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Original article

Prevalence And Distribution of Malaria Infection in Ifedore Local Government Area of Ondo State, Nigeria

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Abstract
Malaria remains the leading cause of mortality among parasitic infectious diseases worldwide, especially in the tropical and Sub-tropical regions of the world. The current study evaluated the prevalence of malaria infection in Ifedore Local Government Area of Ondo State, Nigeria. A total of 2,063 patients attending selected hospitals and health centres across eleven major settlements in the Local Government Area were enrolled for the study. Blood samples were obtained from the patients and examined for malaria parasite(s) using thick blood film microscopy. Demographic information of each patient was obtained using well structured close-ended questionnaire while data obtained were analyzed to test for significance using Pearson's Chi-Square at P=0.05. Results revealed a total of 1,619 (78.5%) participants positive for malaria infection. Respondents from Aaye town recorded the highest prevalence of infection at 95.1% while the least prevalence of 52.5% was recorded from Ero town. There was a significant difference (P<0.05) in the prevalence of infection among the sexes with the male (81.0%) having a higher prevalence than the female (76.8%). There was high prevalence of malaria infection across the study area which calls for more investigation into, and recommendation of, laudable control and preventive programmes.
Keywords: Prevalence, Malaria, *Plasmodium*, Ifedore LGA, Control.

Introduction

For many decades, war between malaria and mankind remains unsolved as malaria remains the leading cause of mortality among infectious diseases worldwide; especially in the tropical and sub-tropical regions of the world (WHO, 2015). Malaria remains a potential public health problem in the world as the annual global burden has been reported to be approximately 241,000,000 cases with 3,200,000,000 people at risk of the infection (WHO, 2015). In 2018, 219,000,000 cases of malaria were reported worldwide (WHO, 2018). Throughout the world, *Plasmodium falciparum* has been reported to be the most virulent of all the known species of *Plasmodium* contributing to about 95% death cases (WHO, 2020). Globally, despite reduction in the malaria cases in the past 15 years, millions of Africans in Africa region still battle with malaria due to lack of preventive and treatments tools (Mfueni *et al.*, 2018). In 2018, Nigeria was reported to have 25% of global malaria cases

with 24% mortality in the world making the country to be the first among 11 countries with high malaria prevalence globally (WHO, 2019).

Malaria transmission to man is done through the bite of an infected female *Anopheles* mosquito which bites mainly between night and dawn to extract blood meal (WHO, 2017). While low-income countries with poor preventive and control facilities still record very high prevalence of malaria; the variation in the epidemiology and clinical manifestation of malaria infection has been linked to some factors such as the species of malaria parasites that occur in a given area, their susceptibility to commonly used or available antimalarial drugs, presence of malaria resistant genes, the distribution and vectorial capacity of mosquito vectors, climate and other environmental conditions and the behaviour and level of acquired immunity of the exposed human population to infection. However, young children, pregnant women, and non-immune visitors to malaria endemic areas are at greatest risk of severe or fatal illness (Bloland, 2001; Schantz-Dunn and Nour, 2009)

In Nigeria, prevalence of the infection varies in different geopolitical zones of the county due to the different environmental conditions and seasonal variation that influence the breeding habit of mosquito vectors which in turn, affects vector abundance. The southwestern part of the country with higher annual rainfall and moderate temperature presents a higher prevalence of infection compared to the northwestern and northeastern regions of the country with a lower annual rainfall and high temperature (Mordi and Borke, 2013). Despite several control strategies employed by the government to reduce the prevalence of the disease, it is necessary to assess if these strategies are effective in reducing the scourge among the population, particularly in poor peasant settlements. Hinging on this, there is the need for continuous surveillance on malaria infection in the region to monitor its epidemiology. This will give an insight on more effective strategy to employ in combating the disease. Therefore, the study is aimed at investigating the prevalence of malaria in Ifedore LGA of Ondo State, south west region of Nigeria.

Materials and Methods

Study Area and Population

The research was conducted in Ifedore Local Government Area (LGA) of Ondo State, south west geopolitical zone of Nigeria. Eleven (11) towns in Ifedore LGA were studied (Figure 1). The LGA had its administrative headquarters at Igbara-Oke. It had an area of 295 km² with a population of 176,327 (NPC, 2009) and lies on latitude $7^0$27'20"N of the equator and longitude $5^0$10'10"E of the Greenwich meridian. It was largely an agrarian area with two climatic seasons, including the rain (wet) season, from March to October and the dry season, from November to February with an average annual rainfall of 1500mm. A total of 2,063 febrile malaria patients visiting selected hospitals and health centres in each of the towns were voluntarily recruited for the study.

