Survey of Mosquitoes in Students Hostels of Federal University of Lafia, Nasarawa State, Nigeria

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ABSTRACT

The presence of mosquitoes in an academic environment is a great threat to both staff and students well-being due to the possibility of the transmission of mosquito-borne diseases if bitten by an infected mosquito. Thus, this study surveyed mosquitoes in students hostels of Federal University of Lafia, Nasarawa State, Nigeria between August and October, 2019 using the Prokopack Aspirator for mosquitoes day catch from 0600 hours to 0900 hours. A total of 114 mosquitoes were collected in which the predominant species was *Culex quinquefasciatus* 65(57.0%) followed by *Anopheles gambiae* 41(36.0%) then *Aedes aegypti* and *Mansonia uniformis* with 3(2.6%) each, while *Anopheles squamosus* and *Anopheles coustani* were the least with 1(0.9%) each. Hence, there was a high significant difference in abundance between the six mosquito species (P<0.001). The abundance of mosquitoes was more in male hostel 79(69.3%) than in the female hostel 35(30.7%) which showed a significant difference (P=0.03636). Mosquitoes abundance significantly varied (P<0.05) in relation to altitude of building floors in favor of ground floor hostels rooms. Most of the female mosquitoes were blood fed 72(69.2%). Transmission indices revealed 2 mosquitoes/room and as well as 1 mosquito/student. 100.0% of the rooms don't use insecticide aerosols and thus mosquitoes were caught in all rooms while 75.30% of such rooms use treated bed nets but still yet 81.2% mosquitoes were caught. Mosquitoes abundance positively increased (r=0.041) with increase in number of sleepers in rooms. This is the first study on mosquitoes populations in the Institution's students hostels which will serve as a baseline data for mosquitoes control in the University environment. Students should avoid human-vectors contact by use of insecticides and treated bed nets.

Introduction

Mosquito are small slender insect dreaded by humans with fragile wing measuring about 4-6mm [1]. The female mosquito sucks the blood of their host which includes humans, horses and other vertebrates. Mosquitoes bite on host after sometime results to a red-ringed bump in the body of the host [1,2]. Mosquito are worldwide in distribution [3] and have well developed adaptation that enable them to thrive during breeding in various environment such as contaminated and clean little water bodies, buckets, tyres and hoof prints [4]. Anthropogenic activities such as road construction, mining, irrigation farming which are intended to improve the quality of life of people give rise to breeding sites that are of favorable condition for disease vectors to thrive [4-6]. Mosquitoes are mostly found around human dwelling and in school environment [**7-**9] and are responsible for the transmission of diseases such as malaria, yellow fever, filariasis, denque which causes morbidity, mortality and socio-economic loss [10].

WHO [11] estimate that, over 438,000 malaria deaths worldwide and most of these death occurred in the African Region (90%) followed by the south-east Asia Region (7%) and the Eastern Mediterranean Region (2%). Nigeria bears the highest burden of malaria and lymphatic filariasis with an estimated 80 to 120 million people at risk [12]. A report by WHO [13] showed that of the 85% malaria most hit countries, Nigeria had the highest number of cases and deaths of 25% and 24% respectively. The students hostels of Federal University of Lafia was commissioned in 2019 for students habitation. Also, at present there is ongoing construction of roads and building of structures on the campus, and as well as presence of rice paddy which are all giving rise to potential mosquitoes breeding habitats in the school environment. Hence, the survey of mosquitoes in students hostels of Federal University of Lafia, Nasarawa State, Nigeria was embarked upon so as to serve as the first entomological baseline data which will guide the decision of the Management in relation to vectors control for the well-being of students against mosquito-borne diseases.

