MOSQUITOES POPULATION DYNAMICS AND ITS IMPLICATION FOR CONTROL IN SOME SELECTED LOCAL GOVERNMENT AREAS OF ANAMBRA STATE, NIGERIA

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ABSTRACT

Insects are beneficial to man, although, some like houseflies, tsetse fly and mosquitoes are vital players in the transmission of certain diseases. A twelve month longitudinal survey of the population dynamics of mosquitoes in Awka South, Awka North and Njikoka Local Government Areas (LGAs) of Anambra State, Nigeria was conducted to determine the predominant mosquito species composition and its breeding ecology between August 2021 and September 2022. Pyrethrum spray trap collections, Centre for Disease Control light trap (CDC-LT) collections, human landing catch (HLC) and larval collection method (LCM) were the methods adopted during the study. Chi-square test was used to check for relationships between mosquito's abundance and other parameters. The total number of mosquitoes collected was 9346 and the highest number was collected in Njikoka LGA 38.2% (3568/9346), followed by Awka South with 34.4% (3215/9346) and Awka North LGAs with 27.4% (2563/9346). The vector density of 23.1% (741/3215) Anopheles spp., 31.1% (1001/3215) Aedes spp., 25.4% (817/3215) Culex spp. and 18.7% (656/3215) Mansonia africana were also recorded. Distribution of mosquito larvae across the three LGAs showed that mosquitoes breeding habitats includes: domestic containers (17.0%), catchment pits (16.4%), broken buckets and tins (14.7%). Recently, resurgence of yellow fever has been reported in some part of Nigeria which Anambra State is part of which suggests that a sustainable public health education campaign on vector management and control should be intensified which will assist in sensitizing the inhabitants on the public importance of mosquito species in Anambra State, Nigeria.

Keywords: Mosquito, Abundance, Population dynamics, Anambra State, Nigeria

INTRODUCTION

Insects are the most successful and abundant class among the arthropods. Their wide distribution can be attributed to a number of factors especially their powers of flight and their highly adaptable nature (Service, 2014). Some insects such as fleas, sand-fly, tsetse fly, lice and mosquitoes are vectors of human and domestic animal disease which transfer pathogens (Service, 2014) even though they are also beneficial to man, others are vital players in the transmission of zoonotic diseases to humans. Mosquitoes (Diptera: Nematocera) belong to the family of small midge-like flies, the Culicidae which are considered a nuisance and a major public health problem because the female suck blood from living vertebrates, including humans, and in doing so transmit harmful diseases such as malaria, yellow fever and filariasis (Obol *et al.*, 2011). Mosquitoes are major vectors of public health importance and the most common blood sucking arthropods (Killeen, 2014) which transmit diseases to more than 219 million people annually and responsible for the death of about 400,000 people globally (WHO, 2020). They are among the major causes of illness and death, particularly in tropical and subtropical countries. Several mosquito vectors in different genera and species have been incriminated with the transmission of serious diseases (Bamou *et al*., 202). In Nigeria, mosquitoes are regarded as public health enemies because of their biting annoyance and noise nuisance, sleeplessness, allergic reaction and disease transmission from their bites cannot be overemphasized (Eze *et al.,* 2022). Effective transmission of mosquito-borne diseases requires successful contact between infected female mosquitoes and their host (Thongsripong *et al*., 2021). Mosquitoes have worldwide distribution and are found in both tropics and temperate regions of the world. *Anopheles, Culex, Mansonia and Aedes* species are common in the tropics and lay their eggs on the open surface of all sorts of both permanent and temporary water collections, just above the water level on walls of containers or attach them to some partially submerged objects, depending on the species (Day, 2016). Environmental changes due to human activities greatly influence the distribution and survival of many mosquito species (Adeleke *et al*., 2008). Aigbodion and Uyi (2013) reported that the recent increase in agricultural activities and urbanization contributed to increased number of breeding sites of different mosquito species. The present reality of demographic growth and urbanization being experienced in many parts of Nigeria has come with many public health problems (Adeleke *et al.,* 2010). Thus the essence of this study was to determine the predominant species and breeding ecology of mosquitoes in Awka South, Awka North and Njikoka Local Government Areas (LGAs) of Anambra State Nigeria.

MATERIALS AND METHODS

Study Area: The research was carried out from September 2021 to August, 2022 covering the two major seasons of the year in Anambra State Nigeria. Anambra State has twenty one LGAs with a total land mass of 4,844 km² (Wikipedia, 2020a). The 2020 projected population of Anambra State is 11,400,000 (Wikipedia, 2020a). The official language of the people of Anambra State is Igbo although English language is widely spoken throughout the state as a secondary language (Wikipedia, 2020a). The State is located on Latitude 6° 16' 32.7576" North of Equator and Longitude 7° 0' 24.6204” East of Greenwich and its daily temperature about 26.8 °C / 80.2 °F (Wikipedia, 2020a). Anambra State has seasonal climatic conditions, the wet season (which falls between April and October) and the dry season (which falls within November and March) with a short spell of harmattan between November and January which is a period of cold weather when the atmosphere is generally misty (Ifeka and Akinbobola, 2015). The total annual rainfall of the State is above 11,450 mm for the six to seven months of the wet season whereas the mean annual temperature range is 30.0 – 36.0 °C (Ifeka and Akinbobola, 2015). Awka South Local Government Area (LGA) is made up of nine communities namely; Awka, Amawbia, Ezinato, Isiagu, Mbaukwu, Nibo, Nise, Okpuno and Umuawulu (Wikipedia, 2020b). Awka South LGA has one ethnic group and the LGA is located on Latitude 6˚10’ North of equator and Longitude 7° 04’ East of Greenwich. Awka North is also a LGA in Anambra State with coordinates of 6° 15’ North of equator and 7°10’ East of Greenwich. Ten communities that make up the local government includes: Awba Ofemili, Amansea, Ugbene, Ebenebe, Achalla, Urum, Amanuke, Isu Aniocha, Mgbakwu and Ugbenu with its local government headquarters at Achalla (Wikipedia, 2020c). Njikoka is a LGA in Anambra State, South-Central Nigeria lying between latitude 06° 20’ 58 ” N to 06° 21’ 00” N and longitude 06° 52’ 55”Eis made up of six towns which include; Abagana, Enugwu-Ukwu, Enugwu-Agidi, Nawfia, Nimo and Abba. The area is characterized by a temperature range of 27˚ - 30˚C and has a double maxima rainfall peak in July and September (Ifeka and Akinbobola, 2015). The area has a land mass of 84.40 km² area with an annual population change of 2.2% and 2022 projected population of 211,500 (City Population, 2020).

