

## Seasonal and Spatial Distribution of Mosquitoes Across Ibadan Metropolis, Ibadan, Oyo State, Nigeria

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## Abstract

## Original Research Article

Mosquitoes are major vectors of debilitating diseases, and their population dynamics are closely shaped by the ecological conditions of their larval habitats. This study investigated the distribution and abundance of mosquito larvae across eleven Local Government Areas (LGAs) in Ibadan, Oyo State, Nigeria, over a period of two-years. This period encompassing both wet and dry seasons to capture seasonal variability. Mosquito larvae were collected from 99 breeding sites using standard plastic dippers, transported to the laboratory and reared to adulthood. The result showed that a total of 11,498 larvae were identified using morphological traits. Two species *Culex* and *Aedes* species were predominant with relative percentage of 45.8 and 37.8 % respectively while *Anopheles* accounted for 11.1%. The population of the larvae was observed to be influenced by seasonal changes. Nevertheless, *Culex* species persisted through the dry season (47.1%) and the wet season (44.8%), while *Anopheles* species were recorded at 12.0% in the dry season and 10.3% in the wet season, the primary malaria vectors, maintained almost same population in both seasons underscoring recurrent transmission risk throughout the year. High mosquito densities were observed in Oluyole (522, 9.9% in the dry season; 695, 11.2% in the wet season) and Ibadan North (502, 9.5% in the dry season; 649, 10.5% in the wet season), whereas comparatively lower densities occurred in Lagelu (421, 7.9% in the dry season; 558, 9.0% in the wet season) and Ido (421, 7.9% in the dry season; 438, 7.0% in the wet season). Lagelu and Ido LGA maintained low populations, likely influenced by water quality, climate, and human activities that limit breeding success. These findings highlighted that urbanization, environmental management, and climatic factors influenced mosquito population and distribution. Emphasis on mosquito borne disease should be tailored toward vector control strategies that integrate habitat sanitation and larval source management to reduce disease transmission risks.

**Keywords:** Mosquito larvae, Vector control, Ibadan, Seasonal variation, Larval ecology, Insecticide resistance.

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## INTRODUCTION

Mosquitoes are among the most medically significant arthropods worldwide, transmitting pathogens responsible for malaria, lymphatic filariasis, yellow fever, dengue, chikungunya, Zika virus infection, and several encephalitides (Awolola *et al.*, 2020; Adeogun *et al.*, 2021). The global burden of mosquito-borne diseases continues to expand, driven by climate change, urbanization, and increased human mobility. Recent reports highlight that dengue, chikungunya, and Zika viruses primarily transmitted by *Aedes* mosquitoes have extended beyond tropical regions, with outbreaks now documented in parts of North America and Europe (Cimberle & Gallagher, 2025). Their public health importance is amplified by their remarkable ecological adaptability, particularly their ability to exploit diverse larval habitats under varying environmental and climatic conditions (Adeleke *et al.*, 2020; Okorie *et al.*, 2021).

Emerging studies emphasize that climate change intensifies transmission dynamics, complicating vector control strategies and expanding risk zones globally (Zhang *et al.*, 2024). Projections further suggest that urban expansion and climatic variability will jointly shape *Aedes aegypti* distribution, creating new arboviral hotspots in regions such as Brazil and beyond (Heath *et al.*, 2025). In tropical regions such as Nigeria, where climatic variability and anthropogenic activities continually reshape the landscape, understanding the ecological distribution of mosquito larvae is critical for predicting adult vector abundance and designing effective vector management strategies (Babalola *et al.*, 2022). Recent Nigerian studies highlight several pressing issues, including the influence of seasonal climate patterns on mosquito net use and malaria prevention behaviors, with perceptions of heat and mosquito presence affecting ITN adoption (Abeku *et al.*, 2025). Indoor and outdoor mosquito assessments in Anambra

State reveal persistent vector presence in student residential areas, underscoring the need for localized surveillance and control (Ogbuefi *et al.*, 2025). Furthermore, geospatial reviews confirm widespread insecticide resistance among mosquito vectors across Nigeria, posing challenges for sustained malaria control and necessitating integrated resistance management strategies (Adeogun *et al.*, 2025).

Mosquito breeding habitats are diverse and widespread, encompassing stagnant water bodies, puddles, natural wetlands, and artificial containers. Recent studies have shown that climate change and altered rainfall patterns are expanding the ecological range of mosquito species, thereby creating favorable conditions for larval development across multiple environments (Zhang, 2024; Simon-Oke, 2015). A report by Sun, (2023) on climate forecasting and deep learning approaches predicted an increase in mosquito larvae abundance in regions experiencing warmer temperatures and prolonged wet seasons. Recent evidence on malaria transmission by *Plasmodium* spp. and climate suitability confirms that mosquito populations thrive within specific temperature and humidity ranges, provided that surface water persists long enough to sustain breeding cycles (Smith and Thomas, 2024; Oluwaseyi, 2026)

Larval ecology plays a pivotal role in shaping mosquito population dynamics. Numerous studies have demonstrated strong correlations between larval abundance and the physicochemical characteristics of aquatic habitats, underscoring the importance of habitat-based surveillance in integrated vector control programs (Ojjanwuna *et al.*, 2021). However, advances in mosquito control in Nigeria face growing challenges due to widespread insecticide resistance. Geospatial reviews have documented resistance among *Anopheles* and *Aedes* populations, particularly to pyrethroids and organophosphates, thereby undermining the effectiveness of conventional chemical interventions and highlighting the urgent need for alternative strategies such as larval source management, biological control, and environmental sanitation (Adeogun *et al.*, 2025).

Seasonal changes in temperature, rainfall, humidity, and water availability strongly influence mosquito developmental rates, larval survival, and adult emergence as reported by Liu, (2024). Chandra and Mukherjee, (2022) emphasized that, mosquito populations fluctuate due to climatic shifts and anthropogenic pressures, complicating vector control and weakening malaria prevention, arboviral preparedness, and targeted interventions. Against this backdrop, the present study assessed mosquito larval distribution and abundance across the eleven LGAs of

Ibadan, Oyo State, Nigeria, over a two-year period, spanning both wet and dry seasons. By examining spatial and temporal variations in larval ecology, this study provides insights into seasonal fluctuations in mosquito populations and highlights implications for sustainable, locally adapted vector control strategies.

