Tropical Biomedicine 38(1): 14-21 (2021)
https://doi.org/10.47665/tb.38.1.003

RESEARCH ARTICLE

Epidemiology of falciparum malaria among residents of some rural and peri-urban communities in Ekiti State, Southwestern Nigeria

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ARTICLE HISTORY

Received: 8 May 2020
Revised: 15 October 2020
Accepted: 16 October 2020
Published: 25 March 2021

ABSTRACT

Malaria which is caused by parasites of the genus *Plasmodium* is a devastating parasitic disease of major public health challenge worldwide, particularly Nigeria. This study was carried out to investigate the epidemiology of falciparum malaria among residents of rural and peri-urban communities in Ekiti State, Southwestern Nigeria. Standard parasitological technique of microscopy was employed to determine and identify parasite prevalence and species. A questionnaire was used to collect subject's information such as age, sex, location, occupation and education. Out of the 300 individuals examined, a total of 283 (93.4%) individuals were infected with malaria parasite. Sex pattern of infection indicated that male had higher malaria prevalence of 95.0% compared to female with the prevalence of 93.3% ($P>0.05$). The age group 51 to 60 years had the highest malaria parasite prevalence of 100% while age group <10 years has the least malaria parasite prevalence of 86.0% ($P>0.05$). Similarly, a total mean malaria parasite density of 1455.90 parasite/µL of blood was recorded. The mean malaria parasite density does not significantly vary ($P>0.05$) among age and sex group. The age group >60 years recorded the highest mean parasite density of 2092.50 parasite/µL of blood while age group <10 has the least mean malaria parasite density of 1044. 42 parasite/µL of blood. In relation to sex, the highest mean malaria parasite density was found among the female (1461.80 parasite/µL of blood) compared to male (1450 parasite/µL of blood). In the same vein, occupation as a socioeconomic risk factor play a major role with respect to malaria infection. The highest malaria prevalence of 113 (98.26%) was recorded among farmers while the least 34 (85%) was recorded among Civil servants ($P<0.05$). Thus, it is apparent that falciparum malaria is heavily prevalent in this study area and as such urgent management control measures and interventions should be made available and fully utilized.

Keywords: Ekiti State, Epidemiology, Malaria, Peri-Urban, *Plasmodium falciparum,* Rural.

INTRODUCTION

Malaria is a mosquito-borne protozoan parasitic disease caused by parasite of the *Plasmodium* genus. It is a serious global public health challenge due to its devastating and detrimental health effect coupled with social and economic consequences in the tropical and sub-tropical regions of the world particularly Nigeria. The major *Plasmodium* spp. in Nigeria are *P. falciparum*, *P. vivax*, *P. ovale* and *P. malariae.* In Nigeria, *P. falciparum* accounts for more than 95% of all malaria disease while *P. ovale* and *P. malariae* account for less than 5% of all malaria disease (WHO, 2016, 2017). Mixed infection with *P. falciparum* and *P. vivax* have also been recorded in Nigeria (Oboh *et al*., 2018). It was estimated by World Health Organization (WHO) that over half of the world's population which amounts to approximately 3.4 billion people were at risk of contracting malaria infection globally in 2017 (WHO, 2018). Furthermore, there were an estimated 228 million alarming cases and 405 000 deaths due to malaria in 2018 (WHO, 2019). In sub-Sahara Africa particularly Nigeria, malaria is highly endemic and elimination of this deadly disease seems to be a mirage due to factors such as poor socio-economic development, highly adapted mosquito vector with great vectorial capacity, lack of adequate support from government, ignorance and even drug resistance (Yeka *et al*., 2012; Wielgosz *et al*., 2014). Nigeria has the most malaria cases in Africa and worldwide in 2018 as it recorded an estimated 25% of total malaria cases worldwide (WHO, 2019). This is indeed a real cause for concern.

