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Original Article

Malaria prevention practices and malaria prevalence among children living in a rural community in Southwest Nigeria

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Abstract

Introduction: Living conditions in most rural African communities favour malaria transmission and threaten global eradication. Prevention strategies and interventions such as the use of bed nets have reduced the prevalence of malaria. This study described the various methods employed to prevent malaria and their effects on malaria parasite prevalence among children living in a rural community in Nigeria.

Methodology: A community-based cross-sectional study conducted among 357 children aged 1–15 years, in a Nigerian rural community. Data was analyzed using SPSS version 25. Chi-squared test of association with a level of significance of $p < 0.050$ was used.

Results: Only 110 (30.8%) participants owned mosquito nets. Mostly those from the high social class (45; 40.9%) used the nets, and these were mostly 'under-five' children. Thirty-six (10.1%) were routinely given antimalarial drugs for malaria prophylaxis. Also, 102 (28.6%), 151 (42.3%), 278 (77.9%), 99 (27.7%) and 15 (5.0%) children used insecticides, local herbs, window nets, outlet door nets and mosquito repellent creams respectively. None of the methods employed to prevent malaria had statistically significant effect on malaria parasite prevalence among participants ($p > 0.050$).

Conclusions: Malaria prevention methods were mostly practiced by participants of the high social class while children under-five considerably used mosquito nets. This study highlights the need to address the socio-demographic imbalance regarding malaria preventive measures in the community where the study was conducted. There is also a need to regulate the use of antimalarial drugs for malaria prophylaxis in the rural community. These suggest that the current malaria prevention methods in the community be reviewed.

Key words: Malaria; prevalence; prevention; nets; antimalarial; herbs.

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Introduction

Malaria in Africa poses an enormous threat to the global eradication agenda, more so when the resources to combat malaria in Africa are inadequate [1,2]. The decline in the burden of malaria observed over the last decade globally has been at a much slower pace in Africa [1–4]. The tropical climate, compounded by poor environmental / living conditions and poverty have been largely implicated in the high transmission of malaria in most African countries [1,5].

Malaria is a protozoan infection of the red blood cells caused by *Plasmodium* sp. and spread through the bites of infected female *Anopheles* mosquitoes. Large plantations, and marshy and poorly drained areas as seen in the tropics, as well as agricultural practices including irrigation, encourage the breeding of mosquitoes [6,7]. The activity and reproduction of mosquitoes are also influenced by the rainfall, altitude, temperature of the geographical area and other environmental factors, including poor drainage and unauthorized dump sites [6–8].

From the foregoing, avoiding mosquito bites is a logical primary method of preventing malaria, infection. However, the use of mosquito repellent creams, bed nets, window nets and outlet door nets prevent mosquito bites to a reasonable extent and also have the potential to reduce the prevalence of mosquito-borne illnesses, such as malaria [9,10]. Household aerosolized insecticide spraying has also been observed to reduce malaria prevalence [11].

Global intervention programmes to combat malaria include the use of artemisinin-based combination

therapy (ACT), increased coverage with insecticide treated nets (ITNs) and in-door residual spraying (IRS). The success recorded due to the implemented malaria control and elimination strategies over the last decade has been attributed to these interventions [4,12–14]. ACTs are currently the first-line drugs for malaria treatment in Nigeria, to which the vast majority of the population has access [13,15,16]. The household ownership of ITNs in Nigeria is 68% in rural areas and 53% in the urban areas, mostly acquired during free net distribution campaigns [16,17]. However, only 1.3% of the households had implemented IRS within the previous 12 months as it has been reported in the 2015 Malaria Indicator Survey conducted in Nigeria [15,17].

Ekiti State is one of the states located in the South-Western part of Nigeria with many rural communities. Similar to other typical rural communities in most developing countries, the drainage systems and other sanitary measures in Ekiti State are poor thus, the living conditions favour high transmission of malaria [13,14,18]. According to the 2018 national demographic health survey (NDHS), the prevalence of malaria among under-five children in Ekiti State is 32.3% [16]. About 40.3% of those who live in the State dispose their refuse on unauthorised dump sites, and up to 30.2% of them use pit latrine, encouraging the breeding of mosquitoes [18]. In addition, the uptake of ITNs and ACTs in the rural communities are relatively low [16,18]. Therefore, there is a need for malaria surveillance in the rural communities of Ekiti State, which will facilitate better allocation of resources to implement malaria intervention programs.

