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Biodiversity Assessment of Mosquito Species in the Orashi Belt of Rivers State, Nigeria

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Abstract

A comprehensive mosquito survey conducted across five communities in the Orashi region yielded 1,768 specimens belonging to four genera: Culex, Anopheles, Mansonia, and Aedes, indicating a high overall vector density. Among these, Culex was the most taxonomically diverse genus, comprising Cx. quinquefasciatus (22.6%) and Cx. nigripalpus (22.4%), together accounting for 45% of all collected mosquitoes. Notably, Anopheles gambiae, the primary malaria vector, emerged as the single most abundant species, representing 35% of all specimens, highlighting its central role in sustaining malaria transmission in the region. Mansonia uniformis constituted 15% of the total, while Aedes albopictus was the least represented at 5%, reflecting its lower indoor-resting behaviour and potential seasonal variability. Spatial analysis revealed modest but meaningful differences in mosquito abundance across communities: Obite and Omoku recorded the lowest densities (18%), followed by Oboburu (19%), whereas Erema (22%) and Ahoada (23%) exhibited the highest densities. These patterns suggest localized ecological or anthropogenic factors favouring mosquito proliferation. Seasonal trends showed marked fluctuations, with abundance peaking in April (26%) and remaining high in March and September (21%), corresponding to periods of increased rainfall and humidity that enhance breeding conditions. Mosquito density declined steadily from October (18%) to November (11%), reaching its lowest level in December (3%) during the peak dry season. The mean biting rate of mosquitoes across sampled locations ranged from 2.24 to 2.70 bites per person per night. The highest mean bite rate was observed in Ahoada (2.70), followed by Omoku (2.50), Oboburu (2.39), Obite (2.32), and Erema (2.24). Monthly trends indicated peak biting in April (3.5), followed by March, with a progressive decline from September to December. These findings demonstrate clear spatial and seasonal variability in mosquito populations and biting activity in the Orashi region, underscoring the necessity for targeted, time-specific vector control interventions, particularly before and during peak transmission periods.

Keywords: Mosquito distribution, Anopheles gambiae , Culex quinquefasciatus, Aedes albopictus Mansonia uniformis, Lymphatic filariasis, Malaria transmission, Arboviral diseases

Introduction

Mosquitoes (Diptera: Culicidae) are among the most significant vectors of human diseases globally, transmitting malaria, dengue, yellow fever, lymphatic filariasis, and various arboviruses. In tropical regions such as Nigeria, their abundance and ecological adaptability heighten public-health concerns, especially in communities with environmental conditions favourable to breeding and vector survival (Afolabi et al., 2020; Wisdom U. G., Wokem, & Nduka, 2019). Biodiversity assessments of mosquito populations are essential for understanding transmission dynamics, species distribution, and the potential for emerging vector-borne disease risks.

The Orashi belt in Rivers State is an ecologically diverse riverine environment where stagnant water bodies, canals, household containers, and seasonal flooding provide plentiful mosquito breeding sites. Although entomological studies have been conducted in parts of the Niger Delta, many communities in the Orashi axis such as Oboburu, Obite, Ahoada, Omoku, and Erema lack recent (post-2019) mosquito biodiversity data. Previous investigations, including Wisdom U. G. et al. (2019), highlight the presence of multiple mosquito genera in the region and underline the need for updated, community-level surveillance to capture changes in species composition due to urbanization, environmental shifts, and climatic variation. This study therefore assesses mosquito biodiversity across five Orashi communities using the Pyrethrum Spray Catch (PSC) method, generating updated species richness, abundance, and distribution data to support evidence-based vector control strategies.