Materials and Methods

Study Area

The study was conducted in students hostels of Federal University of Lafia (FULafia) located on latitude: 8° 29′38" N and longitude: 8° 30′ 5" E (Figure 1). The campus is situated in the Capital of Nasarawa State. The predominant occupation of the people of Lafia people is farming. The temperature and relative humidity of Lafia is high. The wet season lasts for seven months which is between April and October, while the dry season is between November and March [14].
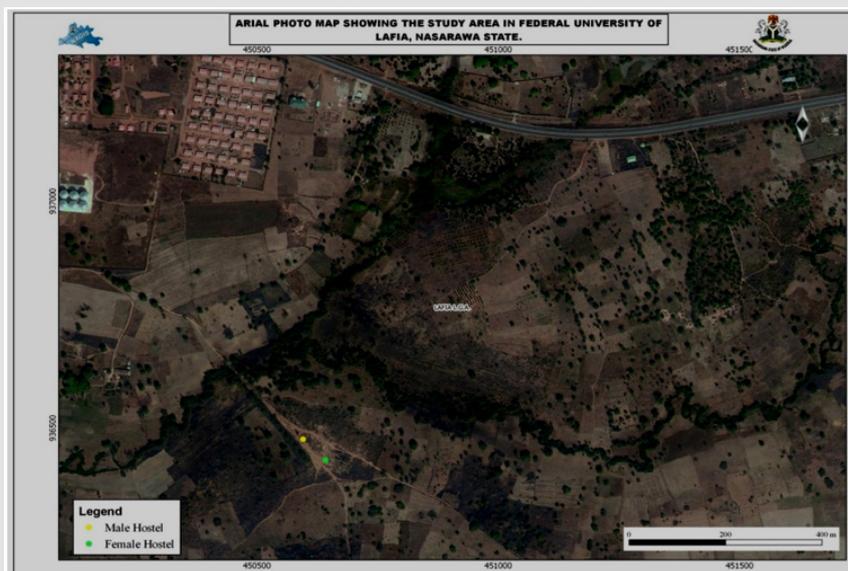

Figure 1: Aerial Photo Map of Federal University of Lafia, Nasarawa State showing the location of students hostels.

Mosquitoes Collection

Mosquitoes were collected indoors in the male and female students hostels between August and October, 2019 during the late raining season period. A total of 64 rooms were sampled in which 32 rooms were selected from male and female students hostels respectively, and the systematic sampling technique was used to select 8 rooms in each floor of the hostels in which an interval of two rooms was considered between the selected rooms. Rooms were selected a day prior to collection and occupants of the rooms were informed to keep doors and windows closed until it was sampled. Each room was visited twice within the study period. Trapping of adult mosquitoes was done using battery powered Prokopack Aspirator during the morning period (day time) between 0600 hours and 0900 hours. Mosquitoes trapped in the collection cup attached to the Prokopack Aspirator were knocked down using cotton wool soaked in chloroform. Thereafter, samples were transferred into a well labeled petri-dish for each room and transported to the laboratory for sorting and morphological identification.

Morphological Identification

Mosquitoes were sorted out and morphologically identified based on their visible features with the aid of a dissecting microscope and identification keys by Service [1], Carpenter and LaCasse [15], Gillies and Coetzee [16], Darsie and Ward [17] and Kent [18]. Identified mosquitoes were preserved in eppendorf tube containing silica gel for further processing.

Statistical Analysis

Data obtained were analyzed using R Console software (Version 3.2.2). Pearson's Chi-square test was used to compare abundance between mosquito groups, species, and sex. Welch two sample t-test was used to compare mean abundance of mosquitoes in relation to male and female hostels, and as well as between sleeping and bathing rooms. One-way analysis of variance (ANOVA) was used to compare mean abundance of mosquitoes in relation to building floors altitude. Pearson's product-moment correlation was used to determine the association between mosquitoes abundance and number of sleepers in rooms. Level of significance was set at P<0.05.

Entomological Transmission Indices

A. Indoor Resting Density of Mosquitoes

The indoor resting density (IRD) of female mosquitoes per structure per night was calculated using the formula by Williams and Pinto [4]:

$$IRD = \frac{Total\ number\ of\ vectors\ collected}{Total\ number\ of\ rooms\ sprayed}$$

B. Man Biting Rate

Man biting rate (MBR) is expressed as the number of bites a person receives from a specific vector species per night. This parameter can indirectly be estimated from mosquito day catches using the formula by Williams and Pinto [4] below:

$$MBR = \frac{Number\ of\ mosquitoes\ collected}{Number\ of\ people\ that\ slept\ in\ the\ rooms\ the\ previous\ night}$$

Diversity Index

Shannon-Wiener diversity index according to Begon et al. [19] and Lamead [20] was used to determine the diversity level of mosquitoes in the area.

$$H' = -\sum_{i=1}^{S}(Pi)(\ln Pi)$$

Where:

H' is the diversity index

Pi is the proportion of individual species

S is the total number of species in the habitat and

i is the proportion of S species

Diversity index is on a scale of 0 to 5 where an index value between 0-2.4 shows a low diversity while 2.5-5 indicates high diversity.