Selection of Communities and Households: Three communities namely Nibo in Awka South LGA, Mgbakwu in Awka North LGA and Enugwu-Agidi in Njikoka LGA (Figure 1) were randomly selected from each LGA to represent the LGAs in the study area, also two villages (Umuanum and Ezeawulu in Nibo community, Amaezike and Akamanator in Mgbakwu community, Umu Agidi and Ifite in Enugwu-Agidi community) were randomly selected from all villages that make-up the respective target communities to represent that communities according to the method described by WHO (1992).

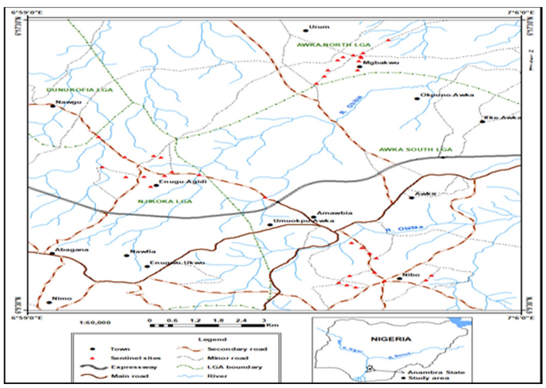

Figure 1: Map of the study areas showing Nibo in Awka South LGA, Mgbakwu in Awka North LGA and Enugwu Agidi in Njikoka LGA of Anambra State. Source: GIS and Cartography Laboratory (2022)

Thirty six households were randomly selected from a pool of village with each household having an equal chance of being selected. Rooms were randomly selected from the different collection sites at the three study areas from a pool of houses with equal representation with each house having an equal chance of being selected. During the larvae sampling, 24 larval collection sites (eight sites from each selected communities were randomly chosen) with an average distance of 1500 m between each site.

Study Design: The study design used was a cross sectional survey. Mosquitoes were sampled from one hundred and eight households from six villages earlier mentioned (two villages from a town) belonging to three LGAs namely: Awka South, Awka North and Njikoka LGAs of Anambra State, Nigeria were randomly sampled between September 2021 and August 2022, covering the wet and dry seasons of the year.

Ethical Considerations: A letter of introduction to the communities was obtained from the Department of Parasitology and Entomology, Nnamdi Azikiwe University, Awka Anambra State. Three levels of advocacy were carried out; first to the Commissioner of Health, Anambra State Ministry of Health, through the Local Government Chairman of the selected LGAs, followed by advocacy visit to the community heads/leaders/president general of the selected LGAs and finally to the households/individuals of the selected communities that will participate in the study. Sensitization was done through churches, markets and kindred enclaves. Mobilization for the study involved youths, women, and men in the study community. The participants were mobilized by a sensitization rally during which the objective of the study, explanation of the project intent and its methodology was disclosed. Approval and informed consent of the participants for the study was obtained before the commencement of the study and the identity of the participants were anonymous during and after the survey. Participation was voluntary and participants had the liberty to withdraw from the study without giving any reason.

Pyrethrum Knockdown Collections for Indoor Mosquito Vectors: Indoor mosquito collection was done monthly using pyrethrum knockdown catches (PKC) method as described by WHO (1975). The rationale behind selection of this method is that it is considered most successful in capturing anthropophagic (human biting) and endophilic (indoor resting) mosquitoes. In each selected households, PKC took place between 06.00 and 09.00 am using pyrethroid (BioMist, USA) mosquito spray which contains the following active ingredients (0.26% esbiothrin, 0.28% permethrin, 0.1% beta-cypermethrin and 0.31% lemon). Food and water were removed from the house and white sheets spread out on the floor and over the furniture in the house. Two field workers were engaged, one inside the house and the other outside who sprayed around the eaves with this non-residual pyrethroid. The field worker inside the house then sprayed the roof and walls. The house was closed for 20 minutes after which the white sheets were brought outside (where there is sufficient light to recover and count the dead and dying mosquitoes).

CDC Light Trap (CDC-LT) Collection for Indoor and Outdoor Malaria Vectors: Indoor and outdoor mosquito collection was also conducted monthly using the miniature CDC-LT as described by the Centers for Disease Control (CDC) (Model 512; John W. Hock Company, Gainesville, Florida, USA). The CDC-LT was used to collect mosquitoes during night time for three consecutive nights. The CDC-LTs were placed approximately 1.2 m above the floor in and outside the room. Traps were switched on from 6:00 pm and removed by 6:00 am the next day. Each night, 6 traps (one trap indoor and one trap outdoor at three different locations) were set for three nights for each site each month and they were rotated in the same order each month.

Human Landing Catch (HLC) for Outdoor and Indoor Malaria Vectors: The HLC method is the standard reference method for monitoring human exposure to mosquito bite was used in the study as described by WHO (1975; 2013). HLC was performed for 50 minutes each hour with 10 minutes break for the collectors. HLC was conducted indoors and outdoors in and around the randomly selected houses at each site each month. At each site, different houses were selected each night, at least 300 m apart, for three consecutive nights. Thus, all households were sampled in the same week each month. Catches were designed to replicate normal human subject behaviour, assuming many residents were outdoors in the early evening, and that most will retire to bed before 22.00. At each house two adults were stationed outdoors 10 m from the house, and two were stationed indoors. Outdoor collections were conducted from 6.00 pm to 9.50 pm, and indoor collections from 6.00 pm to 05.50 am. Collectors sat on chairs with their legs exposed. Using flashlights, collectors caught landing mosquitoes with a hand-held mouth aspirator and improvised test tubes and each hour’s collection were kept separately and the collectors were rotated between sites on different nights.

Preservation of Adult Malaria Vector: All adult malaria vectors collected were temporary preserved on moist filter papers in petri dishes as described by WHO (2013) and transferred to the Vector Research Department at the National Arbovirus and Vectors Research Centre (NAVRC), Enugu, Nigeria for identification and further analysis.

Larval Collection Method (LCM) of Mosquito: The larval collections were performed monthly during three consecutive days from 9:00 am to 12:00 pm. Discarded tyres, puddles, streams and river bodies, gutters, pot holes, catchment pits, containers, excavations, hoof prints, crab holes and rice fields were sampled among others. Ladles and pipettes were used to ensure that each site in the study areas was combed in the course of sourcing for mosquito larvae. Coarse debris like sticks and plant leaves that were collected alongside with the larvae were handpicked and thrown away and a sieve of 0.55 mm mesh size (kitchen sieve) was used to separate the larvae from other debris. The larvae collection was conducted covering both wet and dry seasons of the year. The reason was to ensure that mosquito populations of all possible vectors breeding in the study areas were collected through embarking on comprehensive larval sampling.

Rearing of Mosquito Larvae: Mosquito larvae collected were placed in cock plastic containers and labeled according to the site of collection, time and date collected, and then transported to the Insectary Department at the National Arbovirus and Vectors Research Centre (NAVRC), Enugu, Nigeria where they were reared to adult stages. The larvae were fed with yeast in 500 ml larval bowls covered with a transparent net. On emergence to adult stage, the mosquitoes were transferred to a mosquito cage with the aid of an aspirator and fed with a 10% sugar solution soaked in cotton wool.