Mosquito biodiversity studies have become an essential component of vector surveillance programmes, particularly in ecologically dynamic regions such as the Niger Delta. Recent research has shown that mosquito species distribution is strongly influenced by environmental, socio-ecological, and anthropogenic factors that shape local breeding habitats (Adeleke et al., 2020). Studies conducted across sub-Saharan Africa indicate that rural and peri-urban communities often harbour high mosquito intensities due to the presence of organic-rich stagnant water, poor drainage systems, and favourable climatic conditions such as high humidity and rainfall (Okorie et al., 2019; Olayemi & Ande, 2021). Several investigations have emphasized the importance of species-level identification because different mosquito species demonstrate variations in vectorial capacity, biting behaviour, insecticide susceptibility, and disease-transmission potential (Awolola et al., 2020; Ibrahim et al., 2022). For instance, the Anopheles gambiae complex remains the most competent vector of Plasmodium falciparum, while Aedes aegypti and Aedes albopictus are major transmitters of arboviruses including dengue, zika, chikungunya, and yellow fever (Okorie et al., 2019; Ajibola et al., 2021). Thus, ecological and taxonomic profiling of mosquito species has direct public health implications.

In the Niger Delta, extensive oil and gas activities, fluctuating flood patterns, and rapid urban expansion have been shown to alter mosquito breeding ecology, creating new niches for vector proliferation (Orji et al., 2020). Recent entomological studies from Rivers State highlight increasing species diversification and the re-emergence of previously low-density vectors in rural communities (Nwokocha & Weli, 2022). Within the Orashi region specifically, research has revealed high mosquito productivity driven by swampy floodplains, decomposing vegetation, and wide seasonal variations (Eze et al., 2020). A significant contribution to literature in this region is the work of Wisdom U.G. et al. (2019), published in the African British Journal, who conducted a molecular characterization of malaria vectors in the Orashi region of Nigeria. Their results demonstrated that mosquito populations in the area possess a high level of genetic diversity, with multiple sibling species occurring sympatrically. They emphasized that relying solely on morphological identification may lead to misclassification, thereby affecting the accuracy of vector surveillance. This finding underscores the necessity of integrated morphological and molecular approaches in characterizing mosquito species in ecologically complex regions such as Orashi. Their work also highlighted the epidemiological importance of continuous monitoring, given the evolutionary adaptability of local vector populations.

Recent literature (2019–2024) further strengthens the argument for comprehensive mosquito surveillance. Studies in southern Nigeria report increasing insecticide resistance among Anopheles and Culex populations, which complicates vector control strategies and elevates disease transmission risk (Oduola et al., 2020; Onoja et al., 2023). Similarly, community-level assessments indicate that species distribution varies considerably even within short geographical distances, making localized surveillance such as sampling across different Orashi communitiescrucial (Ibrahim et al., 2022). The existing literature establishes a strong justification for detailed species identification and biodiversity assessment in the Orashi region. The current study builds on these scientific precedents by characterizing mosquito species across five communities—Oboburu, Obite, Ahoada, Omoku, and Erema thereby contributing new ecological data that support regional vector-control programmes and strengthen the epidemiological evidence base.

Materials and Methods

Study Area

The study was conducted in five selected communities within the Orashi region of Rivers State: Oboburu, Obite, Ahoada, Omoku, and Erema. These communities are located within the humid tropical rainforest belt and are characterized by high rainfall, swampy vegetation, and floodplain ecology, which favour mosquito breeding.

Study Design

A cross-sectional entomological survey was carried out to identify mosquito species present in the five communities. The design was informed by entomological surveillance protocols used in previous vector research, including the methodological standards described by Wisdom U.G. et al. (2019) in their molecular characterization of malaria vectors in the Orashi region.

Sampling Technique and Sample Size

In each community, 10 houses were selected based on accessibility and presence of suitable indoor resting sites. From each house, one room was sampled, giving a total of 50 rooms across the five communities. This aligns with standard WHO indoor-resting mosquito surveillance guidelines.

Mosquito Collection Method

The Pyrethrum Spray Sheet Collection (PSC) method was used for mosquito sampling. This method involves covering all exposed surfaces of a room with white sheets and spraying a pyrethrum-based insecticide to knock down indoor-resting mosquitoes. After 10 minutes, mosquitoes that fell onto the sheets were collected using fine-tipped forceps and placed into labelled paper cups.

