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Malaria Parasite Infection in Some Periurban and Rural Communities in Ekiti State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors OFO and OAI designed the study. Author OFO did the sample collection and carried out the laboratory analyses. Authors OFO, OAI, ABI and ORP managed the literature and the manuscript. Authors OFO and ASB did the statistical analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Malaria is one of the leading parasitic diseases worldwide with Nigeria ranked the topmost country in the tropical Africa where the disease is prevalent. This study was designed with the aim to determine the prevalence of malaria parasite (MP) infection in some periurban and rural communities of Ekiti State being one of the 36 states of Nigeria.
Materials and Methods: Three periurban and rural communities were randomly selected in Ekiti State for the study. Blood samples were collected and examined microscopically for the presence of MP in dry and raining seasons among human volunteers in each community. Prevalence of MP infection was determined.
Results: Overall prevalence of MP infection was 26% in dry season and 38% in raining season (P = .001). In dry season, prevalence of MP infection was 22.3% in periurban communities and 31.3% in rural communities (P = .001). During the raining season the prevalence was 39.8% in periurban and

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35.9% in rural communities (*P* = .12), with *Plasmodium falciparum* being the dominant species. Children of 0-5 years had the highest prevalence of infection (61.1%) during raining season while teenagers between 16-20 years had the highest prevalence of infection (31.5%) in the dry season. Generally, there was an increase in malaria parasite density during raining season.

Conclusion: This study confirmed the existence of MP infection in Ekiti State. The distribution of MP infection in both periurban and rural communities was affected by season with higher prevalence occurring during the raining season.

Keywords: Malaria; prevalence; Nigeria; Ekiti; parasite; periurban; rural; malaria density.

1. INTRODUCTION

Malaria remains the leading parasitic disease that causes morbidity and mortality in Nigeria. Nigeria and Democratic Republic of Congo alone were reported to account for 40% of the total world malaria death [1]. Nigeria has also been recently ranked the topmost country along with four other countries in the world where malaria is highly prevalent [2]. In areas with high transmission of malaria, children under five are usually vulnerable to infection, illness and death and more than two thirds (70%) of all malaria deaths have been reported to occur in this age group. Although, the number of under five malaria's deaths was reported to decline globally from 440,000 in 2010 to 285,000 in 2016, malaria still remains a major killer of children of under five years old [2]. In Nigeria, about half of the adult citizens were reported to have at least one episode of malaria each year and seven (7) out of every 10 patients seen in Nigeria hospitals were ill of malaria [3]. The disease also causes hardship and economic lost [4].

The transmission of malaria in Nigeria occurs at steady rate throughout the year which comprises of a distinctive rainy and dry season [3]. The dominant species of malaria parasites in Nigeria is *Plasmodium falciparum* (> 95%) with *P. ovale* and *P. malariae* playing a minor role with the latter being quite common as double infections in children [5]. Malaria parasites are transmitted in Nigeria mainly by *Anopheles gambiae* s.s and members of funustus group [6]. Many authors had reported cases of malaria parasite infection in many states in Nigeria [7-13]. Ekiti is one of the 36 states of Nigeria and it is located in the Southwest geopolitical zone of the country. The state consists of communities which range from peri-urban to rural settlements. Although *Plasmodium falciparum* was reported to be prevalent among the participants in a study carried out on the severity of malaria infection and effect of anti-malaria drugs on gender differences at Federal Teaching Hospital at Ido-Ekiti in Ekiti State [14], but there have been scanty community based studies to produce a baseline information about the prevalence of malaria parasite infection in Ekiti State. Prevalence surveys are known to provide basic data about the state of diseases in a given area and these are usually useful tools for controlled programmes. Therefore, this study aimed at determining the prevalence of malaria parasite (MP) infection in Ekiti State with some periurban and rural communities serving as case study. The characteristics of periurban and rural communities in Nigeria have been given by Emankhu and Ubangari [15]; Agbodike [16] and Ayorinde [17].