Morphological Identification of Mosquito Vectors: All the mosquito vectors collected were identified and sorted out under a Stereomicroscope Leica Model NSW (Series IMNS 210). The mosquitoes were identified to species level using morphological keys of Gillies and Meillion (1968) and Gillies and Coetzee (1987).

Analysis of Data: Descriptive statistics (mean and standard deviation) was used for sample characterization. Data were subjected to one-way analysis of variance (ANOVA) and Chi-square tests using the SPSS Version 20. P-values of <0.05 was considered statistically significant.

RESULTS

The total number of mosquitoes collected in the survey was 9346. The highest number of mosquitoes were collected in Njikoka LGA 3568(38.2%), followed by Awka South and then Awka North LGAs which had 3215(34.4%) and 2563(27.4%) mosquitoes respectively (Table 1). The highest monthly collection of mosquitoes 1565(16.7%) was in the month of July, and the least 200(2.1%) was in the month of November. Mosquito collections from the three local governments and the monthly collections were significant from each other ($p<0.05$).

In Awka South LGA, out of the four mosquito collection techniques employed in the study, the LCM yielded the highest number 1450(45.1%) and the HLC had the least 446(13.9%) (Table 2). Others were CDC-LT 730(22.7%) and PKC 589(18.3%). The p-value showed that there was significant difference ($p<0.05$) in monthly collection as well as the method used in the collection.

In Awka North LGA, out of the four mosquito collection techniques employed in the study, the LCM yielded the highest number 808(31.5%) and the HLC had the least 486(19.0%) (Table 3). Others were CDC-LT 648(25.3%) and PKC 621(24.2%). The p-value showed that there was significant difference ($p<0.05$) in monthly collection as well as the method used in the collection.

In Njikoka LGA, out of the four mosquito collection techniques employed in the study, LCM yielded the highest number 1654(46.4%) and PKC had the least 513(14.4%) (Table 4). Others were CDC-LT 653(18.3%) and HLC 748(21.0%). There was significant difference ($p<0.05$) in monthly collection as well as the method used in collection.

The vector density of 741(23.1%) *Anopheles* spp., 1001(31.1%) *Aedes* spp., 817(25.4%) *Culex* spp. and 656(18.7%) *Mansonia africana* mosquitoes were collected from Awka South LGA; 851(33.3%) *Anopheles* spp., 838(32.7%) *Aedes* spp., 490(19.2%) *Culex* spp. and 377(14.8%) *M. africana* mosquitoes were collected from Awka North LGA whereas 1278 (35.8%) *Anopheles* spp., 1264 (35.4%) *Aedes* spp., 593(16.6%) *Culex* spp. and 434(12.2%) *M. africana* mosquitoes were collected from Njikoka LGA mosquitoes in the 12 months of collection (Table 5). Highest number of *Anopheles* spp. (1278) was collected from Njikoka LGA, followed by Awka North (851) and (741) in Awka South LGA (Table 6). The vector density from each month and LGA were significantly different ($p<0.05$) from each other.

The highest number of mosquito species collected in Awka South LGA was *Culex* spp. (28.6%) and the least number was *Anopheles* spp. (18.1%). In Awka North LGA, the highest number of mosquito species collected was also *Culex* spp. (31.9%) and the least number was *M. africana* (21.9%). The highest number of mosquito species collected in Njikoka LGA was also *Culex* spp. (32.0%) and the least number was *Anopheles* spp. (12.0%) (Table 7).

Table 1: Overall monthly collection of mosquitoes in the three selected Local Government Areas of Anambra State, Nigeria

Month	Awka South N(%)	Awka North N(%)	Njikoka N(%)	Total N(%)
September	223(31.5)^{e2}	111(15.7)^{c1}	374(52.8)^{i3}	708(7.6)^{f}
October	225(31.1)^{e2}	150(20.1)^{d1}	349(48.2)^{g3}	724(7.7)^{g}
November	61(30.5)^{a1}	60(30.0)^{a1}	79(39.5)^{a2}	200(2.1)^{a}
December	89(31.0)^{b1}	105(36.6)^{b3}	93(32.4)^{b2}	287(3.1)^{b}
January	189(32.4)^{d2}	267(45.7)^{g3}	128(21.9)^{d1}	584(6.2)^{d}
February	232(33.6)^{f2}	205(29.7)^{f1}	254(36.7)^{e3}	691(7.4)^{e}
March	236(30.1)^{f2}	181(23.1)^{e1}	366(46.7)^{h3}	783(8.4)^{h}
April	137(30.7)^{c2}	206(46.2)^{f3}	103(23.1)^{c1}	446(4.8)^{c}
May	304(30.6)^{g2}	429(43.2)^{j3}	261(26.3)^{f1}	994(10.6)^{i}
June	497(42.7)^{i3}	186(15.9)^{e1}	482(41.4)^{j2}	1165(12.5)^{j}
July	611(39.0)^{j3}	363(23.2)^{i1}	591(37.8)^{k2}	1565(16.7)^{l}
August	411(34.4)^{h2}	300(25.0)^{h1}	488(40.7)^{j3}	1199(12.8)^{k}
Total	3215(34.4)^{2}	2563(27.4)^{1}	3568(38.2)^{3}	9346(100)

$^{a-l}$ means on the same column with different letter superscripts are significantly different (p<0.05), $^{1-3}$ means on the same row with different number superscripts are significantly different (p<0.05)

Table 2: Monthly mosquito collection using different techniques between September 2021 and August 2022 in Awka South Local Government Area, Anambra State, Nigeria