The epidemiology of malaria parasite includes risk factors that predispose people to malaria infection and can be basically classified into two major groups which include

intrinsic and extrinsic factors. Intrinsic factors are inherent in human hosts and include age, sex and genotype while extrinsic are external factors such as peoples' behaviours, socioeconomic factors, climate and environmental conditions (Ghebreyesus *et al*., 2000; Mutero *et al*., 2004; Clark *et al*., 2008; Temu *et al*., 2012; Hiscox *et al*., 2013). Mitigating malaria requires an ongoing monitoring process and as such studies on malaria prevalence, risk factors and appropriate intervention strategy including mass distribution of insecticide mosquitoes treated bed net are highly essential. Currently, there is a dearth of information on malaria epidemiology in many parts of Ekiti State meanwhile, the few available data are becoming outdated. Thus, there is need to scale-up malaria elimination strategy in endemic regions including Ikole Ekiti. Depending on outdated information necessary for malaria control could be misleading. Therefore, there is an urgent need for adequate and updated epidemiological information upon which control could be based. Thus, this study tends to investigate the current epidemiological status of falciparum malaria among residents of some rural and peri-urban communities in Ekiti State, Southwestern Nigeria.

MATERIALS AND METHODS

Ethical Approval

Ethical approval for the study was obtained from Ondo State Ministry of Health (protocol number OSHREC/21/08/2017/012) and Ethical Review Committee of the Federal University of Technology, Akure, Nigeria. Both written and verbal informed consent was sought from all the subjects and their caregiver or guardians.

Study Area

The study was carried out in three different communities namely, Ikole-Ekiti, Asin-Ekiti and Ara-Ekiti in Ikole Local Government Area (LGA) of Ekiti State, Nigeria. Both Ikole-Ekiti and Asin-Ekiti are peri-urban communities while Ara-Ekiti is a rural community. Ikole-Ekiti with a population of 168,436 is situated between Latitude 7°47'53.76"N and Longitude 5°30'52.17"E while Asin-Ekiti which is less developed and populated compared to Ikole-Ekiti is situated between Latitude 7°47'24.4"N and Longitude 5°29'26.3"E. The distance of both Ikole Ekiti and Asin-Ekiti from Ado-Ekiti, the State capital are 49.0 km and 49.7 km respectively. Ara-Ekiti, a rural community that is poorly developed with a very small population is however situated between Latitude 7.7627° N and Longitude 5.1093° E. Generally, Ikole LGA has a tropical climate with significant rainfall and a short dry season. The wet season is warm, oppressive and overcast with average annual rainfall of 1313 mm and the dry is not hot, humid, and partly cloudy. The average annual temperature is 24.2°C (75.6°F) and typically varies from 62°F to 90°F and is rarely below 56°F or above 95°F. Three hospitals in the Local Government were selected for this study which include General hospital Ikole located in Ikole, Living Well hospital located in Asin and Ogunleye hospital located in Ara (Figure 1). The three hospitals are among the frequently visited health facilities in Ikole LGA. Malaria is hyperendemic in these tropical areas due to the favourable environmental conditions. Thus, these hospitals are located in malaria endemic region to cater for the residents' health particularly for malaria control.

Study Design

A cross-sectional randomised and hospital-based study was conducted between February and October 2019 at three different hospitals namely, General hospital located in Ikole, Living Well hospital located in Asin and Ogunleye hospital located in Ara. All individuals, except pregnant women, visiting these hospitals were sampled so long they meet the criteria for inclusion which include feelings of headache, fever with temperature greater than 38°C, questionnaires completion, submission of blood samples and readiness to give written or oral informed consent.

Determination of sample size

Overall, 300 blood samples were obtained from volunteer individuals in the study area according to sample size calculation which was computed using 50% parasite prevalence of malaria parasite study from a nearby related study using the statistical formula given by Centres for Disease Control and Prevention (CDC, 2005).