This study aimed to investigate the various methods employed to prevent malaria among children living in a rural community in the Southwest Nigeria and their effects on the prevalence of malaria.

Methodology

Study design and setting

This study is a nested analysis of a community based cross-sectional study on malaria surveillance involving the prevalence of malaria parasite and enlarged spleen. It was conducted among children aged 1–15 years who live in a rural community in Southwest Nigeria. The study was conducted in Ire-Ekiti, which is located about 250 metres above the sea level between longitude 5° 23' 48''E and latitude 7° 44' 20''N, with high humidity and an annual rainfall of 109.7 mm [18–20]. This rural community is about 30 km from Ado-Ekiti, the capital of Ekiti State and the annex of the Ekiti State University Teaching Hospital (EKSUTH) is domiciled in Ire-Ekiti.

This study was conducted during the rainy season, over 3 months from April to June 2019. The children living in this rural community often stay outdoors in the evenings for recreation. In addition, the community engaged in rice farming for subsistence and commercial purposes; the children often accompanied their caregivers to the farm, returning in the evenings. Consequently, the children customarily remained outdoors during evening hours, exposing them to mosquito bites.

Sample size determination

The sample size was calculated using the formula proposed by Charan and Biswas [21] for cross-sectional studies/surveys $n = (Z^2\text{pq})/d^2$.Where Z was 1.96, the standard normal variate at 5% type 1 error, p was 32.3%, the prevalence of malaria by microscopy among children in Ekiti State [16], q was 1 – p and d was the acceptable margin of error, set at 5%. At least 336 children aged 1–15 years were required for this study. A total of 357 children were recruited and studied.

Participants' recruitment process

The participants included children aged 1 – 15 years who were randomly selected from their homes and assembled in batches at the EKSUTH annex in the community. The exclusion criteria for the study were children who did not live in the community for the past six consecutive months or those who spent at least one night outside the community within the preceding seven days of the survey.

Caregivers and their children living in households within the rural community were invited to participate in this study, after having informed and obtained the appropriate permission from the community leaders. The purpose of the study was explained to both the community leaders and the participants in a clear and simple language and only children whose caregivers gave consent to participate were recruited into the study.

Data and blood sample collection

Relevant information regarding the study were obtained through a pretested questionnaire administered by the research team and four other trained research assistants. Both the research team members and the research assistants are fluent in both English and Yoruba (the indigenous language of the study location) and as such, the questionnaire was administered in the language preferred by the respondents. The questionnaire was pretested in a neighboring rural community prior to the

commencement of the study and observations made during the pretest period were used to improve the study instrument prior to the main study.

Information on the participants' socio-demographic characteristics including age and their parents' education and occupation were obtained. In addition, participants and their caregivers were asked to list the different methods they employ to prevent malaria in their households such as the use of bed nets, drugs, insecticides, mosquito repellent creams or window and outlet door nets. The caregivers were also asked if the participants had been treated for malaria within six weeks prior to this study.

Thereafter, under aseptic conditions, the children's blood samples were obtained and examined for malaria parasites under the microscope. The thick blood films for malaria microscopy were prepared using Giemsa stain and malaria parasites were identified under the microscope with a 100X oil immersion objective [22].

Data analysis

Data were analyzed using the Statistical Package for Social Science (SPSS) version 25. The socioeconomic classification I – V by Oyedeji [23] was used; where I is the highest class and V, the lowest class. A further classification of the participants' socioeconomic status into High (classes I and II), Medium (class III) and Low (classes IV and V) as proposed by Oseni and Odewale [24] was used to categorize the participants into social classes. These categories were the variables used for the assessment of association between social class and the implemented methods of preventing malaria. Data obtained from the microscopic examination of the participants' blood smear were analyzed in order to investigate the association between the methods of malaria prevention and prevalence of malaria. The Pearson's Chi square test was used to test the association between the different categorical variables. The level of significance was set at $p < 0.05$.

Ethical considerations

The study was approved by the Research and Ethics Committee of EKSUTH, Ado-Ekiti and permission was obtained from the Primary Health Care Development Agency of the Ekiti State Government, Nigeria. Children with symptomatic malaria were treated with ACTs. Only parents who gave written informed consent and their wards were recruited into the study. In addition, assent was obtained from participants aged 7 years and above.

