Species Composition and Biting Activities of Mosquitoes in a Selected Community in Anambra State, Southeast Nigeria

ABSTRACT

Mosquitoes are common biting and sucking arthropods whose females bite man and animals for their blood meal which leads to itching and causes diseases. The study investigated the species composition and biting activities of mosquitoes at Ifite-Awka, Awka South Local Government Area, Anambra State, south east Nigeria. The study was carried out between November and December, 2021 and the mosquitoes were collected using the Human Landing Catch (HLC) and Pyrethrum Spray Collection Method (PSC), whereas Larval Sampling (LS) method was used to collect the immature stages of mosquito. The HLC was carried out from 5:00pm to 8:00pm and the biting peak

was observed from 5:45pm to 7:00pm. A total of 158 adult mosquitoes were collected which comprised of 3 species namely *Culex quinquefasciatus*, *Anophles gambiae* and *Mansonia africana*. *Culex quinquefasciatus* was the most abundant species irrespective of the method of collection which was attributed to their anthropohilic, endophagic and endophilic nature. Pyrethrum Spray Collection method (PKC) produced the highest species of 120 mosquitoes which constitute of 75.83% (91/158) *Culex quinquefasciatus*, 22.5% (27/158) *Anopheles gambiae* and 1.66% (2/158) *Mansonia africana*. The HLC method caught mosquitoes of two different species which was *Culex quinquefasciatus* 89.29% (25/28) and *Mansonia africana* 10.71% (3/28). The Larval Sampling method caught 10 *Culex quinquefasciatus*. Although there was no significant difference among the methods of collection ($p>0.05$), but in the distribution of the mosquitoes species, there was a significant difference ($p<0.05$) among the seven (7) lodges sampled. The study observed high exposure to mosquitoes and the possibility of epidemics of mosquito - borne diseases among Ifite-Awka residents. The need for proper health education, immediate and effective control measures of the mosquito vectors, which includes environmental sanitation is highly advised.

Keywords: Biting activities; specie composition; mosquitoes; Anambra State.

1. INTRODUCTION

Mosquitoes are common biting and sucking arthropods that belong to the class Insecta, Order Diptera and Family Culicidae. They are the world's deadliest animals [1] and are distributed worldwide where they are found in both aquatic and terrestrial habitats [2]. Mosquitoes undergo complete metamorphosis consisting of egg, larva, pupa and adults and the female mosquitoes bite people and animals for their blood meal [3]. These blood meals are necessary to produce eggs. When people or animals are bitten by mosquitoes, it commonly leads to itching and swelling [4]. Mosquitoes have a slender, elongated body covered with scales. The body is divided into three (3) parts namely, Head, thorax and abdomen. The head contains an elongated piercing mouthparts with which they bite and feed from their hosts [5]. Mosquitoes are distinguished from other flies by their long proboscis, characteristic wing venation and scales on the wing. The male mosquitoes can be differentiated from the female mosquitoes by their form of antennae. The male antennae are very plumose while the female antennae have few hairs. There are over 3500 species of mosquitoes [6] of 112 genera. The most important man-biting mosquitoes of these species belong to the genera; *Mansonia, Haemagogus, Sabethes and Psorophora* [7]. Studies from Nigeria have revealed various species of mosquitoes from three (3) genera [8,9]. These genera are *Anopheles, Culex* and *Aedes. Anopheles* mosquitoes are distributed worldwide and can be found in both tropical and temperate regions. *Anopheles* mosquitoes go through the four stages of their life cycle: egg, larva, pupa and adult. The first 3 stages are aquatic and last 7-14 days [4]. They lay their eggs singly and float on water surface with the aid of air filled floats [10]. The larva lie parallel to the water surface due to the absence of siphon. Most *Anopheles* mosquitoes have spotted wings. Malaria and lymphatic filariaris (LF) are primarily transmitted by *Anopheles* mosquitoes [11] whereas recent studies have identified *Anopheles gambiae* and *Anophelses funestus* as the main vectors of these diseases [12]. *Culex* mosquitoes are distributed worldwide except in the extreme northern parts of the temperate regions. They undergo the four stages of their life cycle: egg, larva, pupa and adult. The life cycle takes about 7-10 days. The adult mosquito measures from 4- 10 mm [13]. The eggs are laid one at a time and stick together to form of raft of 100 to 300 eggs [4]. The rafts floats in water. The larvae live in water and are very active shedding their skin severally at this stage [14]. *Culex* mosquitoes are the most widespread mosquito species and contain about 1000 species [15]. These species serve as vectors of important diseases of birds, humans, and other animals [16]. *Aedes* mosquitoes originated in Africa [17] but is now found in tropical, sub-tropical and temperate regions throughout the world. *Aedes* mosquitoes have distinctive white markings on the leg and on the thorax [16]. There are approximately 190 species of *Aedes* mosquitoes [16]. *Aedes* mosquitoes undergo the four stages of their life cycle: egg, larva, pupa and adult. They only need a small amount of water to lay eggs. The eggs look like black dirt and stick to the container walls like glue. They can stay up to 8 months depending on environmental conditions without drying out [18]. The larvae have four instar stages. The adults emerge from seven days to several weeks after egg hatching and