Months	Mosquito species in Awka South LGA				Total N(%)	Mean
	PKC N(%)	HLC N(%)	LCM N(%)	CDC-LT N(%)		
September	72(32.3)^{i3}	17(7.6)^{b1}	68(30.5)^{g2}	66(29.6)^{f2}	223(100)^{e}	55.8 ± 12.9^{e}
October	123(54.7)^{l3}	38(16.9)^{g2}	38(16.9)^{c2}	26(11.6)^{b1}	225(100)^{e}	56.3 ± 22.4^{e}
November	15(24.6)^{b2}	10(16.4)^{a1}	17(27.9)^{a3}	19(31.1)^{a4}	61(100)^{a}	15.3 ± 1.9^{a}
December	13(14.6)^{a}	25(28.1)^{d}	32(36.0)^{b}	19(21.3)^{a}	89(100)^{b}	22.3 ± 4.1^{b}
January	52(27.5)^{h2}	22(11.6)^{c1}	58(30.7)^{f3}	57(30.2)^{e3}	189(100)^{d}	47.3 ± 8.5^{d}
February	41(17.7)^{g2}	36(15.5)^{f1}	83(35.8)^{h4}	72(31.0)^{g3}	232(100)^{f}	58.0 ± 11.5^{f}
March	76(32.2)^{j3}	30(12.7)^{e1}	51(21.6)^{e2}	79(33.5)^{i4}	236(100)^{f}	59 ± 11.5^{f}
April	31(22.6)^{e2}	25(18.2)^{d1}	42(30.7)^{d4}	39(28.5)^{c3}	137(100)^{c}	34.3 ± 3.9^{c}
May	20(6.6)^{c1}	35(11.5)^{f1}	172(56.6)^{j4}	77(25.3)^{h3}	304(100)^{g}	76.0 ± 34.2^{g}
June	24(4.8)^{d1}	61(12.3)^{h3}	373(75.1)^{l4}	39(7.8)^{d2}	497(100)^{i}	124.3 ± 83.3^{i}
July	37(6.1)^{f1}	86(14.1)^{i2}	360(58.9)^{k4}	128(20.9)^{k3}	611(100)^{j}	152.8 ± 71.5^{j}
August	85(20.7)^{k2}	61(14.8)^{h1}	156(38.0)^{i4}	109(26.5)^{j3}	411(100)^{h}	102.8 ± 20.3^{h}
Total	589(18.3)^{2}	446(13.9)^{1}	1450(45.1)^{4}	730(22.7)^{3}	3215(100)	
Mean	49.1 ± 9.7^{2}	37.2 ± 6.3^{1}	120.8 ± 35.8^{4}	60.8 ± 10.0^{3}		

PKC = Pyrethrum Knockdown Collection, HLC = Human Landing Catch, LCM = Larval collection method, CDC-LT = Centre for Disease Control Light Trap, $^{a-l}$ means on the same column with different letter superscripts are significantly different (p<0.05), $^{1-4}$means on the same row with different number superscripts are significantly different (p<0.05)

Table 3: Monthly mosquito collection using different techniques between September 2021 and August 2022 in Awka North Local Government Area, Anambra State, Nigeria

Months	Mosquito species in Awka North LGA				Total (%)	Mean
	PKC N(%)	HLC N(%)	LCM N(%)	CDC-LT N(%)		
September	17(15.3)^{b1}	19(17.1)^{b2}	48(43.2)^{f4}	27(24.0)^{d3}	111(100)^{c}	27.7 ± 7.1^{c}
October	30(20.0)^{e2}	60(40.0)^{i4}	40(26.7)^{d3}	20(13.3)^{b1}	150(100)^{d}	37.5 ± 8.5^{d}
November	11(18.3)^{a2}	9(15.0)^{a1}	17(28.3)^{b3}	23(38.3)^{c4}	60(100)^{a}	15.0 ± 3.2^{a}
December	27(25.7)^{d3}	22(21.0)^{c2}	39(37.1)^{c4}	17(16.2)^{a1}	105(100)^{b}	26.3 ± 4.7^{b}
January	100(37.5)^{k3}	37(13.9)^{e2}	17(6.4)^{b1}	113(42.3)^{j4}	267(100)^{i}	66.8 ± 23.5^{h}
February	35(17.1)^{f1}	36(17.6)^{e1}	60(29.3)^{g2}	74(36.1)^{h3}	205(100)^{g}	51.3 ± 9.5^{g}
March	43(23.8)^{g2}	53(29.3)^{h4}	46(25.4)^{e3}	39(21.5)^{f1}	181(100)^{e}	45.3 ± 2.9^{e}
April	51(24.8)^{h2}	46(22.3)^{f1}	62(30.1)^{h3}	47(22.8)^{g1}	206(100)^{h}	51.5 ± 3.7^{g}
May	21(4.9)^{c1}	60(14.0)^{i2}	253(59.0)^{k4}	95(22.1)^{i3}	429(100)^{l}	107.3 ± 50.9^{k}
June	120(64.5)^{l3}	28(15.1)^{d2}	10(5.4)^{a1}	28(15.1)^{e2}	186(100)^{f}	46.5 ± 24.9^{f}
July	85(23.4)^{j2}	63(17.4)^{j1}	97(26.7)^{i3}	118(32.5)^{k4}	363(100)^{k}	90.8 ± 11.5^{j}
August	81(27.0)^{i3}	53(17.7)^{g2}	119(39.7)^{j4}	47(15.7)^{g1}	300(100)^{j}	75.0 ± 16.4^{i}
Total	621(24.2)^{2}	486(19.0)^{1}	808(31.5)^{4}	648(25.3)^{3}	2563(100)	
Mean	51.8 ± 10.4^{2}	40.5 ± 5.2^{1}	67.3 ± 19.2^{4}	54.0 ± 10.6^{3}		

PKC = Pyrethrum Knockdown Collection, HLC = Human Landing Catch, LCM = Larval Collection Method, CDC-LT = Centre for Disease Control Light Trap, $^{a-l}$ means on the same column with different letter superscripts are significantly different (p<0.05), $^{1-4}$ means on the same row with different number superscripts are significantly different (p<0.05)

Table 4: Monthly mosquito collection using different techniques between September 2021 and August 2022 in Njikoka Local Government Area, Anambra State, Nigeria

Months	Mosquito species in Njikoka LGA				Total (%)	Mean
	PKC N(%)	HLC N(%)	LCM N(%)	CDC-LT N(%)		
September	55(14.7)^{i1}	98(26.2)^{h3}	136(36.4)^{g4}	85(22.7)^{j2}	374(100)^{i}	93.5 ± 16.8^{i}
October	46(13.2)^{f2}	103(29.5)^{i3}	173(49.6)^{i4}	27(7.7)^{c1}	349(100)^{g}	87.3 ± 32.8^{g}
November	14(17.7)^{b1}	22(27.8)^{c2}	31(39.2)^{a3}	12(15.2)^{a1}	79(100)^{a}	19.8 ± 4.3^{a}
December	12(12.9)^{a1}	18(19.4)^{b2}	39(41.9)^{c4}	24(25.8)^{b3}	93(100)^{b}	23.3 ± 5.8^{b}
January	18(14.1)^{c2}	15(11.7)^{a1}	45(35.2)^{d3}	50(39.1)^{f4}	128(100)^{d}	32.0 ± 9.0^{d}
February	58(22.8)^{j1}	62(24.4)^{e2}	76(29.9)^{f3}	58(22.8)^{g1}	254(100)^{e}	63.5 ± 4.3^{e}
March	51(13.9)^{h1}	96(26.2)^{g3}	148(40.4)^{h4}	71(19.4)^{h2}	366(100)^{h}	91.5 ± 20.9^{h}
April	19(18.4)^{d1}	23(22.3)^{c2}	33(32.0)^{b4}	28(27.2)^{d3}	103(100)^{c}	25.8 ± 3.0^{c}
May	25(9.6)^{e1}	130(49.8)^{j4}	59(22.6)^{e3}	47(18.0)^{e2}	261(100)^{f}	65.3 ± 22.7^{f}
June	49(10.2)^{g1}	54(11.2)^{d3}	328(68.0)^{l4}	51(10.6)^{f2}	482(100)^{j}	118.5 ± 69.9^{j}
July	85(14.4)^{l2}	65(11.0)^{f1}	325(55.0)^{k4}	116(19.6)^{k3}	591(100)^{l}	147.8 ± 60.0^{l}
August	81(16.6)^{k2}	62(12.7)^{e1}	261(53.5)^{j3}	84(17.2)^{i2}	488(100)^{k}	122.0 ± 46.6^{k}
Total	513(14.4)^{1}	748(21.0)^{3}	1654(46.4)^{4}	653(18.3)^{2}	3568(100)	
Mean	42.8 ± 7.3^{1}	62.3 ± 11.0^{3}	137.8 ± 32.4^{4}	53.8 ± 8.8^{2}		

