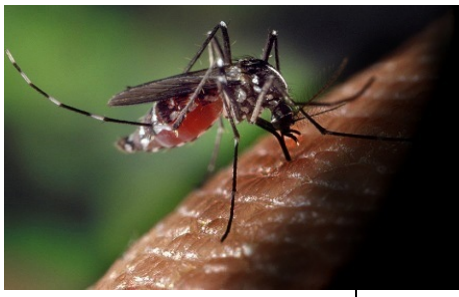

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Determination of malaria vector, Species composition and relative abundance and distribution at Imawa, Kura local government area of Kano State, Nigeria

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Abstract
An entomological survey was conducted (April to June) to determine the malaria vector species composition, relative abundance and distribution in Kura L.G.A, of Kano State, Nigeria. Adult mosquitoes from 10 randomly selected residential houses (5 brick and 5 Mud structure) were collected using Pyrethrum Spray Catch (PSC) and two houses were used for Centre for Disease Control Light Trap (CDC LT) methods. A total of 5322 Anopheles belonging to five different species were identified. 4565 Anopheles mosquito species were collected by CDC LT method. Out of this, 4411 (96.6%) were *Anopheles gambiae S.L*, 143 (3.1%) were An. pharoensis, 7 (0.2%) were An. coustani, 3 (0.06%) were An. funestus and 2 (0.04%) were An. rufipes. A total of 755 Anopheles mosquitoes collected by PSC were all found to be *Anopheles gambiae S.L*. Out of this 568 (75%) An. *gambiae S.L* were collected from mud houses while 189 An. *gambiae S.L* were collected from brick houses. An. *gambiae S.L*. were the most abundant mosquitoes over other species. There is significant difference between Anopheles mosquitoes in relation to house type in the month of April as the significant level (0.000) is less than p-value (0.05) while in May and June there is no significant difference as the significant level (0.143 and 0.560 respectively) were found to be greater than the p-value (0.05). Comparing the two collection methods used, a greater number were collected using CDC LT (4565) than with Pyrethrum spray sheet (757). The highest number of mosquito collections occurred in May 2723 (60%) and the least number was collected in June 748 (16%). Therefore, An. *gambiae S.L* acts as major malaria vector (at Imawa community), followed by An. pharoensis, An. funestus, An. coustani and An. rufipes which acts as minor malaria vector in the community. Conclusively, CDC LT was found to be the more efficient collection method than PSC as the maximum number of Anopheles mosquitoes were collected in May than in April following the onset of rainfall which tends to create more breeding sites that in turn increase mosquito population, longevity and hence increase malaria transmission.

Keywords: *Anopheles*, *mosquitoes*, Centre for disease control Light Trap (CDC LT), Pyrethrum Spray Sheet Collection (PSC), Relative abundance, Distribution

Introduction
The disease malaria is spread via the bite of female Anopheles mosquitoes. Of the more than 400 species of *Anopheles* mosquitoes, about 30 are significant malaria carriers. Every significant species of vector bites occur between dark and dawn. The parasite, the vector, the human host, and the environment all have an impact on how intensely the infection spreads.
Approximately half of the world's population was at risk from malaria. In 2019, 245 million cases of malaria were reported worldwide, according to a report by the World Health Organization. It was projected that 568 000 malaria fatalities would occur in 2019. In addition, the number of cases of malaria worldwide in 2020, 2021, and 2022 was 241, 247, and 349 million, respectively. Approximately 50% of malaria-related deaths worldwide happened in six (6) countries: Nigeria (23%), Democratic Republic of the Congo (11%), Burkina Faso, Mozanbique, Niger, and Nigeria (4% each).

The ability of an entomologist to identify and track malarial vectors is facilitated by studying the diversity, density, behavioral patterns, and temporal fluctuations of *Anopheles* species. The ability of a vector to spread malaria is affected by various factors, such as abundance, anthropophily, zoophily, sensitivity to malaria parasite infection, infection rates, and female longevity (Aniedu, 1992) [4].