2. MATERIALS AND METHODS

2.1 Study Location and Selection of Participants

Six communities were selected through a multi-stage sampling method [18]. Stage 1 was the selection of all the three senatorial districts in Ekiti State. Senatorial district is a geopolitical division that exists in every state of Nigeria. Each state has three Senatorial Districts and within each of the senatorial district are local government areas (LGAs). In the case of Ekiti State, each of Ekiti North and Ekiti Central Senatorial Districts consists of five LGAs while Ekiti South Senatorial District consists of six LGAs. Stage 2 was selection of one local government area (LGA) from each of the senatorial district by lottery. Stage 3 involved purposefully selection of one peri-urban community and one rural community [15-17] from each of the selected LGA. The selected communities were Iye, Ewu, Iyin, Eyio, Agbado and Ilupeju-Ijan. The geographic location of the communities in Ekiti State is shown in Fig. 1. The people of these communities are Yoruba ethnic group and their major occupation is farming. However, some of them are artisans and government workers. Table 1 shows the population of each community [19] and the sample size used was according to Yemane [20].

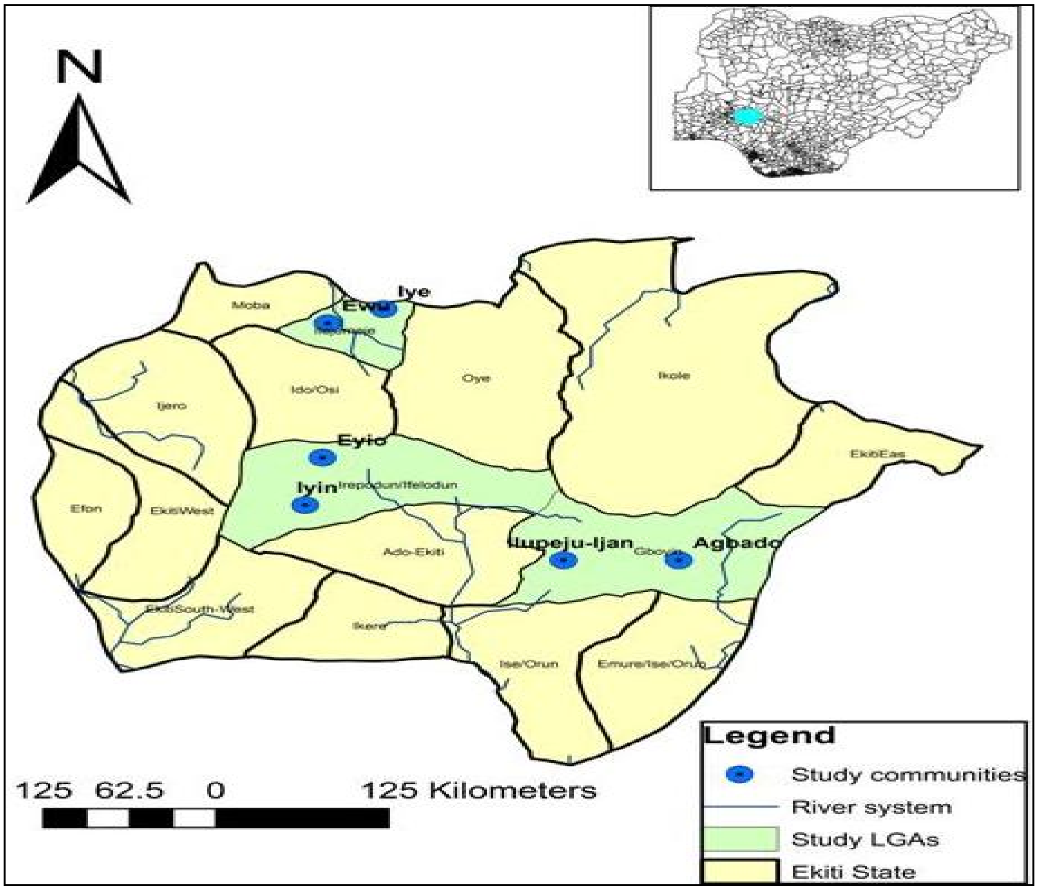

Fig. 1. Map of Ekiti State of Nigeria showing the study communities

Table 1. Populations of the study communities

Senatorial district	LGA	Community	Population
Ekiti North	Ilejemeje	Iye (Periurban)	20,885
		Ewu (Rural)	7,018
Ekiti Central	Irepodun/Ifelodun	Iyin (Peri-urban)	42,422
		Eyio (Rural)	4,281
Ekiti South	Gbonyin	Agbado (Periuban)	23,495
		Ilupeju-Ijan (Rural)	5,598
Total			**103,699**