PKC = Pyrethrum Knockdown Collection, HLC = Human Landing Catch, LCM = Larval Collection Method, CDC-LT = Centre for Disease Control Light Trap, $^{a-l}$ means on the same column with different superscripts are significantly different (p<0.05), $^{1-4}$means on the same row with different superscripts are significantly different (p<0.05)

Table 5: Identification of mosquito species and vector density in Awka South, Awka North and Njikoka LGA, between September 2021 and August 2022

Month	*Anopheles* spp. (%)	*Aedes* spp. (%)	*Culex* spp. (%)	*Mansonia africana* (%)	Total (%)
		Mosquito species in Awka South LGA			
September	58(26.0)^{h2}	48(21.5)^{c1}	57(25.6)^{e2}	60(26.9)^{h3}	223(100)^{e}
October	10(4.4)^{b1}	106(47.1)^{i4}	92(40.9)^{i3}	17(7.6)^{e2}	225(100)^{f}
November	9(14.8)^{b}	24(39.3)^{a}	19(31.1)^{a}	9(14.8)^{b}	61(100)^{a}
December	13(14.6)^{c2}	31(34.8)^{b2}	39(43.8)^{d4}	6(6.7)^{a1}	89(100)^{b}
January	4(22.8)^{a1}	94(49.7)^{g4}	38(20.1)^{c3}	14(7.4)^{d2}	189(100)^{d}
February	41(17.7)^{g2}	99(42.7)^{h4}	83(35.8)^{h3}	9(3.9)^{b1}	232(100)^{g}
March	28(11.9)^{f1}	98(41.5)^{h4}	58(24.6)f3	52(22.0)^{g2}	236(100)^{h}
April	18(13.1)^{d1}	59(43.1)^{d4}	32(23.4)^{b3}	28(20.4)^{f2}	137(100)^{c}
May	20(6.6)^{e1}	129(42.4)^{j4}	68(22.4)^{g1}	87(28.6)^{i3}	304(100)^{i}
June	124(24.9)^{i2}	91(18.3)^{f1}	131(26.4)^{j3}	151(30.4)^{k4}	497(100)^{k}
July	197(32.2)^{k3}	146(23.9)^{k2}	142(23.2)^{k2}	12(20.6)^{c1}	611(100)^{l}
August	180(43.8)^{j4}	76(18.5)^{e2}	58(14.1)^{f1}	97(23.6)^{j3}	411(100)^{j}
Total	741(23.1)^{2}	1001(31.1)^{4}	817(25.4)^{3}	656(18.7)^{1}	3215(100)
		Mosquito species in Awka North LGA			
September	36(32.4)^{f3}	43(38.7)^{d4}	5(4.5)^{a1}	27(24.3)^{e2}	111(100)^{c}
October	10(7.1)^{b1}	45(32.1)^{e3}	65(46.4)^{j4}	20(14.3)^{d2}	140(100)^{d}
November	5(8.3)^{a1}	29(48.3)^{a4}	15(25.0)^{b3}	11(18.3)^{b2}	60(100)^{a}
December	11(10.5)^{c1}	33(31.4)^{c3}	42(40.0)^{d4}	19(18.1)^{c2}	105(100)^{b}
January	104(39.0)^{h4}	86(32.2)^{i3}	43(16.1)^{d2}	34(12.7)^{g1}	267(100)^{h}
February	19(9.3)^{d1}	57(27.8)^{f3}	86(42.0)^{k4}	43(21.0)^{i2}	205(100)^{g}
March	120(66.3)^{j4}	31(17.1)^{b3}	19(10.5)^{c2}	11(6.1)^{b1}	181(100)^{e}
April	54(26.2)^{g3}	63(30.6)^{h4}	49(23.8)^{f2}	40(19.4)^{h1}	206(100)^{g}
May	174(40.6)^{k4}	143(33.3)^{l3}	50(11.7)^{h1}	62(14.5)^{j2}	429(100)^{k}
June	27(14.5)^{e3}	140(75.3)^{k4}	16(8.6)^{b2}	3(1.6)^{a1}	186(100)^{f}
July	178(49.0)^{l4}	104(28.7)^{j3}	53(14.6)^{i2}	28(7.7)^{f1}	363(100)^{j}
August	113(37.7)^{i4}	61(20.3)^{g2}	47(15.7)^{e1}	79(26.3)^{k3}	300(100)^{i}
Total	851(33.3)^{4}	835(32.7)^{3}	490(19.2)^{2}	377(14.8)^{1}	2553(100)
		Mosquito species in Njikoka LGA			
September	216(57.8)^{h3}	70(18.7)^{g2}	71(19.0)^{h2}	17(4.5)^{b1}	374(100)^{i}
October	250(71.6)^{j4}	48(13.8)^{e3}	44(12.6)^{g2}	7(2.0)^{a1}	349(100)^{g}
November	11(13.9)^{b1}	38(48.1)^{d4}	14(17.7)^{a2}	16(20.3)^{b3}	79(100)^{a}
December	12(12.9)^{b1}	28(30.1)^{a3}	33(35.5)^{d4}	20(21.5)^{c2}	93(100)^{b}
January	23(24.7)^{c1}	33(35.5)^{c2}	41(44.1)^{f3}	31(33.3)^{e2}	128(100)^{d}
February	53(20.9)^{d1}	51(20.1)^{f1}	70(27.6)^{h2}	80(31.5)^{j3}	254(100)^{e}
March	172(47.0)^{f4}	88(24.0)^{h3}	37(10.1)^{e1}	69(18.9)^{i2}	366(100)^{h}
April	8(7.8)^{a1}	32(31.1)^{b3}	29(28.2)^{c2}	34(33.0)^{f3}	103(100)^{c}
May	12(4.6)^{b1}	128(49.0)^{i4}	95(36.4)^{i3}	26(10.0)^{d2}	261(100)^{f}
June	99(20.5)^{e3}	333(69.0)^{l4}	21(4.3)^{b1}	30(6.2)^{e2}	483(100)^{j}
July	233(39.4)^{i4}	201(34.5)^{j3}	98(16.6)^{j2}	59(10.0)^{h1}	591(100)^{l}
August	189(32.0)^{g3}	214(36.2)^{k4}	40(6.8)^{f1}	45(7.6)^{g2}	488(100)^{k}
Total	1278(35.8)^{4}	1264(35.4)^{3}	593(16.6)^{2}	434(12.2)^{1}	3569(100)