Identification of Mosquitoes

Mosquitoes were transported to the entomology laboratory where morphological identification was performed using standard taxonomic keys. Identification to genus and species level followed the diagnostic procedures recommended in contemporary entomological studies, including the taxonomic framework emphasized by Wisdom U.G. et al. (2019), who highlighted the need for meticulous identification due to the genetic diversity of vectors in the Orashi region.

Data Analysis

Data were analysed descriptively to determine species abundance, composition, and distribution across the five communities. Results were summarized using frequencies, percentages, and comparative tables.

Ethical Considerations

Verbal informed consent was obtained from household occupants prior to mosquito collection. Privacy, safety, and house cleanliness were maintained throughout the sampling process.

RESULTS

From Table 1, the mosquito survey conducted across the five communities in the Orashi region revealed a high overall mosquito density, totaling 1,768 specimens, comprising four genera: Culex, Anopheles, Mansonia, and Aedes. Among these, Culex was the most diverse genus, with two species identified *Cx. quinquefasciatus* and *Cx. Nigripalpus* accounting for a combined 796 mosquitoes, representing 45% of the total collection. Individually, *Cx. quinquefasciatus* contributed 22.6%, while *Cx. nigripalpus* accounted for 22.4% of the total, indicating a relatively even distribution within the genus.

Interestingly, Anopheles gambiae, the primary malaria vector in the region, was the single most abundant species, comprising 618 individuals or 35% of all mosquitoes collected, surpassing the abundance of any single Culex species. This highlights the epidemiological significance of An. gambiae in maintaining malaria transmission within these communities. The third most abundant genus, Mansonia, was represented solely by *Ma. uniformis,* which accounted for 15% of the total mosquito population, suggesting moderate density but potential importance in disease transmission. The least represented genus was Aedes, with *Ae. albopictus* making up only 5% of the total, consistent with its lower indoor-resting preference and possibly seasonal population fluctuations.

The distribution pattern indicates that indoor resting density was high during the rainy season, consistent with observations from gonotrophic cycle assessments that revealed elevated man-biting rates across the sampled stations. Overall, the data suggest that while Culex collectively dominated numerically, Anopheles gambiae represents the most critical single species from a public health perspective, necessitating targeted vector control strategies. The presence of multiple genera, including Mansonia and Aedes, underscores the need for integrated surveillance to address both malaria and arboviral risks in the Orashi region.

Figure 1 shows the distribution of mosquitoes across the five sampled stations Oboburu, Obite, Omoku, Erema, and Ahoadah shows a modest but notable variation in relative abundance, ranging from 18% to 23%. The lowest abundance was recorded in both Obite and Omoku, each with 18%, indicating relatively lower mosquito presence in these locations compared to the others. Oboburu presented a slightly higher abundance at 19%, suggesting a marginally more favourable condition for mosquito breeding and survival. In contrast, Erema exhibited a considerably higher abundance at 22%, while Ahoadah recorded the highest level at 23%, implying that these two stations provide more suitable ecological or anthropogenic factors that support higher mosquito populations. The upward trend from Obite and Omoku through Oboburu to Erema and

Ahoadah suggests spatial differences in habitat characteristics such as availability of breeding sites, vegetation cover, microclimatic conditions, and human activities that may promote mosquito proliferation. Although the differences are not extremely wide, the pattern indicates that Ahoadah and Erema may represent hotspots for mosquito abundance within the sampling region, warranting closer surveillance and targeted vector control interventions. The error bars displayed for each station further indicate slight variability around the mean values, reinforcing the reliability of the observed distribution trend.