2.2 Blood Samples Collection and Laboratory Procedures

Peripheral blood samples were collected through finger prick from volunteers in the dry season and raining season in all the communities. The blood samples were used to prepare thick and thin blood smears on clean grease-free microscope slides as described by Cheesbrough [21]. Thin films were fixed with methanol and allowed to air dry after which both thick and thin smears were stained with 10% Giemsa stain for 30 minutes. Stained slides were afterwards rinsed with distilled water and air dried. The films were examined for the presence of malaria parasite under a compound microscope as described by Cheesbrough [21]. The parasites were identified into species as guided by Fleck and Moody [22]. Slides were considered negative if no parasites were seen in 100 oil-immersion fields. For positive smears, the number of parasites was counted against 100 white blood cells (WBC). Parasite density was recorded as number of parasite/μl of blood, assuming an average leucocytes count of 8,000/μl of blood [23]. Parasite density was categorized as low

(501-5000 p/µl of blood), moderate (>5000-100000 p/µl of blood) and high (>5000-100000 p/µl of blood).

Parasite density = Number of parasites counted/ Number of leukocytes counted× 8000

Prevalence of malaria infection = Number of infected individuals/ Total number of participants ×100%

2.3 Statistical Analyses

Chi-square was used to analyze data obtained in the study and a probability value (p-value) of $P < .05$ was regarded as significant.

3. RESULTS

3.1 Prevalence of Malaria Parasite Infection between Periurban and Rural Communities in both Dry and Raining Seasons

A total number of 1,883 and 1,522 persons were enrolled during dry and raining seasons respectively (Table 2). Majority of the respondents were females with the ratio of 6:4 to the males in both seasons. The prevalence of malaria parasite (MP) infection was significantly higher (P = .001) in the raining season (38%) compared to that of the dry season (26%). There was also a significant difference (P = .001) in the prevalence of malaria parasite infection across the communities during both seasons. Prevalence of MP infection was significantly higher (P = .001) in rural communities (31.3%) compared to periurban communities (22.3%) during dry season. On the other hand, no statistically significant difference (P = .12) was observed in prevalence of the infection between periurban and rural communities in the raining season (Table 3). *Plasmodium falciparum* was the most prominent species examined among the infected participants in both dry season (99.2%) and raining season (99.1%). However, *P. malariae* was examined among 13 participants (0.7%) and mixed infections of *P. falciparum* and *P. malariae* among 3 participants (0.2%) in dry season. Five participants (0.9 %) were infected with *P. malariae* in raining season.

3.2 Prevalence by Age and Sex in both Dry and Raining Seasons

There was no significant relationship (P = .88) between age and prevalence of MP infection during dry season. Prevalence of infection was slightly higher among the children and teenagers

Table 2. Prevalence of malaria parasite infection among the participants in the six study communities in Ekiti State

		Dry season		Raining season		P-value
Community types	**Community**	**Number examined**	**MP positive**	**Number examined**	**MP positive**	**Dry against raining seasons**
Peri-urban	Iye	386	92 (23.8%)	263	79 (30.0%)	.078
	Iyin	379	92 (24.3%)	293	152 (51.9%)	.001
	Agbado	354	66 (18.6%)	273	99 (36.3%)	.001
Rural	Ewu	240	63 (26.2%)	234	95 (40.6%)	.011
	Eyio	218	79 (36.2%)	209	68 (32.5%)	.421
	Ilupeju-Ijan	306	97 (31.7%)	250	86 (34.4%)	.500
Total number examined		**1883**	**489 (26.0%)**	**1522**	**579 (38.0%)**	**.001**