has a narrow black body [19]. *Aedes* mosquitoes feed during the day [20] with peak feeding activities between dawn and dusk [19]. Many of the species prefer to feed outdoor though some still prefer to live close to humans and lay their eggs indoors [19]. Mosquitoes serve as vector of diseases. Three (3) main genera of mosquitoes which includes *Aedes, Culex* and *Anopheles* transmit the causative agents of various diseases to man and animals [21]. Malaria is the most important characteristic disease of man currently endemic in about 80 countries and transmitted by Anopheles mosquitoes [22]. Malaria is caused by the parasite, *Plasmodium*. There are about 430 species of *Anopheles species* of which only 30-40 commonly serve as vectors of malaria to humans [23]. Mosquitoes also serve as vectors of Lymphatic filariasis. Lymphatic filariasis is endemic in 50 countries and is caused by filarial parasites *Wuchereria bancrofti, Brugia malayi or Brugia timori* [11]. The genera of mosquito that transmit the parasites depend on the geographically location (CDC, 2018). The most common vector in Africa is *Anopheles* (CDC, 2018) though *Culex* has been reported as a vector of Mosquito in Africa (Ughasi et al. 2021). In America, the parasites are transmitted by *Culex* mosquitoes (CDC, 2018) while in the Pacific and Asia, it is transmitted by *Aedes* and *Mansonia* (CDC, 2018). The breeding sites of mosquitoes are increased by abundant rainfall and human activities such poor sanitation, and indiscriminate rate of waste disposal. For effective reduction of mosquito breeding sites and control strategies, the knowledge of the bionomics of mosquitoes is essential [24]. For instance, knowledge of a biting activity of mosquito at night will lead to the use of repellant or protective collecting. These control methods resulting from bionomics knowledge are grouped into chemical, biological, mechanical, and environmental control methods. Various Mosquito control interventions have been implemented in various regions though with varying successes [25,26]. There is also need for health education, sensitization, and adequate policies to improve environmental sanitation for effective control of mosquitoes.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Ifite Awka, Awka South Local Government Area. Awka being the capital city of Anambra state, Nigeria is located at 199.1km by road. Ifite Awka is located geographically in Awka-South, Anambra state Nigeria. The geographical coordinates of the area are 6°15N, 7°5E and 150m above sea level. Ifite Awka lies below 300m above sea level in a valley on the plains of the Manu River. Ifite Awka is sited in a fertile tropical valley and being in the tropical rainforest zone of Nigeria they experience both the rainy and dry seasons. The temperature is generally 27℃-30℃ between June and December but rises to 32℃-34℃ between January and April, with the last few months of the dry season marked by intense heat. The area is densely populated by staff and students of Nnamdi Azikiwe University (NAU) as well as public servants who live in and around commissioner's quarter's axis due to its proximity to the Anambra State Government. The villages that made up of Ifite-Awka are Enu-Ifite, Ezinato-Ifite and Agbada-Ifite (Wikipedia, 2021).

2.2 Study Design

Simple Random Sampling design was used in the study. Each of the lodges sampled were randomly selected to represent all the lodges in Ifite Awka, Awka South L.G.A., Anambra State.

2.3 Sampling Techniques

The sampling techniques used was Human landing catch method (used to collect the outdoor biting mosquitoes), Pyrethrum Spray Collection method (used to collect the indoor resting mosquitoes), larval sampling (used to collect the immature stages of mosquitoes and subsequently reared to Adults).

