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Research Article

Investigating the Knowledge, Attitude, and Practice (KAP) of Mosquito Control in Osun State, Nigeria

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ABSTRACT
Mosquito vector control still remains crucial in the control and prevention of mosquito-borne diseases. The present study investigates the impact of knowledge, attitude, and practice in vector control among residents in Osun State, Nigeria. The study employed a cross-sectional approach across three study areas comprising an urban, a semi-urban and a rural community between October and November, 2025. These include Owode, Alekunwodo and Ilobu, respectively. A total of 309 well-structured qualitative questionnaires were administered to critically assess residents' knowledge on vector control measures and others. Data were analysed using descriptive and chi-square statistical analysis. Two hundred and sixty (260) (81.6%) respondents could identify mosquito larvae with the local name 'tanwiji'. 107 (35.2%) were aware that it is the larval stage that transforms into adult mosquitoes. Only 100 (32.9%) respondents owned long-lasting insecticidal nets and slept under them. The number of respondents, 74(60.2%), sleeping under insecticide-treated nets every night, was highest in urban settings. The majority of respondents, 216(71.1%) reported using insecticides, with 45.4% using them monthly. Antimalarial drugs were the most commonly used therapy for malaria treatment by respondents (56.6%), followed by antimalarial injections and medicinal plants (agbo) (11.0%). These findings indicate the urgent need for effective sensitization and awareness on the utilization of current vector control interventions by residents, such as LLIN, particularly in semi-urban and rural areas of the state. Additionally, there is the vitality of environmental management, which remains an inevitable measure in vector control.

Keywords: KAP; LLIN; Malaria; Mosquito Control; Osun

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INTRODUCTION

Mosquito-borne diseases constitute a significant public health challenge in sub-Saharan Africa, with Nigeria experiencing a disproportionately high burden (Adeleke *et al.,* 2025; Adeogun *et al*., 2025). Malaria remains a significant MBD of global public health concern. The disease is caused by the *Plasmodium* parasite, which is transmitted by female *Anopheles* mosquitoes the primary vector of malaria in Africa (Egbuche *et al*., 2020). *Plasmodium* is the leading parasitic disease of public health concern and is currently a global health priority. The World Health Organization reported that Africa had the highest

number of malaria cases in 2023, with 246 million cases, followed by the WHO's Southeast region, which accounted for 5% of cases, and the Eastern Mediterranean region, which accounted for 8.3% of cases (WHO, 2024).

Fifteen countries in Sub-Saharan Africa and India accounted for 80% of the global malaria burden, with five countries responsible for about half of all malaria cases worldwide. These include Nigeria (27%), Democratic Republic of the Congo (12%), Mozambique (3.5%), India (0.1%), and Uganda (4.5%) (WHO, 2023). An overview from WHO in 2023 reports that some countries have successfully eliminated malaria over the past few decades across different regions, and current records show that countries have recently been certified as malaria-free, along with future elimination goals.

In Nigeria, Resistance to insecticides, especially pyrethroids, undermines the efficacy of insecticide-treated nets (ITNs) in malaria prevention. However, this resistance has been observed in various mosquito genera, notably in *Anopheles, Aedes and culex* (Babalola *et al.,* 2025). Vector control has been pivotal in decreasing disease transmission. Interventions such as long-lasting insecticidal nets (LLINs), indoor residual spraying (IRS), and larval source management have demonstrated effectiveness in reducing vector densities and malaria prevalence (Adeogun *et al*., 2025; Busari *et al*., 2025). In Osun State, which remains endemic, there are still insufficient information that is resident-centered capturing their knowledge, attitude and practice to vector control since vector control is impossible with human input. Therefore, the present study seeks to address this gap by assessing residents' knowledge, attitude and practice, an avenue to unravel their awareness, acceptance and utilization of mosquito vector control intervention which is invariably pivotal for disease control and elimination.

MATERIALS AND METHODS

Ethical Consideration

Ethical approval for this study was obtained from the ethics committee of the Osun State Ministry of Health (Reference Number: OSHREC/PRS/569T/1264). Before administering the questionnaire, oral and written informed consent were obtained from the participants, following clear explanation of the study objectives of the study, the voluntary nature of participation, and the right to withdraw at any time. This study was conducted adhering strictly to international ethical guidelines.

Study Design and Area

This was a cross-sectional study conducted between October and November 2025 in three communities representing distinct settlement types in Osun State, southwestern Nigeria: Alekunwodo (urban), Owode (semi-urban), and Oke-Ayepe-Ilobu (rural), located within the Osogbo metropolis and its environs. The study areas lie at approximately latitude 7°30'N and longitude 4°30'E. These areas are located in Osogbo (Alekunwodo, Owode) and Irepodun (Ilobu) Local Government, Osun State, Nigeria. Alekunwodo is an urban district in the capital city. Owode is also located in the state capital, with some of the residents involved in subsistence farming. Ilobu is a rural community whose residents are predominantly engaged in agricultural farming.