Results

In total, 357 participants were recruited and examined for the presence of malaria parasites in their red blood cells after microscopic examination. Of those, 110 (30.8%) participants lived in households with at least one mosquito net, majority (57; 51.8%) of these belonged to the age group of 1–5 years. Although there was no significant relationship between participants' age group and their possession of mosquito nets (p =

Table 1. Ownership and Use of mosquito nets among the participants.

Characteristics	Ownership of mosquito nets (%)*			*p*-value[α]
	YES	NO	TOTAL	
	N = 110 (30.8)	N = 251 (69.2)	N = 357 (100.0)	
Age group				
1–5 years	57 (51.8)	114 (46.2)	171 (47.9)	
6–10 years	34 (30.9)	86 (34.8)	120 (33.6)	0.612
11–15 years	19 (17.3)	47 (19.0)	66 (18.5)	
Social Class				
I	0 (0.0)	2 (0.8)	2 (0.6)	
II	20 (18.2)	15 (6.1)	35 (9.8)	
III	51 (46.4)	105 (42.5)	156 (43.7)	0.002**
IV	39 (35.5)	122 (49.4)	161 (45.1)	
V	0 (0.0)	3 (1.2)	3 (0.8)	
	Owned and slept under mosquito nets (%)*			
	YES	**NO**	**TOTAL**	
	N = 45 (40.9)	**N = 65 (59.1)**	**N = 110 (100.0)**	
Age group				
1–5 years	28 (62.2)	29 (44.6)	57 (51.8)	
6–10 years	14 (31.1)	20 (30.8)	34 (30.9)	0.038**
11–15 years	3 (6.7)	16 (24.6)	19 (17.3)	
Social Class				
II	4 (8.9)	16 (24.6)	20 (18.2)	
III	24 (53.3)	27 (41.5)	51 (46.4)	0.104
IV	17 (37.8)	22 (33.8)	39 (35.5)	

N: Number of participants; α: Statistical test – Chi-squared test.*: Percentage of Column Total; **: Significant *p*-values.

0.612), there was however, a statistically significant relationship between participants' social class and their ownership of mosquito nets (p = 0.002), as almost half of the participants who did not own mosquito nets (122; 49.4%) belonged to the low social class IV (Table 1).

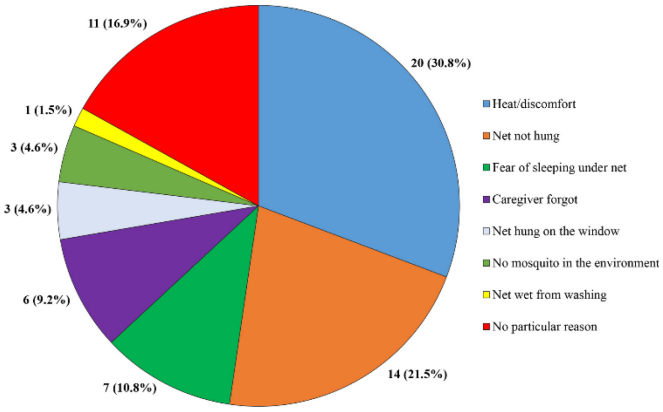
Among the 110 participants who owned mosquito nets, 45 (40.9%) of them slept under the nets the night before the survey. Majority (28; 62.2%) of those who slept under a mosquito net the night before the survey belonged to age group of 1–5 years; this was a significant finding (p=0.038) as shown in Table 1.

There was no significant association between the participants' social class and sleeping under a net the night before the survey (p = 0.104), even though majority (24; 53.3%) of those who slept under a net belonged to the social class III (Table 1).

There were various reasons why the 65 (59.1%) participants who owned mosquito nets did not use them the previous night. These reasons included complaints of experiencing heat or discomfort when sleeping under nets (20; 30.8%), not hanging the nets in the first place (14; 21.5%), the belief that there were no mosquitoes in the environment (3; 4.6%) among other reasons, displayed in Figure 1. Eleven of the participants had no particular reason for not using mosquito nets.