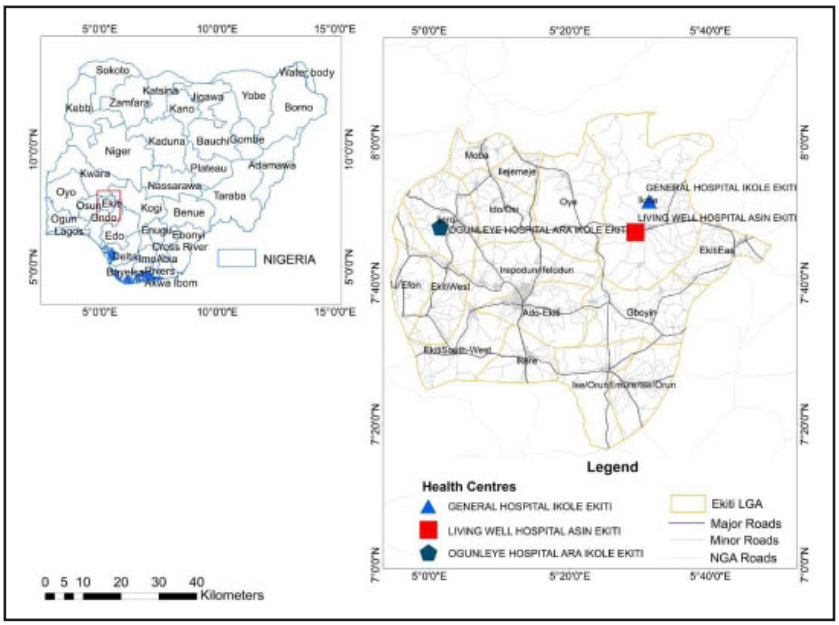

Figure 1. Map of Nigeria showing the study area in Ekiti State which include General hospital Ikole, Living Well hospital, Asin and Ogunleye hospital, Ara.

Questionnaire administration and design

A well designed pre-tested questionnaire was administered to the participants in order to collect relevant information on their sex, age, location, occupation and education. Data was collected from the respondents via face-to-face interviews.

Collection, preparation and examination of blood samples

Blood samples were collected intravenously with the aid of an expert Laboratory Technician. A 2-3mL venous blood was collected using syringe and needle. The blood samples were collected into an ethylenediaminetetraacetic acid (EDTA) tube to prevent the blood from clotting in order to preserve the samples. Thereafter, thick and thin smears were prepared on clean and well disinfected slides. The thin smear was fixed in absolute ethanol. Subsequently, 5% Giemsa stain was added to both the thick and thin smears on the slide for 30 minutes. The slides were thereafter examined under x1000 magnification in order to determine the prevalence of *Plasmodium* parasites and their specific species. Each slide was considered negative when approximately 200 microscopic fields have been observed. The level of parasitaemia or parasite density was classified as low when parasitaemia is less than 1000 parasites/µL of blood; moderate when parasitaemia is between 1000 and 9999 parasites/µL of blood and severe when parasitaemia is greater than or equal to 10,000 parasites/µL of blood (White, 2003; Atroosh *et al*., 2015). Parasite density was recorded as number of Parasite/µL of blood, assuming an average leucocyte count of 8,000/µL of blood for an average individual (WHO, 2015).

$$\text{Parasite Density} = \frac{\text{Number of parasites counted x Total White Blood Cell of 8000/µL}}{\text{Number of White Blood Cell Counted}}$$

Statistical Analysis

Data were analysed using Statistical Package for Social Science (SPSS) version 22.0. The prevalence of falciparum malaria was calculated and the difference of prevalence between age groups and sex were calculated using chi square at 95% level of confidence. The malaria parasite density was explored using one-way analysis of variance for variable with more than two categories while student's t-test was used to determine dichotomous variable. *P-values* less than 0.05 were considered statistically significantly.