According to recent research, the most popular entomological indicator for establishing the connection between malaria incidence and vectors in any given area is the abundance of *Anopheles* mosquito species (Muturi *et al*., 2006) [20]. Climatic factors such as rainfall affect adult mosquito abundance by drastically altering the quality and quantity of breeding habitats. To determine parasite activity levels and associated disease risk, the relationship between rainfall and mosquito abundance must be ascertained (Bashar and Tuno, 2014) [6]. Malaria continues to be a persistent and sneaky disease that impedes human progress. The vectors of the *Anopheles* mosquito eased their way out of extinction at every point when it was thought that the disease could be eliminated. Lack of sufficient understanding of the vector ecology and species composition has been identified as a major contributing factor to the incapacity to control this disease (CDC, 2010) [8].

Although the disease has proven to be far more difficult to manage, significant progress has been made in our understanding of the biology of the malarial parasites, the human host, and the development of anti-malarial medications. Previously, it was believed that the control of malaria would be simple, based on the assumption that the relationship between the parasites, the vector, and the human host was clearly understood, that effective therapeutic and chemotherapeutic agents were available, and that insecticides held a great promise for vector control.

Thus, knowledge of the seasonal population size and species distribution of *anopheles* mosquitoes is essential for malaria epidemiology research as well as for developing control strategies in malaria endemic locations. Malaria is a vector-borne disease that dramatically raises morbidity and death rates worldwide, especially for the world's poorest citizens (Wilson *et al*., 2020) [30]. The primary tactic for ending this horrible disease is vector management, which has a long and illustrious history. More so than vaccinations or drugs, malaria vector management has reduced the incidence of multiple vector-borne diseases, including malaria (Wilson *et al*., 2020) [30].

One of the most popular kinds of traps for gathering mosquitoes both indoors and outdoors is the Centers for Disease Control and Prevention light trap (CDC LT). CDC LT is a standard instrument for monitoring and surveillance of disease vectors, as well as for adult mosquito sample in entomological surveys. However, while using the CDC method, it is usual for specimens to lose crucial exterior features like legs, causing injury to the mosquitoes as they are sucked through the fan blades. This is a downside of the CDC LT method to morphological species identification.

The Pyrethrum Spray Collection method (PSC) was utilized to capture adult mosquitoes that were sleeping indoors. Apart from *Anopheline gambiae* S.L., no other anopheline was obtained with the PSC collection method. Pyrethrum spray collection is another technique for gathering samples from host-seeking African malaria vectors that are sleeping indoors.

However, the two primary malaria vectors in Africa, *Anopheles gambiae* and *An. funestus*, are very anthropophilic and therefore among the most effective malaria vectors globally.

For humans to become ill from malaria, parasites must mature inside the mosquito after being eaten. The duration of the extrinsic incubation period, which determines the parasite type and temperature, can range from 10 to 21 days for mosquito development. A mosquito cannot transmit malaria parasites if it perishes before the extrinsic incubation period, according to the CDC (2015).

Study Area

The Imawa community in Kura Local Government Area, Kano State, Nigeria, served as the study's site. The geographical coordinates of Imawa: 11°48'03.6"N 8°27'43.2"E. About 200 miles (322 km) north of Abuja, the capital of Nigeria, is the town of Kano, which is part of Kano State. Kura is a local government area located in Kano State, Nigeria's northwest region. It is 206 km2 in size. The Local Government Area's headquarters is bordered by the Local Government Areas of Kura, Dawakin Kudu, Madobi, and Garun Malan. Kura L.G.A is made up of a number of cities and villages, most of which are inhabited by people from the Hausa and Fulani ethnic groups.

Imawa has a rich Agricultural Heritage and is known for the cultivation of a number of crops such as rice, wheat, onion, tomatoes, cabbage and cucumber. A number of domestic animals are also reared and sold there. These include; camels, cows and horses. Other economic activities engaged in by the people of the village.