MP = malaria parasites, p-value across the six communities in dry season (P = .001), p-value across the six communities in raining season (P = .001)

Table 3. Prevalence of malaria parasite infection among the participants in the peri-urban and rural communities in Ekiti State

Community types	Dry season		Raining season		P-value
	Number examined	**MP positive**	**Number examined**	**MP positive**	**Dry against raining season**
Periurban	1119	250 (22.3%)	829	330 (39.8%)	.001
Rural	764	239 (31.3%)	693	249 (35.9%)	.067
	1883	**489 (26.0%)**	**1522**	**579 (38.0%)**	**.001**

MP = malaria parasites, p-value across community types in dry season (P = .001), p-value across community types in raining season (P = .12) compared to the adults (Table 4). On the other hand, a significant relationship (*P* = .001) existed between age and prevalence of MP infection in the raining season. Children of 0-5 years had the highest prevalence of malaria parasite infection (61.1%) while a gradual decrease in prevalence of infection was observed as the age group increased (Table 4).

In the dry season, 26.9% of male and 25.3% of females had malaria parasites infection respectively (*P*=.36). In the raining season, 40.2% males and 36.4% of females had malaria parasite infection with *P*=.13 (Table 5). However, the difference in the prevalence of malaria parasite infection with respect to gender was not statistically significant.

Table 4. Prevalence of malaria parasite infection across the age group in the study communities in Ekiti State

Age group (years)	Dry season		Raining season	
	Number examined	MP positive	Number examined	MP positive
0-5	283	68 (24.0%)	280	171 (61.1%)
6-10	258	72 (27.9%)	267	154 (57.7%)
11-15	421	112 (26.6%)	205	89 (43.4%)
16-20	73	23 (31.5%)	77	27 (35.1%)
>20	848	214 (25.2%)	693	138 (19.9%)
Total number examined	**1883**	**489 (26.0%)**	**1522**	**579 (38.0%)**

MP =Malaria parasites. Dry season; (P = .88), Raining season; (P = .001)

Table 5. Prevalence of malaria parasite infection between the male and female participants in the study communities in Ekiti State

Sex	Dry season		Raining season	
	Number examined	MP positive	Number examined	MP positive
Male	802	216 (26.9%)	641	258 (40.2%)
Female	1081	273 (25.3%)	881	321 (36.4%)
Total number examined	**1883**	**489 (26.0%)**	**1522**	**579 (38.0%)**

MP =Malaria parasites. Dry season; (P = .36), Raining season; (P = .13)

Table 6. Malaria parasite density among the participants in the six study communities in Ekiti State

During dry season					
	Community	**Number with MP**	**Low MPD (<500 p/µl of blood)**	**Moderate MPD (501-5000 p/µl of blood)**	**High MPD (>5000-100000 p/µl of blood)**
Peri-urban	Iye	92	4 (4.3%)	83 (90.2%)	5 (5.4%)
	Iyin	92	1 (1.1%)	86 (93.5%)	5 (5.4%)
	Agbado	66	2 (3.0%)	64 (97.0%)	0 (0.0%)
Rural	Ewu	63	5 (7.9%)	58 (92.1%)	0 (0.0%)
	Eyio	79	0 (0.0%)	74 (93.7%)	5 (6.3%)
	Ilupeju-Ijan	97	6 (6.2%)	90 (92.8%)	1 (1.0%)
Total		**489**	**18 (3.7%)**	**455 (93.0%)**	**16 (3.3%)**
During raining season					
Peri-urban	Iye	79	2 (2.5%)	42 (53.2%)	35 (44.3%)
	Iyin	152	15 (9.9%)	83 (54.6%)	54 (35.5%)
	Agbado	99	0 (0.0%)	40 (40.4%)	59 (59.6%)
Rural	Ewu	95	3 (3.2%)	67 (70.5%)	25 (26.3%)
	Eyio	68	1 (0.5%)	41 (60.3%)	26 (38.2%)
	Ilupeju-Ijan	86	0 (0.0%)	70 (81.4%)	16 (18.6%)
Total		**579**	**21 (3.6%)**	**343 (59.2%)**	**215 (37.1%)**