RESULTS

A total of 300 individuals were examined which consists of 180 (60%) male and 120 (40%) female. A total of 100 individuals were examined in each of the three different hospitals namely, General hospital in Ikole, Living well hospital in Asin and Ogunleye hospital in Ara. Additionally, the population consists of age range 5 to 90 years with different occupational status such as traders, students, civil servants and farmers. The result showed that a total overall of 283 (94.3%) individuals were positive while 17 (5.7%) were negative. All infections recorded were identified to be *P. falciparum*.

The age pattern of malaria infection in the study area showed that age group 51 to 60 years have the highest malaria parasite prevalence of 100% while age group <10 have the lowest prevalence of 86.0% (Table 1). However, it was not statistically significant ($X^2 = 8.647$, $df = 6$, $P>0.05$). Additionally, the sex pattern of malaria infection in the study area showed that male subjects have a higher malaria parasite prevalence of 95.0% compared to the female subjects with a lower prevalence of 93.3% as shown in Table 1 ($X^2 = 0.374$, $df = 1$, (P >0.05). In the same vein, a total mean malaria parasite density of 1455.90 parasite/µL of blood was recorded (Table 1). The age group >60 years had the highest mean parasite density of 2092.50 parasite/µL of blood while age group <10 has the lowest mean parasite density of 1044.42 parasite/µL of blood. It was however not statistically significant ($P>0.05$). Additionally, in relation to sex, the highest mean malaria parasite density was observed among the female subjects (1461.80 parasite/µL of blood) compared to their male counterparts with lower parasite density (1450 parasite/µL of blood). It was however not statistically significant ($P>0.05$).

Similarly, with respect to location, a total of 100 individuals were examined in each of the three different hospitals namely, General hospital in Ikole, Living well hospital in Asin and Ogunleye hospital in Ara. Ogunleye hospital recorded the highest prevalence with 96% while Living Well hospital recorded the least prevalence with 92% (Table 2). However, there was no significant difference $P>0.05$. Furthermore, the parasitaemia classification of the study population according to sex and age is shown in Figure 2 and Figure 3 respectively. It was observed that an estimated 165 (58.30%) of the infected individuals have low level of parasitaemia, 96 (33.92%) have moderate level of parasitaemia while only 22 (7.77%) have severe parasitaemia.

Table 1. Prevalence and density of malaria parasite with respect to sex and age group among residents of Ikole Local Government Area of Ekiti State

Variables	No. Examined	No. Infected	Prevalence (%)	Mean (±S.E) of Parasite Density (parasite/ µL of blood)
Sex				
Male	180	171	95.0	1452.00 ± 173.226
Female	120	112	93.3	1461.80 ± 123.051
Age Group (years)				
≤10	50	43	86.0	1044.42 ± 176.810
11-20	76	72	94.7	1112.85 ± 213.114
21-30	51	49	96.1	1431.36 ± 322.480
31-40	42	40	95.2	1540.05 ± 384.005
41-50	28	27	96.4	1427.12 ± 473.564
51-60	14	14	100.0	1543.23 ± 804.048
>60	39	38	97.4	2092.50 ± 446.048
Total	300	283	94.3	1455.90 ± 172.480

Table 2. Prevalence of malaria parasite with respect to different location in Ikole Local Government Area of Ekiti State

Location	No. Examined	No. Infected	Prevalence (%)
Ogunleye hospital, Ara	100	96	96
General hospital, Ikole	100	95	95
Living well hospital, Asin	100	92	92
Total	300	283	94.33

