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MALARIA VECTOR ABUNDANCE, KNOWLEDGE AND PRACTICES FOR ITS CONTROL AMONGST RESIDENTS OF SELECTED COMMUNITIES IN ABIA STATE, SOUTH EASTERN NIGERIA

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ABSTRACT
Malaria transmission in Nigeria is sustained by high mosquito vector abundance and community attitudes towards control measures. Understanding both entomological and behavioural factors is essential for effective intervention. Adult mosquitoes were collected indoors using human landing catch methods across selected Local Government Areas (LGAs) in Abia State. Morphological identification revealed the species composition, while sporozoite infection rates were determined by dissecting the mosquitoes' salivary glands. Structured questionnaires were administered to assess knowledge, attitudes, and practices (KAP) related to vector control. Statistical analyses explored associations between socio-demographic variables and control practices. A total of 446 mosquitoes were collected, with *Anopheles gambiae* being the predominant species. The mean vector density was six *Anopheles* per household, with an estimated human biting rate of 0.69. Among female *Anopheles*, 46.6% were blood-fed, and 22.0% carried sporozoites. Questionnaire responses showed insecticide use (70.8%) as the most preferred control method, while 46.6% of respondents reported using long-lasting insecticidal nets (LLINs). Barriers to LLIN use included discomfort and heat. Awareness of community-level intervention was low (32.4%). Findings highlight that both entomological and socio-behavioural factors sustain malaria transmission. Also, high vector abundance coupled with inconsistent adoption of control measures sustains malaria transmission in Abia State. Strengthening health education programs to improve awareness and promote consistent use of effective interventions, particularly LLINs, is recommended to reduce malaria burden.

Keywords: Mosquito, Attitude, Vector control, *Anopheles,* Bed nets, Abia State.

INTRODUCTION
Malaria continues to pose a major public health challenge in Nigeria, where transmission is perennial and driven by high mosquito vector abundance and socio-behavioral factors (Ekedo et al., 2026). Nigeria accounts for nearly one-third of global malaria deaths, with children under five years and pregnant women disproportionately affected (WHO, 2024). Despite sustained interventions such as long-lasting insecticidal nets (LLINs), indoor residual spraying, and chemoprevention, malaria prevalence remains high in many regions, underscoring the need for localised studies that integrate entomological and behavioural perspectives (WHO, 2024).

Successful mosquito-based malaria control depends heavily on the susceptible biometrics of local malaria vectors. Hence, it is necessary to have accurate and reliable methods of determining the mosquito species composition in a locality (St Laurent et al., 2016). Different vector species can contribute to malaria transmission in some geographical areas, leading to prolonged transmission periods due to their distinct feeding behaviors and environmental adaptations (Antonio-Nkondjio et al., 2006).

Vector abundance is a critical determinant of malaria transmission intensity. The density of *Anopheles* mosquitoes, their feeding behavior, and sporozoite infection rates directly influence the risk of infection within communities. In southeastern Nigeria, climatic conditions such as high rainfall, high humidity, and low temperature create favorable breeding grounds for *Anopheles gambiae* and *Anopheles coluzzii*, the dominant malaria vectors, with *Anopheles funestus* serving as a secondary vector. The persistence of these species highlights the importance of continuous surveillance to guide control strategies (Ezeigbo et al.,2016).

Equally important are community attitudes and practices towards vector control. The success of interventions depends not only on availability but also on acceptance and consistent utilization (Aina et al.,2013). Long-lasting insecticidal nets, for instance, remain underutilized due to barriers such as discomfort, heat, and misconceptions, while insecticide use is often preferred despite its limitations in terms of sustainability (Oguonu et al., 2005). Socio-demographic factors, including education, occupation, and residence, further shape community responses to malaria prevention. Understanding these attitudes is essential for designing effective health education programs and improving uptake of proven interventions.

Abia State, located in southeastern Nigeria, presents a relevant case study due to its climatic suitability for vector breeding (high rainfall and humidity) and its socio-economic diversity. Previous studies have documented high malaria prevalence in the region, but limited attention has been given to the interplay between vector abundance and patient attitudes towards control measures. Addressing this gap is crucial for informing targeted interventions that combine entomological evidence with socio-behavioural insights.

