.3%
	Follow up	Count	59	33	92
		% within Malaria diagnosis	28.9%	34.4%	30.7%
Total	Count		204	96	300
	% within Malaria diagnosis		100.0%	100.0%	100.0%

Estimation of Incidence rate, Relative risk and Attributable risk of malaria cases by type of attendance

Incidence of malaria cases among new attendants is $63/96 \times 100 = 66$ per 100

Incidence of malaria cases among follow-up is $33/96 \times 100 = 34$ per 100

Relative risk (RR) is $66/34 = 1.91$ (malaria disease is 1.91 times more common among new patients than follow-up patients)

Attributable Risk (AR) is $(I_e - I_n) \times 100 / I_e = (66 - 34) \times 100 / 66 = 47.62\%$

This implies that malaria cases among reported new patients are not attributed to attendance difference since attributed risk (47.62%) is less than 50.0%.

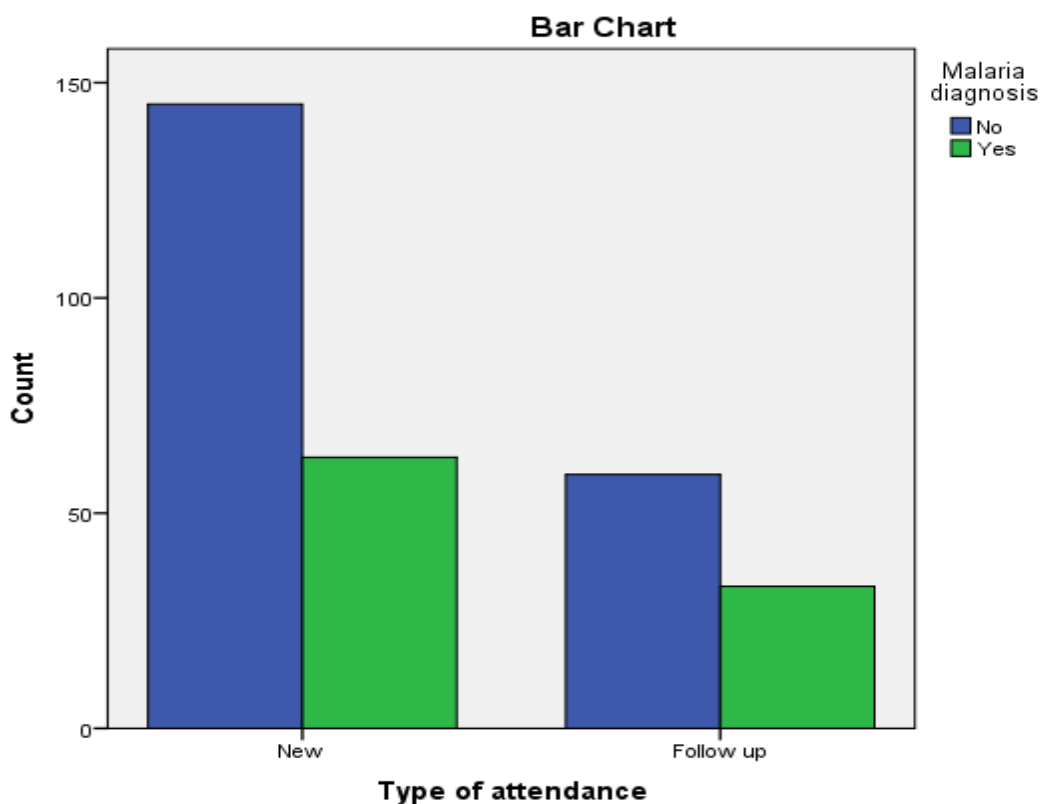


Figure 3: Multiple Bar chart of malaria disease on type of attendance

DISCUSSION

The present study mainly focused on the impact of gender, age and type of attendance of patients on malaria infectious disease. Then, the research employed descriptive statistics, chi-square test and epidemiological characteristics to analyze the data collected from Badore PHC. The analysis was run on EPI Info v7 and SPSS v25.