## 2.0 METHODS

### 2.1 Study Area

The study area is Ibadan city, located in Oyo State, Nigeria. Ibadan lies near the forest–grassland boundary of Southwestern Nigeria, between longitude 2° 50' and 3° 20' east of the Greenwich meridian, and latitude 7° 20' and 7° 50' north of the equator (Afolayan, 1994). It is the third most populous city in Nigeria, with a population of over 6 million people. The city experiences two distinct seasons: the wet season from April to October, and the dry season from November to March. Average annual rainfall is approximately 2,100 mm, while the mean annual temperature is about 27 °C (Ogolo *et al.*, 2009). The city comprises eleven Local Government Areas (LGAs).

### 2.2 Sample Collection

Mosquito larvae were collected from natural breeding sites including gutters/drainages, peridomestic containers, puddles, tyres, and open water bodies using a plastic dipper. Approximately 50 cm<sup>3</sup> of water was sampled from each breeding site for larval harvesting. The collected water samples were analyzed *in-situ* for physicochemical parameters. Measurements included temperature, pH, dissolved oxygen (DO), and electrical conductivity (EC). These were determined using H19813-6 multi-meter (Hanna, USA) for pH, a pre-calibrated dissolved oxygen meter (Model 970), and a conductivity meter (Model 470), respectively.

### 2.3 Mosquito Identification and Determination

The morphological identification of different species of mosquitoes was done by studying the scales on the mosquito and colour of the palps at the head region, the patterns of spots on the wings, thorax, terminal abdominal segments, scales of the legs and striations on the body using dissecting microscope guided by morphological keys (WHO/AFRO, 2024; Harbach, 2018; Service, 1993).

### 2.4 Statistical Analysis

All data collected were presented in Tables and line graphs using Microsoft Excel. The data were also analyzed using Statistical Package for Social Sciences (SPSS Version 26). One-way ANOVA was used to determine significance between the mean across different locations.

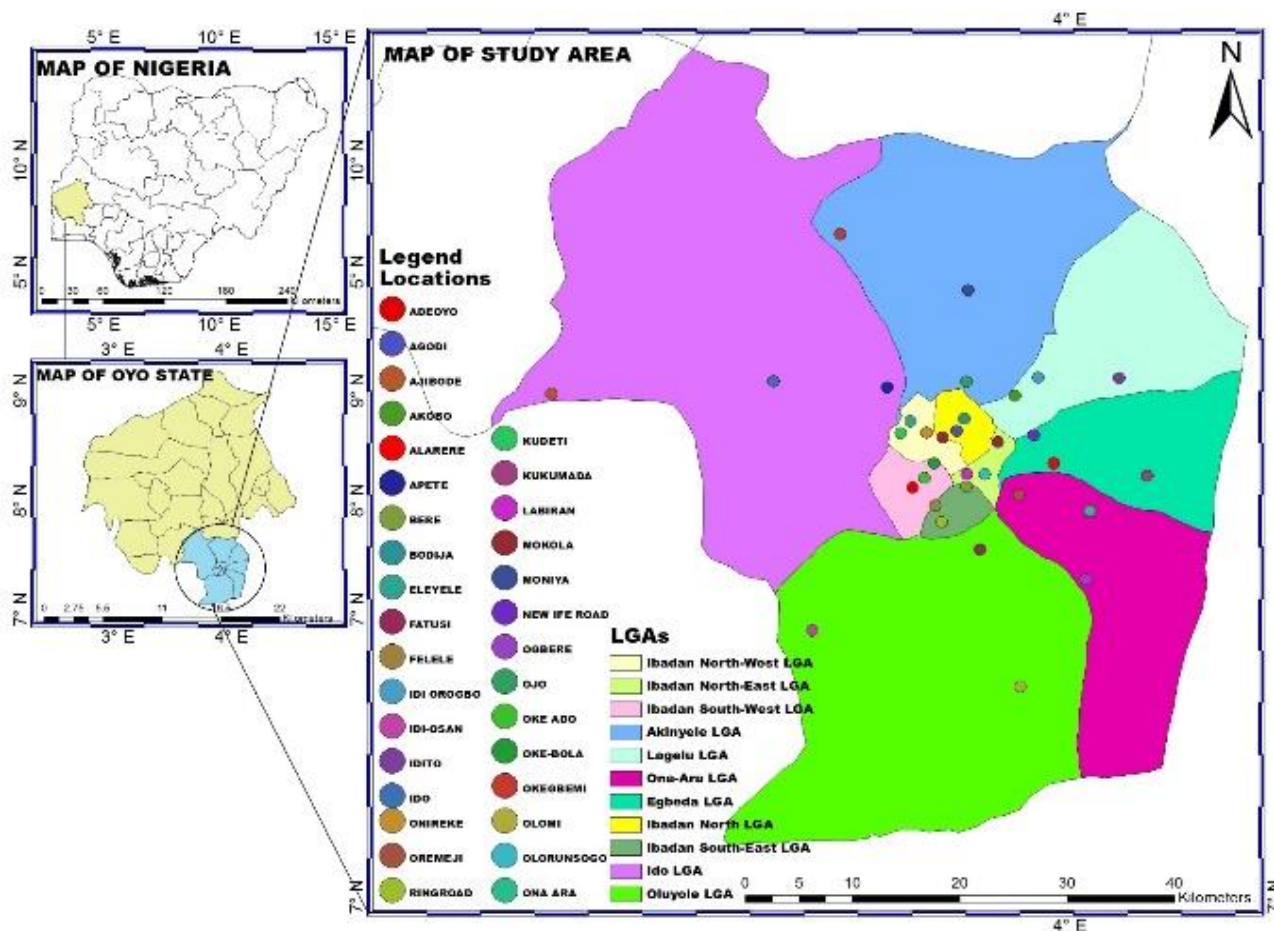


Figure 1: Map of Ibadan showing the Sampled Locations

Table 1: Seasonal Distribution of Mosquito Species Collected in Ibadan, Oyo State, Nigeria