There were 36 (10.1%) participants who were routinely given antimalarial drugs to prevent malaria. The antimalarial drugs commonly given were Artemether/Lumefantrine (30), Sulfadoxine/Pyrimethamine (3) and Chloroquine (3). Figure 2 displays the frequency at which these drugs were given to the participants, which ranged from daily administration to monthly ingestion of these drugs.

Figure 1. Reasons why participants who had mosquito nets did not use them the night before the survey.



Besides the use of mosquito nets and antimalarial drugs, other methods of preventing malaria included the use of insecticides (102; 28.6%), ingestion of local herbs (151; 42.3%) and use of mosquito repellent creams (18; 5.0%). Some participants' homes had window nets (278; 77.9%), while a few fixed nets at their outlet doors (99; 27.7%).

Table 2 displays the social classes of the participants and the various methods of preventing

Table 2. Other methods of preventing malaria among the different Social Classes.

Other methods of preventing malaria	Social class (%)*			Total (%)*	*p*-value[α]
	High	Medium	Low		
Antimalarial Drugs					
Yes	4 (10.8)	13 (8.3)	19 (11.6)	36 (10.1)	0.620
No	33 (89.2)	143 (91.7)	145 (88.4)	321 (89.9)	
Use of insecticides					
Yes	18 (48.6)	43 (27.6)	41 (25.0)	102 (28.6)	0.015**
No	19 (51.4)	113 (72.4)	123 (75.0)	255 (71.4)	
Use of local herbs					
Yes	12 (32.4)	63 (40.4)	76 (46.3)	151 (42.3)	0.246
No	25 (67.6)	93 (59.6)	88 (53.7)	206 (57.7)	
Windows have nets					
Yes	33 (89.2)	126 (80.8)	119 (72.6)	278 (77.9)	0.045**
No	4 (10.8)	30 (19.2)	45 (27.4)	79 (22.1)	
Outlet doors have nets					
Yes	13 (35.1)	54 (34.6)	32 (19.5)	99 (27.7)	0.006**
No	24 (64.9)	102 (65.4)	132 (80.5)	258 (72.3)	
Use of mosquito repellent creams					
Yes	4 (10.8)	5 (3.2)	9 (5.5)	18 (5.0)	0.154
No	33 (89.2)	151 (96.8)	155 (94.5)	339 (95.0)	
Methods Used					
None	0 (0.0)	9 (5.8)	13 (7.9)	22 (6.2)	0.493
Only one	11 (29.7)	46 (29.5)	46 (28.0)	103 (28.9)	
More than one	26 (70.3)	101 (64.7)	105 (64.0)	232 (65.0)	
TOTAL[#]	37 (10.4)	156 (43.7)	164 (45.9)	357 (100.0)	

*: Percentage of Column Total; #: Percentage of Row Total; α: Chi-squared Test. **: Significant *p*-values.

malaria. Almost half (18; 48.6%) of the participants who belonged to the high social class ($p = 0.015$) used insecticides. About a third of those who belonged to the low social class did not fix nets on their windows (45; 27.4%; $p = 0.045$) and the majority of the low social class did not have nets at their outlet doors (132; 80.5%; $p = 0.006$). There was no other significant difference in the malaria prevention practices between the social classes ($p > 0.050$). As shown in Table 2, there were 335 (93.8%) participants who employed at least one method of preventing malaria, they included all the 37 (10.4%) participants belonging to the high social class. Of the 22 (6.2%) participants who did not use any method, 13 belonged to the low social class ($p = 0.493$).

There were 103 (28.9%) participants who used only one method of preventing malaria. Among these included 60 (58.3%) participants who had window nets, 26 (7.8%) participants who took local herbs, 9 (8.7%) participants who used insecticide sprays and 3 (2.9%) participants each who ingested antimalarial drugs or had outlet door nets. Of the participants who employed only one method of preventing malaria, only one participant each slept under net or used mosquito repellant cream. Just one participant combined all the methods except the use of antimalarial drugs for prophylaxis, while none of the participants combined all the seven methods of malaria prevention observed in this community.