2.3.1 Indoor collection of adult mosquitoes

This was achieved using pyrethrum Spray Collection Method (using BNC mosquito insecticides, the active ingredients include; Esbiothrin: 0.26%, Permethrin: 0.28%, Beta-Cypermethrin: 0.1% and LEMON: 0.31% which is less toxic to humans). The collections were made in the early hours between 6:00am-8:00am rooms where at least one person slept the previous night, was chosen randomly for the exercise as described by Okorie et al. [27]. When entering the rooms; the windows and doors were properly closed to avoid the escape of the insecticides, spaces were made in the room to be able to cover all the edges of rooms and a white cloth sheets measuring 12m×12m were used to cover the floor of each room. The white cloth sheets were covered properly to avoid escape of mosquitoes. The rooms were left for

15 to 20mins to allow the insecticides sufficient time to knock down the mosquitoes. After 15-20mins the doors and windows were opened; carefully entered the room. The white sheets were then folded starting from the edges and with gentle jerking to ensure that all fallen mosquitoes were collected with an entomological forceps into a damp Petri dish prepared with cotton wool soaked in ethyl acetate and covered with filter paper as described by Onyido et al. [28].

2.3.2 Outdoor collection of adult mosquitoes

These were collected on human volunteers and research participants who gave informed consent to be part of the study. Human Landing Catch (HLC) was used in this study. All catches were recorded between 5:00pm to 8:00pm. Mosquitoes are attracted to odor and carbon dioxide emitted from human body by the help of their palms. All the human volunteers were short skirts and knickers with sleeves shirts and singlet to expose the hands and legs to bites from mosquitoes. The volunteers sat on a low stool with 10m apart from each other and carefully, gently and consistently with patience searches for alighting mosquitoes all over their bodies when the mosquitoes would have come for blood meals. The alighting mosquitoes on their bodies were allowed to settle before being collected with test tube and sealed with balls of damped cotton wools oaked with 70% Ethanol. The time and place of each collection were recorded subsequently.

2.3.3 Collection of immature stages of mosquitoes

Mosquito larvae and pupae were collected from different mosquito breeding sites such as ground water pools, stills and standing water, discarded tins, polluted water in gutters around homes, puddles made from vehicles. The eggs of mosquitoes were seen together in form of rafts. The immature stages of mosquitos' collections were done between 10:00am-12pm as described by Onyido et al. [29].

2.3.4 Rearing of immature stages of mosquitoes

The mosquito larvae and pupae collected were reared into adult mosquitoes. The collected larvae were placed in white small bowl covered with nets and reared in the insect rearing cage which served as the insectary. The larvae were fed with a mixture of yeast and biscuits. The adults that emerged from th e larvae were fed with glucose solution as described by Ekwebene et al. [30].