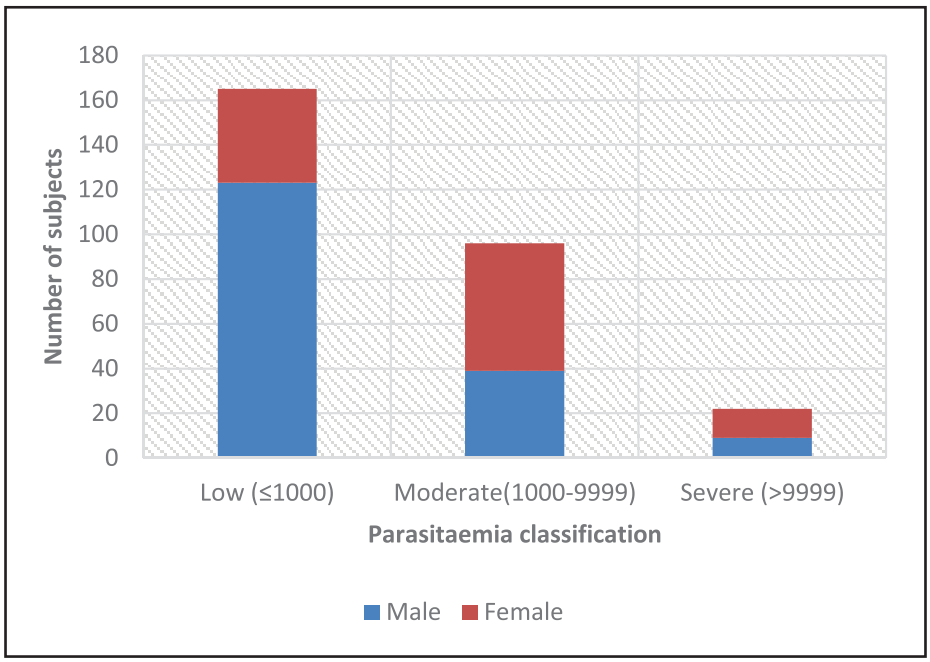

Figure 2. Parasitaemia classification of respondent among sex group in Ikole Local Government Area.

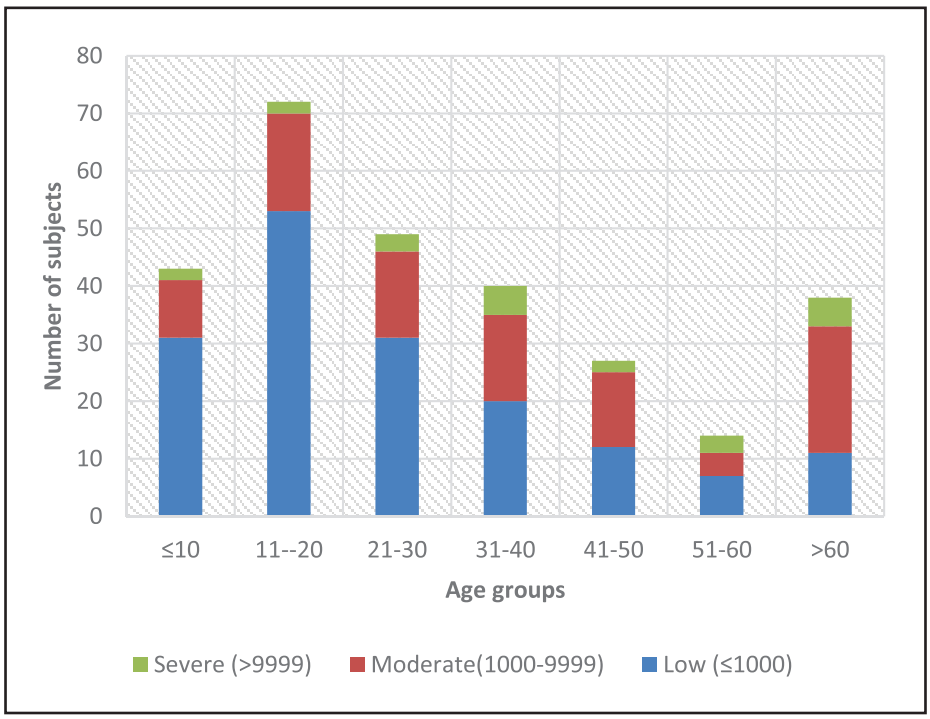

Figure 3. Parasitaemia classification of respondent among age group in Ikole Local Government Area.