Sample Size Determination

The sample size was determined to be 360 using the relative precision method at 95% confidence level and an expected proportion of 50%, according to Lemeshow *et al.* (1990).

$$N = \frac{Z^2 .(1-P)}{E^2 \cdot P}$$

Z= score for the 95% confidence level

P= anticipated population is 1.96

E= The relative population precision is 0.10 (10%)

Systematic random sampling was used to administer the questionnaire door-to-door to households in each community.

Data Collection

The data was collected through an interview method, with the respondent's comments documented. The questionnaires were aimed at gathering information from respondents about mosquitoes and diseases linked with them, as well as control techniques. The questionnaire was categorized into four sections: (A) socio-demographic information, (B) KAP linked to mosquito habitats, mosquitoes, prevention, and control, (C) KAP on vector control. (D) KAP on mosquito-borne diseases and methods of treatment.

Data analysis

The data were entered into Microsoft excel (version 21) and analyzed with SPSS version 22. The multiple groups of variables and percentages from each questionnaire were evaluated using descriptive statistics. In addition, a Chi-square test was performed to examine the relationship between demographic and socioeconomic factors and respondents' KAP on vector and disease transmission.

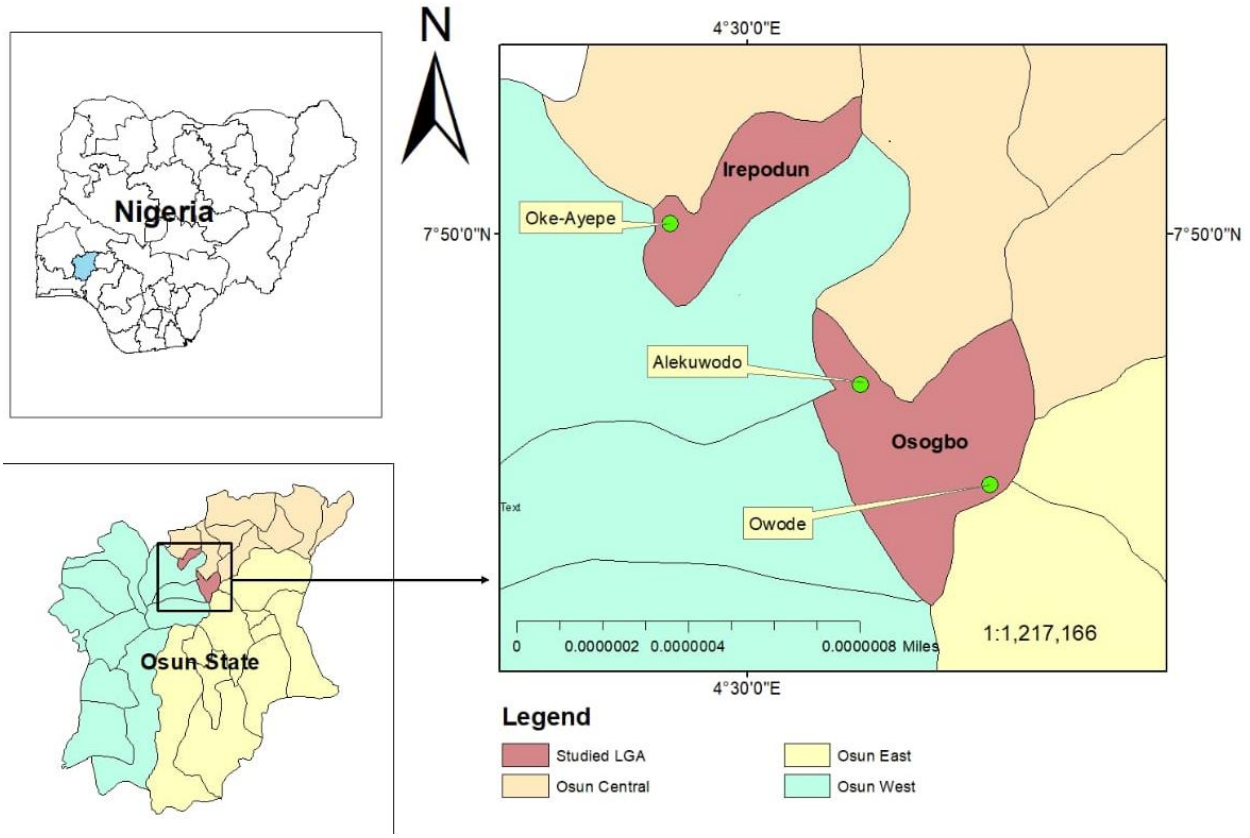

Fig. 1: Map of Irepodun and Osogbo Local Government showing the study areas (ArcGIS, version 10.7)

RESULTS

The percentage of respondents varied across the study areas with 33.9%, 32.6%, and 33.6% in Owode, Alekuwodo, and Ilobu, respectively. Female (66.0%) respondents were more highly represented than the males (34.0%). Only a few of the respondents have no formal education, while the majority have attained secondary (54.5%), tertiary (25.1%), and primary (16.2%). Yoruba people have the highest respondents in all the communities with 96.0%, followed by other tribes: Igbo (2.0%), others (1.7%), and Hausa (0.3%). The age group 26-35 (27.7%) recorded the highest percentage of respondent followed by age groups 36-45 (23.0%), 15-25 (22.3%), 46-50 (11.3%) and >50(15.7%). The majority of them are engaged in trading (75.2%) and live in a flat apartment (41.1%). The majority of the households comprise more than 6 members (41.8%) (Table 1).