This study, therefore, investigated mosquito vector abundance and patient attitudes towards its control in selected Local Government Areas of Abia State. By integrating entomological surveillance with

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structured questionnaires, the research provides evidence on the relationship between vector density and community practices. The findings are expected to inform malaria control strategies, strengthen health education programs, and help reduce the malaria burden in Abia State and similar endemic regions.

MATERIALS AND METHODS

Study area

The study was conducted in three randomly selected Local Government Areas (LGAs) of Abia State, Southeast Nigeria: Umuahia North (Urban/Peri-urban; Latitude: 5°30'00"N – 5°36'00"N and Longitude: 7°27'00"E – 7°33'00"E, with an area of 245km^2, and a population of 324,900), Ugwunagbo (Rural; Latitude: 5°00'00"N – 5°08'00"N and Longitude: 7°24'00"E – 7°30'00"E, with an area of 108km^2 and a population of 124,300) and Bende (Rural/agricultural; Latitude: 5°32'00"N – 5°50'00"N and Longitude: 7°30'00"E – 7°45'00"E, covering 601km^2, with a population of 280,500). (Figure 1). (National Population Commission, 2006). The region is characterized by a tropical rainforest climate with distinct rainy (April–October) and dry (November–March) seasons, providing an ideal environment for *Anopheles* mosquito breeding.

The main occupations of the inhabitants are trading, farming and public service (civil servants). The major religion is Christianity, with a small Muslim minority. Abia State, located in the southeastern part of Nigeria, is a suitable study area for malaria research due to its climatic and environmental conditions that favor the proliferation of mosquito vectors. The state has a tropical rainforest zone in the south and a woodland savanna in the north, with a tropical monsoon climate. The mean annual temperature is about 27 °C, with a mean maximum temperature of 31 °C, and the mean relative humidity ranges from 60% to 90%.

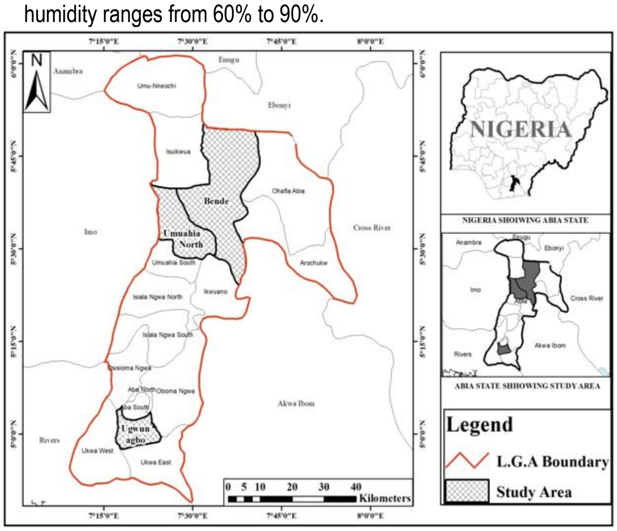

Figure 1: Map of Abia State, Nigeria, showing the study areas (LGA)

Study Design:

This is a cross-sectional study that included both clinical and molecular components. It involved the collection of data (Individual patient information, blood samples, and mosquito samples) between January and December, 2025. The study population consisted of male and female individuals aged 0 to 70 years residing within the three LGAs.

Sample Size: The study population size was determined using the Taro Yamane formula (Yamane, 1967):

$$n= \frac{N}{1+N_{e^2}}$$

where population size (N) = 729700 and Margin of error (e) = 0.0500 (±5.0%), which gave a minimum sample size of 400.

Hence, a total of 600 individuals were recruited, of whom 552 responded, using a cross-sectional, descriptive, purposive sampling technique to ensure representation across the selected areas, age brackets and genders.

Ethical Considerations

Approval was obtained from the Health Research Ethics Committee of the Abia State Ministry of Health, Umuahia (AB/MH/PRS/ECS/T.1/1172)

DATA COLLECTION

Administration of the questionnaire

A total of 552 participants took part in the study, in which structured questionnaires were administered. Interpreters were used for persons who could neither read nor write English. The volunteer respondents assembled at the village square, and after receiving an explanation of the research, each consenting respondent was administered a structured questionnaire.