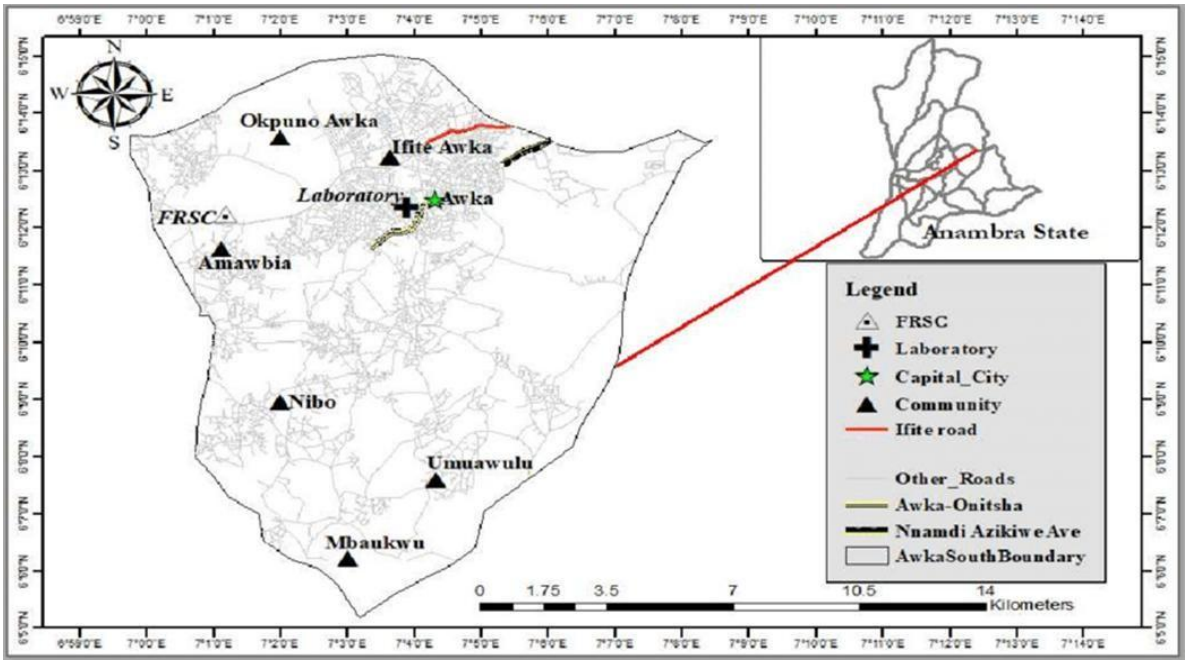


Fig. 1. Map of Ifite Awka, Awka South Local Government Area, Anambra State, Nigeria
Source: Norris D.E. (2004)

2.3.5 Identification of the collected mosquitoes

All the adult mosquitoes reared from the larvae or collected through indoor and outdoor collections methods were transported to the Laboratory Unit of the Department of Parasitology and Entomology, Nnamdi Azikwe University Awka for proper Identification. The mosquitoes were identified to the specie level using morphological keys as described by Service [10], Gillett [31] and Hopkins [32].

2.4 Analysis of Data

Data obtained from the study was summarized using Tables. Test of statistical significance at 5% levels was done. Analysis of variance (ANOVA) and Chi Square were used to compare the species composition of different mosquito genera and species in the study area.

3. RESULTS AND DISCUSSION

3.1 Results

A total of 158 mosquitoes were collected from the study area, 7.94% were collected at the immature stage whereas the rest were collected as adults mosquitoes. These adult mosquitoes were collected through human Landing catch and pyrethrum Spray Collection Method (for indoor resting collection). A total of 17.72% were collected through human Landing catch which consists of *Culex quinquefasciatus* and *Mansonia africana*. Whereas 75.95% mosquitoes were collected from Pyrethrum Spray Collection method which are made up *Culex quinquefasciatus*, *Anopheles gambiae* and *Mansonia Africana.*

The Table 1 shows the composition of mosquitoes species collected from various methods of sample collection, However, analysis of variance shows no significant difference in the three methods of mosquitoes collection (ANOVA $P>0.05$).

The Fig. 2 shows the quarterly biting time of mosquitoes in outdoor locations using human bait collection method. The peak biting of *Culex quinquefasciatus* which is the most predominant is between 6:00pm to 7:00pm.

The Fig. 3 shows the quarterly biting time of all mosquitoes collected in the biting area. Mosquitoes were between 5:00pm to 8:00pm. The quarterly peak biting time is 5:45pm-7:00pm (Fig. 3).

This Table 2 the number of mosquitoes species collected indoor both the male and female. *Culex quinquefasciatus* is the most predominant with 91(75.83%) whereas *Mansonia africana* was the least the least prominent at (1.66%).

It was observed that *Culex quinquefasciatus* was the most predominant with 116 (78.38%). However, statistical analysis of variance (ANOVA $P<0.05$) showed a significant difference in the distribution of mosquitoes species within the lodges.

3.2 Discussion

One hundred and fifty-eight (158) mosquitoes were collected in the study area and three (3) species of mosquito which includes *Culex quinquefasciatus, Anopheles gambiae and Mansonia Africana* were recorded. These are the most dominant species of mosquito in Nigeria as they have been reported in the researches of Okorie et al. [27], Joseph et al. [33], Omoregie et al. [34] and Umeanaeto et al. [35]. They are also vector borne diseases of economic importance as was reported by Okorie et al. [27] and Umaru et al. [36]. All the mosquitoes collected through larval samplings were that of *Culex quinquefasciatus* and were from polluted water in gutters. This is similar to the report of the research of Okoye et al. 2020 who recorded that *Culex* species were found to breed in polluted groundwater pools. *Culex quinquefasciatus* was the most abundant specie accounting for 79.75% of the total mosquitoes collection. This corresponds to the research of Yayock et al. [37] and Ajao et al. [38] which reported a high abundance of *Culex species* in their study.