Materials and Methodology

Mosquito Collection by Centre for Disease Control (CDC) Light trap Indoor

Materials and Reagents

Centre for disease control light trap (CDC LT) with all accessories, petri-dishes, camp beds, bed-nets, forceps, measuring tape, filter papers, dissecting Microscopes, Eppendorf tubes, self-indicating blue silica gel, white paper, Microscope lens, cleaning solution (ethanol: Diethyl ether, 1:3), Record Sheet, Pen (black and red), permanent markers, GPS device, Zip-lock bags.

Procedure for House Selection

Two houses were selected for the study (both mud). Permissions were sought from the households' heads for accessibility into the selected houses. Two houses were chosen for CDC LT collections, where household 1 and 2 are located at Lat.11.79821, Longitude 8.46261 and Latitude 11.79804, Longitude 8.46221.

Procedure for Indoor Adult Mosquito Collection

At each house, CDC LT collections were carried out between 6:00 pm to 06:00 am hours over three days period each in the month of April, May and June respectively. CDC light traps were assembled 1.5 meters above the floor level using a support, close to the legs of sleeping bait under a non-treated bed-net. The collection cups were labeled prior to collection. The CDC light traps were connected and switched on at exactly 18:00 hours and collection made on hourly basis.

Procedure for indoor adult mosquito transportation to the laboratory
Collected mosquitoes samples were transferred to the Centre for Infectious Disease Research, Public health Laboratory, Aminu Kano Teaching Hospital, Kano

Procedure for adult Mosquitoes' sorting and preservation
Prior to preservation, adult mosquitoes were sorted to separate *Anopheline* mosquitoes from other insects. Adult *Anophelines* were then identified and preserved in 1.5ml Eppendorf tubes. During the preservation, 1.5ml Eppendorfs were half-filled with self-indicating silica gel and covered with tissue paper. Each collected mosquito was put in a tube, using forceps and the lid of the tube covered. The tubes were labeled legibly with marker to include time and date of collection, the house number and type of house.

Mosquito Collection with CDC light trap Outdoor
Materials and reagents
Materials and the reagents are the same as for indoor adult mosquito collection.

Procedure for House Selection
Same as for indoor adult mosquito collection.

Procedure for Outdoor adult Mosquito Collection
Same houses used for indoor mosquito collection were also used for outdoor adult mosquito's collection. In Outdoor adult mosquito collection, Sleeping baits were made to sleep out the house in an open/uncovered space under bed-net. The CDC LT were assembled 1.5 meters above the floor level close to the leg of sleeping bait under a non-treated bed-net. The collection cups were labeled on hourly basis for collection (between 6:00pm to 06:00am hours) prior to collection. The CDC light traps were connected and switched on at exactly 6:00pm.

Procedure for Indoor adult Mosquito Transportation to the Laboratory
Collected mosquitoes samples were carefully transferred to the Centre for Infectious Disease Research, Public health Laboratory, Aminu Kano Teaching Hospital, Kano state.

Procedure for adult Mosquitoes' Sorting and Preservation
Prior to preservation, adult mosquitoes were sorted to separate *Anopheline* mosquitoes from other insects. Adult *Anophelines* were then identified and preserved in 1.5ml Eppendorf tubes. During preservation, 1.5ml Eppendorfs were half-filled with self-indicating silica gel and covered with tissue paper. Each collected mosquito was put in a tube, using forceps and the lid of the tube covered. The tubes were labeled legibly with marker to include time and date of collection, the house number and type of house.

Collection of indoor Resting Mosquito by using Pyrethrum Spray Catch (PSC) Method
Materials and Reagents
Flash lights, spare batteries, insecticides aerosol (hand sprayers), white cotton sheets, Petri-dishes, Forceps. Cotton wool, Filter paper, Labels, field box, Timer, Binocular Microscope, Microscope lens cleaning solution (80/20 Ethyl Ether solution)/xylene, Record sheet and pens (black and red).