There were 151 (42.3%) participants who routinely ingested local herbs to prevent malaria. Some of the herbal mixtures consisted of seeds, peels, leaves and tree barks of fruit bearing trees such as mango (60; 39.7%), cashew (34; 22.5%), orange (5; 3.3%), grape (2; 1.3%), pawpaw (2; 1.3%) and lemon (2; 1.3%) as well as some leaves and tree barks of plants listed in Supplementary Table 1. The details of the constituents and/or concentration of the herbal mixtures administered to 32 (21.2%) of the participants were however not known, although two of these were reportedly alcohol-based. Most of the caregivers claimed that routine ingestion of local herbs was a practice handed down their lineage; and that the constituents included materials from plants within their vicinity.

Figure 2. Use of Antimalarial drugs for malaria prophylaxis.

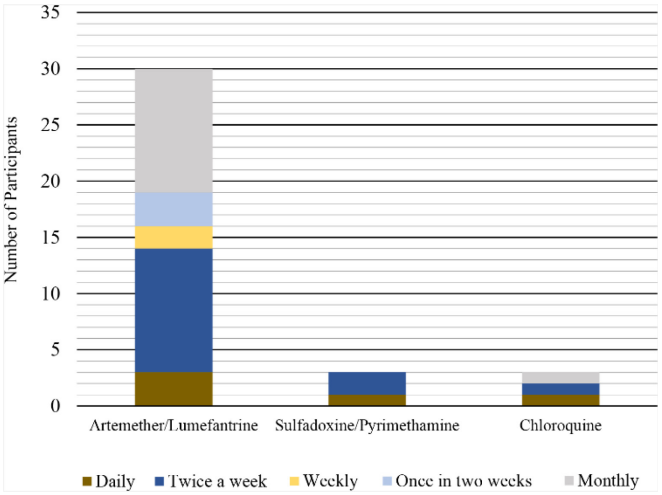


Table 3. Malaria Parasite prevalence among those who took antimalarial drugs.

Use of antimalarial drugs	Malaria parasitaemia		Total	*p*-value[α]
	Yes	No		
Malaria Prophylaxis (%)*				
Yes	11 (30.6)	25 (69.4)	36	0.601
No	85 (26.5)	236 (73.5)	321	
Total	96 (26.9)	261 (73.1)	357	
Drug used for prophylaxis (%)*				
Artemether/Lumefantrine	8 (26.7)	22 (73.3)	30	
Chloroquine	1 (33.3)	2 (66.7)	3	0.356
Sulfadoxine/Pyrimethamine	2 (66.7)	1 (33.3)	3	
Total	11 (30.6)	25 (69.4)	36	
Treatment of malaria in the previous 40 days[β] (%)*				
Yes	12 (14.8)	69 (85.2)	81	0.005**
No	84 (30.4)	192 (69.6)	276	
Total	96 (26.9)	261 (73.1)	357	
Drug used for treatment (%)*				
Artemether/Lumefantrine	9 (12.7)	62 (87.3)	71	
Chloroquine	1 (50.0)	1 (50.0)	2	0.241
Dihydroartemisinin/Piperaquine	0 (0.0)	2 (100.0)	2	
Sulfadoxine/Pyrimethamine	2 (33.3)	4 (66.7)	6	
Total	12 (14.8)	69 (85.2)	81	

α: Statistical test – Chi-squared test; β: The longest incubation period of *Plasmodium* [25]; *: Percentage of Row Total; **: Significant *p*-values.

Table 3 displays the malaria parasite prevalence among the participants who were said to have ingested antimalarial drugs prior to the survey. There were 81 (22.7%) participants who were said to have been previously diagnosed of and treated for malaria within 40 days prior to this survey; 69 (85.2%) of them did not have parasites in their blood during this study. Conversely, there were 36 (10.1%) participants who had routinely ingested antimalarial drugs for prophylaxis against malaria, 11 (30.6%) of these had malaria parasitaemia (Table 3). This proportion was higher compared to that of the participants who did not use any antimalarial drugs for prophylaxis and had malaria parasitaemia (85; 26.5%); although this was not a significant finding ($p > 0.050$). Among the 30 participants who had used Artemether/Lumefantrine for malaria prophylaxis, only 8 had malaria parasitaemia ($p > 0.050$).

There were 12 (14.8%) participants out of the 81 who had been treated for malaria within the previous 40 days that had malaria parasites. However, this percentage is considerably lower than the prevalence of malaria among 84 (30.4%) of the remaining 276 participants that had not been recently treated for malaria and had malaria parasites. This finding was statistically significant ($p = 0.005$). The type of antimalarial drug used did not have any statistically significant association with malaria parasitaemia in the participants ($p > 0.050$) as shown in Table 3. None of the other methods employed to prevent malaria had any statistically significant effect on the prevalence of malaria among the participants ($p > 0.050$) (Table 4).