Season	<i>Culex</i> sp. (%)	<i>Aedes</i> sp. (%)	<i>Anopheles</i> sp. (%)	<i>Toxorhynchitinae</i> I(%)	<i>Mansonia</i> sp. (%)	Total
Wet season	2780 (44.8)	2492 (40.1)	639 (10.3)	186 (3.0)	111 (1.8)	6208
Dry season	2489 (47.1)	1857 (35.1)	633 (12.0)	158 (3.0)	153 (2.9)	5290
Total	5269 (45.8)	4349 (37.8)	1272 (11.1)	344 (3.0)	264 (2.3)	11,498

Table 2: Abundance of Mosquito species in Dry Season across 11 Local Government in Ibadan Metropolis

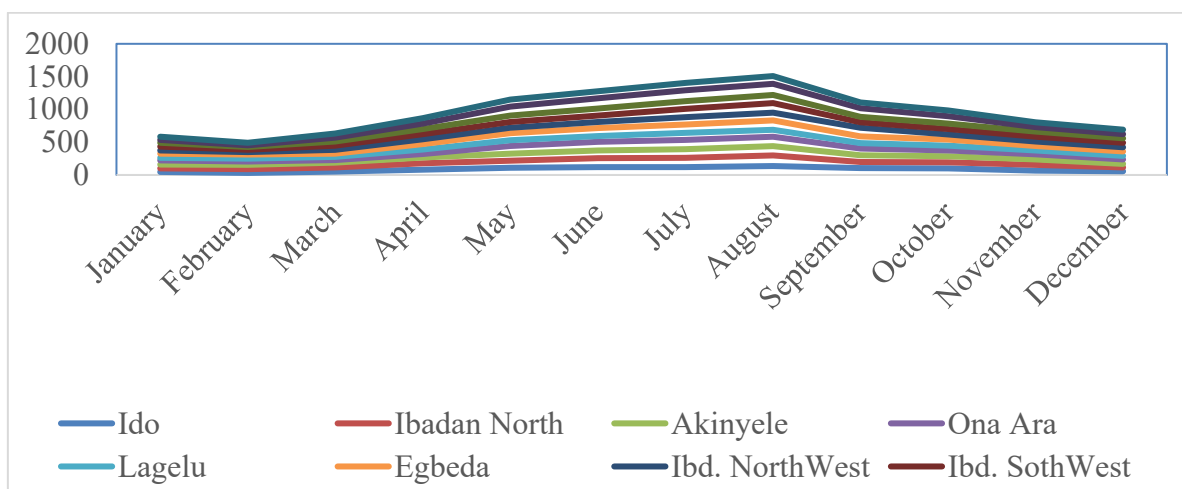
Sampled Location	<i>Culex</i> sp.(%)	<i>Aedes</i> sp. (%)	<i>Anopheles</i> sp. (%)	<i>Toxorhynchitinae</i> (%)	<i>Mansonia</i> sp. (%)	Total (%)
Ido	201 (8.1)	155 (8.3)	51 (8.1)	31 (19.6)	22 (14.4)	460 (8.7)
North	283 (11.4)	133 (7.2)	60 (9.5)	19 (12.0)	7 (4.6)	502 (9.5)
Akinyele	313 (12.6)	79 (4.3)	48 (7.6)	34 (21.5)	24 (15.7)	498 (9.4)
Ona Ara	178 (7.2)	270 (14.5)	36 (5.7)	0 (0.0)	0 (0.0)	484 (9.1)
Lagelu	213 (8.6)	134 (7.2)	54 (8.5)	5 (3.2)	15 (9.8)	421 (7.9)
Egbeda	236 (9.5)	203 (10.9)	54 (8.5)	20 (16.5)	0 (0.0)	513 (9.7)
North West	276 (11.0)	125 (6.7)	39 (6.2)	0 (0.0)	29 (18.9)	469 (8.8)
South West	161 (6.5)	241 (13.0)	66 (10.4)	0 (0.0)	4 (2.6)	472 (8.9)
South East	276 (11.0)	76 (4.1)	71 (11.2)	15 (9.5)	18 (11.8)	456 (8.6)
Oluyole	163 (6.5)	248 (13.4)	73 (11.5)	22 (10.1)	16 (10.4)	522 (9.9)
North East	189 (7.6)	193 (10.4)	81 (12.8)	12 (7.6)	18 (11.8)	493 (9.3)
<b>Total</b>	<b>2489 (100)</b>	<b>1857 (100)</b>	<b>633 (100)</b>	<b>158 (100)</b>	<b>153 (100)</b>	<b>5290 (100)</b>

**Table 3: Abundance of Mosquito species in Wet Season across 11 Local Government in Ibadan Metropolis**

Sampled Location	<i>Culex</i> sp. (%)	<i>Aedes</i> sp. (%)	<i>Anopheles</i> sp. (%)	<i>Toxorhynchitinae</i> (%)	<i>Mansonia</i> sp. (%)	Total (%)
Ido	210 (7.6)	256 (10.3)	76 (11.9)	16 (8.6)	0 (0.0)	558 (9.0)
North	342 (12.3)	208 (8.3)	57 (8.9)	23 (12.3)	19 (17.1)	649 (10.5)
Akinyele	412 (14.8)	90 (3.6)	60 (9.4)	42 (22.6)	18 (16.2)	622 (10.0)
Ona Ara	260 (9.3)	284 (11.4)	41 (6.4)	0 (0.0)	0 (0.0)	585 (9.4)
Lagelu	149 (5.3)	201 (8.1)	48 (7.5)	26 (14.0)	14 (12.6)	438 (7.0)
Egbeda	255 (9.2)	241 (9.7)	46 (7.2)	12 (6.5)	9 (8.1)	563 (9.1)
North West	302 (10.9)	111 (4.4)	43 (6.7)	31 (16.7)	11 (9.9)	498 (8.0)
South West	194 (7.0)	269 (10.8)	58 (9.1)	0 (0.0)	11 (9.9)	532 (8.6)
South East	246 (8.9)	193 (7.7)	54 (8.5)	0 (0.0)	8 (7.2)	501 (8.1)
Oluyole	179 (6.4)	403 (16.2)	75 (11.7)	17 (9.1)	21 (19.0)	695 (11.2)
North East	231 (8.3)	236 (9.5)	81 (12.7)	19 (10.2)	0 (0.0)	567 (9.1)
<b>Total</b>	<b>2780 (100)</b>	<b>2492 (100)</b>	<b>639 (100)</b>	<b>186 (100)</b>	<b>111 (100)</b>	<b>6208 (100)</b>