Ethical Considerations

Ethical approval was sought and obtained from the Ethical Review Committee, Ministry of Health of Ondo State. Similarly, advocacy visits were paid to Ondo State Primary Health Care Development Agency, Coordinators of Basic Health Centres in Ifedore LGA, Officers in Charge (OICs) and the Chief Medical Directors (CMD) of various health centres and hospitals where samples were collected. Also, informed consent was obtained from the volunteers who voluntarily participated in the study.

Sample Size Determination

The sample size was determined using of Raosoft sample size calculator (Raosoft, 2004) at 5% margin of error and 95% confidence level (WHO, 2009). The sample size obtained for each of the studied town varied with the population size of each town.

Sample Collection

Phlebotomists were engaged in the collection of blood samples from febrile malaria patients of all ages visiting the selected hospitals and health centres in each of the towns for malaria test. Samples from each patient were collected through venipuncture with the use of sterile needle and syringe and transferred directly into an Ethylenediamine tetra-acetic acid (EDTA) bottle to prevent coagulation of the blood. Also, demographic data on each patient were recorded. The sample collection was done between January, 2019 to May, 2020 with a total of 2,063 samples collected in all the selected hospitals and health centres in the LGA.

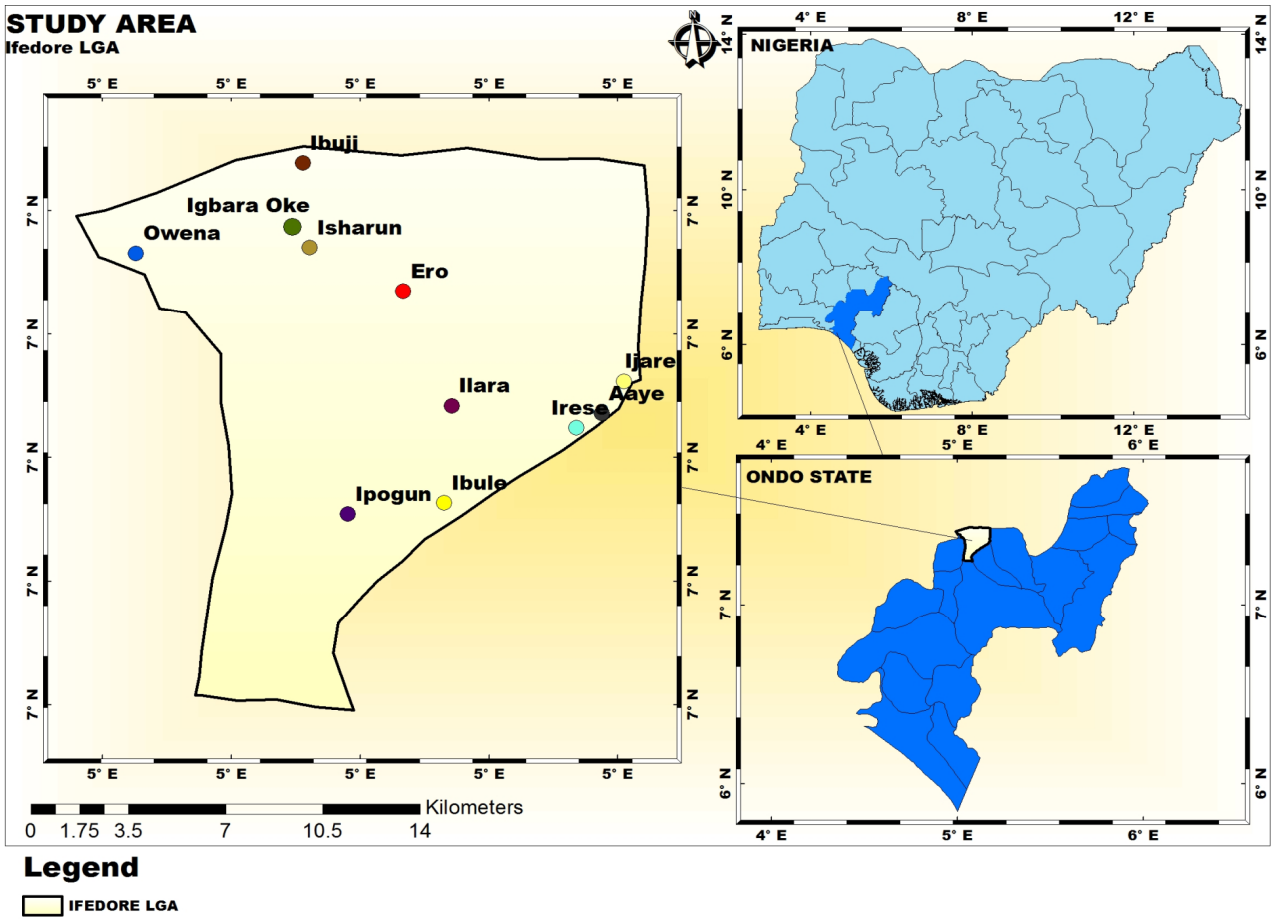


Figure1: Map of Ifedore LGA Showing the Study Sites.

Malaria Parasite Screening

Think blood film was used in screening the blood samples for malaria parasite. For every sample, the film was prepared on a clean grease-free glass slide and allowed to air dry for 15 minutes, and was followed with Giemsa staining for 15 minutes (Cheesbrough, 2000). After staining, the slide was rinsed using distilled water and left to air dry. Two drops of immersion oil was added to the slide and observed under the microscope at x100 objective lens for characteristic feature of malaria parasite (Dacie and Lewis, 2001). It was ensured that the slides that were negative were re-examined for accuracy.

Data Analysis

All data collected were recorded on Microsoft excel sheet and then exported to Statistical Package for Social Sciences (SPSS) version 26 (IBM SPSS Statistics) where the data were analyzed. Test for significance was done using Pearson's Chi-Square, Phi and Cramer's V Tests at P=0.05. All charts were created using Microsoft Excel.