$^{a-l}$ means on the same column with different letter superscripts are significantly different (p<0.05), $^{1-4}$ means on the same row for a mosquito species with different number superscripts are significantly different (p<0.05)

Table 6: Distribution of mosquito larvae collected from different breeding habitats in Awka South, Awka North and Njikoka Local Government Areas of Anambra State, Nigeria

Breeding habitats	Number of breeding sites sampled	Number of larvae collected	Mean
		Mosquito species in Awka South LGA	
Broken buckets/tins	4	68	17.0 ± 2.5^{c}
Clay pots	4	138	34.5 ± 4.9^{g}
Domestic containers	5	273	54.6 ± 11.3^{j}
Ground pools	4	172	43.0 ± 12.7^{h}
Reservoir tanks	2	58	29.0 ± 9.0^{f}
Used tyres	4	83	20.8 ± 3.7^{d}
Crab holes	2	51	25.5 ± 6.5^{e}
Catchment pits	4	306	76.5 ± 21.4^{k}
Rivers and streams	3	156	52.0 ± 13.9^{i}
Gutters	4	71	17.8 ± 5.1^{c}
Pot holes	3	49	$16.3 \pm 7.0^{\mathbf{b}}$
Excavations	4	25	6.3 ± 3.5^{a}
Total	43	1450	33.7 ± 4.12
		Mosquito species in Awka North LGA	
Broken buckets/tins	3	48	16.0 ± 2.4^{e}
Clay pots	3	40	13.3 ± 2.6^{d}
Domestic containers	3	10	3.3 ± 0.9^{a}
Ground pools	5	253	50.6 ± 16.7^{j}
Reservoir tanks	3	17	5.7 ± 0.3^{b}
Used tyres	2	60	30.0 ± 2.0^{h}
Crab holes	2	46	23.0 ± 3.0^{g}
Catchment pits	4	97	24.3 ± 5.5^{g}
Rivers and streams	3	119	39.7 ± 4.3^{i}
Gutters	4	52	13.0 ± 3.1^{d}
Pot holes	2	39	19.5 ± 9.5^{f}
Excavations	3	27	9.0 ± 4.16^{c}
Total	37	808	21.8 ± 3.01
		Mosquito species in Njikoka LGA	
Broken buckets/tins	2	98	49.0 ± 5.0^{f}
Clay pots	3	173	57.7 ± 7.8^{h}
Domestic containers	4	128	32.0 ± 6.5^{d}
Ground pools	3	159	53.0 ± 9.5^{g}
Reservoir tanks	4	45	11.3 ± 1.4^{a}
Used tyres	3	76	25.3 ± 7.2^{b}
Crab holes	3	148	49.3 ± 6.4^{f}
Catchment pits	5	225	45.0 ± 12.7^{e}
Rivers and streams	4	261	65.3 ± 14.9^{i}
Gutters	3	101	33.7 ± 5.0^{d}
Pot holes	4	129	32.3 ± 5.6^{d}
Excavations	4	111	27.8 ± 8.04^{c}
Total	42	1654	39.4 ± 3.29

$^{a-l}$ *means on the same column with different letter superscripts are significantly different (p<0.05)*

Table 7: Mosquito larvae species identified from larvae collected from different breeding habitats in Awka South, Awka North and Njikoka Local Government Areas of Anambra State, Nigeria