**Table 4: The Physicochemical Parameters of the Microhabitat Waters of the Larvae**

Location	pH (Mean ± Std)	Temp (°C Mean ± Std)	RH (%) (Mean ± Std)	EC (Mean ± Std)	TDS (Mean ± Std)	DO (Mean ± Std)	BOD (Mean ± Std)	COD (Mean ± Std)
Ido	7.28 ± 0.53	26.63 ± 0.91	76.17 ± 8.56	114.23 ± 30.73	217.06 ± 57.70	2.42 ± 0.53	168.78 ± 28.96	209.72 ± 44.31
Lagelu	7.01 ± 0.46	26.43 ± 0.75	77.39 ± 7.87	92.60 ± 6.56	168.59 ± 51.69	2.15 ± 0.77	163.78 ± 34.17	199.72 ± 57.26
Ona Ara	7.39 ± 0.36	28.63 ± 2.88	75.00 ± 10.62	96.61 ± 6.08	343.88 ± 108.96	13.66 ± 49.00	179.72 ± 26.42	192.22 ± 30.51
Ibadan SE	7.16 ± 0.23	27.37 ± 1.94	72.61 ± 4.96	93.26 ± 5.31	418.33 ± 154.23	2.50 ± 1.06	178.50 ± 47.84	174.00 ± 33.51
Ibadan NE	7.12 ± 0.23	27.37 ± 1.48	77.83 ± 5.75	93.59 ± 6.54	339.00 ± 142.01	2.16 ± 0.36	161.39 ± 20.02	172.67 ± 39.80
Akinyele	7.19 ± 0.19	27.04 ± 0.52	79.33 ± 8.83	99.58 ± 9.10	189.28 ± 44.07	3.10 ± 3.06	176.28 ± 45.50	201.56 ± 57.27
Ibadan NW	7.26 ± 0.29	27.22 ± 1.68	72.94 ± 13.95	149.60 ± 62.03	197.06 ± 73.90	2.50 ± 1.27	174.81 ± 33.57	170.62 ± 43.07
Ibadan SW	7.21 ± 0.51	26.03 ± 0.56	76.00 ± 11.45	109.01 ± 32.60	309.78 ± 153.43	2.91 ± 2.99	173.44 ± 24.04	193.00 ± 46.31
Egbeda	7.16 ± 0.35	26.33 ± 0.89	85.51 ± 8.45	122.30 ± 54.10	327.33 ± 134.43	2.57 ± 1.29	155.78 ± 26.71	205.72 ± 50.17
Oluyole	6.93 ± 0.37	26.03 ± 0.85	82.83 ± 7.48	112.93 ± 34.55	183.56 ± 45.11	3.44 ± 1.96	177.28 ± 33.02	215.31 ± 44.27
Ibadan North	7.43 ± 0.40	26.80 ± 0.39	71.50 ± 7.09	109.91 ± 41.40	339.94 ± 94.57	2.75 ± 1.06	169.33 ± 22.66	191.72 ± 38.82



**Figure 2: Monthly Distribution/Abundance of Mosquito across the Sampled Local Government Area for the First Year**

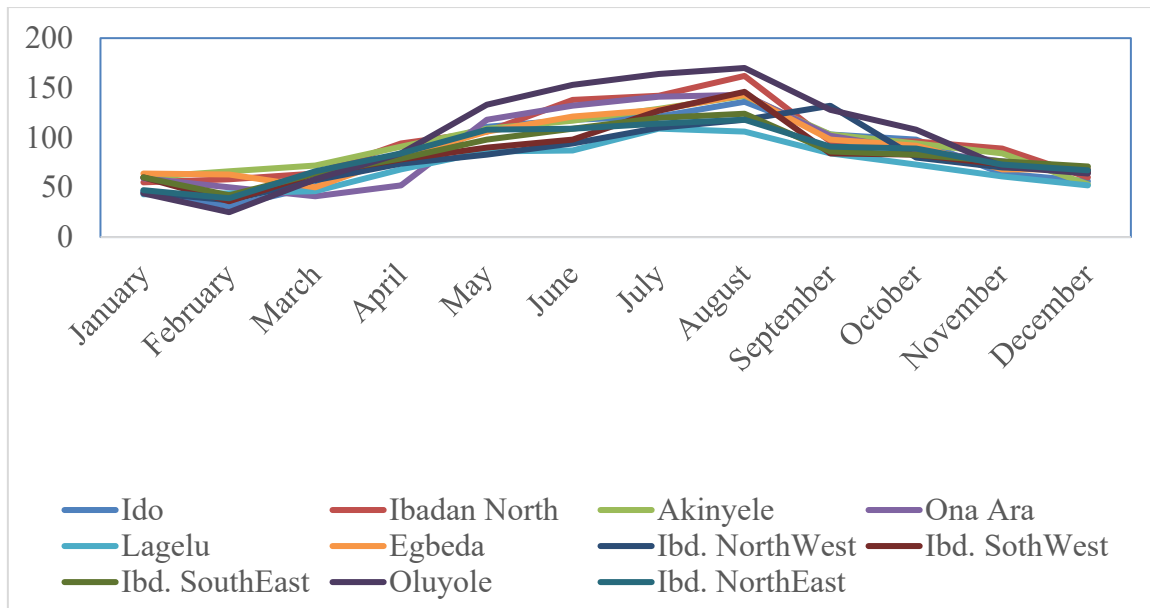


Figure 3: Monthly Distribution/abundance of Mosquito across the Sampled Local Government Area for the Second Year