Results

Composition of Mosquito Species in Students Hostels of Federal University of Lafia, Nasarawa State

A total of 114 indoor resting adult mosquitoes in students hostels of Federal University of Lafia were caught which belong to anopheline and culicine groups that spread across six species namely, *Anopheles gambiae, Anopheles squamosous, Anopheles coustani, Culex quinquefasciatus, Aedes aegypti and Mansonia uniformis* (Table 1). The culicine group had a higher number of individuals 71(62.3%) than the anophelines 43(37.7%). Thus, abundance of mosquitoes between the two groups showed a high significant difference (χ^2=6.8772, df=1, P=0.0087). The predominant of the mosquito species caught was *Culex quinquefasciatus* 65(57.0%) followed by *Anopheles gambiae* 41(36.0%) then *Aedes aegypti* and *Mansonia uniformis* with 3(2.6%) each while *Anopheles squamosus* and *Anopheles coustani* were the least with 1(0.9%) each (Table 1). Therefore, there was a very high significant difference (χ^2 = 197.89, df=5, P<0.001) in abundance between the six mosquito species recorded. Female mosquitoes were more 104(91.2%) than males 10(8.8%) (Table 1). Hence, there was a high significant difference (χ^2=77.509, df=1, P<0.001) in abundance across mosquitoes sex.

Table 1: Checklist of mosquito species in male and female students hostels of Federal University of Lafia, Nasarawa State between August and October, 2019.

Species	Hostels		Total (%)
	Male	Female	
Aedes aegypti	2	1	3 (2.6)
Anopheles coustani	1	0	1 (0.9)
Anopheles gambiae	27	14	41 (36.0)
Anopheles squamosus	1	0	1 (0.9)
Culex quinquefasciatus	46	19	65 (57.0)
Mansonia uniformis	2	1	3 (2.6)
Total (%)	79 (69.3)	35 (30.7)	114

Comparison of Mosquitoes Abundance in Relation to Hostels; Altitude of Building Floors; and Sleeping/Bathing Rooms

Hostels: The abundance of mosquitoes was more in male hostel 79(69.3%) than in female hostel 35(30.7%). Therefore, the mean abundance of mosquitoes between female and male hostels showed a significant difference (t=-2.1172, df =116.96, P=0.03636, Figure 2).
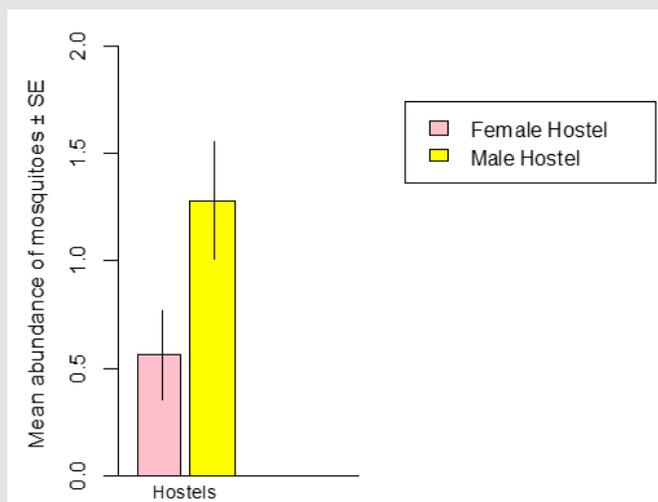
Figure 2: Mean abundance of mosquitoes in relation to female and male students hostels of Federal University of Lafia.