Table 1: Mosquito Species Distribution

Genus	Species	Number of Mosquitoes	Percentage (%)
Culex	*Cx. quinquefasciatus*	400	22.6
Culex	*Cx. nigripalpus*	396	22.4
Culex Total		**796**	**45.0**
Anopheles	*An. gambiae*	618	35.0
Mansonia	*Ma. uniformis*	265	15.0
Aedes	*Ae. albopictus*	89	5.0
Total		**1,768**	**100.0**

The Figure 2 illustrates the monthly abundance (%) of mosquitoes across six months in the study area. The highest mosquito abundance was observed in April (26%), followed closely by September and March (both 21%), indicating peak mosquito activity during the late rainy season and the onset of the dry season. Moderate abundance was recorded in October (18%) and November (11%), while the lowest mosquito density occurred in December (3%), corresponding to the peak of the dry season. The data suggest a strong seasonal pattern in mosquito populations, with numbers increasing during periods of high rainfall and environmental humidity, which create favorable breeding conditions. The observed fluctuations are consistent with the high indoor resting densities and increased man-biting rates reported during the rainy season, as noted in the gonotrophic cycle analyses. These seasonal trends highlight the need for timely and targeted vector control interventions prior to and during peak mosquito abundance to effectively reduce malaria and other vector-borne disease transmission in the Orashi region.