Breeding habitats	*Anopheles* spp. (%)	*Aedes* spp. (%)	*Culex* spp. (%)	*Mansonia africana* (%)	Total (%)
		Mosquito species in Awka South LGA			
Broken buckets/tins	50(35.0)^{h3}	21(14.7)^{d2}	61(42.7)^{f4}	11(7.7)^{b1}	143(39.5)^{g}
Clay pots	6(8.1)^{b1}	31(41.9)^{e4}	22(29.7)^{c3}	15(20.2)^{c2}	74(23.3)^{b}
Domestic containers	45(23.7)^{g1}	48(25.3)^{i2}	44(23.2)^{e1}	53(27.9)^{h3}	190(39.7)^{h}
Ground pools	7(9.3)^{b1}	17(22.7)^{b2}	22(29.3)^{c3}	29(38.7)^{e4}	75(35.9)^{b}
Reservoir tanks	19(21.3)^{e2}	21(23.6)^{d3}	40(44.9)^{d4}	9(10.1)^{a1}	89(38.5)^{d}
Used tyres	17(13.1)^{d1}	35(26.9)^{f2}	61(46.9)^{f3}	17(13.1)^{d1}	130(26.8)^{e}
Crab holes	11(7.7)^{c1}	62(43.7)^{k4}	20(14.1)^{b2}	49(34.5)^{g3}	142(48.9)^{g}
Catchment pits	53(24.5)^{i3}	49(22.7)^{j2}	44(20.4)^{e1}	70(32.4)^{j4}	216(49.9)^{i}
Rivers and streams	12(9.3)^{c1}	19(14.7)^{c2}	63(48.8)^{g4}	35(27.1)^{f3}	129(41.5)^{e}
Gutters	18(20.9)^{d2}	41(47.7)^{g3}	10(11.6)^{a1}	17(19.8)^{d2}	86(38.6)^{c}
Pot holes	22(15.6)^{f2}	43(30.5)^{h3}	19(13.5)^{b1}	57(40.4)^{i4}	141(52.2)^{f}
Excavations	3(8.6)^{a1}	12(34.3)^{a3}	9(25.7)^{a2}	11(31.4)^{b3}	35(11.6)^{a}
Total (%)	263(18.1)^{1}	399(27.5)^{3}	415(28.6)^{4}	373(25.7)^{2}	1450(37.1)
		Mosquito species in Awka North LGA			
Broken buckets/tins	33(45.8)^{h4}	12(16.7)^{e2}	8(11.1)^{b1}	19(26.4)^{g3}	72(19.9)^{f}
Clay pots	18(20.9)^{e2}	41(47.7)^{h3}	10(11.6)^{c1}	17(19.8)^{f2}	86(27.1)^{g}
Domestic containers	23(21.7)^{g2}	39(36.8)^{g4}	18(17.0)^{e1}	26(24.5)^{h3}	106(22.1)^{h}
Ground pools	10(20.8)^{d2}	19(39.6)^{f3}	8(16.7)^{b1}	11(22.9)^{d2}	48(23.0)^{e}
Reservoir tanks	8(18.6)^{c1}	7(16.3)^{c1}	21(48.8)^{f2}	7(16.2)^{b1}	43(18.6)^{d}
Used tyres	21(12.7)^{f2}	9(5.4)^{d1}	109(65.7)^{h4}	27(16.3)^{h3}	166(34.2)^{j}
Crab holes	3(12.5)^{b1}	5(20.8)^{b1}	4(16.7)^{a1}	12(50.0)^{d2}	24(8.2)^{b}
Catchment pits	45(31.7)^{i2}	48(33.8)^{i3}	44(31.0)^{g2}	5(3.5)^{a1}	142(32.8)^{i}
Rivers and streams	3(8.1)^{b1}	9(24.3)^{d2}	11(29.7)^{c3}	14(37.8)^{e4}	37(11.9)^{c}
Gutters	9(37.5)^{d3}	2(8.3)^{a1}	4(16.7)^{a2}	9(37.5)^{c3}	24(10.8)^{b}
Pot holes	7(14.9)^{c2}	5(10.6)^{b1}	16(34.0)^{d3}	19(40.4)^{g4}	47(17.4)^{e}
Excavations	0(0.0)^{a1}	3(23.1)^{a2}	5(38.5)^{a3}	5(38.5)^{a3}	13(4.3)^{a}
Total (%)	180(22.3)^{2}	199(24.6)^{3}	258(31.9)^{4}	171(21.9)^{1}	808(20.7)
		Mosquito species in Njikoka LGA			
Broken buckets/tins	11(7.5)^{c1}	24(16.3)^{b2}	63(42.9)^{g4}	49(33.3)^{i3}	147(46.4)^{h}
Clay pots	16(10.2)^{d1}	42(26.8)^{g3}	20(12.7)^{d2}	79(50.3)^{k4}	157(49.5)^{i}
Domestic containers	41(22.4)^{h2}	33(18.0)^{e1}	62(33.9)^{g4}	47(25.7)^{h3}	183(38.2)^{j}
Ground pools	18(20.9)^{e2}	41(47.7)^{g3}	10(11.6)^{a1}	17(19.8)^{b2}	86(41.1)^{c}
Reservoir tanks	23(23.2)^{f2}	29(29.3)^{c3}	42(42.4)^{f4}	5(5.1)^{a1}	99(42.9)^{d}
Used tyres	12(6.3)^{c1}	39(20.6)^{f3}	119(63.0)^{i4}	19(10.1)^{c2}	189(41.3)^{k}
Crab holes	9(7.2)^{b1}	71(56.8)^{i4}	12(9.6)^{b2}	33(26.4)^{f3}	125(43.0)^{f}
Catchment pits	7(9.3)^{a1}	17(22.7)^{a2}	22(29.3)^{e3}	29(38.7)^{e4}	75(17.3)^{a}
Rivers and streams	6(4.1)^{a1}	24(16.6)^{b2}	71(49.0)^{h4}	44(30.3)^{g3}	145(46.6)^{g}
Gutters	23(20.4)^{f2}	46(40.7)^{h4}	15(13.3)^{c1}	29(25.7)^{e3}	113(50.7)^{e}
Pot holes	6(7.3)^{a1}	31(37.8)^{d3}	22(26.8)^{e2}	23(28.0)^{d2}	82(30.3)^{b}
Excavations	33(13.0)^{g1}	89(35.2)^{j4}	71(28.1)^{h3}	60(23.7)^{j2}	253(84.1)^{l}
Total (%)	198(12.0)^{1}	486(29.4)^{3}	529(32.0)^{4}	434(26.2)^{2}	1654(42.3)

$^{a-l}$ means on the same column with different letter number superscripts are significantly different (p<0.05), $^{1-4}$ means on the same row for a mosquito species with different number superscripts are significantly different (p<0.05)

DISCUSSION

A total of 9346 mosquitoes were collected in the present study from all the study areas in Anambra State, Nigeria from September 2021 to August, 2022. Njikoka LGA accounted for the highest 3568 (38.2%) percentage of mosquitoes whereas Awka South and Awka North had 3215 (34.4%) and 2563(27.4%) mosquito catching rate respectively. The reason for this high vector density could be for the long duration of twelve months spent in the collection of mosquitoes. Also the different collection methods (PKC, HLC, LCM and CDC-LT) used in the present study may also account for the high number of mosquitoes collected. According to the month of collection, the highest monthly collection of mosquitoes 1565(16.7%) was in the month of July which corresponds to the wet season of the year, and the least number of mosquitoes 200(2.1%) was in the month of November which corresponds with the dry season of the year. It is on record that there was a high prevalence of mosquitoes in the wet season than in the dry season as has been earlier reported by Egwu *et al*. (2018) in Ohafia, Abia State, Nigeria. This is because rainfall creates water collections and flood pools which increase the numbers of favourable breeding sites for mosquitoes (Mbanugo and Okpalaononuju, 2003). Also, Onyido *et al*. (2009) observed that mosquito populations in a tropical zoological garden in Enugu, south-eastern Nigeria were least in the dry seasons because most of the larval breeding sites were dried up.

In the contrary, Okorie *et al*. (2014) reported that mosquito populations in Ibadan, Southwestern Nigeria were more abundant during the dry months of December, January and February than the wet months of March, April, May, June and July. Their study showed that mosquito abundance was inversely related with rainfall but not with temperature and relative humidity. Mosquito abundance have been reported to have positive relationship with rainfall and inverse relationship with temperature in Umuowa Ibu in Okigwe LGA, Imo State, Nigeria (Uttah *et al*., 2013). Studies in Abeokuta, South west Nigeria showed that mosquito abundance increased as the season progressed from January with a drastic decline between June and July (Alaii *et al*., 2003). Some studies in Nigeria have also recorded a dominance of mosquito species during the wet season than during the dry season (Olayemi and Ande, 2008; Oduola *et al*., 2013; Uttah *et al*., 2013). Since the major breeding site for the mosquitoes in the area was the stream polluted with dung and damaged drainage systems or run-off areas, the heavy rainfall might have flushed larvae and eggs from their breeding sites. Njikoka LGA which recorded the highest population of mosquito 3568 (38.2%) may be as a result of the baseline study done across Anambra State in 2010 and various intervention tools engaged which include; LLINs and IRS that was deployed in Anambra State to control malaria vectors in Awka South and Awka North but wasn't done in Njikoka LGA particularly in Enugwu Agidi which was where the sampling site was located for the LGA.