Altitude of Building Floors: Ground floor had the highest mosquitoes population 47(41.2%) followed by first floor 40(35.1%) then third floor 16(14.0%) while second floor was the least. Thus, there was significant difference (F_{124}=2.678, Adjusted R^2=0.03813, P=0.04998, Figure 3) in mosquitoes abundance in relation to building floors.
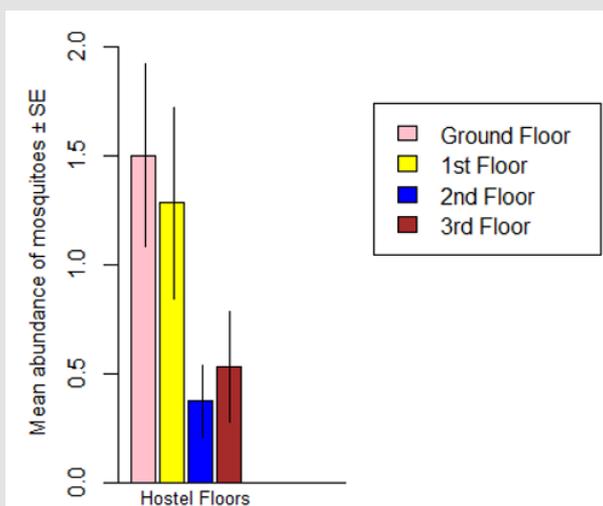

Figure 3: Mean abundance of mosquitoes in relation to hostels altitude of building floors.

Sleeping versus Bathing rooms: The number of mosquitoes was higher in bathrooms 68(59.6%) than sleeping rooms 46(40.4%). Hence, mosquitoes abundance between sleeping and bathing rooms showed a high significant difference (t=-3.0476, df=33.87, P=0.004451, Figure 4).
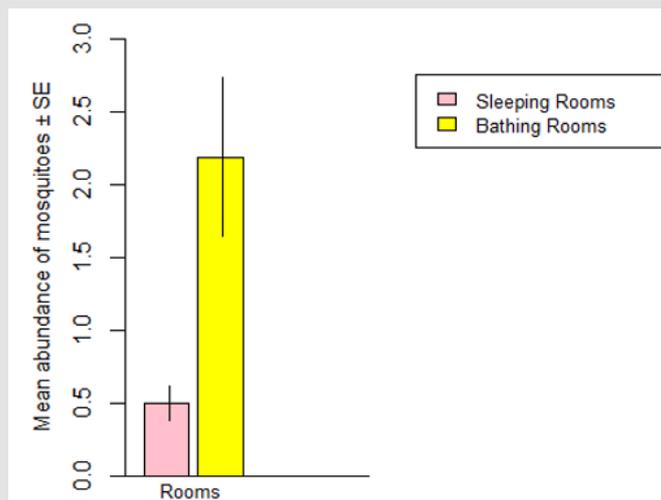
Figure 4: Mean abundance of mosquitoes in relation to sleeping and bathing rooms.

Abdominal Conditions of Female Mosquitoes

Most of the female mosquitoes collected were blood fed 72(69.2%) followed by those gravid 20(19.2%), then unfed 9(8.7%) while the least was half gravid individuals 3(2.9%) (Table 2). Hence, abundance of female mosquitoes in relation to their abdominal conditions showed a very high significant difference (χ^2=114.23, df=3, P<0.001).

Table 2: Abdominal conditions of female mosquitoes caught in students hostels of Federal University of Lafia, Nasarawa State.

Abdominal Conditions	Mosquito species						Total (%)
	Aedes aegypti	*Anopheles coustani*	*Anopheles gambiae*	*Anopheles squamosus*	*Culex quinquefasciatus*	*Mansonia uniformis*	
Unfed	0	0	3	0	5	1	9 (8.7)
Fed	3	1	33	1	33	1	72 (69.2)
Half Gravid	0	0	0	0	2	1	3 (2.9)
Gravid	0	0	2	0	18	0	20 (19.2)
Total (%)	3 (2.9)	1 (1.0)	38 (36.5)	1 (1.0)	58 (55.8)	3 (2.9)	104

Entomological Transmission Indices of Female Mosquitoes in Students Hostels

Indoor resting density (IRD): an overall approximate IRD of 2 female mosquitoes per hostel room was recorded (Table 3).

An. gambiae and *Cx. quinquefasciatus* have an approximate IRD of 1 mosquito per room whereas other mosquito species had an IRD that was less than 0.5 mosquitos per room as shown in Table 3.

Man biting rate (MBR): the pooled result from Table 3 showed that the MBR is one mosquito per student.

Table 3: Entomological transmission indices of female mosquitoes in students hostels.