MP = Malaria parasites, MPD = malaria parasite density. MPD in dry season across the communities (P = .026), MPD in raining season across the communities (P = .001), MPD in Dry season against MPD in raining season showed (P = .001)

Table 7. Malaria parasite density among the participants in the periurban and rural communities in Ekiti State

Community types	Number with MP	Low MPD (<500 p/µl of blood)	Moderate MPD (501-5000 p/µl of blood)	High MPD (>5000-100000 p/µl of blood)
During dry season				
Peri-urban	250	7 (2.8%)	233 (93.2%)	10 (4.0 %)
Rural	239	11 (4.6%)	222 (92.9%)	6 (2.5 %)
Total	**489**	**18 (3.7%)**	**455 (93.0%)**	**16 (3.3 %)**
During raining season				
Peri-urban	330	17 (5.2%)	165 (50.0%)	148 (44.8 %)
Rural	249	4 (1.6%)	178 (71.5%)	67 (26.9 %)
Total	**579**	**21 (3.6%)**	**343 (59.2%)**	**215 (37.1 %)**

MP =Malaria parasites, MPD = malaria parasite density. MPD in dry season (P = .39), MPD in raining season (P = .001)

Table 8. Malaria parasite density among the participants across the age group in the study communities

Age group	Number with MP	Low MPD (<500 p/µl of blood)	Moderate MPD (501-5000 p/µl of blood)	High MPD (>5000-100000 p/µl of blood)
During dry season				
0-5	68	3 (4.4%)	63 (92.8%)	2 (2.9%)
6-10	72	2 (2.8%)	68 (94.4%)	2 (2.8%)
11-15	112	7 (6.2%)	103 (92.0%)	2 (1.8%)
16-20	23	0 (0.0%)	21 (91.3%)	2 (8.7%)
>20	214	6 (2.8%)	200 (93.5%)	8 (3.7%)
Total	**489**	**18 (3.7%)**	**455 (93.0%)**	**16 (3.3%)**
During raining season				
0-5	171	5 (2.9%)	94 (55.0%)	72 (42.2%)
6-10	154	6 (3.9%)	95 (61.7%)	53 (34.4%)
11-15	89	2 (2.2%)	53 (59.6%)	34 (38.2%)
16-20	27	1 (3.7%)	15 (55.6%)	11 (40.7%)
>20	138	7 (3.6%)	86 (62.3%)	45 (32.6%)
Total	**579**	**21 (3.6%)**	**343 (59.2%)**	**215 (37.1%)**

MP = Malaria parasites, MPD = malaria parasite density. MPD down the age group in dry season (P = .49), MPD down the age group in raining season (P = .78)

3.3 Seasonal Differences in MP Density between Periurban and Rural Communities

Malaria parasite density (MPD) among the infected participants across the six communities in the dry and raining seasons were presented in Table 6. Generally MPD increased significantly (*P* = .001) during raining season compared to that of dry season.

Majority of the MP infected participants (93.0%) showed moderate MPD followed by low (3.7%) and high MPD (3.3%) in the dry season. On the other hand, the proportion of infected participants with the moderate MPD decreased (59.2%) while those with the high MPD increased (37.1%) in the raining season.

There was no significant difference (*P* = .39) in the MPD between the peri-urban communities and the rural communities in the dry season. But a significant difference (*P* = .001) existed in the MPD between the periurban communities and the rural communities in the raining season (Table 7). MPD across the age group showed no significant difference in both dry season and raining season (Table 8).