Different mosquito collection techniques were engaged in the present study. The Chi-square analysis also showed that there was a significant difference in monthly collection as well as method used in the collection in Njikoka LGA. Larval mosquitoes were the most abundant mosquitoes types collected from the three LGA. These results were in line with the study done by Onyido *et al*. (2014) who recorded a total of 329 mosquitoes in Abagana community of Anambra State, Southeastern Nigeria, where 177(53.79%) were larvae and 152(46.20%) were adults. This also corroborated with earlier findings of Onyido *et al.* (2009) on mosquito populations in a tropical zoological garden in Enugu, Nigeria. The difference in the numbers of adults and larvae collected may be attributed to the spatial distribution of the different stages. The larvae and other immature stages of mosquitoes live in aggregated colonies in varying volumes of stagnant water and can be collected with one scoop of the bowl in their habitats. The adults on the other hand are highly dispersed and fly scattered in the air, their entry into the houses depended solely on their physiological state of hunger and preference for human blood which attracts them inside the houses (Aribodor *et al*., 2011; Onyido *et al*., 2014).

The vector density observed from the study showed that Anopheline species alongside with other genera were present almost throughout the year both at the larval and adult stage. These findings were in agreement with the reports of Afolabi *et al.* (2019) where a total number of 2940 mosquitoes belonging to four genera were collected in Akure South LGA, Ondo State, Nigeria, and these larvae were distributed among four mosquito genera. The genera were *Aedes, Anopheles, Culex* and *Toxorhynchites.* Out of the total larvae population (2940), 714 larvae belong to the genus *Aedes,* 52 larvae belong to genus

Anopheles, 2151 larvae to the genus *Culex,* and 23 larvae were identified in the genus *Toxorhynchites*. Generally, it was observed from the present study that Njikoka LGA had the high relative abundance of mosquitoes, and is an area with high anthropogenic activities such as market where there is high density of peridomestic containers such as plastics and cans. These peridomestic containers serve as habitats for mosquito breeding especially during the raining season. In contrary, locations such as Awka South where low relative abundance was recorded is noted for fair drainage system, sanitation and semi-organized structures. These factors may have contributed to low density of mosquito obtained in these areas. In addition, the significant difference of mosquito density across the locations may have been as a result of the disparity in social and economic activities within the locations that would encourage or discourage mosquito breeding (Adebote *et al*., 2006). Hence, areas with high anthropogenic activities may have high population density of mosquitoes, while areas with low anthropogenic activities may have low population density of mosquitoes.

From the survey, a total number of 3912 mosquito larvae were collected in all the study areas. The number collected in the present study was higher than that of Eze *et al*. (2018), who reported 1,180 mosquito larvae in Obi-Akpor, Rivers State, Nigeria, Egwu *et al*. (2018) who recorded 2,641 larvae in Ohafia, Abia State,Nigeria and Okonkwo *et al*. (2014) who collected 2,319 larvae in Oba, Anambra State, Nigeria. A significantly higher number of larvae 4,256 larvae were collected by Afolabi *et al*. (2013) in Akure, Ondo State, Nigeria and 4,871 larvae by Dalhatu *et al*. (2016) in Azare, Bauchi State, Nigeria. The differences in the number of mosquito larvae collected in the different areas may depend on the period of the year and length of the period of the studies as was the case in this present study. Also other factors responsible for abundance of larval mosquitoes such as poor sanitation, poor environmental management and availability of breeding sites may abound in these areas. Assorted types of mosquitoes breeding habitats ranging from broken buckets/tins, clay pots, domestic containers, ground pools, reservoir tanks, used tyres, crab holes, catchment pits, small rivers and streams, gutters, pot holes and excavations were explored in the study area. Similar types of breeding sites were reported in different studies from Nigeria (Dalhatu *et al*., 2016; Egwu *et al*., 2018; Ekedo *et al*., 2020) This observation was in agreement with the findings of Mbanugo and Okpalaononuju (2003) who reported that the preponderance of mosquitoes in Awka metropolis was due to the abundance of mosquito breeding habitats in the area. These various sites identified, collect and hold water that forms the breeding sites for mosquitoes especially during the wet season. Also, Irikannu and Chukwuekezie (2015) also reported that in Nigeria and most developing countries, the urban landscapes were often littered with garbage, plastic and tin cans, bottles, disposable cups, discarded vehicle tyres and earthen wares which form breeding grounds for mosquitoes especially during the wet season. In the present study the highest number of mosquito larvae 628(16.1%) were collected from catchment pits, while the least 120(3.1%) were collected from reservoir tanks. Catchment pits retain sewage water throughout the year and mosquito species such as *Culex* spp. continue to breed in them even during the dry season when other sites have dried up. Mafiana *et al*. (1998) reported that *Culex quinquefasciatus* has preference for polluted water. Thus their breeding in catchment pits was justifiable. Okoye *et al.* (2023) reported that in Nigeria which Anambra State is part of it, there are higher breeding rates of mosquito vectors due to the rainfall patterns of the area and the amount of rainfall positively correlates with the abundance of mosquito breeding sites.

As observed in the present study, *Anopheles* spp. like other species was found to breed in all the habitats as against former the notion that they only breed in clean water. In Awka South LGA, Awka North LGA and Njikoka LGA, *Anopheles gambiae* s. l. collected were 263-(18.1%), 180(22.3%) and 198(12.0%) respectively from diverse breeding habitats ranging from broken buckets/tins, clay pots, Domestic containers, ground pools, reservoir tanks, used tyres, crab holes, catchment pits, rivers and streams gutters, pot holes and excavations. This indicated that larval mosquitoes were not evenly distributed across all the communities. The major factors that influence the uneven distribution may be the availability of breeding sites and the nature of the settlements of the inhabitants in the different communities. Simon-Oke *et al.* (2012) reported that mosquito distribution and abundance were related to population, land use and human activities. Also, Afolabi *et al*. (2013) suggested that anthropogenic related factors such as open drainage systems contribute to the increasing abundance of mosquitoes in the breeding sites in highly developed and populated area such as was observed in Awka South and Awka North LGA in this study. Therefore rural community such as Njikoka LGA that has no such open drainage system and has fewer inhabitants had less number of mosquitoes breeding in their area.

Conclusion: The persistent occurrence and distribution of *Aedes, Culex*, and *Anopheles* species in the present study pose a serious epidemiological concern to the inhabitants of Awka South, Awka North and Njikoka LGAs of Anambra State. Therefore, public enlightenment on vector control is of paramount importance in these LGAs. The abundance of mosquito depends largely on a number of environmental factors including the availability of breeding sites. The four mosquito species (*Aedes, Anopheles, Culex*, and *Mansonia*) in Awka South, Awka North and Njikoka LGAs of Anambra State are well-known vectors of parasites and help in transmission of diseases such as yellow fever, malaria, and filariasis. All these diseases are associated with high morbidity and mortality. Recently, resurgence of yellow fever has been reported in some part of Nigeria and this suggests that a sustainable public health campaign on vector management and control should be intensified in Nigeria. The lack of adequate sanitary conditions in the study area could be blamable for the large number of mosquitoes collected in the survey therefore health education could help in sensitizing the inhabitants on the public importance of the mosquito species.

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