Table 5: Seasonal Variation in Mosquito Distribution Across Eleven LGAs in Oyo State

Locations											
Parameters	Ido	Ibadan North	Akinyele	Ona Ara	Lagelu	Egbeda	Ibadan NW	Ibadan SW	Ibadan SE	Oluyole	Ibadan NE
<i>Aedes</i> species											
Dry season	8.89±0.39 <sup>c</sup>	7.39±0.11 <sup>b</sup>	5.00±0.10 <sup>a</sup>	14.44±0.15 <sup>f</sup>	7.56±0.06 <sup>b</sup>	10.72±0.43 <sup>d</sup>	7.00±0.10 <sup>b</sup>	13.39±0.11 <sup>c</sup>	4.44±0.06 <sup>a</sup>	13.39±0.11 <sup>c</sup>	11.00±0.25 <sup>d</sup>
Wet Season	13.61±0.45 <sup>ab</sup>	32.94±2.19 <sup>b</sup>	5.78±0.28 <sup>a</sup>	14.56±0.22 <sup>ab</sup>	10.78±0.81 <sup>a</sup>	13.39±0.20 <sup>ab</sup>	6.06±0.15 <sup>a</sup>	13.67±0.44 <sup>ab</sup>	11.28±0.22 <sup>a</sup>	22.39±0.11 <sup>ab</sup>	13.44±0.15 <sup>ab</sup>
<i>Culex</i> species											
Dry season	12.44±0.15 <sup>b</sup>	17.39±0.39 <sup>c</sup>	17.61±0.11 <sup>c</sup>	9.50±0.00 <sup>a</sup>	13.61±0.06 <sup>c</sup>	14.39±0.11 <sup>d</sup>	14.28±0.11 <sup>d</sup>	9.44±0.05 <sup>a</sup>	14.33±0.17 <sup>d</sup>	9.44±0.06 <sup>a</sup>	9.67±0.10 <sup>a</sup>
Wet Season	11.11±0.20 <sup>a</sup>	48.06±2.95 <sup>b</sup>	20.67±0.25 <sup>a</sup>	13.67±0.42 <sup>a</sup>	6.56±0.33 <sup>a</sup>	14.00±0.35 <sup>a</sup>	16.94±0.36 <sup>a</sup>	11.33±0.25 <sup>a</sup>	14.33±0.25 <sup>a</sup>	11.44±0.06 <sup>a</sup>	13.28±0.31 <sup>a</sup>
<i>Anopheles</i> species											
Dry Season	2.11±0.20 <sup>a</sup>	2.89±0.11 <sup>b</sup>	2.72±0.06 <sup>b</sup>	1.89±0.05 <sup>a</sup>	2.83±0.10 <sup>b</sup>	2.94±0.06 <sup>b</sup>	2.06±0.05 <sup>a</sup>	2.94±0.05 <sup>b</sup>	3.50±0.00 <sup>c</sup>	3.61±0.11 <sup>c</sup>	4.06±0.24 <sup>d</sup>
Wet Season	3.61±0.11 <sup>ab</sup>	8.27±0.36 <sup>b</sup>	3.11±0.06 <sup>ab</sup>	2.06±0.06 <sup>a</sup>	2.28±0.39 <sup>a</sup>	2.61±0.06 <sup>a</sup>	2.50±0.00 <sup>a</sup>	3.00±0.00 <sup>ab</sup>	2.67±0.25 <sup>a</sup>	3.50±0.00 <sup>ab</sup>	3.44±0.06 <sup>ab</sup>
<i>Toxorynchitinae</i>											
Dry season	1.56±0.06 <sup>c</sup>	1.33±0.00 <sup>d</sup>	1.50±0.00 <sup>c</sup>	0.00±0.00 <sup>a</sup>	0.44±0.05 <sup>b</sup>	1.50±0.00 <sup>c</sup>	0.00±0.00 <sup>a</sup>	0.00±0.00 <sup>a</sup>	0.94±0.11 <sup>c</sup>	1.22±0.06 <sup>d</sup>	1.00±0.10 <sup>c</sup>
Wet season	1.00±0.10 <sup>a</sup>	3.44±0.28 <sup>b</sup>	1.94±0.06 <sup>ab</sup>	0.00±0.00 <sup>a</sup>	1.28±0.15 <sup>ab</sup>	0.61±0.06 <sup>a</sup>	1.50±0.00 <sup>ab</sup>	0.00±0.00 <sup>a</sup>	0.00±0.00 <sup>a</sup>	0.94±0.11 <sup>a</sup>	1.06±0.11 <sup>a</sup>
<i>Mansoni</i>											
Dry season	1.94±0.53 <sup>c</sup>	0.50±0.00 <sup>ab</sup>	1.44±0.05 <sup>bc</sup>	0.83±0.83 <sup>ab</sup>	0.89±0.05 <sup>ab</sup>	0.00±0.00 <sup>a</sup>	1.50±0.00 <sup>bc</sup>	0.50±0.11 <sup>ab</sup>	1.06±0.11 <sup>bc</sup>	0.56±0.06 <sup>a</sup>	1.18±0.01 <sup>bc</sup>
Wet season	0.00±0.00 <sup>a</sup>	4.22±0.69 <sup>b</sup>	1.00±0.10 <sup>a</sup>	0.00±0.00 <sup>a</sup>	0.78±0.06 <sup>a</sup>	0.56±0.06 <sup>a</sup>	0.61±0.05 <sup>a</sup>	0.61±0.05 <sup>a</sup>	0.89±0.40 <sup>a</sup>	1.06±0.11 <sup>a</sup>	0.00±0.00 <sup>a</sup>

Note: Mean values with the same superscript alphabets in the rows are not significantly different from each other at (P>0.05).