Species	No. of female mosquitoes	IRD/room (n=64 rooms)	MBR/person (n=204 persons)
Aedes aegypti	3	0.046875	0.015
Anopheles coustani	1	0.015625	0.005
Anopheles gambiae	38	0.59375	0.186
Anopheles squamosus	1	0.015625	0.005
Culex quinquefasciatus	58	0.90625	0.284
Mansonia uniformis	3	0.046875	0.015
Total	104	1.625	0.51

The Association between Students Measures of Protection against Human-Vectors Contact and Mosquitoes Abundance

Figure 5 showed that none of the student use aerosol insecticide in their hostels rooms as a means of protection against mosquitoes bite thus, mosquitoes were present in all rooms sampled (100.00%) with at least 2 mosquitoes in each hostel room. Of the 36(75.30%) rooms that hung insecticide treated bed nets (ITNs) a high number of mosquitoes were caught 37(81.20%) while those rooms that don't use ITNs 12(24.70%) had a low catch 9(18.80%).
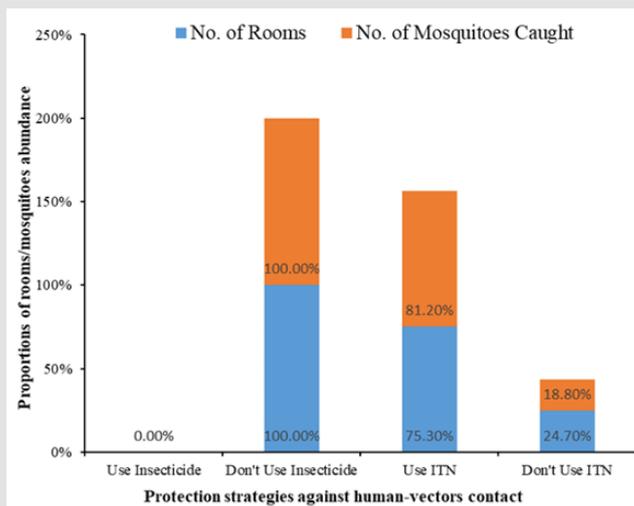
Figure 5: The association between protection strategies against human-vectors contact and mosquitoes abundance.

The Relationship between Number of People that Slept in Rooms and Mosquitoes Abundance

There was a weak positive relationship between mosquitoes abundance and the number of people that slept in rooms the previous night (t=0.39789, df=94, P=0.6916, r=0.041, Figure 6). The number of students in hostels rooms influenced mosquitoes abundance by 0.2% (coefficient of determination, r^2=0.002).
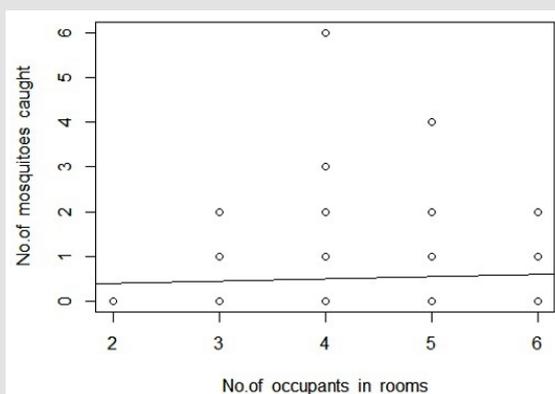

Figure 6: The association between numbers of people that slept in rooms the previous night and mosquitoes abundance.

Mosquito Species Diversity Level in the Students Hostels

Shannon-Wiener diversity index (H') obtained showed that mosquito species diversity was relatively low (H'≈1.0) as shown in Table 4.

Table 4: Mosquitoes diversity in students hostels using Shannon-Weiner diversity index.

Species	Total	Pi	ln(Pi)	Pi[ln(Pi)]
Aedes aegypti	3	0.026316	-3.638	-0.09573
Anopheles coustani	1	0.008772	-4.736	-0.04155
Anopheles gambiae	41	0.359649	-1.023	-0.36779
Anopheles squamosus	1	0.008772	-4.736	-0.04155
Culex quinquefasciatus	65	0.570175	-0.562	-0.32033
Mansonia uniformis	3	0.026316	-3.638	-0.09573
Total	114			-0.9627

H' = - (-0.96)