Coordinate Collection and Map Construction

The coordinate of each town was taken using Geographical Positioning System (GPS) device (2Kit consulting, Dusseldof, Germany ©2006-2013 Google Inc. Version 2.0) (Table 1). While maps were constructed using Microsoft ArcGIS software (Esri® ArcGIS Desktop 10.7.1 Version 10.7.0.10450).

Results

A total of 2,063 malaria Patients across the eleven major towns in Ifedore LGA participated in the research, out of which 1,619 (78.5%) tested positive for malaria. Table 1 and Figure 2 present the prevalence and hotspot regions of malaria infection across the eleven towns respectively. It was observed that Aaye town

presented the highest prevalence of the infection (95.1%) with Ero town having the lowest prevalence (52.5%). Statistical analysis revealed a significant difference in the prevalence of malaria among the different towns (P<0.05).

The prevalence of malaria infection in relation to sex (Table 2) among the participants revealed that of the 816 male participants, 661 (81.0%) were positive for the infection; giving a higher prevalence than the female participants which showed 958 (76.8%) out of 1,247 that tested positive for the infection (P<0.05).

In the age group category, the highest prevalence (86.8%) was recorded among the age group ≤10, followed by participants within age group of 41-50 (81.8%), 11-20 (77.3%); while the lowest prevalence was recorded among participants within the age group of 51-60 (58.7%) (Figure 3). Result showed statistical significance at P<0.05 among the different age groups in the study area.

The infection rate of malaria in relation to marital status of participants in the study area is shown in Fig. 4. Results showed the 'single' group had the highest rate of infection (38%) followed by the 'divorced/widow' group (32%) while the lowest rate of infection was recorded among the 'married' group (30%) (P<0.05).

With regards to monthly prevalence of malaria infection in the study area, it was observed that the highest prevalence of infection was recorded in August (89.5%) followed by the months of January and March with the same prevalence of 86.7% and the least prevalence of infection was recorded in the month of May with 67.1% prevalence of infection. Statistical analysis showed a significant difference in the prevalence of malaria infection within the months (P<0.05) (Figure 5). However, there was no significant difference (P>0.05) in the seasonal prevalence of infection in the study area (Table 3).