### 3.0 RESULTS AND DISCUSSION

The result of the seasonal distribution of mosquito species collected in 11 LGA of Ibadan, Oyo state, Nigeria is shown in Table 1. It was observed that during the dry season, mosquito abundance declined to 5,290 in number from 6208 recorded in wet season

representing 17.35 % decrease. *Culex* spp. population (47.1%) maintained dominance, while *Aedes* spp. population stood at 35.1% during the dry season. The persistence of *Culex* spp. during dry months might be attributed to the species ability to exploit diverse man-made habitats such as domestic water storage containers,

blocked drainages, and organically polluted stagnant water; which is submission similar to the report by Bermond, 2023. In contrast, *Anopheles* spp. showed a slight increase in relative abundance (12.0%), suggesting that residual pools and slow-moving water bodies sustain breeding during periods of reduced rainfall, a trend corroborated by Simon-Oke and Afolabi (2019).

Table 2 shows the Spatial distribution varied across LGAs in the dry season. *Culex* spp. was most abundant in Akinyele (12.6%) and Ibadan North (11.4%), while *Aedes* spp. peaked in Oluyole (13.4%) and Ona Ara (14.5%), reflecting its affinity for urban peridomestic habitats. *Anopheles* spp. was highest in Ibadan North-East (12.8%) and Oluyole (11.5%). *Toxorhynchitinae* and *Mansonia* spp. occurred sparsely, with higher number in Akinyele and Ibadan North-West. These spatial variations mirror earlier findings that urbanization, vegetation cover, and drainage conditions strongly influence mosquito distribution (Simon-Oke and Afolabi, 2019).

Table 3 shows the result for wet season, overall abundance increased, with *Culex* spp. (44.8%) and *Aedes* spp. (40.1%) dominating. Rainfall created extensive breeding habitats, particularly in poorly drained areas. *Culex* spp. thrived in organically polluted stagnant water, gutters, and open drains, while *Aedes* spp. proliferated in artificial containers, discarded tyres, and rainwater-filled receptacles (Sánchez *et al.*, 2015; Chaves *et al.*, 2021). *Anopheles* spp. (10.3%) peaked in Ibadan North-East (12.7%) and Ido (11.9%), highlighting suitable habitats for malaria vectors. *Toxorhynchitinae* and *Mansonia* spp. remained sparse, with localized peaks in Akinyele and Ibadan North.

Mosquito abundance peaked in July and August, coinciding with peak of rainfall. Oluyole and Ibadan North-East consistently recorded the highest number while Ido exhibited the lowest abundance across both years of study. Seasonal fluctuations followed a predictable trend: low number in February, rising from March, peaking in August, and declining towards December as shown in Figure 2. The consistently low abundance in Ido may be attributed to drier land, efficient drainage, and reduced vegetation, in contrast to LGAs with poor drainage and dense vegetation Simon-Oke and Afolabi, 2019; Mataba *et al.*, 2024). Breeding site characteristics varied across LGAs. pH values ranged from slightly acidic (6.93 in Oluyole) to moderately alkaline (7.43 in Ibadan North). Temperatures varied between 26.03°C and 28.63°C, with relative humidity generally above 70%. Electrical conductivity (EC) and total dissolved solids (TDS) indicated varied mineral content, with Ibadan Southeast and Ona Ara recording higher TDS levels (418.33 and 343.88 mg/L). Dissolved oxygen (DO) values were mostly between 2–3 mg/L, except for Ona Ara's outlier of 13.66 mg/L (Table 4).

Spatial and temporal differences corresponded closely with physicochemical parameters. LGAs with near-neutral to slightly alkaline pH, moderate temperatures, and high organic content (e.g., Ibadan Southeast and Ona Ara) provided favorable breeding environments. Conversely, Ido consistently recorded low mosquito abundance, likely due to efficient drainage, reduced vegetation, and fewer stagnant water bodies (Thangamathi *et al.*, 2018; Avramov *et al.*, 2024).

Tables 5 present mosquito species abundance across different local government areas sampled for wet and dry seasons. In the wet season, *Aedes* and *Culex* mosquitoes were most abundant, particularly in Ibadan North, where their populations were much higher compared to other areas. *Anopheles*, the malaria vector, remained relatively low but showed slightly higher numbers in Ibadan North, while *Toxorhynchites* and *Mansonia* were rare or absent in several locations. This suggests that wet conditions strongly favor the proliferation of *Aedes* and *Culex*. During the wet season, *Aedes* and *Culex* species were dominant, particularly in Ibadan North, while *Anopheles* remained relatively low. In contrast, the dry season showed reduced overall abundance but a relative increase in *Anopheles*, especially in Ibadan North East. These findings underscore the strong influence of rainfall and water availability on culicine mosquito proliferation, while *Anopheles* species appear more resilient in drier conditions, likely due to their ability to exploit permanent water bodies.

Similar seasonal patterns have been reported in other regions of Nigeria and sub-Saharan Africa. (Elosiuba *et al.*, 2023) observed that *Aedes* and *Culex* were significantly more abundant during the rainy season in Southeastern Nigeria, reflecting the proliferation of temporary breeding habitats created by rainfall (Lamidi 2020) in Taraba State also documented peak *Culex* populations in wet months. *Anopheles* spp.-maintained presence across seasons, although at lower densities. Studies in North Central Nigeria further noted that *Anopheles* abundance increased slightly in dry months, suggesting that permanent water sources sustain their breeding during periods of reduced rainfall (Amaechi *et al.*, 2018). Comparable findings from Ghana and Kenya also emphasize that *Aedes* thrives in wet urban environments. These findings shows that wet season favors explosive growth of *Aedes* and *Culex* due to abundant breeding sites, *Anopheles* sustains its presence during the dry season by adapting to more stable habitats. (Owusu-Asenso *et al.*, 2022). Ibadan North shows higher culicine densities, likely due to poor drainage and water storage practices.