4. DISCUSSION

Malaria infection occurred in all the six communities selected for this study in Ekiti State. The overall prevalence of malaria parasite infection was 26% in the dry season and 38% in the raining season. Occurrence of malaria parasite infection in these communities agrees with the earlier reported cases of malaria parasite infection in Ekiti State [14,24,25]. The reason for this high prevalence of the parasite infection could be connected with the poor or inconsistent intervention strategy for vector control in the state. Insecticide-treated bed nets (ITNs) were distributed to the people of Ekiti State last in 2014 by the Federal Ministry of Health in collaboration with Society for Family Health (SFH) through a Global Fund. However, the prevalence of malaria parasite infection in this study either in the raining season (38%) or in the dry season (26%) was not as high when compared with the reported prevalence of malaria infection from some states in Nigeria. For instance, Edogun, et al. [7] recorded overall prevalence of 51.9% in Niger State and Sam Wobo, et al. [11] reported prevalence of 71.1% from four Primary Health Facilities located at Abeokuta in Ogun state. The reason why the prevalence of malaria infection in these states was higher than the present study might be due to the design of those studies which were hospital based.

The prevalence of malaria parasite infection was significantly higher among the participants from rural communities (31.3%) than those from periurban communities (22.3%) in the dry season. Wang, et al. [26] had reported a trend of increase in malaria prevalence from urban to periurban to rural settings in Burkina Faso. Many African settlements had been reported to show a clear trend of increasing malaria transmission from urban to periurban to rural settings [27] as African cities tend to grow outwards with perimeters consisting of relatively underdeveloped, poorly serviced settlements [28]. Characteristic of rural-areas such as availability of vector breeding grounds and favourable climatic conditions had been reported to promote mosquitoes' breeding and their effectiveness in the transmission of malaria [29], thereby leading to an increase in the number of people being infected with malaria parasites in rural areas. In contrary to what was observed in the dry season, the prevalence of malaria parasite infection during raining season was higher in periurban communities (39.8%) than the rural communities (35.9%) but the difference in the prevalence was however not significant. Mourou, et al. [30] also obtained result that is similar to this in Gabon.

The higher prevalence of malaria parasite infection observed in the raining season when compared to the prevalence in the dry season was due to changes in environmental factors that are usually influenced by climate especially rainfall and humidity. Environmental factors have been reported to contribute significantly to malaria prevalence, its distribution, seasonality, and transmission intensity [31]. Darkoh, et al. [32] has also identified malaria as the most climate sensitive disease in which changes in temperature, rainfall, and humidity could influence malaria prevalence directly by modifying the behaviour and geographical distribution of malaria vectors as well as changing the length of the cycle of the parasite within the vectors. The reason is that the malaria vectors usually thrive well and more abundant during raining season due to availability of abundant breeding places [33].

There was no statistically significant difference in the prevalence of malaria parasite infection across the age group during the dry season. However, the result of malaria infection during raining season is consistent with the age-related patterns of prevalence of malaria infection for a typical endemic area. The prevalence of infection decreased with increasing age group. The observed decline in malaria infection among the adults is most likely due to the development of non-sterile clinical immunity over time [34]. This background immunity regulates infection and is usually pronounced in children above 15 years and in adults. These are people who have been exposed to mosquito bites over the years and have experienced malaria many times. Such limited immunity enables the individuals to tolerate severe malaria infection without getting ill even though they may have malaria parasites [34,35].

Majority of the participants across the study communities whether from periurban or rural communities had a moderate malaria parasite density during dry season while very few of them had a high malaria parasite density. In overall, 3.7% of them had a low malaria parasite density, 93% had a moderate malaria parasite density and 3.3% had a high malaria parasite density. Although, majority of the participants still had a moderate malaria parasite density (59.2%) during raining season, but sizable number of them (37.1%) had a high malaria parasite density. This was mainly due to the malaria transmission dynamics being influenced majorly by environmental factors and climate as it is described above. Odongo-Aginya, et al. [36] also reported a high malaria parasite density during the time of rain in Mali which they linked with fluctuation in monthly rain pattern.