The younger age groups were guided by their parents when responding to the questionnaire items. The questionnaires were used to obtain information on Knowledge, attitude and practices towards malaria vector control.

Vector Sample Collection

The human landing catch method (HLC) was used to collect adult mosquitoes. The principle of this method is that mosquitoes are collected while biting a human or other vertebrate host. The night was divided into two 6-hour periods (18:00 – 00:00 and 00:00 – 06:00). Four teams, composed of trained vector collectors, caught adult female mosquitoes from 18:00 – 06:00 hours each day of collection across all study sites. Each team consisted of two vector collectors, with each collector working for 6-hour periods. With all other parts of the body protected (covered) and with the aid of a torchlight, the collectors caught mosquitoes that landed on their exposed legs and transferred them into 1.5ml hemolysis plastic tubes. Mosquitoes caught each hour were placed in their corresponding moistened cotton bags, referred to as hour bags, and kept on ice in cooling boxes to immobilize them (WHO, 1975).

Mosquito Identification

Mosquitoes were identified morphologically to species level using taxonomic keys of Gillies and Coetzee (1987) and Gillett (1972). Mosquitoes were morphologically classified using features of their maxillary palps. The female Anopheles species were identified morphologically using the keys developed by Gillies and Coetzee (1987). Each identified species was counted and recorded. They were further classified according to physiological status as unfed, blood-fed, half-gravid, or gravid by examining the abdominal appearance (WHO, 1975). The mosquitoes were preserved individually in well-labeled Eppendorf tubes containing silica gel. This was then taken to the Center for Molecular Biology and Biotechnology (CMBB), Michael Okpara University of Agriculture, Umudike, Abia State.

RESULTS

Vector Composition, abundance and distribution

Five species of mosquitoes were identified in Ugwunagbo, Bende and Umuahia North Local Government Areas of Abia State between January and December, 2025. *Anopheles gambiae s.l., with 347 individuals, was the most predominant species across all study sites, followed by Anopheles funestus (67), Culex quinquefasciatus (19), Aedes aegypti (8), and Mansonia uniformis (5), which* was the least (Tables 1 and 2)**.** The abundance of *Anopheles gambiae s.l* was significantly ($F = 27.54$, $p < 0.01$) higher than the others. A total of 446 mosquitoes were recorded, out of which 186 (41.7%) were recorded in Bende LGA, 158 (35.4%) in Ugwunagbo LGA, and the lowest 102(22.9%) were recorded in Umuahia North LGA (Table 2). The highest number of mosquitoes was recorded in August 2025 (67), followed closely by October 2025 (63). The least (10) was in January 2025.

Physiological status of *A. gambiae* and *A. funestus*

The physiological status of *A. gambiae s.l* and *A. funestus* is shown in Table 4.9. Of the 214 female *A. gambiae* examined, 165 (37.0%) were blood-fed, while 49 (11.0%) were not blood-fed. Of the 49 female *A. funestus* examined, 28(6.3%) were blood-fed, while 21(4.7%) were not blood fed (Table 3).

Table 1: Mosquito species distribution throughout the sampling period

Species	*Anopheles gambiae*	*Anopheles funestus*	*Culex quinquefasciatus*	*Aedes aegypti*	*Mansonia uniformis*
January	15	6	4	2	-
February	17	9	6	1	2
March	20	11	2	1	1
April	29	8	1	1	-
May	35	12	3	1	-
June	52	5	-	-	-
July	62	2	-	-	-
August	52	4	-	-	-
September	21	6	-	-	-
October	19	2	1	1	1
November	17	1	1	1	1
December	8	1	1	-	-
Total	**347**	**67**	**19**	**8**	**5**

Table 2: Mosquitoes collected from the three LGAs in Abia State.