Procedure for house/room selection and Pyrethrum Spray
Adult mosquitoes resting indoors were collected ten (10) randomly selected houses (5 bricks and 5 muds houses) at Imawa community in Kura L.G.A. Permissions were obtained from the household heads through informed consent. PSC collections were performed with the help of trained household heads from 6:00 to 7:00 am. Each house were labeled with codes to avoid mix up. Small furniture were moved out and essential items were covered. White sheets were used to completely cover the floor and all flat surfaces (tables were covered as well) and all consumable items taken away from the selected apartment. All windows and doors were closed. The rooms were carefully sprayed with pyrethrum (insecticide aerosol) in a clockwise direction toward the ceiling until the room is filled with evenly sprayed fine mist. The room was exited, door closed and allowed for 10-15 minutes before the specimen collection.

Procedure for Mosquito Specimen Collection and Transportation
Starting from the entrance, the corners of the sheets were lifted and taken outside. All the knock-down mosquitoes were collected with forceps and placed in labeled petri-dish. Mosquitoes sample were transported to the Public Health Laboratory, Centre for infectious Disease Research, Aminu Kano Teaching Hospital, Kano for processing and Morphological Identification.

Procedure for adult Mosquito Sorting and Preservation
Anophelines mosquitoes were sorted from *culicines* and other non-target insects. The number of *anopheline* mosquitoes per room were recorded on a sheet. Adult *Anophelines* were then identified and preserved in 1.5ml Eppendorf tubes. Prior to preservation, 1.5ml Eppendorfs were half-filled with self-indicating silica gel and covered with tissue paper. Each collected mosquito was put in a tube, using forceps and the lid of the tube covered. The tubes were labeled legibly with marker to include time and date of collection, the house number and type of house.

Morphological identification of *Anopheles* species
Mosquito species were classified as male or female based on the presence or absence of plumose (feathery) antennae, whereas Anopheles species were recognized based on the morphological features of their maxillary palps. Using a dissecting microscope and the taxonomic keys of Gillies and Coetzee (1987) [14].

A. *Anopheles gambiae* S.L
Species of female *Anopheles* were recognized by examining the scales and color of the palps in the head region, the patterns of spots on the wings, thorax, terminal abdominal segments, and the scales of the legs.
A smooth, long proboscis and, in certain cases, smooth, dark palps with a pale tip were noted characteristics of *Anopheles gambiae S.L.* In some cases, the thorax had tufts of white scales at the front end, but otherwise it was almost entirely covered in scales. The scutellum lacked lobes. The costa of the wings were speckled with pale or black patches, and in certain cases, the wings were primarily dark-scaled with a few, brief pale costal interruptions (the pale portions being more widespread in certain Congo species). According to Gimba and Idris (2014) [11], some individuals had irregularly shaped legs with barely perceptible speckles, while others had dark legs with the exception of a few pale patches at the tips

of the tibiae and femorae. Some individuals also had dark, hairy abdomens, while others had none at all.

B. *Anopheles rufipes*

This species of mosquito lacks tufts of scales that protrude laterally from its abdomen, and it does not have speckles on its legs. The fore tarsus 1-3 lack distinct apical pale bands, but the hind tarsal segments 4 and 5 are entirely white. Their palps are broad and rarely fused, with the two outer ones being smooth. The second main dark area, or median dark area, is well-defined on Vein 1 with two pale interruptions, while the third main dark area, or preapical dark area, is not interrupted by any pale areas on Vein I (Gimba and Idris, 2014) [11].

C. *Anopheles funestus*

These mosquito groups lack tufts of scales that protrude laterally from their abdomen, and their legs lack speckles. Their basal half has at least one pale spot on the Costa, and the pale banding on tarsus 4 and 5 is narrow and apical where it does present. The third preapical dark region on vein I does not have a pale spot interruption, but it is wider than the subcostal pale spot (Gimba and Idris, 2014) [11].

D. *An. pharoensis*

An. pharoensis is a gray-colored mosquito with a pale abdomen covered with scales that protrude laterally. This type of mosquito has a palpus with four (4) whitish bands on it. Legs Ta-I, II5, pale rings, pale throughout the apical half, and completely pale Ta-III5. Costa: Wing with four or more black spots. Largely coated in broad, pale scale turfs on the abdomen (Theobald, 1901).