Research in Ibadan has consistently highlighted the interplay between climate variability, urbanization, and vector ecology. Studies by Simon-Oke and Afolabi (2018, 2019) emphasized the dominance of *Culex* spp. in urban environments, while more recent work (Mataba *et*

*al.*, 2024) linked mosquito distribution to vegetation density and drainage efficiency. Ibadan's rapid urban expansion, coupled with poor waste management and drainage systems, has created heterogeneous breeding habitats that sustain diverse mosquito populations.

Furthermore, Ibadan's role as a major urban center in Southwestern Nigeria makes it a critical site for vector surveillance. The persistence of *Aedes* spp. in peridomestic habitats raises concerns about arboviral transmission risks (e.g., dengue, yellow fever), while the presence of *Anopheles* spp. underscores ongoing malaria transmission potential. These findings align with broader regional studies that emphasize the need for integrated vector management strategies tailored to local ecological and socio-environmental contexts.

#### 4.0 CONCLUSION

This study reveals pronounced seasonal and spatial variations in mosquito populations across Ibadan's eleven Local Government Areas. *Culex* and *Aedes* species dominate year-round, sustained by urbanization, poor drainage, and artificial breeding sites, while *Anopheles* species maintain a steady presence, perpetuating malaria transmission risk. Ido and Lagelu LGA consistently recorded the lowest mosquito densities, likely due to water quality, climate, and human activities which combine to make breeding and survival less favorable. Mosquito population dynamics in Ibadan are shaped by seasonal rainfall, physicochemical properties of breeding sites, and urban ecological heterogeneity. *Culex* spp. remains the dominant species across seasons, while *Aedes* spp. and *Anopheles* spp. exhibit habitat-specific peaks. The consistently low abundance in Ido highlights the mitigating role of effective drainage and reduced vegetation. Overall, climatic variability, habitat heterogeneity, and water quality collectively influence mosquito ecology in Ibadan, reinforcing the need for localized vector control interventions.

#### REFERENCES

- Abeku, T. A., Iwegbu, A., Ogunmola, S., & Oluwagbemiga, A. O. (2025). Seasonal climate patterns and their impact on mosquito net use in Nigeria: Evidence from repeated surveys. *Malaria Journal*, 25(65). Springer Nature. <https://doi.org/10.1186/s12936-025-0065-3>
- Adeleke, M. A., Mafiana, C. F., Idowu, O. A., Sam-Wobo, S. O., & Surakat, O. A. (2020). Larval habitats of mosquitoes in Ibadan, Nigeria: Implications for vector control. *Journal of Vector Ecology*, 45(2), 234–242. <https://doi.org/10.1002/jvec.12345>
- Adeogun, A. O., Babalola, A. S., Babatunde, T. P., Oyelude, F. J., Fawole, J., Adediran, A., Olagundoye, O., Busari, L., Adesoye, O. A., Adeleke, M. A., & Idowu, O. A. (2025). Insecticide resistance in mosquito vectors in Nigeria: a geospatial review of published evidence. *fudma journal of sciences*, 9(10), 19-27. <https://doi.org/10.33003/fjs-2025-0910-3938>
- Adeogun, A.O., Babalola, A.S., Taiwo, B.P., Janet, O.F., Jumoke, F., Adewale, A., Olalekan, O., Adesoye, O.A., Monsuru, A.A., & Olufunmilayo, A.I. (2021). Insecticide resistance in mosquito vectors in Nigeria: A geospatial review of published evidence. [Journal/Publisher details depending on the source].
- Afolayan, J.A. (1994). *Malaria in Ibadan: Epidemiology and control*. Malaria and Vector Control in Nigeria, pp. 35–46. Ibadan University Press.
- Amaechi, E. C., Ukpai, O. M., Ohaeri, C. C., Ejike, U. B., Irole-Eze, O. P., Egwu, O., & Nwadike, C. C. (2018). Distribution and seasonal abundance of Anopheline mosquitoes and their association with rainfall around irrigation and non-irrigation areas in Nigeria. *Cuadernos de Investigación UNED*, 10(2), 267-272.
- Avramov, M., Thaivalappil, A., Ludwig, A., Miner, L., Cullingham, C. I., Waddell, L., and Lapen, D. R. (2024). Relationships between water quality and mosquito presence and abundance: a systematic review and meta-analysis. *Journal of Medical Entomology*, 61(1), 1-33.
- Awolola, T.S., *et al.*, (2020). Vector competence and distribution of mosquitoes in Nigeria: A review. *Malaria Journal*, 19(1), 1–10.
- Babalola, A. S., Adeogun, A. O., Thabet, H. S., TagEldin, R. A., Oyeniyi, T., Adekunle, O., and Harwood, J. F. (2025). Geospatial modeling of geographical spread of *Aedes* species, in relation to climatic and topographical factors in Lagos State, Nigeria. *PLOS Neglected Tropical Diseases*, 19(2), e0012860.
- Bermond, C. D. (2023). How Sewage Pollution Affects Distribution and Life History Traits of the Southern House Mosquito, *Culex Quinquifasciatus*. [https://aquila.usm.edu/masters\\_theses/1003](https://aquila.usm.edu/masters_theses/1003)
- Chandra, G., & Mukherjee, D. (2022). Effect of climate change on mosquito population and changing pattern of some diseases transmitted by them. In *Advances in animal experimentation and modeling* (pp. 455-460). Academic Press.
- Chaves, L. S. M., Bergo, E. S., Conn, J. E., Laporta, G. Z., Prist, P. R., and Sallum, M. A. M. (2021). Anthropogenic landscape decreases mosquito biodiversity and drives malaria vector proliferation in the Amazon rainforest. *PLoS One*, 16(1), e0245087.
- Cimberle, M., & Gallagher, J. (2025). Emerging challenges for mosquito-borne disease control and the promise of symbiont-based transmission-blocking strategies. *PLOS Pathogens*, 21(8), e1013431. <https://doi.org/10.1371/journal.ppat.1013431>.
- Elosiuba, N.V., Akulue, J.C., Imakwu, C.A., & Chikwendu, J.I. (2023). Abundance and diversity of man-biting mosquito species in the tropical rainforest belt of Southeastern Nigeria. *Journal of Entomology and Zoology Studies*, 11(2), 52–56. <https://doi.org/10.22271/J.ENTO.2023.V11.I2A.9183>.
- Lamidi, T.B. (2020). Seasonal distribution and abundance of Culicine mosquito species in three selected areas of Taraba State, North-east Nigeria. *IOSR Journal of Pharmacy and Biological Sciences*, 15(3), 56–64.