The prevalence of malaria was higher among participants who slept under mosquito nets (13; 28.9%), used insecticides (29; 28.4%), took local herbs for prophylaxis (41; 27.2%) or used mosquito repellent creams (5; 27.8%) compared to those who did not use these methods (24.6%, 26.3%, 26.7% and 26.8% respectively) and had malaria parasitaemia as shown in Table 4.

On the other hand, fewer participants who had nets on their windows (73; 26.3%) or outlet doors (23; 23.2%) had malaria parasitaemia compared to those who did not have window nets or outlet door nets. A higher proportion of participants who did not employ any prevention method (8; 36.4%) had malaria parasitaemia compared to those who did. Similarly, the proportion of participants who used only one method

Table 4. Other methods of preventing malaria and malaria parasite prevalence.

Methods of preventing malaria	Malaria parasitaemia		Total	*p*-value[α]
	Yes	No		
Slept under mosquito nets (%)*				
Yes	13 (28.9)	32 (71.1)	45	0.617
No	16 (24.6)	49 (75.4)	65	
Total	29 (26.4)	81 (73.6)	110	
Use of insecticides (%)*				
Yes	29 (28.4)	73 (71.6)	102	0.678
No	67 (26.3)	188 (73.7)	255	
Total	96 (26.9)	261 (73.1)	357	
Use of local herbs (%)*				
Yes	41 (27.2)	110 (72.8)	151	0.924
No	55 (26.7)	151 (73.3)	206	
Total	96 (26.9)	261 (73.1)	357	
Windows have nets (%)*				
Yes	73 (26.3)	205 (73.7)	278	0.614
No	23 (29.1)	56 (70.9)	79	
Total	96 (26.9)	261 (73.1)	357	
Outlet doors have nets (%)*				
Yes	23 (23.2)	76 (76.8)	99	0.334
No	73 (28.3)	185 (71.7)	258	
Total	96 (26.9)	261 (73.1)	357	
Use of mosquito repellent creams (%)*				
Yes	5 (27.8)	13 (72.2)	18	0.931
No	91 (26.8)	248 (73.2)	339	
Total	96 (26.9)	261 (73.1)	357	
Methods used (%)				
None	8 (36.4)	14 (63.6)	22	0.504
Only one	25 (24.3)	78 (75.7)	103	
More than one	63 (27.2)	169 (72.8)	232	
Total	96 (26.9)	261 (73.1)	357	

α: Statistical test – Chi-squared test; * Percentage of Row Total.

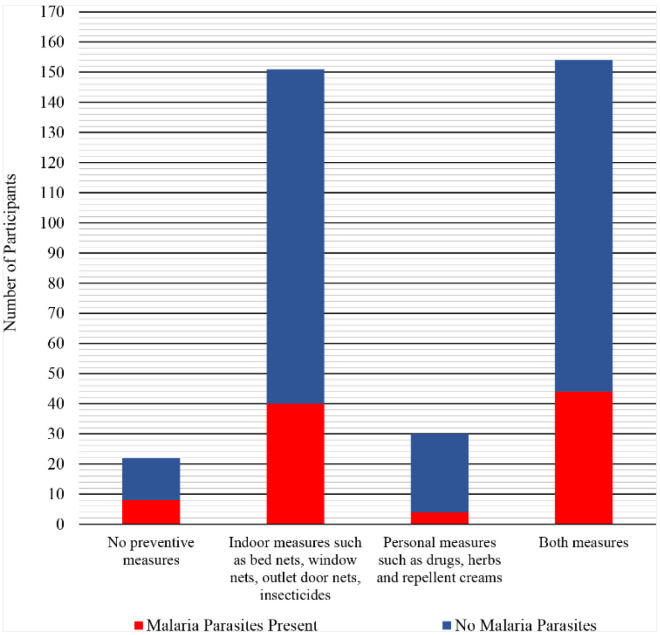
but had malaria (25; 24.3%) was less than those who used more than one method and still had malaria parasitaemia (63; 27.2%) ($p > 0.050$). The details are displayed on Table 4.