Table 1: Prevalence of Malaria Infection in Towns of Ifedore LGA

Towns	Coordinates	Number Examined	Positive	Negative	Prevalence (%)
Aaye	5.161362; 7.348226	81	77	4	95.1
Ero	5.097260; 7.389621	101	53	48	52.5
Ibuji	5.064725; 7.432737	120	107	13	89.2
Ibule	5.110505; 7.318195	209	153	56	73.2
Igbara-Oke	5.061310; 7.41138	403	271	132	67.2
Ijare	5.168620; 7.359066	281	249	32	88.6
Ilara	5.112870; 7.350833	224	131	93	58.5
Ipogun	5.079285; 7.314411	196	168	28	85.7
Isharun	5.066987; 7.404285	79	74	5	93.7
Owena	5.010697; 7.402393	208	187	21	89.9
Irese	5.153278; 7.343449	161	149	12	92.5
Total		2063	1619	444	78.5

χ^2 =217.211, df = 10, P = 0.001, Phi= 0.001, Cramer's V= 0.001

Table 2: Prevalence by sex of malaria infection in Ifedore LGA

Sex	Number Examined	Positive	Negative	Prevalence (%)
Male	816	661	155	81.0
Female	1247	958	289	76.8
Total	2063	1619	444	78.5

χ^2 =5.104, df = 1, P = 0.024, Phi= 0.024, Cramer's V= 0.024

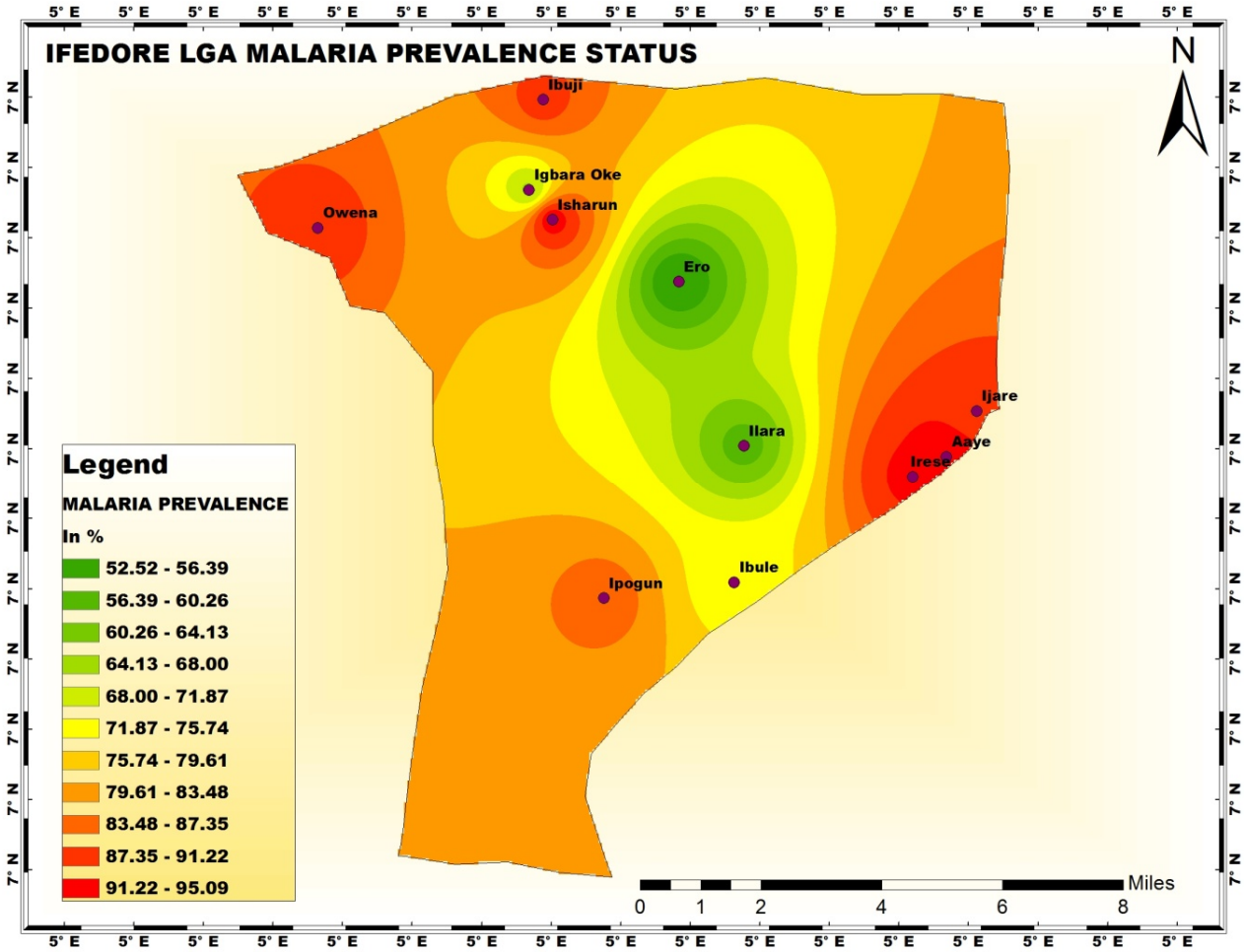


Figure 2: Malaria hotspot regions in Ifedore LGA

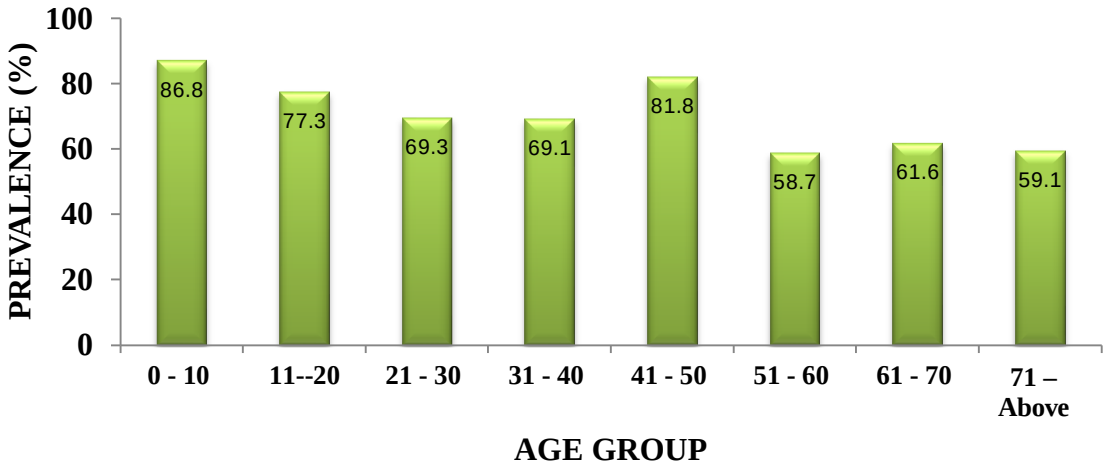
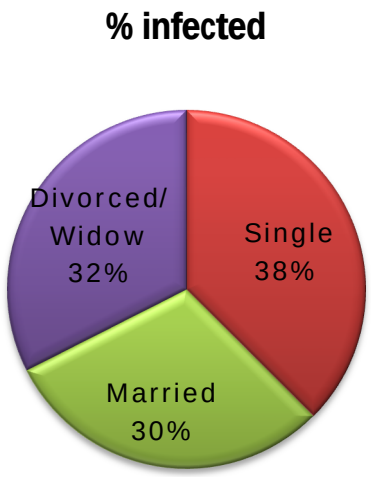
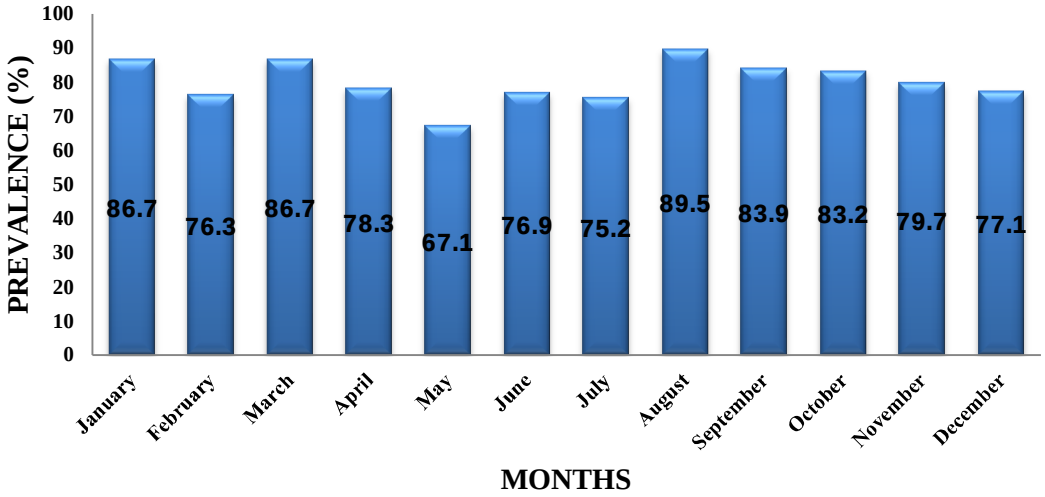