H' = +0.96

∴ H' ≈ 1.0

Discussion

Mosquitoes survey using the Prokopack Aspirator was efficient and effective based on species composition and abundance of biting and indoor resting mosquitoes caught in the students hostels in the Permanent Site of FULafia which is undergoing rapid development. The presence of mosquitoes in the students hostels will possibly expose the students to high risk of human-vectors contact that will result in transmission of mosquito-borne diseases which will negatively affect students performance due to loss of both lectures hours and scarce resources meant for upkeep to be used for purchase of drugs. This is in line with previous studies by Amusan et al. [21], Okwa et al. [22] and Adeoye et al. [23] who collected mosquitoes from students hostels of University of Agriculture, Abeokuta, Lagos State University (LASU), and University of Lagos respectively. Similarly, Madara [24] in a study on adult mosquitoes in University of Abuja main campus in FCT - Abuja, Nigeria recorded high number of mosquitoes belonging to three genera. Accordingly, Mistica et al. [9] documented the presence of mosquito species in public schools of Metro Manila in the Philippines. Furthermore, Ombugadu et al. [25] reported diverse and abundant mosquitoes in students private accommodation around the take-off site of FULafia in Mararraba-Akunza area.

Culex quinquefasciatus was the most dominant species collected possibly due to the short proximity between students hostels and houses in Lafia metropolis where a lot of polluted breeding sites are available thereby making it very easy for *Cx. quinquefasciatus* to successfully breed and fly to the university environment. This is in accordance with Adeoye et al. [23] who showed that *Culex quinquefasciatus* was the most abundant mosquito species in students hostels of University of Lagos and its environment. Also, Mistica, et al. [9] recorded only culicine mosquitoes in public school environment. Likewise, Okwa and Sulaimon [26] noted more *Culex* than *Anopheles* in Ojo area of Lagos. On the contrary, studies by Onyido et al. [7], Madara et al. [24] and Ombugadu et al. [25] showed *Anopheles gambiae* proportion to be the predominant over other mosquito species in schools and its environs. Also, Okwa et al. [22,27,28] obtained more *Anopheles* than *Culex* mosquitoes in Badagry, six areas in Lagos and LASU students hostels respectively. Furthermore, Amusan et al. [21] showed that *Aedes* mosquito was the most abundant in students hostels of University of Agriculture, Abeokuta.

The presence of *Anopheles gambiae* as the second most dominant species in this study possibly suggests that the ongoing anthropogenic activities in the Permanent Site of the University have given rise to more temporary breeding sites (such as tyre tracks, hoof prints and rice paddy) for *An. gambiae* to successfully breed. This is in accordance with Williams and Pinto [4], Patricia et al. [10], Youdeowei and Service [29] and Adeleke et al. [30] who showed that transient habitats accounted for breeding success of *Anopheles* mosquitoes. Also, Adeoye et al. [23] reported *An. gambiae* as the second most abundant mosquito in a study on endophilic mosquitoes in students hostels of University of Lagos and its environment.

The high number of indoor resting female mosquitoes over males may be due to the need for blood meal in order to provide nutrient for the development of their fertilized eggs. Thus, this is of public health concern since it is only the female mosquito that bites and sucks blood during which mosquito-borne diseases may likely be transmitted into students as they feed. This agrees with the studies by Onyido et al. [7], Okwa et al. [22] and Madara et al. [24] who collected more female mosquitoes as compared to male mosquitoes in both male and female hostels. Consequently Okwa and Sulaimon [26], Okwa et al. [27,28], Lindsay and Birley [31] and Oyewole et al. [32] confirmed more female mosquitoes than males in their studies.

The observed variation in mosquitoes abundance in favor of male hostels may probably be due to the high amount of volatile compounds exuded by male students that attracts mosquitoes. This concurs with Bundy [33] who showed that male and female sex differ physiologically and biologically, thus resulting in variations in attractiveness to vectors. Also, mosquitoes are not attracted to females due to the fact that they have better immunity to malaria and other diseases which have been attributed to genetic or hormonal factors [34]. On the other hand, more female mosquitoes were collected from female students hostels than in male hostels of the Lagos State University in south-western, Nigeria [22].

The difference in mosquitoes abundance in relation to altitude of hostels floors possibly suggests that mosquitoes prefer the ground floor level due to presence of high number of students at dusk in the area which directly translates to high amount of volatile compounds being exuded on the ground flat. However, Onyido et al. [7] got most of their catches on the first floor rooms of the students hostels building of Nnamdi Azikiwe University Awka, Anambra State and South-eastern Nigeria.