- Harbach (2018): Harbach, R.E. (2018). *Culicipedia: species-group, genus-group and family-group names in Culicidae (Diptera)*. CABI, Wallingford, UK. viii + 378 pp.
- Heath, K., Muniz Alves, L., & Bonsall, M.B. (2025). Climate change, urbanisation and transmission potential: *Aedes aegypti* mosquito projections forecast future arboviral disease hotspots in Brazil. *PLoS Neglected Tropical Diseases*, 19(9), e0013415. <https://doi.org/10.1371/journal.pntd.0013415>.
- Lamidi, T.B. (2020). Seasonal distribution and abundance of Culicine mosquito species in three selected areas of Taraba State, North-east Nigeria. *IOSR Journal of Pharmacy and Biological Sciences*, 15(3), 56–64.
- Liu, Y. (2024). Life cycle dynamics of mosquitoes under varied environmental conditions. *Journal of Mosquito Research*, 14.
- Mataba, T., *et al.*, (2024). Seasonal variation in mosquito abundance and its relationship with vegetation and drainage in tropical regions. *Acta Tropica*, 235, 106–118.
- Ogbuefi, E.O., Umeh, B.C., Aniefuna, C.O., Chidi-Okeke, C.A., Emma-Ogbuefi, O.V., & Mbanugo, C.J. (2023). Species composition and biting activities of mosquitoes in a selected community in Anambra State, Southeast Nigeria. *Asian Journal of Research in Zoology*, 6(3), 16–25. <https://doi.org/10.9734/AJRIZ/2023/v6i3112> (doi.org in Bing)
- Ogolo, E.O., & Adeyemi, B. (2009). Variations and trends of some meteorological parameters at Ibadan, Nigeria. *Pacific Journal of Science and Technology*, 10(2), 980–987.
- Ojianwuna, C. C., Enwemiwe, V., and Ekeazu, C. N. (2021). Abundance and distribution of *Anopheles* mosquito in relation to physicochemical properties in Delta State, Nigeria. *Fudma Journal of Sciences*, 5(3), 274-280.
- Okorie, P.N., *et al.*, (2021). Mosquito ecology and larval habitat diversity in Nigeria: Implications for integrated vector management. *Acta Tropica*, 217, 105–118.
- Oluwaseyi, T. A., Adeogun, A. O., Orabueze, I. N., Adediran, A. D., Oranusi, S. U. (2026). Permethrin resistance of *Anopheles* mosquito species across diverse habitats in rural and urban areas of Ogun and Oyo States, Nigeria. *The Journal of Basic and Applied Zoology*, 87(15). This research documents widespread permethrin resistance in mosquitoes across multiple breeding environments.
- Owusu-Asenso, C.M., Afrane, Y.A., Abdulai, A., Mohammed, A.R., Akuamoah-Boateng, Y., Sraku, I.K., Yanney, S.A., Malm, K., Lobo, N.F. (2022). Detection of invasive *Anopheles stephensi* mosquitoes through molecular surveillance in Ghana. *Malaria Journal*, 21(1), 250. <https://doi.org/10.1186/s12936-022-04250-7> (doi.org in Bing)
- Sánchez, A. S., Cohim, E., and Kalid, R. A. (2015). A review on physicochemical and microbiological contamination of roof-harvested rainwater in urban areas. *Sustainability of Water Quality and Ecology*, 6, 119-137.
- Service (1993): Service, M.W. (1993). *Mosquito Ecology: Field Sampling Methods*. 2nd Edition. Springer Netherlands, Dordrecht. ISBN: 1851667989.
- Simon-Oke, I. A. (2015). The effect of climatic factors on the distribution and abundance of mosquito vectors in Ekiti State, Nigeria. *International Journal of Pure and Applied Zoology*, 3(4), 347–353
- Simon-Oke, I.A., & Afolabi, O.J. (2018). Distribution and abundance of mosquito species in Southwestern Nigeria. *International Journal of Mosquito Research*, 5(3), 12–18.
- Simon-Oke, I.A., & Afolabi, O.J. (2019). Influence of urbanization and drainage conditions on mosquito distribution in Nigeria. *Journal of Vector Borne Diseases*, 56(2), 145–152.
- Smith, M. W., Thomas, C. J. (2024). Future malaria environmental suitability in Africa is sensitive to hydrology. Science and related climate modeling studies. These investigations confirm that malaria transmission depends on specific ranges of temperature, humidity, and the persistence of surface water.
- Sun, C., Nimbalkar, J. (2023). Predicting Future Mosquito Habitats Using Time Series Climate Forecasting and Deep Learning. *IEEE Xplore*. This study used climate projections and deep learning models to predict mosquito larvae abundance, showing increases in regions with warmer temperatures and prolonged wet seasons.
- Thangamathi, P., Nithya, M., Lavanya, H., and Gnanasoundari, A. (2018). Review on wetlands and mosquitoes. *International Journal of Advance Research, Ideas and Innovations in Technology*, 4(2), 2742-2749.
- Zhang, W. (2024). Role of climate and environmental changes in mosquito population dynamics. *Journal of Mosquito Research*, 14(4), 195–203. This study highlights how climate change and altered rainfall patterns influence mosquito ecology, expanding their range and affecting larval development.
- WHO/AFRO (2024): Joseph, N.K., Mumo, E., Morlighem, C., Macharia, P.M., Snow, R.W., & Linard, C. (2024). Mosquito-borne diseases in urban East African Community region: a scoping review of urban typology research and mosquito genera overlap, 2000–2024. *Frontiers in Tropical Diseases*, 5, 1499520. <https://doi.org/10.3389/fitd.2024.1499520>