Figure 3: Prevalence of malaria infection among different age groups in Ifedore LGA



χ^2 =73.511, df = 2, P = 0.001, Phi= 0.001, Cramer's V= 0.001

Figure 4: Malaria infection rate in relation to marital status of participants in the study area



χ^2 =50.307, df = 11, P = 0.001, Phi= 0.001, Cramer's V= 0.001

Figure 5: Monthly Prevalence of Malaria Infection in the Study Area

Table 3: Seasonal Prevalence of Malaria Infection in the Study Area

Season	Number Examined	Positive	Negative	Prevalence (%)
Dry	425	340	85	80.0
Wet	1638	1279	359	78.1
Total	2063	1619	444	78.5

χ^2 =0.734, df = 1, P = 0.392, Phi= 0.392, Cramer's V= 0.392

Discussion

In the current study, the prevalence of malaria infection in the Ifedore LGA of Ondo State, Nigeria was evaluated. A very high overall prevalence of 78.5% of malaria infection was recorded. High prevalence of malaria infection

recorded in this study showed that malaria remains endemic in the study area which is a serious public health concern for intervention. Reports of high prevalence of the infection have also been shown in previous works (Houmsou *et al*., 2011; Dawaki *et al*., 2016; Obimakinde and Simon-Oke, 2017; Idris *et al*., 2018; Peter *et al*., 2019) in different parts of Nigeria, affirming the public health concern of malaria infection since the worst hit are children under 5 years of age.

Ifedore LGA is located in the rain forest zone of Nigeria, which is characterized with high rainfall that favours mosquito vector breeding. Therefore, high prevalence of malaria infection recorded in this study compared to low malaria prevalence region in the country could be attributed to the varying environmental conditions in the different study areas which could have influenced the diversity of the mosquito vector (Mordi and Borke, 2013). Across the different towns in the study area, that there was high prevalence of malaria infection, though there were variations fluctuating between 52.5% and 95.1%. These variations are not new (Kreuels *et al*., 2008; Woyessa *et* al., 2012; Mazigo *at* al., 2017; Solomon *et al*., 2020) and are expected, due varying anthropogenic activities, environmental conditions and vectorial capacity of the mosquitoes and more importantly, local and governmental efforts aimed at control.

The high prevalence of the infection in all the towns could be attributed to the presence of auspicious breeding sites for *Anopheles* mosquito vector in the study area. Oniya *et al*. (2019) in their research on ecological factors favouring mosquito breeding in Ifedore LGA of Ondo State, Nigeria encountered abundance of moquito vector larvae in all the towns. They reported presence of *Anopheles* mosquito larvae in Aaye, Owena and Isharun towns while other species of mosquito larvae not belonging to the genus *Anopheles* were also reported in other towns. High prevalence of infection in Aaye, Owena and Isharun towns compare to other towns may be linked to presence of *Anopheles* larvae as previously reported by Oniya *et al*. (2019). Variation in the prevalence of malaria infection in the different towns could also be as a result of malaria control and prevention activities in the various towns as malaria infection differed between geographical setting and population, the control strategy must vary according to each area's local epidemiology (Howes *et al*., 2016).