F. *Anopheles coustani*

(i) *Anopheles coustani* senso strico has hairy palps and wingless on the basal half of the costa; the hind tibia has a long, pale steak at the apex above that is at least four times wider than it is; and the hind tarsi segment 1 has a pale basal ring that is not significantly shorter.

(ii) *Anopheles var*. ziemani has a pale region on hind tarsal segment 1 and a little speck at the apex of their hind tibia. (Coetzee, 1987) [14].

Data Analysis and Interpretation

The data collected were subjected to descriptive statistics; charts were plotted, percentages were calculated and presented in tables. The data collected by PSC method were analyzed using SPPS version 16. Analysis of variance (ANOVA) was used to determine the difference between house types and *Anopheles* mosquito density. All statistical analyses were performed at 5% significance.

Estimation of Indoor Resting Density (D) for Mosquito samples collected by PSC Method.

Indoor resting density of mosquitoes collected by Pyrethrum Spray Catch (PSC) was calculated by dividing the total number of female *anopheline* mosquitoes collected by number of houses (rooms) used for spray sheet collection. Indoor Resting Density (D) = (number of females ÷ number of houses) ÷ number of nights (Pinto, 2012) [25].

Results

***Anopheles* Species Composition and Abundance using CDC LT Collection Method**

Four thousand, five hundred and sixty five (4565) *Anopheles* mosquitoes (com prising *Anopheles. gambiae S.L, An. pharoensi, An. coustani, An. funestus* and *An. rufipes*) were collected by CDC LT (Table 1). *An. Gambiae S.L* were identified *Anopheles* as the most abundance which accounted for 96.63% (4411/4565), followed by *An. pharoensis* (3.11%, 142/4565), where as *An. funestus* (0.07%, 3/4565), *An. rufipes* (0.04%, 2/4565) and *An. coustani* (0.15%, 7/4565) were identified as the least collected.

A total of 1094(24%) *Anopheles spp*. (*An. gambiae S.L, An. pharoensis, An. coustani, An. funestus* and *An. rufipes*) were collected from Imawa community in April, out of which 638(85.3%) *anopheles* mosquitoes were collected outdoor while the remaining 110(14.7%) *anopheles* were collected indoor (Fig. 6). Also in May, 2723(60%) *anopheles* mosquitoes were captured from both indoor (1668/62%) and outdoor (1035/38%. (Figure 7). Collections were also carried in June in which a total of 748(16%) *ano pheles* species were caught by CDC LT as well as 638(85.3%) were collected indoor while 210(24.76%) were collected from outdoor (Figure 8).

An. gambiae S.L were the most abundant species with highest percentages followed by *An. pharoensis* then *An. coustani and An. funestus*. The least *anopheles* mosquitoes found were *An. rufipes.*

Table 1: Anopheles Mosquitoes obtained by CDC LT from April to June, 2021

Mosquito species	April		May		June		Total
	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	
An. gambiae	350	733	1661	933	625	109	4411
An. pharoensis	1	1	26	101	12	1	142
An. coustani	0	7	0	0	0	0	7
An. funestus	0	2	0	0	1	0	3
An. rufipes	0	0	1	1	0	0	2
Total	351	743	1687	1036	638	110	4565
Grand total		1094		2723		748	
Percentage abundance		24%		60%		16%	

A total of seven hundred and fifty seven (757) indoor resting *Anopheles* mosquitoes (mainly *Anopheles gambiae* senso lato) were collected by Pyrethrum Spray Collection from ten (10) randomly selected houses (Table 2). Two hundreds and eight *An. gambiae S.L* were caught in April, out of which 178 *anopheles* mosquitoes were collected from five brick houses whereas only 30 *Anopheles* mosquitoes were caught in the five mud houses. But, in May a total of four hundred and fifty nine *Anopheles* mosquitoes were sampled in both Mud and brick houses, 350 *Anopheles gambiae S.L* were collected from

Mud houses and one hundred and nine *An. gambiae S.L* were collected from the brick houses. Ninety (90) *Anopheles gambiae S.L* were sampled in June, 50 and 40 *Anopheles gambiae* were caught in both Bricks and mud houses respectively.