The methods of preventing malaria were grouped further into indoor measures and personal measures as shown in Figure 3. Indoor measures included use of bed nets, window nets, outlet door nets and insecticides while personal measures included ingestion of drugs and herbs as well as use of mosquito repellent creams. The prevalence of malaria was highest among participants who did not use any preventive measure (8; 36.4%) followed by those who combined both measures (44; 28.6%). Those who employed personal measures however had the least prevalence of malaria (4; 13.3%). This finding was however not significant ($p = 0.257$).

Discussion

One of the main strategies for malaria prevention is the use of mosquito nets. In this study, participants employed various methods for preventing malaria infection such as mosquito nets, insecticides and medications including antimalarial drugs and herbs. Only a third of the participants owned mosquito nets, this is much lower than the percentage ownership of 44% – 57% and 73.4% previously observed in Ekiti State as documented in the 2018 NDHS and 2015 malaria indicator survey (MIS) reports respectively [16,17]. This implies that the ownership of mosquito nets is low in the rural community surveyed when compared to the average state level. In addition, this study's finding could be an indication that ownership of mosquito nets might have generally declined when compared to the percentage ownership observed in the state within five years prior to this survey. These raise the need to intensify net distribution campaigns in the rural communities.

Figure 3. Comparison of malaria parasite prevalence across measures of malaria prevention.



As expected, more than half of the participants who owned mosquito nets in this study were 5 years and younger, and this might be related to the fact that most of the malaria interventions, especially the distribution of nets, were targeted at children younger than the age of five years [13,18,25,26]. Contrary to the observation from the MIS report [17], this study observed that a higher proportion of participants belonging to the higher social class owned mosquito nets. This may be due to increased awareness of the importance of using mosquito nets, increased accessibility to mosquito nets or to the financial capability to procure mosquito nets among the higher social class.

The findings of this study point out that the utilization of mosquito nets in the study area was low though marginally better than previous reports, but the reasons for non-utilization were quite similar to previous studies [16,17]. The main reasons for non-utilization of mosquito nets included non-availability, high cost, claustrophobia, and not seeing a need for one [16,17]. Some of these reasons, such as claustrophobia, are largely non-modifiable while some are amendable practices. This shows that there is a need to intensify health education in order to dispel misconceptions during net distribution campaigns such as non-use of mosquito nets when caregivers perceive that there are no mosquitoes and improper use of mosquito nets.

In contrast to some earlier reports that observed considerably low malaria prevalence among individuals that use mosquito nets [27,28], this study found no association between the use of mosquito nets and malaria parasite prevalence. Nevertheless, this study's findings were similar to that of Iwuafor *et al*. [29], who reported no significant reduction in malaria prevalence among children under-five who used ITNs in South-East Nigeria. A possible explanation for these findings include the possibility that the participants who used nets might have been bitten by mosquitoes prior to sleeping under the nets hence, the lack of significant difference in malaria prevalence observed between both groups. However, it may be necessary to also review the effect of environmental factors such as the presence of stagnant water bodies and thick vegetation in the vicinity of the participants' homes that may encourage the breeding of mosquitoes.

This study also observed indiscriminate use of ACTs for malaria prophylaxis; some of the participants also had routinely taken monotherapy of Sulfadoxine/Pyrimethamine and Chloroquine, probably because these drugs were available for over-the-counter purchase in the study area. None of the participants was given the WHO recommended combination of Sulfadoxine/Pyrimethamine and Amodiaquine for malaria prophylaxis in malaria endemic areas [30]. Howbeit, this study did not observe any significant difference in the prevalence of malaria between participants who took antimalarial drugs as malaria prophylaxis and those who did not. This finding may be due to inadequate dosing and/or haphazard frequency of administration of the drugs.

The uncoordinated use of ACTs observed in this study area may encourage the development of resistance against the ACTs, just as resistance to Sulfadoxine/Pyrimethamine and Chloroquine has been already observed [31,32]. These findings are of great concern given that some authors have already reported cases of malaria treatment failure with Artemether/Lumefantrine in Nigeria [7,32–38]. Even though Oboh *et al*. [39] reported no evidence of malaria parasite resistance to artemisinin in South-West Nigeria in 2018, there is still a great need to preempt resistance to ACTs in the community, where this study took place.