The high number of mosquitoes in bathing rooms could be due to more favorable microclimatic conditions, dampness, easy access to exposed host body when cleaning up, and wet hanged clothes. This is in agreement with Entertainment Times [35] who pointed out bathrooms and toilets as one of the immense contributor to mosquitoes breeding success in and around house environment in India.

The variation across female mosquitoes abdominal (physiological) conditions clearly shows that the fed females are anthropophilic. This finding is in conformity with the works of Okwa et al. [22], Adeleke et al. [30], and Ebenezer et al. [36] in LASU, some parts of Abeokuta and Bayelsa States respectively. Also, most of the mosquitoes caught by Amusan et al. [21] in students hostels of University of Agriculture, Abeokuta were blood fed individuals.

This is not in agreement with the finding by Adeoye et al. [23] who recorded no difference in the physiological status of the endophilic mosquitoes caught in students hostels of University of Lagos and its environment.

The pooled indoor resting density of 2 mosquitoes per room in this study suggests a high likelihood of human-vector contact since occupants in each room is a maximum of 4 persons. Of the 2 mosquitoes per room, *Anopheles gambiae* and *Cx. quinquefasciatus* were 1 each. This is in line with the finding of Onyido et al. [**7**] who reported a room density of 8 mosquitoes per room.

An overall man biting rate of 1 mosquito per student per night was observed which connotes a definite human-vector contact likely to occur. This is in agreement with the finding of Ombugadu et al. [25] who recorded a biting rate of 5 mosquitoes per man per hour.

The none usage of insecticidal aerosols by students in hostels rooms accounted for the presence of mosquitoes in all the rooms surveyed (100%), although, some of the students use insecticide treated bed nets but still yet had more mosquitoes but wouldn't be bitten for the sake of sleeping under the treated bed net. Equally, Msugh-Ter et al. [8] found out that most undergraduate students of Federal University of Agriculture Makurdi protect themselves against mosquito bites by use of window and door nets.

This study shows that the higher the number of students that slept in hostels rooms the previous night the more the number of mosquitoes that were attracted indoors seeking for human host. This stands with Lwetoijera et al. [37] who showed that the density of mosquito increased as the number of people increased the more inside houses in rural Southern Tanzania.

The coefficient of determination (0.2%, $r^2=0.002$) recorded in this study implies that apart from the number of students being an attractive factor on the number of mosquitoes indoors visitors other microclimatic conditions such temperature and relative humidity as well played a much more vital role in influencing mosquitoes abundance in the hostels. Likewise, Ombugadu et al. [25] showed that temperature and relative humidity influences mosquitoes abundance at both indoor and outdoor points.

The low mosquitoes diversity index value recorded in this study signifies low species diversity in spite of the species richness observed. Möhlmann et al. [38] equally obtained a low diversity index value from mosquitoes collected in three European countries at different latitudes.

Conclusion

This study clearly showed that mosquitoes are present in FULafia's students hostels. The number of mosquitoes specimens collected during the study period was relatively low due to high amount of rainfall which flooded breeding sites in the area. The *Culex quinquefasciatus* population was the most dominant. Male hostel rooms had higher mosquito population. Most of the mosquitoes were collected in the ground floor hostels rooms. More mosquitoes were caught in bathing than sleeping rooms. The engorged females were the highest over the other abdominal conditions. The transmission indices revealed a relatively average indoor resting density and a definite human-vector contact. The lack of usage of insecticide aerosols by students in all the hostels rooms will make mosquitoes to fly into all the rooms unhindered despite the hung treated bed nets in most hostels rooms. Abundance of mosquitoes favorably increased with increase in number of sleepers in the rooms. Mosquitoes diversity level was on the low scale. The mosquitoes collected are of public health concern because they are known for the transmission of one form of disease or the other. Hence, students should avoid human-vectors contact by all means through the use of insecticides, treated bed nets and repellants. Mosquito-net screens should be placed on the doors and windows of both the hostels sleeping and bathing rooms since the students may not have enough funds to purchase insecticide aerosols at all times. Also, all the hostels rooms occupants should be provided with treated bed nets.

Acknowledgement

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