KAP on Mosquito Identification, Habitat, and Larval Control

Respondents across the three study sites demonstrated a high level of awareness regarding mosquito identification. The majority (86.1%) correctly identified the vector's larval stage (tanwiji), and 96.7% correctly recognized adult mosquitoes. In contrast, knowledge of the transitional developmental form from larva to adult was low, with only 107 (35.2%) of respondents recognizing this relationship. Regarding breeding sites, stagnant water was identified by 107 (35.4%) of respondents, gutters 18 (6.0%), and multiple habitats 137 (45.4%), with 9 (3.0%) mentioning grasses. Sanitation and waste disposal practices varied significantly across communities: waste disposal in Owode was largely through burning (29.1%) and dumpsites or canals (70.9%), whereas government or Private Sector Participation (PSP) collection predominated in Alekunwodo, and Ilobu respondents showed a balanced distribution across disposal methods. Gutter clearance was reported as largely absent in Owode, where most respondents indicated no gutters in their area, but was more commonly practiced in Ilobu and Alekunwodo (Table 2). Covering water-holding containers was widely practiced across all communities (88.1%); however, fewer respondents regularly drained or disposed of water from containers and tires (57.3%). Awareness of mosquito biting times was generally consistent, with night and midnight identified as peak periods, although a notable proportion perceived and

statistically significant with P value less than 0.05 (P=0.001<0.005). mosquitoes as biting throughout the day.

Tables 1: Socio-demographic of study respondents

Variables	Category	No of respondents	% in each category
Study communities	Owode	103	33.9
	Alekunwodo	99	32.6
	Ilobu	102	33.6
Gender	Male	102	34.0
	Female	198	66.0
Tribe	Yoruba	287	96
	Hausa	1	0.3
	Igbo	6	2.0
	Others	5	1.7
Age group	15 - 25	67	22.3
	26 - 35	83	27.7
	36 - 45	69	23.0
	46 - 50	34	11.3
	> 50	47	15.7
Level of education	Primary	49	16.2
	Secondary	165	54.5
	Tertiary	76	25.1
	No formal education	13	4.3
Occupation	Student	33	14.3
	Trader	248	75.2
	Civil servant	12	5.2
	Farmer	12	5.2
Type of dwelling houses	Single room	60	19.9
	Room and Parlor	72	23.8
	A room self-contained	14	4.6
	Flat	124	41.1
	Bungalow	32	10.6
No of household members	1	18	5.9
	2	14	4.6
	3	17	5.6
	4	37	12.2
	5	44	14.5
	6	48	15.8
	>6	125	41.8

Table 2: KAP about mosquito bioecology across the study areas by respondents

Category	Owode	Ilobu	Alekunwodo	Total	P Value
	No (%)	No (%)	No (%)	No (%)	
Do you know that it is the larva ("tanwiji") that develops into adult mosquito("efon")?	39 (37.9)	35 (34.3)	33 (33.3)	107 (35.2)	0.923
Yes	64 (62.1)	67 (65.7)	66 (66.7)	197(64.8)	
No					
Can you identify a mosquito larva ("tanwiji")?					
Yes	89 (86.4)	95 (94.1)	76 (77.6)	260 (86.1)	0.003
No	14 (13.6)	6 (5.9)	22 (22.4)	42 (13.9)	
Can you identify an adult mosquito?					
Yes	98 (95.1)	101 (99.0)	93 (95.9)	292 (96.7)	
No	2 (1.9)	1 (1.0)	3 (3.1)	6 (2.0)	0.333
Maybe	3 (2.9)	0	1 (1.0)	4 (1.3)	
What do you know that breeds mosquitoes?	4 (3.9)	4 (4.0)	1 (1.0)	9 (3.0)	
Grasses	49 (47.6)	30 (29.7)	28 (28.6)	107 (35.4)	0.001
Stagnant water	7 (6.8)	8 (7.9)	3 (3.1)	18 (6.0)	
Gutter	28 (27.2)	53 (52.5)	56 (57.1)	137 (45.4)	
All	15 (14.6)	6 (5.9)	10 (10.2)	31 (10.3)	
Others					
Do you know mosquito bites?					
Yes	91(88.3)	99 (97.1)	94 (94.9)	284 (93.4)	
No	9 (8.7)	0	5 (5.1)	14 (4.6)	0.018
Sometimes	3 (2.9)	3 (2.9)	0	6 (2.0)	
What time does mosquito bites in your area?	6 (5.8)	3 (2.9)	2 (2.0)	11 (3.6)	
Morning	3 (2.9)	2 (2.0)	2 (2.0)	7 (2.3)	0.001
Afternoon	47 (45.6)	49 (48.0)	73 (73.7)	169 (55.6)	
Night	28 (27.2)	13 (12.7)	4 (4.0)	45 (14.8)	
Midnight	19 (18.4)	35 (34.3)	18 (18.2)	72 (23.7)	
All time of the day					
How do you dispose your garbage/waste?	0	1 (1.0)	1 (1.0)	1 (0.3)	
On the street	0	7 (6.9)	75 (75.8)	82 (27.2)	0.001
Government/PSP	70 (70.9)	38 (37.6)	11 (11.1)	119 (39.4)	
Dumpsite/Canal	33 (29.1)	55 (54.5)	12 (12.1)	100 (33.1)	
Burning					
Do you clear your gutters?					
Yes	5 (4.9)	48 (48.5)	81 (81.2)	134 (44.5)	
No	10 (9.7)	2 (2.0)	3 (3.0)	15 (5.0)	0.001
There is no gutter in area	88 (85.4)	49 (49.5)	15 (15.2)	152 (50.5)	
How often do you clear gutters?					
Daily	0	16 (16.5)	19 (19.2)	35(12.1)	
Weekly	3 (6.3)	27 (27.8)	53 (53.5)	83 (28.7)	0.001
Monthly	1 (1.0)	5 (5.2)	10 (10.1)	16 (5.5)	
Quarterly	1 (1.0)	1 (1.0)	1 (1.0)	3 (1.0)	
Yearly	0	1 (1.0)	7 (7.1)	8 (2.8)	
No gutter in my area	88(91.7)	47 (48.5)	9 (9.1)	144 (49.8)	