Table 3. Prevalence of malaria parasite with respect to socioeconomic variables in Ikole Local Government Area of Ekiti State

Variables	No. Examined	No. Infected	Prevalence (%)
Occupation			
Artisans	30	28	93.33
Traders	67	64	95.52
Farmers	115	113	98.26
Students	36	33	91.66
Civil servants	40	34	85.00
Others	12	11	91.66
Education			
No Formal education	32	30	93.75
Primary education	194	187	96.39
Secondary Education	74	66	89.18
Marital Status			
Married	170	165	97.05
Single	102	95	93.13
Divorced	3	2	66.66
Others	25	21	84.00
Total	300	283	94.3

Moreover, prevalence of malaria parasite with respect to socioeconomic variables is presented in Table 3. Obviously, the highest falciparum malaria prevalence of 113 (98.26%) was recorded among farmers while the least 34 (85%) was recorded among Civil servants. The result was statistically significant (*P<0.05*). In the same vein, those who had primary education had the highest malaria infection (96.39) followed by those without formal education (93.75) while the least (89.18) was observed among those who had secondary education. However, there was no significant difference (*P>0.05*). Regarding marital status, though malaria infection was highest among those married (97.05) and was least among those who were divorced (66.66), there was no significant difference (*P>0.05*).

DISCUSSION

Nigeria is no doubt a hot spot for malaria infection worldwide and the current study provide corroborating and supportive report. The high malaria parasite prevalence recorded is an evidence that malaria infection is endemic, and transmission is ongoing and have formed a stable pattern in Ikole Local Government Area of Ekiti State, Nigeria. The only malaria parasite species recorded in this study area was *P. falciparum* similar to the findings of studies reported from within and outside Ekiti State, Nigeria (FMOH, 2008; Simon-Oke *et al.*, 2012; Esan *et al*., 2014; Nyamngee *et al*., 2014; Salau *et al*., 2016; Awosolu *et al*., 2019; Olorunniyi *et al*., 2019). In the same vein, World Health Organization has observed that most prevalent malaria parasite species in sub Saharan Africa was *P. falciparum* (WHO, 2003). Indeed, the high malaria parasite prevalence recorded in this study was also similar to the reports of previous studies in other parts of Nigeria (Greenwood *et al*., 2005; Asaolu & Igbaakin, 2009; Okonko *et al*., 2009; Iwueze *et al*., 2014; Ayogu *et al*., 2016; Umma *et al*., 2017; Awosolu *et al*., 2019, 2020). However, malaria parasite prevalence in this study is greater than studies reported by Nzeako *et al*. (2013), Udoh *et al*. (2013) and Simon-Oke *et al*. (2019). The high malaria parasite prevalent in this current study can be attributed to the multifaceted prevailing environmental factors such as temperature, rainfall and forest cover which provide good breeding system for the mosquito vector. The more the mosquito vectors in the environment, the more the transmission and the more the malaria parasite prevalence. This could be aggravated by lack of control intervention such as insecticide treated bed net which may currently be limited in this study area (Owoseni, 2018).

Furthermore, while malaria prevalence is slightly higher though insignificant among male compared to their female counterparts, parasite density is higher among females than male. Previous studies have shown that males usually have malaria infection than females (Sachs & Malaney, 2002; Esan, 2014; Sam Wobo *et al*., 2014; Adewole *et al*., 2017; Umma *et al*., 2017). Though both male and female are basically at risk of contracting malaria infection, males were generally more exposed in this study area. This could be attributed to their engagement in many activities such as farming which may expose male to mosquito bite. Other factors could be the engagement of males in businesses in dirty environments, coming back home late at night, preference to stay late outside while gathered discussing together and entertaining in an open place, carefree attitudes of males towards the use of mosquito nets and other preventive measures including treatment, common outdoor sleeping by male subjects during dry season when there is heat. All these factors have been reported to contribute to the increase in malaria prevalence among male in other study areas (Reuben *et al*., 1993; Rahman *et al*., 1996; Müller *et al*., 1998; Cotter *et al*., 2013). Thus, malaria prevention and control policies should be all-encompassing and comprehensive targeting both male and female subjects. In this study area, our findings indicated that only few females were infected with greater parasite density and health consequences compared to male subjects. This agrees with the report of Tin-Oo *et al*. (2001) who reported that both male and female are at risk of contracting malaria infection if they are both given the same exposure pattern to mosquito bites. However, Bates *et al*. (2004) showed that greater consequences of malaria infection among female subjects may occur. This implies that females are more susceptible to malaria infection than males in this study area. This could be as a result of low immunity among females as demonstrated by Duffy and Fried (2005).