The study indicated a high survival and fecundity rate of *Culex quinquefasciatus* due to its high indoor resting density of 75.83% collaborating with the research of Irikannu et al. [39] who reported almost the same. The predominance of *Culex quinquefasciatus* over *Anopheles gambiae* and *Mansonia africana* mosquitoes at the area may be associated to the dry seasons of collections. This was in line with the report of Umeanato et al. [35] in their study which could be as a result of presence of large blocked drainage with very dirty stagnant water, ground collections of dirty water, and soak-away pits among others which serve as a breeding grounds. The

Table 1. Identification of mosquitoes species in Ifite-Awka, Awka South L.G.A, Anambra State

Mosquito species	Human Landing catch	Larva sampling	Pyrethrum Spray Collection	Total (%)	Mean±S.E
Culex quinquefaciatus	25(19.84%)	10(7.94%)	91(72.22%)	126(79.75%)	42.0±24.8
Anopheles gambiae	0	0	27(100.0%)	27(17.09%)	9.0±9.0
Mansonia Africana	3(60.0%)	0	2(40.0%)	5(3.16%)	1.6±0.9
Total	28(17.72%)	10(6.33%)	120(75.95%)	158(100%)	17.5±9.8
Mean±S.E	9.3±7.8	3.3±3.3	40.0±26.5	17.5±9.8	

Table 2. Mosquito species collected indoors at Ifite-Awka, Awka South L.G.A, Anambra State

Mosquito species	Number of females	Number of males	Total	% collected
Culex quinquefaciatus	20	7	27	22.5
Anopheles gambiae	78	13	91	75.83
Mansoni africana	2	0	2	1.66
Total	102(85%)	18(15%)	120	100

Table 3. Distribution of Mosquitoes Species within Seven lodges representing in Ifite Awka, Awka South L.G.A, Anambra State

Mosquito species	Favour lodge	Justice court	Emeka Akaigwe	El glory	Our Lady's hotel 3	Thank God	Next Level	Total	Mean ±S.E
Culex quinquefaciatus	25 (21.55)	11 (9.48)	17 (14.66)	7 (6.03)	22 (18.97)	21 (18.10)	13 (11.21)	116 (78.38)	16.5±2.4
Anopheles gambiae	10 (37.04)	0	10 (37.04)	0	7 (25.93)	0	0	27 (18.24)	3.8± 1.8
Mansoni africana	2 (40.0)	0	3(60.0)		0	0	0	5 (3.38)	0.7± 0.4
Total	37 (25.0)	11 (7.4)	30 (20.3)	7 (4.7)	29 (19.6)	21 (14.2)	13 (8.7)	148 (100)	7.0± 1.8
Mean±S.E	12.3± 6.7	3.6± 3.6	10.0± 4.0	2.3± 2.3	9.6± 6.4	7.0± 7.0	4.3± 4.3	7.0± 1.8	

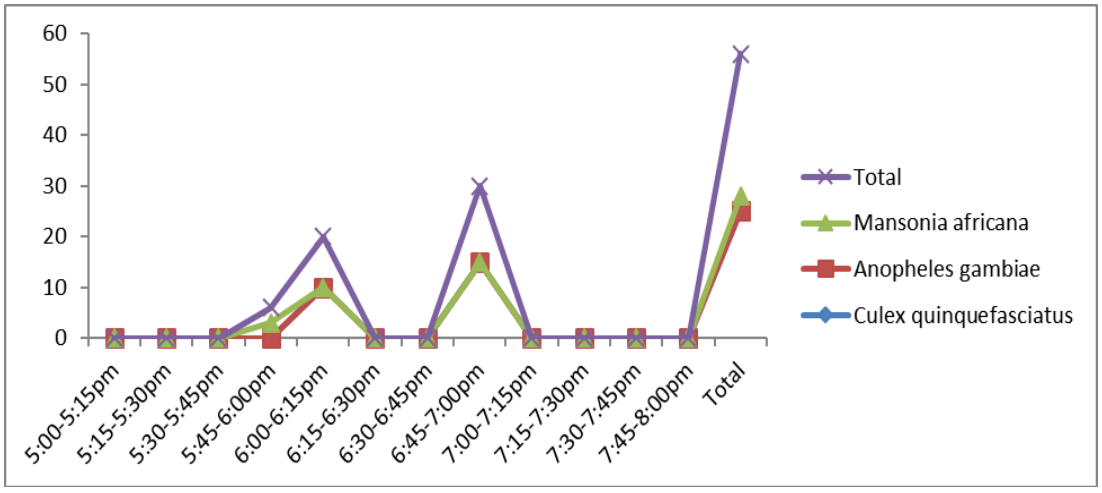
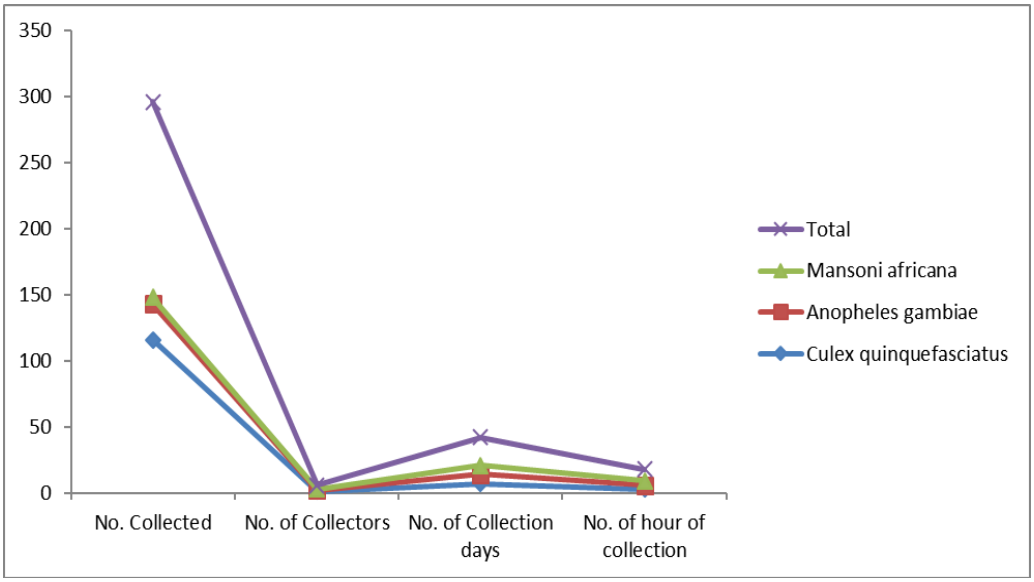