Do you cover water-holdings like domestic containers?					
Yes	95 (92.2)	94 (92.2)	71 (71.0)	260 (88.1)	
No	4 (3.9)	6 (5.9)	18 (18.0)	26 (8.81)	0.002
Maybe	4 (3.9)	2 (2.0)	3 (19.0)	9 (3.1)	
Do you drain/dispose water from water-holding containers and tires?					
Yes	50 (48.5)	52 (52.0)	71 (71.7)	173 (57.3)	0.001
No	2 (1.9)	4 (4.0)	18 (18.2)	24 (7.9)	
No domestic containers or tires in my surroundings	51 (49.6)	44 (44.0)	10 (10.1)	105 (34.8)	

Prevention of Adult Mosquito Bites Among the Respondents in Each Community

The study communities differ in their mosquito prevention practices. Corrugated iron sheets were the most common roofing material (78.6%), followed by thatched roofs (1.9%) and tukul structures (1.0%) at Owode. Ilobu respondents reported greater diversity in dwelling structures, with corrugated iron sheets and corrugated metal sheets accounting for the largest percentages (62.6% and 27%, respectively), followed by fewer thatched and tukul roofs and tukul with iron sheets. The roofing material utilized at Alekunwodo was more consistent, with corrugated iron sheets and corrugated metal sheets dominating the axis at (72.9%) and (26.0%), respectively. In Owode, aluminum windows were the most common (58.8%), however in Ilobu, resident response is heavily reliant on non-screened louvers (46.4%), followed by wooden windows (15.5%), preceded by insecticidal net-screened windows (13.4%). Alekunwodo had a wider range of window types used, with insecticide-treated nets (30.6%), aluminum windows (29.6%), and non-screened louvers (23.5%) all making substantial contributions. Mosquito preventive strategies have similarities and variances between areas. In Owode, aerosol sprays were the most commonly used (43.6%), followed by long-lasting insecticidal nets (LLINs) (24.7%). Ilobu households reported a more evenly distributed use of LLIN (26.5%), closing doors and windows (26.5%), and aerosols (21.4%). Aerosols (43.3%) and LLINs (33.0%) were the most commonly used tactics in Alekunwodo, with just 4.1% of residents closing doors and windows.

Use of Insecticides and Long-Lasting Insecticidal Nets

This result shows that respondents from the three communities indicate using insecticides (aerosol), with Alekunwodo revealing the highest proportion (80.8%) of respondents using insecticides. Usage patterns vary, but infrequent and monthly use predominate across all communities (45.4%), while daily use is relatively low (20.4%). LLIN ownership is limited; only 32.9% of respondents' overall report sleeping under an insecticidal net (ITN/LLIN). Alekunwodo has the highest ownership (40.4%), followed by Ilobu (31.4%), while Owode has the lowest (27.2%). Most respondents across the three sites report using a mosquito net for 1-4 years, with fewer reporting longer durations. Daily use of LLINs is most common among net owners (60.2%), though usage is less consistent in both Owode and Ilobu.

KAP on Mosquito-Borne Diseases and Treatment Methods

This shows that malaria is widely acknowledged as the predominant mosquito-borne disease among respondents across the locations (89.1%), while other medical conditions, such as typhoid, were reported by just a minority. The primary treatment method is the use of anti-malarial drugs (56.6%), succeeded by injections (11%) and medicinal plants (11%), with certain respondents employing a multifaceted approach to combat malaria. The therapy exhibited significant variation, with the majority of respondents (40%) reporting no malaria medication, while others indicated monthly treatment (17.4%), yearly treatment (15.1%), and quarterly treatment (3%). Nonetheless, the frequency of daily treatment remains few (2.7%).