The prevalence of malaria infection in the LGA among the sexes revealed that there was a higher prevalence of infection among the male than the female participants. Similar findings were reported in previous studies (Houmsou *et al*., 2011; Feleke *et al*., 2018; Peter *et al*., 2019; Solomon *et al*., 2020) However, reports of Nzobo *et al*. (2015), Obimakinde and Simon-Oke, (2017) and Akogwu *et al*. (2018) showed a higher prevalence in female than the male. Although, reason for suceptibility of sexes to malaria infection has not been proven scientifically (Gilles and Warell, 1993), however, high prevalence of malaria infection among the male could be linked to their active engagement in farming and domestic activites which could have exposed then to *Anopheles* mosquito vector bite since one of the major occupations in the study area is farming which the male engaged in mostly. The ecology of the vectors may also play a role here, though the biting hours are largely between dusk to dawn, exophilic species may find the male a more ready source of blood meal than the endophilic species.

Among the age groups, result showed that all age groups were susceptible to malaria infection with the highest prevalence recorded among the age group ≤ 10 years. It was observed that the prevalence of infection decreased as the age increased. However, this was not the case in the age group 41-50 years. Obimakinde and Simon-Oke, (2017) in their study in Akure, Nigeria also reported similar malaria prevalence trend among the studied age group, however Alemu *et al*. (2012), Feleke *et al*. (2018) and Gebretsadik *et al*. (2018) in their various studies recorded a lower prevalence among the younger age group than the older age groups. The variation in the prevalence of infection in the different age groups could be attributed to behavioural habits (Mordi and Borke, 2013). Age group ≤ 10 years been the most susceptible to malaria infection could be as a result of low level acquired immunity among the subjects within the age group (Mordi and Borke, 2013) while the older age group had lesser prevalence to the infection due to previous exposure to the infection allowing them to have acquired some form of immunity against infection (Kamwi *et al*., 2012). Considering prevalence of infection

among the marital status, this could also be the reason while the participants that were single had the highest rate of infection compared to the married and divorced/widows because larger percentage of those that were single were in the lower age group bracket.

The monthly prevalence of malaria infection in the study area, and pattern of distribution of infection across the months revealed a variation in the prevalence of infection in all the months with the highest and lowest prevalence recorded in the months of August and May (both wet season months) respectively. Obimakinde and Simon-Oke, (2017) reported a different pattern of distribution of malaria infection across the months in their study in Akure, Nigeria where they recorded significant variation of malaria prevalence across the months with the highest prevalence of 95.6% in a dry season month (November) and the least prevalence of 45.2% in the month of October. In the study area region, rainfall is known to be at its peak in the month of August as high rainfall is an important environmental factor that aids the breeding of *Anopheles* mosquito vector (Mattah *et al*., 2017). Therefore, highest prevalence of infection recorded in the month could have been as a result of abundance of *Anopheles* mosquito vector in the month.

Result of the seasonal prevalence of malaria infection in the study area revealed that there was higher prevalence of malaria infection in the dry season compared to the wet season. Kamwi *et al*. (2012) in their study in Northern Namibia also reported a higher prevalence of malaria infection during the dry season compared to the wet season. During the dry season, the microhabitats that serve as mosquito vector breeding sites are not disturbed by flood (a disaster common during the wet season that could wipe off significant number of mosquito vector larvae) which could contribute to high vector density in this period. The high vector density could have contributed to higher prevalence of malaria infection in the dry season compared to the wet season in the study area.

A very salient issue in disease control is ownership. To a large extent, ownership of disease control programmes in sub Saharan Africa is relinquished to the government in my instances as the latter is always blamed where endemic status persists. While acknowledging the responsibility of the government in these impoverished nations, the narrative should also change to an all inclusive ownership, not only in malaria infection but all endemic diseases in these areas where several millions are either at risk or inflicted. When the people also take responsibility for the control of diseases, perhaps it may tell on the prevalence and attitude towards treatment seeking behaviour

Conclusion

With the result obtained from this study, it is evident that there was all year-round transmission of malaria infection in the study area. This indicates that conquering the war against malaria is still a tall order! Therefore, there is need for increased malaria prevention and control strategies programmes across the LGA through mass awareness and health education to give the residents in this region more orientation on the use of available malaria control and preventive tools such as proper use of Long-Lasting Insecticidal Nets (LLINs), maintaining non-stagnant water-free environment, eliminating probable breeding sites of the vectors and taking to proper treatment seeking behaviour. Inculcating an all inclusive ownership of control programmes should be embedded in public health enlightenment campaigns as this will contribute greatly to ending the scourge caused by infectious disease pathogens.

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