From the results, the study found that out of all the 300 patients that visited health centre, the general prevalence of malaria infectious disease was low

(32%). Out of all the patients positively tested for malaria disease, relative risk of malaria disease of male to female was 0.81, which indicated that malaria disease is 0.81 times less common among male patients than female patients. The overall prevalence of malaria disease reported in this study is lower than the 71.1% found in Ogun state southwest parts of Nigeria by Sam-wobo et al (2014).

In the study carried out in Iwo, Oyo state southwest part in Nigeria, the overall prevalence of malaria reported by Igbenegbu et al. (2011) is 21.1%, and a study by Anumudu et al. (2006) reported malaria disease prevalence to be 17%.

Some other studies the research reviewed, reported high overall prevalence of malaria disease, one of them is the study carried out in Abeokuta Ogun state southwestern part of Nigeria by Okonkwo et al. (2009) with 85.1% malaria prevalence, also Oyido et al. (2011) reported 70.8% in Anambra State eastern part of Nigeria, Aribodor et al. (2007) from Anambra eastern part of Nigeria revealed 76% malaria infectious disease and a study by Ukpai and Ajoku (2001) revealed 80.25% malaria disease overall prevalence in Owerri eastern part of Nigeria.

The findings also revealed that relative risk of malaria disease between patient with new cases of malaria and patients already under follow-up is 1.91, which means that malaria disease is 1.91 times more common among new patients than follow-up patients. None of the reviewed papers considered type of attendance as a risk factor of malaria infectious disease.

In this present study, we found that the prevalence of female positively tested for malaria disease is more than male counterpart, with which 44.8% is the prevalence of male with malaria and 55.2% with positive malaria are female. This was not in agreement with the study conducted by awoke and Yikbeltal (2021) in Bichena primary hospital Amhara region in Ethiopia, in which prevalence of malaria disease is higher in male than female. The study conducted in Ghana by Quaresima et al (2021) found that women were more exposed to malaria infectious disease than male counterparts, which also agreed with the present study.

The study conducted in Ogun state, southwest of Nigeria found that more male were affected by malaria disease than their opposite sex (Sam-wobo et al, 2014). Though, the present study further used chi-square test to determine if gender is associated with malaria infection disease and the result found that gender was not statistically associated with malaria infectious disease ($X^2 = 2.226$, p-value > 0.05). This was in support of the study conducted by Sam-wobo et al, 2014).

The study found that the highest prevalence of malaria disease was in age group 20 years and above which is 61.5%. While the prevalence of malaria in age under five years is 18.7% which is next to that of age group 20 years above. These

findings support the WHO (2022) report where stated that age under five years account for more malaria disease. And the study conducted by Sam-wobo (2014) did not support these findings since he found that ages 11 years below accounted for the highest prevalence of malaria disease. Gahutu et al (2011) supported this findings, and found that older age are more prone to malaria disease than the younger one that is increase in age bring about increase in the prevalence of malaria disease. The chi-square test of association indicated that age is not statistically associated with malaria infectious disease ($X^2 = 0.007$, p-value > 0.05).

CONCLUSION

Based on the results and findings, the following conclusions were reached;

The overall prevalence of malaria infectious disease is low when compare to most of the past authors. Though some authors reported overall prevalence of malaria that is lower than the present study results. Prevalence based on gender revealed that female patients are more affected by malaria infectious than male counterparts. The relative of male to female also connotes that more female are likely to be affected by malaria disease than male. More so, in the prevalence of malaria disease by age, it was found that under age five years still have pronounced prevalence of malaria even though age 20 years above have the highest prevalence of malaria disease above all other ages.

In the aspect of prevalence of malaria by type of attendance, there are more prevalence of malaria disease among new cases patients than those under followed-up.

The test of association revealed that gender, age and type of attendance are not statistically associated with malaria infectious disease. It is therefore recommended that government need to bring in intervention like health education through the health workers and the used of radio and television to be able to the main concern in the public. Based on the past studies, there is need for the health workers to educate the public more to use treated mosquitoes net.

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