Table 3: KAP on prevention of adult mosquito bites among the respondents in each community

	Owode	Ilobu	Alekunwodo	Total	P value
Category	No (%)	No (%)	No (%)	No (%)	
Type of roof					
Corrugated iron sheet	81 (78.6)	63 (62.4)	70 (72.9)	214 (72.1)	0.033
Thatched roof	2 (1.9)	4 (4.0)	0	6 (2.0)	
Tukul with thatched roof	1 (1.0)	2 (2.0)	0	3 (1.0)	
Tukul with iron roof	0	2 (2.0)	0	2 (0.7)	
Corrugated metal sheet	16 (15.5)	28 (27.7)	26 (27.1)	70 (23.6)	
Other	0	2 (2.0)	0	2 (0.7)	
Type of window					
Screened with non-insecticide net	19 (18.6)	8 (8.2)	16 (16.3)	43 (14.5)	0.001
Screened with insecticide net	18 (17.6)	13 (13.4)	30 (30.6)	61 (20.5)	
Non screened with louver	5 (4.9)	45 (46.4)	23 (23.5)	73 (24.6)	
Aluminum window	60 (58.8)	16 (16.5)	29 (29.6)	105 (35.4)	
Louver with non- insecticide net	0	0	0	0	
Wooden window	0	15 (15.5)	0	15 (5.1)	
How did you prevent mosquitoes?					
Mosquito coil	13 (12.6)	16 (16.3)	15 (15.5)	44 (14.9)	0.001
Use of aerosol	44 (43.6)	21 (21.4)	42 (43.3)	107 (36.1)	
Use of LLIN	25 (24.7)	26 (26.5)	32 (33.0)	83 (28)	
Shutting of windows and doors	14 (13.8)	26 (26.5)	4 (4.1)	44 (14.9)	
No prevention	4 (3.9)	9 (9.2)	4 (4.1)	17 (5.7)	
Burning of botanical leaves	1 (1.0)	0	0	1 (0.3)	
If no for all Preventive measures against mosquitoes, why?					
Nonchalant attitude	0	0	1 (1.0)	1 (33.3)	0.223
Mosquito doesn't bite	1 (1.0)	0	0	1 (33.3)	
Financial status	1 (1.0)	0	0	1 (33.3)	

Table 4: KAP on the use of insecticides and Long-Lasting Insecticidal Nets (LLIN) among respondents across the study areas

	Owode	Ilobu	Alekunwodo	Total	P value
Category	No (%)	No (%)	No (%)	No (%)	
Do you use Insecticide					
Yes	68 (66.0)	68(66.7)	80 (80.8)	216 (71.1)	0.033
No	35 (34.0)	34(33.3)	19 (19.2)	88 (28.9)	
How often do use insecticide spray/aerosol?					
Daily	15 (22.1)	11(16.2)	18 (22.5)	44 (20.4)	0.012
Every other day	7 (10.3)	4 (5.9)	11 (13.8)	22 (10.2)	
Weekly	6 (8.8)	3 (4.4)	9 (11.3)	18 (8.3)	
Fortnightly	15 (22.1)	5 (7.4)	14 (18.0)	34 (15.7)	
Monthly/not frequently	25 (36.8)	45 (66.2)	28 (35.0)	98 (45.4)	
Do you own ITN/LLIN which you sleep under it?					
Yes	28 (27.2)	32 (31.4)	40 (40.4)	100 (32.9)	0.125
No	75 (72.8)	70 (68.6)	59 (59.6)	204 (61.1)	
How long have you been using it?					
1 - 2 years	7 (25)	13 (40.6)	18 (45)	38 (38)	0.781
3 - 4 years	9 (32.1)	10 (31.3)	10 (25)	29 (29)	
5 - 6 years	5 (17.9)	4 (12.5)	6 (15)	15 (15)	
7 - 8 years	1(3.6)	1 (3.1)	1 (2.5)	3 (3)	
9 - 10 years	1 (3.6)	2 (6.3)	3 (7.5)	6 (6)	
> 10 years	5 (17.9)	2 (6.3)	2 (5)	9 (9)	
How often do you use the ITN/LLIN?					
Daily	25 (71.4)	20 (48.8)	29 (61.7)	74 (60.2)	0.093
Every other day	5 (14.3)	4 (9.8)	3 (6.4)	12 (9.8)	
weekly	1 (2.9)	0	2 (4.3)	3 (2.4)	
Fortnightly	2 (5.7)	7 (17.1)	2 (4.3)	11 (8.9)	
Monthly/not frequently	2 (5.7)	10 (24.4)	11 (23.4)	23 (18.7)	

Table 5: KAP on mosquito-borne diseases and treatment among respondents in each community