This study also observed that the proportion of the participants who did not test positive for malaria parasites after they were said to have been diagnosed and treated for malaria within six weeks prior to the commencement of this study was significantly higher than those who had not recently treated malaria. This further buttresses the effectiveness of ACTs in the treatment of malaria [40–42]. Moreover, there was no significant difference between the type of antimalarial drugs used and the presence of malaria parasites between the two groups as majority of those who treated malaria with ACTs did not have malaria parasites.

That almost half of the study participants use sundry herbs to prevent malaria, ranging from fruits to different plant parts, some of which have been documented by Oyelami [43] attests to the acceptability of herbal medicines in the state [44]. The compositions, combination, frequency, quantity, and duration of the use of these herbs varied widely among the participants. While some were mixed with alcohol, some were water-based and similar observations have been previously reported by some authors [45,46].

Nonetheless, malaria parasite prevalence among those who routinely took local herbs for prophylaxis did not differ significantly from those who were not given, thus raising speculations regarding the effectiveness of these herbal therapies regarding malaria prevention. This observation might be related to inadequate dose of the local herbs reported to have antimalarial properties [43,45,46] or the duration of ingestion was not adequate to interrupt the life cycle of malaria parasites. Besides, the therapeutic or prophylactic doses of local herbs as antimalarial agents are yet to be fully established [46,47]. Moreover, some of the local herbs used by the participants may not even have any antimalarial properties. These observations highlight the need for an increased education of caregivers in the study area on the use and misuse of conventional antimalarial drugs and other local measures for malaria control. In addition, it also raises the need to conduct proper randomized clinical trials on these therapies to evaluate their efficacies.

The lack of a statistically significant difference in the malaria parasite prevalence between users and non-users of insecticides might be attributed to the possible development of resistance to insecticides in mosquitoes, as also alluded to by previously published studies [48,49]. Likewise, some authors previously suggested that the use of mosquito repellent creams do not have considerable effect on the prevalence of malaria [50], as also observed in this study. However, a lower prevalence of malaria was observed among the participants of this study who used mosquito repellent creams among other personal measures compared to the other groups of participants. Perhaps this observation lacked statistical significance because of the small number of repellent cream users.

Furthermore, this study did not find any significant reduction in malaria parasite prevalence among the participants who had nets on their windows and outlet doors, even though window nets were used by majority of the participants across the three social classes. Some of the participants even cited the presence of window nets as their reasons for not sleeping under mosquito nets; a similar observation was reported by Oyekale [10], among Cameroonian children under-five. Moreover, the integrity of the window or outlet door nets might have been compromised so as to allow mosquitoes into the house and bite unprotected participants indoors, thus transmitting malaria.

This study observed that the prevalence of malaria was lower among participants who used only one method of malaria prevention compared to those who did not use any method or used more than one method. It may be presumed that participants who use only one method exercise more caution to reduce exposure to mosquito bites than those who use more than one

method. A qualitative study may be necessary for better understanding of this assumption.

The use of antimalarial drugs for prophylaxis was associated with the highest prevalence of malaria among all the methods while the use of outlet door and window nets was associated with the lowest prevalence of malaria. Nevertheless, the overall highest prevalence of malaria was observed among participants who did not employ any method of preventing malaria. Generally, this study suggests that participants should combine their preferred methods of malaria prevention with environmental sanitation to discourage the breeding of mosquitoes and ultimately halt the transmission of malaria. Efforts need to be targeted at vector control strategies, which has been noted to be effective in reducing malaria prevalence [51].

Conclusions

The participants used various methods for preventing malaria including mosquito nets, antimalarial drugs such as ACTs and local herbal medicines. The participants who had nets on their outlet doors and windows had the least prevalence of malaria compared to the other participants, while study participants who did not use any method had the highest prevalence of malaria. However, none of these methods provided a statistically significantly higher protection from malaria between the groups of participants who used these methods and those who did not.

The malaria prevention methods were mostly practiced by participants of the high social class while most of those that slept under mosquito nets were under-five children. This study highlights the need to address the socio-demographic imbalance regarding malaria preventive measures in the community where this study was conducted. There is also a need to regulate the use of antimalarial drugs for malaria prophylaxis in the rural community. This study suggests a review of the malaria prevention methods used in the locality.

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