Fig. 2. Collection of Mosquitoes Using the Human Landing Catch Method at Ifite-Awka, Awka South L.G.A, Anambra State



No. = Number

Fig. 3. Effects of the biting time of mosquitoes species in Ifite-Awka, Awka-South L.G.A, Anambra State

identified species of mosquito are vector borne diseases of economic importance [27] and Umaru et al. [36] *Culex, Anopheles* and *Mansonia*, are known vectors of malaria and lymphatic filariasis. *Culex quinquefasciatus* is responsible for the transmission of filariasis, especially Bancroftian filariasis caused by *Wuchereria bancrofti*. This is highly prevalent in Nigeria with about 106 million people at risk in Nigeria [40]. In Africa, the prevalence of lymphatic filariasis is on the increase as reported by Agibodion et al. [41].

Adult female mosquitoes generally differ in their behavior especially biting activities including host blood meal preferences, time, and place of biting and resting sites, which are very important in the epidemiology of diseases transmission [28]. *Culex quinquefasciatus* predominating in the collections could be because adults of *Culex quinquefasciatus* are anthropophilic (biting humans only), endophagic and endophilic (biting and resting indoors). The more important vectors of human diseases are those that show close association with man and prefer man to animals as source or food as was observed in the present study. In the pyrethrum spray collection method, *Culex quinquefasciatus* was the dominant species followed by *Anopheles gambiae* and *Mansonia africana.* This study agrees with that of

Gbaye et al. [42] which reported that *Culex quinquefasciatus* was the most predominant mosquito species recorded in a south-western state in Nigeria and that of Dalhatu et al. [43] in Bauchi state, Nigeria [44]. Most *Culex* and *Anopheles* are night feeders which attack their victims when they are at rest indoor and the presence of mosquito vector habitat is directly associated with diseases transmission corresponding with the study of Mbanugo and Okpalanonuju [45].

4. CONCLUSION

There is a fast rate of urbanization going on in Ifite-Awka which is indicated by the presence of *Culex* mosquitoes since they have a predilection for urban environments. Urbanization indirectly implies that there is an increasing human population in the areas which is increasing the number of people that may be exposed to the lymphatic filariasis and malaria disease. It was observed that most of the houses have no window and door nets and residents do not sleep with Long Lasting Insecticidal nets (LLIN s) and the environment is litter with organic matter and polluted water. So the residents should be enlightened about the dangers of dumping refuse and sewage into drainage systems. Cleaning of already existing drainage and good construction practices will help to make the water unsuitable as a breeding habitat. Above all, massive larvae control interventions in the gutters and canals should be carried out especially during the dry season.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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