	Owode	Ilobu	Alekunwoodo	Total	P value
Category	No (%)	No (%)	No (%)	No (%)	
What are the diseases spread by mosquitoes that you know?					
Malaria	93 (95.9)	81(81.8)	81 (90.0)	255 (89.2)	0.001
Malaria and fever	2 (2.1)	3 (3.0)	1 (1.1)	6 (2.1)	
Malaria and Typhoid	1(1.0)	0	3 (3.3)	4 (1.4)	
Headache, body pain, rashes and body temperature	1 (1.0)	12 (12.1)	1 (1.1)	14 (4.9)	
No diseases	0	3 (3.0)	4 (4.4)	7 (2.4)	
How do you treat malaria?					
Anti-malaria drug	54 (58.1)	46 (46)	64 (66.0)	164 (56.6)	0.177
Anti-malaria injection	10 (10.8)	12 (12)	10 (10.3)	32 (11.0)	
Medicinal Plants (Agbo)	10 (10.8)	12 (12)	10 (10.3)	32 (11.0)	
All of the above	5 (5.4)	11 (11)	1 (1.0)	17 (5.9)	
Drug and Injection	5 (5.4)	8 (8)	4 (4.1)	17 (5.9)	
Drug and Agbo	9 (9.7)	11 (11)	8 (8.2)	28 (9.6)	
How often do you treat malaria?					
Daily	3(3.4)	0	4 (4.6)	7 (2.7)	0.021
Monthly	12 (14)	18 (21.2)	15 (17.2)	45 (17.4)	
Weekly	5 (5.8)	4 (4.7)	3 (3.4)	12 (4.7)	
Quarterly	10 (11.6)	7 (8.2)	7 (8.0)	24 (9.3)	
Half yearly	6 (7.0)	5 (5.9)	17 (19.5)	28 (10.9)	
Yearly	20 (23.3)	9 (10.6)	10 (11.5)	39 (15.1)	
I don't treat malaria	30 (34.9)	42 (49.4)	31 (35.6)	103 (40.0)	

DISCUSSION

The level of awareness of residents is crucial in the vector control of mosquito-borne diseases (MBD). The present study shows respondents demonstrated high awareness of mosquitoes and malaria (P=0.003<0.005), the findings highlight important gaps in understanding of mosquito development, inconsistent larval and adult vector control practices, suboptimal long-lasting insecticidal net (LLIN) use, and substantial reliance on self-medication and herbal remedies. Together, these factors may sustain transmission despite long-standing control efforts in southwestern Nigeria.

The sociodemographic profile of respondents predominantly women, Yoruba, with secondary education, engaged mainly in trading, living in flats and often in large households has several implications for KAP and control interventions. Female predominance is consistent with many Nigerian malaria KAP studies that recruit respondents at home or at health facilities, where women are more available and act as primary caregivers (Adegbehingbe *et al*., 2025; Nassai *et al.,* 2022; Emmanuel *et al.,* 2024). This places women at the Centre of household decision-making about net use, sanitation and treatment-seeking, but also means that male perspectives and behaviors may be under-represented. The high proportion with at least secondary education is higher than in many rural KAP surveys from northern and central Nigeria (Nassai *et al*., 2022; Nwibari *et al*., 2024), more similar to urban and peri-urban samples from Lagos and Ogun States (Fagbohun *et al*., 2021; Oforka *et al*., 2023; Wakai *et al.,* 2025). Yet, as in Canaan land, Ota, Ogun state, where 82% of respondents were students but preventive practices remained poor (Wakai *et al.,* 2025), education in this study did not automatically translate into optimal preventive or treatment behaviors.

The results on mosquito biology knowledge were mixed. Recognition of adult mosquitoes (96.7%) and larvae (86.1%) was very high, and most respondents correctly associated stagnant water with breeding. This level of awareness is higher than reported in earlier Lagos and Jos surveys where only 65–75% recognized larvae or linked them to adult mosquitoes (Oforka *et al*., 2023; Nwibari *et al*., 2024), and comparable to findings in urban Lagos LGAs where >90% of respondents identified mosquitoes as vectors (Fagbohun *et al*., 2021). However, only about one-third understood larval-to-adult metamorphosis, indicating a conceptual break in the understanding of the mosquito life cycle. Similar disconnects have been documented in Lagos informal settlements (Oforka *et al*., 2023) and Ekiti communities (Olorunniyi & Idowu, 2021), where residents recognize larvae and adults but do not consistently connect larval habitats with adult mosquito densities or disease risk. This limits community appreciation of the value of larval source management and routine environmental sanitation as core components of vector control. Biting time knowledge was moderately accurate: most respondents identified night or midnight peaks, but nearly one-quarter believed mosquitoes bite “any time”. While this may partially reflect recognition of diurnal Aedes or Culex biting, it could also reflect undifferentiated perceptions of risk that may not translate into time-specific protective behaviors (e.g., evening net use or early evening repellent use). Studies in Lagos and Tanzania have similarly found that while people associate mosquitoes with night-time nuisance, they often underestimate early evening and outdoor biting (Omotayo *et al*., 2021; Sumari *et al*., 2016; Liheluka *et al.,* 2023). The implication is that behaviour change communication should not only reinforce the link between larvae, breeding sites and adult emergence, but also emphasize the timing and ecology of different vectors to support both indoor and outdoor risk reduction.