Table 2: *Anopheles* species composition and distribution in relation to house type and PSC Method

House type	Spp. Composition	April	May	June	Total	Blood fed	Unfed
Brick	*An. gambae S.L*	5	6	12	23	13	10
Brick	*An. gambae S.L*	8	11	8	27	7	20
Brick	*An. gambae S.L*	8	14	9	31	12	19
Brick	*An. gambae S.L*	3	40	13	56	25	31
Brick	*An. gambae S.L*	6	38	8	52	21	31
Mud	*An. gambae S.L*	32	15	5	52	14	38
Mud	*An. gambae S.L*	40	19	3	62	21	41
Mud	*An. gambae S.L*	31	37	8	76	18	58
Mud	*An. gambae S.L*	23	129	20	172	36	136
Mud	*An. gambae S.L*	52	150	4	206	43	163
Total		208	459	90	757	210	547

Table 3: The distribution and relative abundance between Indoor resting and Outdoor *Anopheles* Species (April-June).

Anopheles Species	Indoor	% Abundance	Outdoor	% Abundance
An. gambiae S.L	3393	98.46%	1775	94%
An. pharoensis	39	1.46%	103	5.5%
An. coustani	0	0.00%	7	0.3%
An. funestus	1	0.04%	2	0.10%
An. rufipes	1	0.04%	1	0.1%
Total	3434	100%	1888	100%

Hourly distribution of relative abundance of *Anopheles* Species using CDCLT method (April-June)