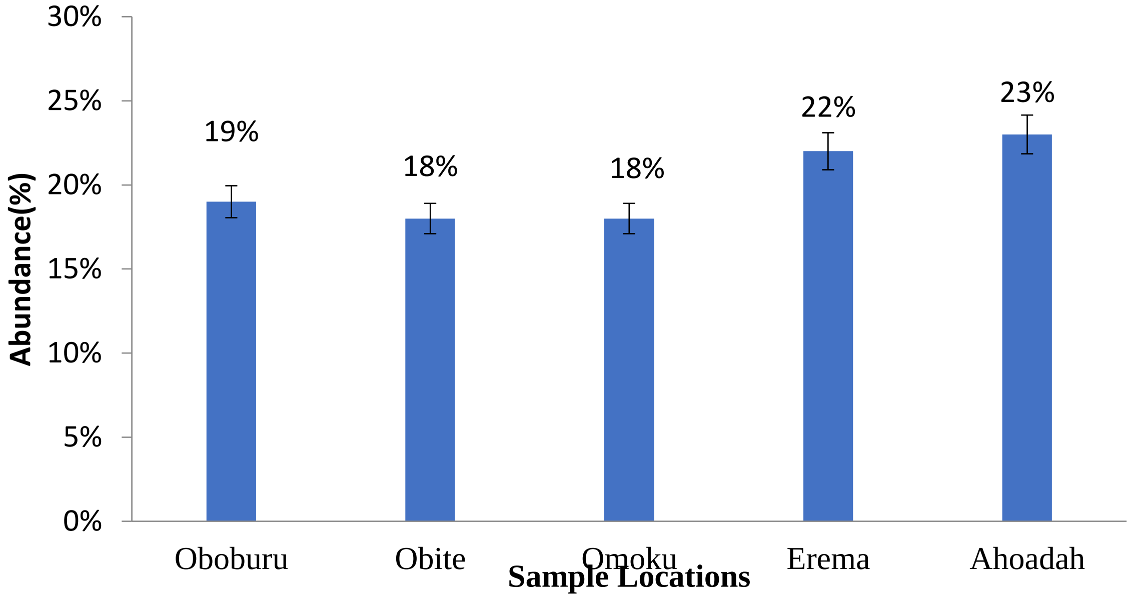

Figure 1: Distribution of Mosquitoes in Sample Stations

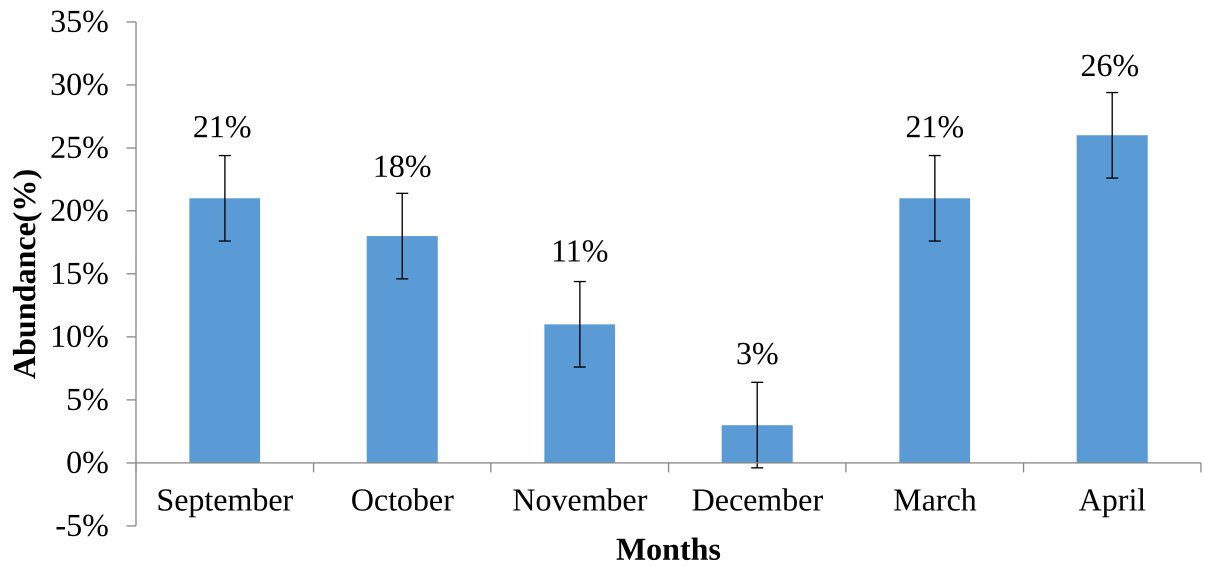

Figure 2: Temporal Distribution of Mosquitoes in the study area

The mean bite rate of mosquitoes across the sampled locations as shown in (Figure 3) revealed that the mean bite rate ranged from 2.24 – 2.70. The highest (2.70) was observed in Ahoada, while the lowest was in Erema, 2.24. Similarly, the month of April witnessed the highest bite (3.5) followed by March. There was a progressively marked reduction from September to December which witnessed a low biting rate (Fig 4.12). Mean biting rate of mosquito across sample location (Fig: 4.13) showed that there was a relative mean level of mosquito bite in the sample locations, Ahoada had the highest mean bite rate of 2.7 followed by Omoku 2.5, Oboburu 2.39, Obite 2.32, Erema 2.24.