Sanitation and larval control practices varied substantially between communities and were clearly structured by local infrastructure. Burning of waste dominated in Owode, formal PSP or government collection in Alekunwodo, and mixed practices in Ilobu. This heterogeneity echoes findings from Lagos informal settlements, where formal solid waste services are patchy and residents’ resort to burning or dumping in canals (Oforka *et al.,* 2023). Gutter clearance was reported as “not applicable” by most respondents in Owode, consistent with the reported lack of gutters, but was common in the more infrastructure-developed Alekunwodo and in Ilobu. High reported gutter clearance (48–81%) is encouraging in principle, as clogged drains and stagnant runoff have been repeatedly associated with increased Anopheles and Culex breeding in Nigerian and Tanzanian cities (Amoran *et al*., 2014; Liheluka *et al.,* 2023). However, experience from Lagos and Dar es Salaam suggests that routine weekly or fortnightly clearance is required to meaningfully reduce breeding, and self-reported sanitation may overestimate sustained practice (Oforka *et al*., 2023; Maheu-Giroux & Castro, 2013). The widespread covering of water-holding containers (88.1%) is consistent with good knowledge of

container-breeding risks and parallels reports from Oluyole LGA of Oyo state, Nigeria (Adegbehingbe *et al.,* 2025), but only 57.3% consistently drained water from containers and tires. This incomplete practice mirrors the 25–30% of respondents in Ekiti and Lagos who did not identify or act on container breeding sites (Olorunniyi & Idowu, 2021; Oforka *et al.,* 2023). In contexts where Anopheles can exploit both natural and artificial habitats, such gaps can sustain vector populations despite high awareness. These findings reinforce the need to integrate simple, feasible larval source management as promoted in Dar es Salaam, Tanzania and other cities (Govella & Ferguson, 2012; Maheu-Giroux & Castro, 2013) into community health education and municipal waste and drainage planning.

Adult mosquito prevention practices in this survey were heavily skewed towards aerosol insecticides, with LLINs and structural measures playing a secondary role. Aerosol sprays were the dominant intervention overall (36.1%), especially in urban and semi-urban communities (over 43% in Owode and Alekunwodo), and monthly or infrequent spraying was common. This pattern aligns closely with studies in Lagos where 50–80% of respondents reported frequent aerosol use and only 41–66% owned bed nets (Fagbohun *et al.,* 2021; Oforka *et al*., 2023). It also reflects a broader reliance on household insecticides across Nigerian urban and peri-urban settings, often using pyrethroid-based aerosols and even unapproved formulations such as dichlorvos (DDVP) (Fagbohun *et al*., 2021; Adeniyi, 2022). While aerosols provide quick relief from nuisance biting and visible insect mortality explaining their popularity, they exert strong selection pressure for resistance and pose potential health risks with chronic inhalational exposure. In contrast, LLIN ownership was low in this Osun sample (32.9%) and daily use among owners, although moderate (60.2%), was inconsistent across communities. Ownership levels here are somewhat lower than the 41.8% reported in Lagos informal settlements (Oforka *et al*., 2023), far below the 66.1% reported in more mixed Lagos LGAs (Fagbohun *et al*., 2021), and markedly below national targets and the ~60% household coverage reported in the 2018 NDHS and 2021 Malaria Indicator Survey (NPC & ICF, 2019; NMEP, 2022). The urban site (Owode) had the lowest LLIN ownership, echoing the rural-urban gradient seen in national data where urban households are less likely to own or use LLINs than rural ones (Duodu *et al.,* 2022; Ameyaw *et al*., 2020).

The gap between LLIN ownership and nightly use observed here is consistent with patterns from multiple Nigerian and West African studies, where discomfort due to heat, perceived low mosquito density, difficulties in hanging, and fears about insecticide safety are recurrent barriers (Fagbohun *et al*., 2021; Adegbehingbe *et al*., 2025; Liheluka *et al*., 2023). In Lagos and Ogun States, respondents often described feeling "caged", excessive heat and unpleasant odours as reasons for not sleeping under nets (Fagbohun *et al*., 2021; Wakai *et al.,* 2025), while in Tanzania and Rwanda, bed nets have been associated with bedbugs, infertility, or impotence (Ingabire *et al*., 2015; Liheluka *et al.,* 2023). Although this Osun survey did not systematically elicit reasons for non-use, the low coverage and inconsistent nightly use, especially in the urban site, align with this broader literature. The low prevalence of window insecticide-screening (20.5% overall) and the dominance of unscreened louvers, particularly in Ilobu, further reduce passive protection and highlight structural inequities in housing quality, which have been strongly linked to malaria risk in Nigeria (Morakinyo *et al*., 2018). Collectively, these data indicate that vector control in these communities is driven more by individually purchased aerosols and coils than by LLINs and structural improvements, a profile that may be less sustainable and less effective in achieving the universal coverage envisaged by WHO.