	Umuahia North			Ugwunagbo			Bende		
Species	**Males**	**Females**	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	**Total**
A. gambiae	21	45	66	53	72	125	59	97	156
A funestus	4	15	19	7	17	24	7	17	24
C. quiquefasciatus	1	7	8	1	4	5	1	5	6
A. aegypti	0	1	1	0	1	1	3	3	6
M. uniformis	1	0	1	1	0	1	1	2	3
Total			**95**			**156**			**195**

Table 3: Adult indoor resting mosquitoes caught during the study

	Examined		Females collected		
Species	Males (%)	Females (%)	With blood in the abdomen	Without blood in the abdomen	**Total (%)**
A. gambiae	133 (29.8)	214 (48.0)	165 (37.0)	49 (11.0)	347 (77.8)
A. funestus	18 (4.0)	49 (11.0)	28 (6.3)	21(4.7)	67(15.0)
C. quiquefasciatus	3(0.7)	16(3.6)	10(2.2)	6(1.3)	19(4.3)
A. aegypti	3(0.7)	5(1.1)	3(0.7)	2(0.4)	8(1.8)
M. uniformis	3(0.7)	2(0.4)	2(0.4)	0(0.0)	5(1.1)
Total	160(35.9)	286(64.1)	208(46.6)	78(17.5)	446(100)

Indoor resting mosquitoes

Indoor resting mosquitoes were collected from 36 houses across 3 LGAs in Abia State. The result showed that at least one *An. Gambiae* was caught in each of the 27 houses during the sampling period. Houses with mosquitoes were in the range of 40-55% throughout the sampling period. The mean vector population density was 6 Anopheles per house, and the estimated human biting rate was 0.69 (Table 4)

Knowledge and practices for mosquito control

The results on knowledge and practices related to mosquito control showed that the majority of participants use several methods to control mosquitoes. Common methods employed include - the use of insecticides (390, 70.8%), sleeping under Long Lasting insecticide nets (257, 46.6%), burning of mosquito coil (141, 25.5%) and use of protective clothing (152, 27.5%) (Table 5)

A large number of respondents (373, 67.6%) were unaware of any

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community interventions related to mosquito vector control by Government Organizations, NGOs or other bodies (Table 5).

Table 4: Human biting rates of *Anopheles gambiae* species in the study area

Variables	Umuahia North	Ugwunagbo	Bende	Total
No of houses	12	12	12	36
No of houses harbouring anopheles	7(58.3)	9(75.0)	11(91.7)	27(75)
No of anopheles caught	45	72	97	214
Mean no. of anopheles per house	3.8	6	8.1	59
No of persons in houses	21	18	19	53
No of mosquitoes with blood in the abdomen	14	9	17	40
Human biting rates	0.67	0.5	0.89	0.69

Table 5: Knowledge and practices for mosquito control

	N (%)	
Methods employed for protection against mosquitoes	**Yes**	**No**
	(N = 552)	(N = 552)
Sleeping under an ordinary net	83 (15.0)	469 (85.0)
Sleeping under LLINS	257 (46.6)	295 (53.4)
Use of insecticides	391 (70.8)	161 (24.2)
Burning of a mosquito coil	141 (25.5)	411 (74.5)
Use of repellent cream on the body	47 (8.5)	505 (91.5)
Cutting bushes around the house	118 (21.4)	434 (78.6)
Use of window/door netting	111 (20.1)	441 (79.9)
Protective clothing	152 (27.5)	400 (72.5)
Use of herbs	193 (35.0)	359 (65.0)
Government organizations, NGO and other malaria control programmes	Yes	179 (32.4)
In the community	No	373 (67.6)

Knowledge and attitude related to LLIN

Out of 552 respondents, 257 (46.6%) use LLINs for mosquito control. About 49.4% of the respondents obtained it from the hospital, while others obtained it from other sources. For example, community health workers' distribution (18.3%), free distribution around the community (15.2%), gifts from family and friends (4.3%), and purchases from patent medicine stores (4.7%). Perceptions of LLINs' effectiveness and source were not significantly related to both LGAs and respondents' education ($P<0.05$) (Table 6).