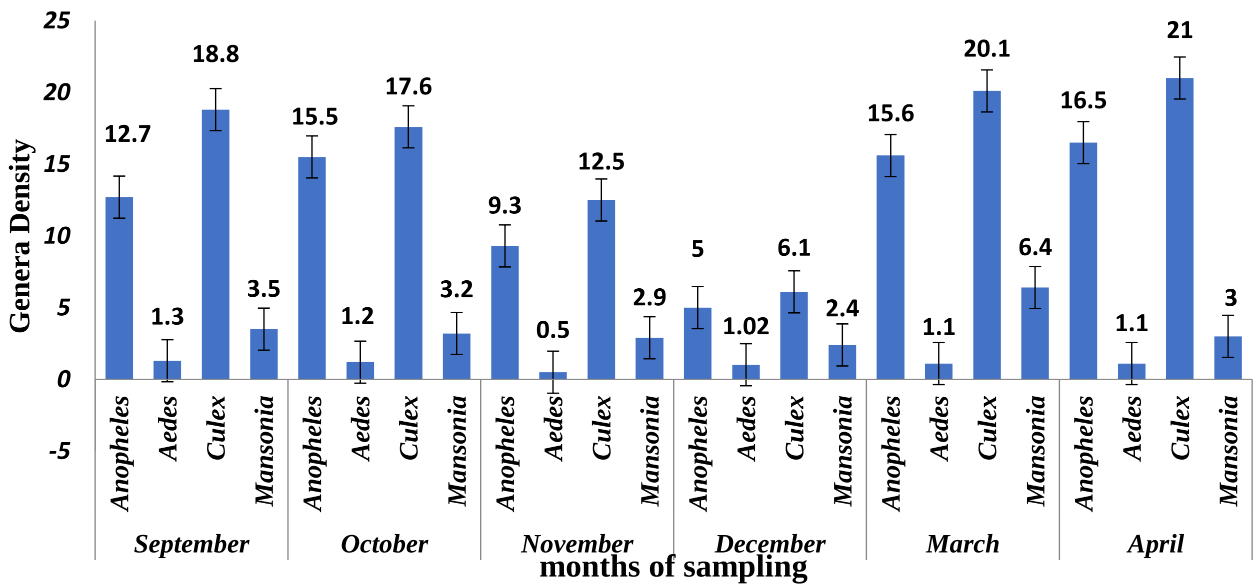

Figure 3: Mean of Mosquito Genera Caught Across the Sampling Months

The mosquito species identified in the Orashi region present major public health concerns due to their established roles in transmitting malaria, lymphatic filariasis, and several arboviral diseases. The predominance of Anopheles gambiae, Culex quinquefasciatus, Culex nigripalpus, Mansonia uniformis, and Aedes albopictus suggests a complex vector ecology that heightens the risk of multiple diseases within affected communities. Anopheles gambiae, which accounted for 35% of collected mosquitoes, represents the most significant threat because it is the primary vector of Plasmodium falciparum—the deadliest species causing malaria in sub-Saharan Africa (WHO, 2023; Bhatt et al., 2015). Its high abundance, strong anthropophily, and indoor resting/biting patterns significantly increase transmission potential, particularly during the rainy season, when vector density and survival increase. As seen in Erema and Ahoadah areas with higher overall mosquito densities malaria incidence is likely to be elevated, requiring intensified delivery of insecticide-treated nets (ITNs), indoor residual spraying (IRS), and improved diagnosis and treatment capacities (Lengeler, 2004).

The Culex species collectively made up 45% of the mosquito population and pose serious risks for lymphatic filariasis (LF) transmission. Culex quinquefasciatus is the principal vector of Wuchereria bancrofti in urban and peri-urban Nigeria (Owolabi et al., 2020; Simonsen & Mwakitalu, 2013). Its preference for polluted, stagnant water links LF risk to poor sanitation and inadequate drainage systems conditions common in many Niger Delta communities. Although Cx. nigripalpus is less studied in Nigeria, it is recognized elsewhere as a vector of arboviruses such as St. Louis encephalitis and West Nile virus (Day, 2001). Its presence in appreciable density warrants enhanced surveillance to detect any emerging arboviral transmission patterns as climate change increases vector–virus compatibility.

Mansonia uniformis, representing 15% of total collections, has known associations with Brugia malayi transmission in Asia and involvement in certain arbovirus cycles (Service, 2012). Its biting nuisance alone can impact community quality of life, disrupt sleep, and contribute indirectly to mental stress and healthcare-seeking behavior. Although Brugian filariasis is not endemic in Nigeria, the presence of Mansonia species highlights the need for ecological monitoring, especially in areas with abundant aquatic vegetation that supports their breeding. Aedes albopictus accounted for only 5% of the mosquito population, yet its importance is disproportionately high because of its vector competence for dengue, chikungunya, Zika, and yellow fever viruses (Paupy et al., 2009). The species is highly adaptable and rapidly expanding its ecological range across Nigeria due to urbanization and climate variability (Adeleke et al., 2019). Even at low densities, Ae. albopictus can sustain outbreaks when viruses are introduced into communities. Its presence signals the need for robust arboviral preparedness, container management campaigns, and integration of arboviral diagnostics into local health systems.