Disease knowledge in this population was strongly focused on malaria, with limited awareness of other mosquito-borne diseases. Nearly 90% of respondents identified malaria as the key mosquito-borne disease, consistent with most Nigerian and West African KAP studies (Nassai *et al.*, 2022; Adegbehingbe *et al.,* 2025; Oforka *et al.,* 2023). However, few mentioned dengue, Zika, yellow fever or lymphatic filariasis, mirroring the very low recognition of non-malarial arboviruses and filarial infections in Lagos informal settlements and elsewhere (Fagbohun *et al*., 2021; Oforka *et al*., 2023; Oyeleye, 2024). This disease-specific risk perception is understandable given malaria's dominant burden and frequent symptomatology, but it may hamper uptake of integrated vector management and acceptance of interventions framed beyond malaria. Treatment practices were heterogeneous and concerning: although anti-malarial drugs were the most commonly cited treatment (56.6%), substantial proportions used injections (11%) or herbal remedies (11%), and 40% reported never treating malaria at all, with others treating only monthly or yearly. A similar

treatment landscape with prompt formal care uptake for some but high levels of self-diagnosis, self-medication and reliance on herbs has been described in rural Kano, Plateau, and Oyo States, and in Malawi and Tanzania (Chipwaza *et al.,* 2014; Nwibari *et al.,* 2024; Oyeleye, 2024; Birhanu *et al*., 2016). In Oyo and Osun rural communities, for example, 39–40% of respondents believed that local herbs could "easily clear malaria from the blood" and many reported using them before or instead of ACT (Oyeleye, 2024; Adegbehingbe *et al*., 2025). The very high proportion in the current study who reported never treating malaria at all may reflect misunderstanding of the question (e.g., respondents interpreting "malaria" as severe illness only), recall bias, or normalization of recurrent fever, but nonetheless signals a critical gap in effective case management.

The frequent use of herbal remedies alone or in combination with conventional drugs is consistent with a wide African literature documenting syncretic treatment-seeking, where local remedies such as neem leaves, "agbo", and other decoctions are widely perceived as effective for "cooling" or "purging" malaria (Birhanu *et al*., 2016; Liheluka *et al*., 2023; Oyeleye, 2024). While some plant-based remedies may provide symptomatic relief or antiparasitic effects, unsupervised use risks delayed diagnosis, incomplete treatment, and potential interactions with ACT, and has been implicated in ongoing transmission and selection of drug-tolerant parasites (Chipwaza *et al*., 2014; Idowu *et al*., 2020). The high reported use of injections a pattern also seen in Plateau and Enugu States (Ezenduka *et al*., 2014) raises concerns about inappropriate parenteral therapy, unsafe injection practices, and patient preference for "stronger" treatments even for uncomplicated episodes. Together with the sizeable group reporting no treatment, these patterns suggest that health-seeking for malaria in these Osun communities may be fragmented and suboptimal, reinforcing calls from national surveys to improve community awareness of the importance of prompt testing and treatment with quality-assured ACT (NPC & ICF, 2019; NMEP, 2022).

Several findings are notable in light of previous KAP work. First, the combination of high recognition of larvae and adult mosquitoes with low understanding of metamorphosis is relatively unusual and suggests that residents see larvae as "something in dirty water" rather than as a developmental stage of the mosquito. This disconnect has rarely been explicitly documented in Nigerian surveys, which tend to ask about breeding sites but not metamorphic links (Fagbohun *et al.*, 2021; Oforka *et al.,* 2023), and points to an opportunity to introduce very simple visual tools on the mosquito life cycle in community education. Second, the predominance of aerosol sprays over LLINs in a semi-urban southwestern context, despite years of national net campaigns, reinforces emerging evidence that urban and peri-urban Nigerians are diverging from the "LLIN-centric" model that underpins many control programs (Oforka *et al*., 2023; Duodu *et al*., 2022). This divergence is driven by perceived convenience and immediate effect but has implications for insecticide resistance management and for equity, as poorer households may spend a greater proportion of their income on recurrent aerosol purchases than they would on maintaining LLINs. Third, the very high proportion reporting never treating malaria stands in contrast with facility-based studies among symptomatic patients, where almost all had attempted some form of treatment (Oranusi *et al.,* 2025; Adegbehingbe *et al.,* 2025). This discrepancy underscores the importance of triangulating community-reported behaviors with health facility data and, where possible, parasitological surveys. Notably, this study has several strengths. It covered three communities representing an urban, semi-urban, and rural gradient within the same state, allowing exploration of how infrastructure and socio-economic context shape behaviors. Systematic random door-to-door sampling reduced selection bias compared with convenience recruitment, and the focus on mosquitoes and mosquito-borne diseases, rather than malaria alone, enabled assessment of broader vector control knowledge and practices.

CONCLUSION

This study reveals that residents of the study areas possessed high awareness of mosquitoes and malaria and were generally able to recognize larvae, adults and key risk environments, yet important gaps in knowledge of bioecology, inconsistent environmental management, and an over-reliance on household aerosols undermined effective vector control. In addition is the low ownership and poor utilization of standard vector control interventions such as LLIN and non-orthodox treatment method.

Therefore, there is the need for effective orientation and sensitization on the bioecology, standard vector control and treatment measures for malaria prevention, control and treatment. This is with a view to curtailing malaria transmission.

Abbreviations
LLIN – Long- Lasting Insecticidal Net
OSMoH–REC - Osun State Ministry of Health Research and Ethics Committee

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Authors' contributions
Conceptualization–Z. O, M.A
Data curation–Z.O., Q.O., D.I., L.O., G.O., I.O.
Supervision–A.M., K.A., O.A., M.A.
Data analysis–Z.O., Q.O.
Manuscript draft—Z.O.
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The authors declare no conflict of interest regarding the article

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