In the context of our study, while the age pattern of malaria infection showed that the highest malaria prevalence of 100% was recorded among age group 51 to 60 years, it is crystal clear that malaria parasite density was highest among subjects above 60 years. This is corroborated by many studies conducted previously (Gjorup & Ronn, 2002; Mühlberger *et al*., 2003; Bruneel *et al*., 2010; Checkley *et al*., 2012; WHO, 2012; Allen *et al*., 2016; Herrador *et al*., 2019). The high malaria infection among age 51 to 60 and 60 years above could be attributed to growing comorbidities as reported by Checkley *et al*. (2012) and Bruneel *et al*. (2010). When this comorbidity factor is coupled with other general risk factors contributing to exposure pattern such as staying outside late to receive fresh air during hot weather could increase odds of malaria infection and its consequences among these older age groups.

On the other hand, individuals within the age group 10 years and below have the least prevalence and intensity of malaria infection which may be as a result of care and protection against mosquito bites by their parents through the use of mosquito nets and adequate treatments. This corroborated the results of previous surveys conducted by Bonilla and Rodriguez (1993) and Manjurano *et al*. (2011) who stated that the ownership and proper use of mosquito bed nets is strongly linked to the prevention of the disease.

Therefore, even though malaria infection may tend to be higher among younger children as reported by many studies (Roca-Feltrer *et al*., 2010; Mawili-Mboumba *et al*., 2013; Farnert *et al*., 2014; Nankabirwa *et al*., 2014; Ursing *et al*., 2014; Ceesay *et al*., 2015; Mathanga *et al*., 2015; Pinchoff *et al*., 2016), the use of suitable prevention and control intervention can greatly help reduce malaria among children and generally across all age and sex group.

The impact of socioeconomic factors such as occupation and education cannot be overemphasized in this study area. Those who are farmers tend to have more malaria infection compared to others. The high malaria prevalence recorded among famers in this study area is in conjunction with other previous studies (Alemu *et al*., 2014; Amuta *et al*., 2014). This could be as a result of frequent and indiscriminate exposure of these farmers to mosquito bites on the farm which eventually led to malaria infection. The use of repellent and long sleeve clothes could be employed by these farmers to prevent mosquito bites. Furthermore, our study reveals that education indirectly affected malaria distribution though there was no significant difference. Those who have primary education and those without formal education had higher malaria infection which is in agreement with the report of Essendi *et al*. (2019). This could be due to their low level of knowledge and awareness about malaria control and prevention. This could be addressed by increasing the level of awareness of the populace through the use of all available means including radios and televisions that could easily be understood by those who are less educated. Eventually, this would in turn gradually lead to the long-awaited dream of a malaria-free world.

CONCLUSIONS

Conclusively, malaria parasite particularly, *P. falciparum* is endemic and remains a leading cause of morbidity in Ekiti State and Nigeria at large. Thus, both male and female are at risk of infection in the study area. Older age group of 60 years and above are of concern as they may need special care regarding malaria infection. Farming and low level of education could be a major risk factor in the study area. Generally, a comprehensive health intervention should be deployed in the study area to mitigate local malaria transmission.

ACKNOWLEDGEMENTS

We sincerely appreciate all that voluntarily participated in this study from Ikole Ekiti Local Government Area of Ekiti State, Nigeria.

Conflict of Interest

The authors declare that no conflict of interest exist.

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