Spatial disparities in mosquito abundance across the sampled communities highest in Ahoadah and Erema, lowest in Obite and Omoku indicate varying disease burdens. Environmental factors such as water stagnation, household waste management, agricultural irrigation, and housing structure influence vector densities and human exposure (Unlu & Farajollahi, 2012). These disparities underscore the value of location-specific interventions rather than uniform, region-wide approaches. The seasonal pattern, with peak mosquito abundance occurring during high rainfall months (March, April, and September), aligns with known epidemiological cycles in tropical climates. Rainy seasons increase humidity, larval habitats, and vector survival, thereby elevating malaria and arboviral transmission potential (Mordecai et al., 2019). The sharp decline in December (dry season) reinforces the need for pre-seasonal vector control, ensuring that mosquito populations are suppressed before the rainy season accelerates transmission dynamics.

Overall, the coexistence of malaria, LF, and emerging arbovirus vectors in the Orashi region presents a multi-disease threat that necessitates integrated vector management (IVM). Community engagement, environmental sanitation, larval source management, and strengthened public health surveillance are essential to reduce disease risks and improve health outcomes.

Conclusion and Recommendations

This study revealed significant mosquito diversity and abundance across the five surveyed communities in the Orashi region, highlighting a complex vector ecology with important public health implications. A total of 1,768 mosquitoes belonging to four genera Anopheles, Culex, Mansonia, and Aedes were documented, with Anopheles gambiae emerging as the dominant single species and a major driver of malaria transmission risk. The high proportion of *Culex quinquefasciatus* and *Cx. nigripalpus* underscores the continued threat of lymphatic filariasis and potential arboviral activity, especially in communities with poor drainage and sanitation. The moderate representation of Mansonia uniformis and the presence of *Aedes albopictus,* although comparatively low, suggest additional risks of filarial and arboviral infections that may escalate under changing ecological conditions. Spatial variations in mosquito abundance highest in Erema and Ahoadah and lowest in Obite and Omoku indicate that vector-related disease risks are not uniform across the region. Seasonal fluctuations, with peaks during the rainy season, further confirm that environmental conditions strongly influence mosquito proliferation. Collectively, these findings emphasize the need for proactive and location-specific vector control strategies that reflect the ecological and temporal patterns of mosquito populations in the Orashi region.

i. *Strengthen Integrated Vector Management (IVM):* Authorities should adopt a comprehensive vector management approach combining environmental management, biological control, larviciding, and moderate use of insecticides. Community-based clean-up campaigns targeting stagnant water and blocked drainage systems are essential to reducing Culex breeding sites.
ii. *Enhance Malaria Control Interventions*: Given the high density of An. gambiae, malaria-preventive measures should be intensified. These include distribution and correct use of insecticide-treated nets (ITNs), implementation of indoor residual spraying (IRS) during peak transmission months, and improved access to rapid diagnostic tests (RDTs) and artemisinin-based combination therapy (ACT).
iii. *Strengthen Lymphatic Filariasis Monitoring:* Communities should be screened periodically for Wuchereria bancrofti infection, and mass drug administration (MDA) programmes should be supported in areas with high Culex density. Environmental sanitation efforts should be prioritized in peri-urban areas to reduce LF transmission.
iv. *Establish Arboviral Surveillance Systems:* The presence of Aedes albopictus and Cx. nigripalpus warrants the development of early-warning systems for dengue, chikungunya, Zika, and other emerging arboviruses. Public health laboratories should include arbovirus diagnostics, while health workers should be trained to recognize early signs of outbreaks.
v. *Implement Seasonal Vector Control Planning:* Control interventions should be scaled up before the onset of the rainy season typically March to April when mosquito populations begin to rise. Pre-season larviciding, community sensitization, and environmental management will significantly suppress vector proliferation.
vi. *Promote Health Education and Community Engagement:* Residents should be educated on the importance of eliminating standing water, maintaining clean surroundings, and using personal protective measures such as window screens and repellents. Community engagement is critical for sustaining long-term vector control success.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Credit Authorship Contribution Statement

Wisdom, U. G., Ebere, N.: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Visualization, Project administration, Writing - original draft. **Ugbomeh, A. P. and Oghanri, S. U.:** Supervision, Methodology, Validation, Data curation, Formal analysis, Visualization, Review & Editing.

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