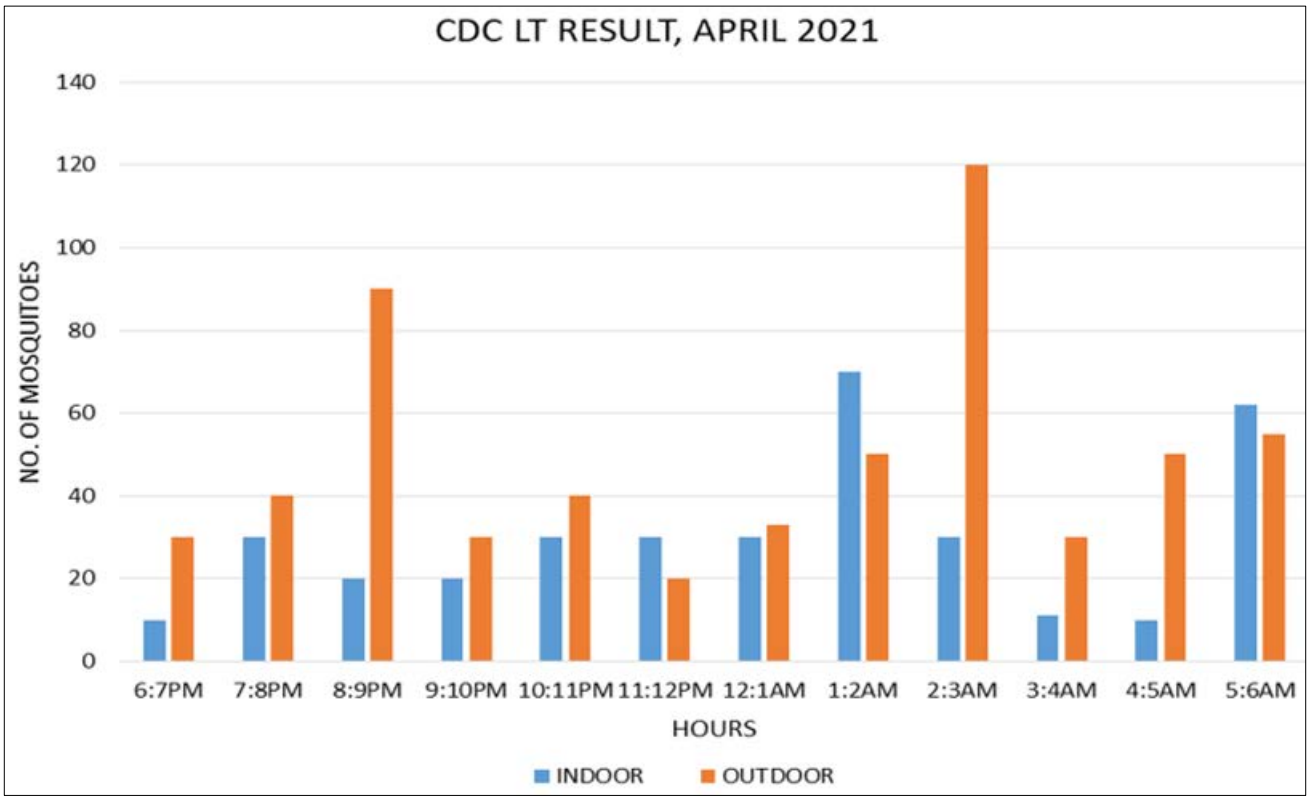

Fig 1: Shows the hourly distribution of *anopheles* mosquitoes obtained using CDC light trap collection method

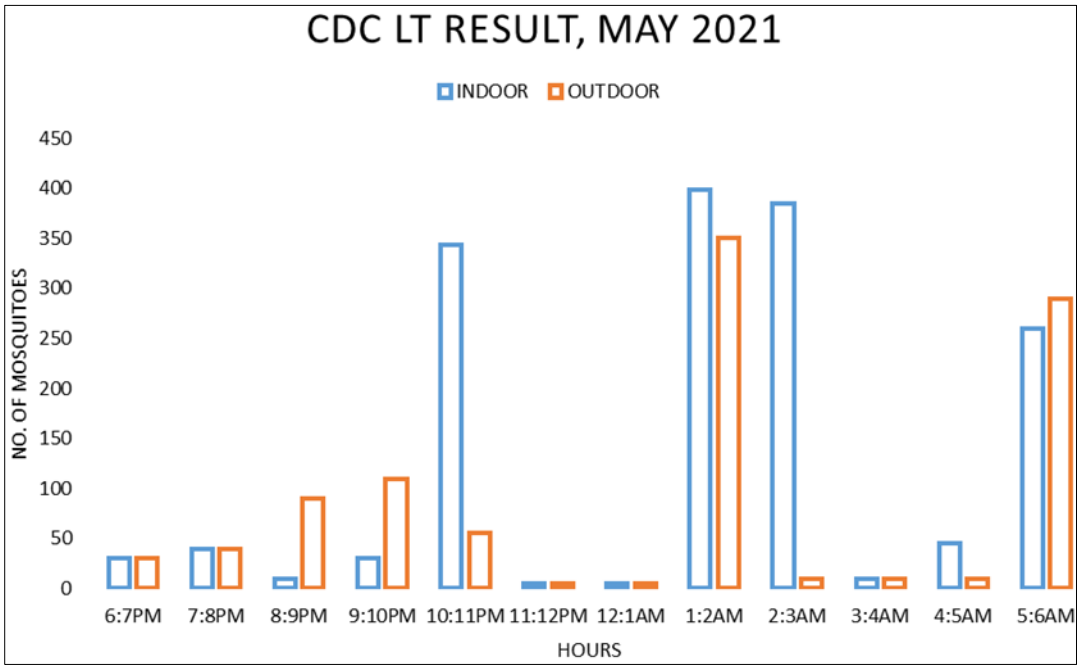

Fig 2: Shows the hourly distribution of *anopheles* mosquitoes obtained using CDC light trap collection method