Male participants had higher prevalence of malaria parasite infection than female participants in both seasons. The overall prevalence of malaria infection during dry season was 26.9% in males and 25.3% in females. During raining season, the prevalence was 40.2% in males and 36.4% in females. Adewole, et al. [37] also reported higher prevalence of malaria infection in males than in females in their studies that involved three Local government Areas in Ekiti State. Similarly, Hayat, et al. [38] reported infection rate to be higher among young adult males than females in Pakistan. However, Mogaji, et al. [39], Ibekwe, et al. [40] and Okonko, et al. [41] reported higher prevalence of malaria infection in females than in males.

Actually, both males and females are affected by malaria but gender roles and gender dynamics such as exposure pattern has been reported to give rise to different vulnerabilities. For example, traditional gender roles in which men work late in the fields or women going out very early in the morning to gather water expose them to peak mosquito biting times [41]. However, in societies where the activities of men and women during peak biting times result in equal risks of infection no difference has been reported to be observed in malaria infection [42]. Example was the study in Myanmar on activities that enhance human vector contact which revealed that gender specific patterns of both leisure and work activities during peak biting periods by men and women placed them at equal risk of contracting malaria through exposure to mosquitoes' bites [42].

One major reason that has been identified to cause differences in the prevalence of malaria infection between males and females is the attitude toward prevention and treatment of malaria [42]. Women have been reported to be more willing than men to invest in malaria preventive measures such as purchasing of insecticide treated bed nets [43]. Also, gender norms around sleeping arrangements can affect who sleeps under mosquito nets [44]. More often, young children sleep under bed-net with their mother and are therefore, protected from mosquitoes' bites. However, in some societies priority is given to male head to sleep under bed net if only one is available [45]. Men tend to sleep outdoors especially during hot weather and this may increase their risk of exposure to mosquitoes. As regard to prompt treatment of malaria, males were reported to utilize health care services less than females [46]. However, there are cases where gender dynamics influence who within a household decide if and when to access healthcare [45]. For biological and social reasons women, particularly pregnant women and children are at the greatest risk of contracting malaria both in high and low malaria endemic areas [47,48]. Understanding how gendered patterns influence the attitude of people in predisposing them to malaria infection can assist in developing more effective recommendations for the control of malaria infection.

The prevalence of malaria infection was not affected by the location of the study communities. Iye which is at the northern part of Ekiti State had the least prevalence of malaria infection (30.0%) during raining season and Ewu also in the same region had a prevalence of malaria infection which was as high as 40.6%. Whereas, Agbado and Ilupeju-Ijan which are both located in the south had a lower prevalence of malaria infection than Ewu. During the dry season, Agbado which is in the south had the least prevalence of malaria infection (18.6%) and Ilupeju-Ijan also in the same region had a prevalence of malaria infection as high as 31.7%. On the other hand, Eyio which is at the centre of the state had the highest prevalence of malaria infection (36.2%) during dry season. The reason is that the entire area land of Ekiti State is climatically homogenous and the difference in prevalence of malaria parasite infection observed was probably due to the attitude and practice of the community members.

5. CONCLUSION AND RECOMMENDATION

The results obtained in this study confirmed the earlier report that malaria infection is endemic in Ekiti State. The prevalence of malaria parasite infection was higher in rural communities than the periurban communities during the dry season. Although, the prevalence of the infection was higher in periurban than rural in the raining season but there was no statistically significant difference in the prevalence of the parasite infection in the two community types. Generally, there was a higher prevalence of malaria parasite infection in the raining season than the dry season. Children under five were observed to be more susceptible to the infection during raining season. Therefore, control programme should be more targeted to this population group in Ekiti State.

CONSENT AND ETHICAL APPROVAL

Ethical approval to carry out this study was obtained from Ethics and Research Committee, Ekiti State University Teaching Hospital, Ado-Ekiti, Ekiti State with reference number EKSUTH/A67/07/002. Approval to conduct the study within the communities in Ekiti State was obtained from Ekiti State Ministry of Health, Ado-Ekiti with reference number MOH/PRS/15. The consents of volunteers were obtained after explaining the aim and purpose of the study to them. Only participants who gave their consents were recruited into the study. Participants that tested positive for malaria parasite infection were treated with Artemether/lumefantrine tablets (20 mg/120 mg) in accordance with WHO recommendation [49].

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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