Table 6: Knowledge and attitude related to LLIN

	N (%)
LLIN as a mosquito control tool	**N = 552**
Yes	257 (46.6)
No	295 (53.4)
LLIN effectiveness	
Yes	234 (91.1)
No	23 (89)
Source of LLIN	**N = 257**
Free distribution in your community	39 (15.2)
Gift from family/friends/neighbor	11 (4.3)
Community health workers	47 (18.3)
Market	21 (8.2)
Hospital	127 (49.4)
Bought from a patent medicine store	12 (4.7)

DISCUSSION

Five mosquito species were identified in the study area: *Anopheles gambiae s.l.*, *Anopheles funestus*, *Culex quinquefasciatus*, *Aedes aegypti*, and *Mansonia uniformis*. This aligns with related studies in southeastern Nigeria and other endemic regions, where *Anopheles gambiae* consistently dominates due to its strong anthropophilic and endophilic tendencies (Ifejika et al., 2025; Garba, 2023). The year-round presence of *Anopheles* species observed here reflects their ability to undergo aestivation or diapause during unfavorable seasons, enabling survival and resurgence in subsequent rainy periods (Adamou et al., 2011; Mwima et al., 2024). Similar seasonal persistence has been reported in Cambodia (Boyer et al., 2024), reinforcing the global relevance of these adaptive strategies. Spatially, mosquito abundance was highest in rural LGAs (Ugwunagbo and Bende), consistent with findings that rural environments provide less polluted breeding sites, abundant larval habitats, and housing structures conducive to mosquito survival (Ferraguti et al., 2016; Salako et al., 2019). The temporal peaks in August and October coincide with seasonal rainfall patterns, in which moderate rainfall combined with high temperatures creates optimal breeding conditions (Ahmed et al., 2019; Nwele et al., 2025). Conversely, the lowest abundance in January reflects the dry season, when breeding sites diminish (Yamba et al., 2026). These seasonal fluctuations highlight the need for intensified control measures during peak transmission months.

Blood meal analysis revealed that most female *Anopheles* were blood-fed, particularly *An. gambiae*, underscoring its efficiency as a malaria vector. Its aggressive feeding behavior and adaptability to multiple hosts make it a primary driver of transmission in the region (Adugna et al., 2021; Akirso et al., 2024). The mean vector density of six *Anopheles* per household and biting rate of 0.69, though lower than reports from Equatorial Guinea (Ooko et al., 2024), remains significant in sustaining transmission, especially in poorly constructed rural houses (Ondiba et al., 2018).

Community knowledge and practices revealed widespread reliance on insecticides (70.8%) and moderate use of LLINs (46.6%). While insecticides were preferred for their perceived effectiveness, concerns about health impacts, such as respiratory irritation, limited their acceptance. LLINs, though considered effective, were underutilized due to discomfort and heat, echoing findings from Lagos and Enugu, where similar barriers reduced net usage (Aina et al., 2013; Oguonu et al., 2005). Other methods, such as mosquito coils, herbs, and protective clothing, were supplementary but less effective. Importantly, education level significantly influenced the choice of control methods, suggesting that health education interventions could improve uptake of proven strategies. The lack of awareness of community-level interventions (67.6% of respondents) underscores a critical gap in public health outreach. Strengthening government and NGO-led programs, particularly in rural areas, could enhance community participation and improve consistency in control practices. This is vital given that rural environments harbor higher vector densities and thus greater transmission risk.

Overall, the findings demonstrate that both entomological and sociobehavioral factors sustain malaria transmission in Abia State. High vector abundance, seasonal peaks, and inconsistent adoption of control measures collectively perpetuate the burden. Targeted interventions should therefore integrate entomological surveillance with culturally sensitive health education to promote consistent LLIN use and reduce reliance on unsustainable methods like insecticides. Such integrated approaches are essential for achieving meaningful reductions in malaria transmission in endemic regions.

Conclusion
This study demonstrates that malaria transmission in Abia State is sustained by both high mosquito vector abundance and inconsistent adoption of control measures. Anopheles gambiae was the predominant species, with significant blood-feeding and sporozoite infection rates, underscoring its role in local transmission. Although insecticide use was common, long-lasting insecticidal nets (LLINs) were underutilized due to discomfort and misconceptions. Education level and housing type strongly influenced control practices, while awareness of community interventions remained low. These findings highlight the urgent need for integrated strategies that combine entomological surveillance with behavioral change interventions to reduce malaria burden.

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