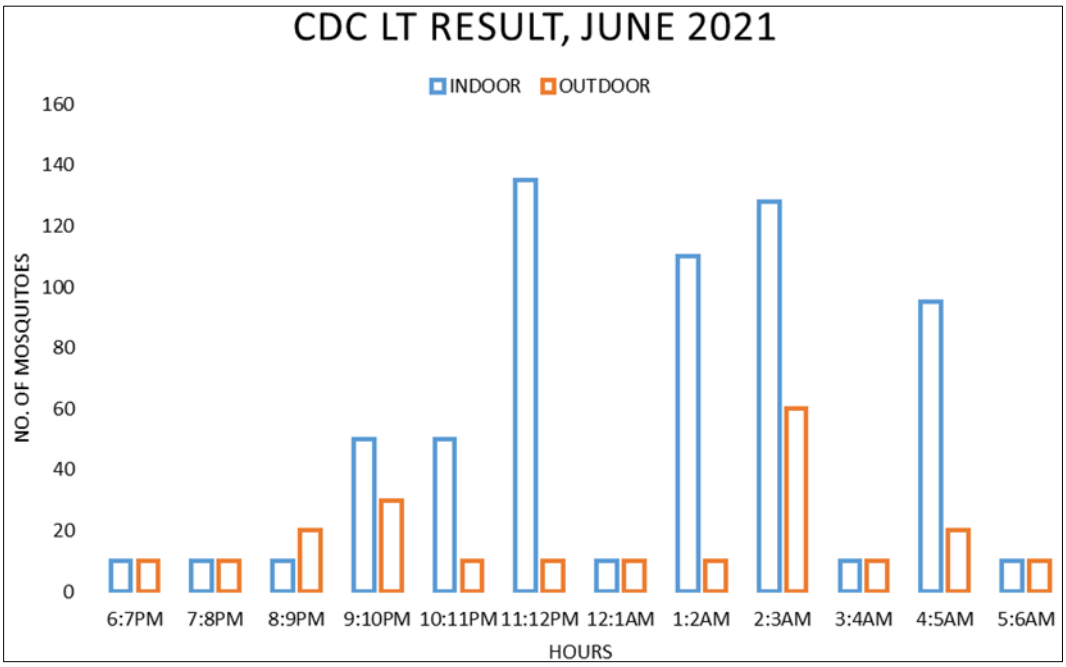

Fig 3: Shows the hourly distribution of *anopheles* mosquitoes obtained using CDC light trap collection method

Result of data Analysis and Interpretation

From the ANOVA table, it could be observed that there is significant difference between Anopheles mosquitoes in relation to house type in the month of April as the significant level (0.000) is less than p-value (0.05) while in the month of May and June there is no significant difference as the significant level (0.143 and 0.560 respectively) is greater than the p-value (0.05).

Estimation of Indoor Resting Density for the Mosquito samples collected by PSC Method

Indoor Resting Density (D) = (Number of females ÷ number of houses) ÷ number of nights

Where D = indoor Resting Density

Number of female =104

Number of houses = 10

Number of night =2

Thus, Indoor Resting Density (D) = (104 female ÷ 10 houses) ÷ 2 night ==> 5.2 mosquitoes/house/night

Therefore, there are 5.2 mosquitoes per house per night.

Discussion

Ten Anopheles mosquito species were found in the Imawa community; *An. gambiae S.L.* was found to be the most abundant, while the other species (*An. pharoensis*, *An. coustani*, *An. funestus*, and *An. rufipes*) were the least abundant. Table 1 displays the findings of these species. According to earlier research by (Dondorp *et al.*, 2009) [13], the variety of environments in which these species can thrive may be the reason for *An. gambiae*'s dominance. The results

of Okwa (2006) [24] and Oguoma (2008) [23], who stated that *Anopheles gambiae* was the most prevalent species in Lagos and Kano, respectively, are identical to this one. This outcome is comparable to that of (Koffi *et al*. 2023) [16] who discovered that *Anopheles gambiae* was the primary malaria vector in the Gbêkê region of Côte d'Ivoire Mwalimu *et al*., (2024) [21] report that *Anopheles gambiae S.L*. and *Anopheles funestus* group were determined to be the most abundant *Anopheles* species in Mainland Tanzania after other species were recognized morphologically. *Anopheles stephensi*, *Anopheles* coustani, *Anopheles funestus*, *Anopheles moucheti*, and *Anopheles nilli* were also detected, although *An. gambiae* complex dominated the samples (98%) (Adeogun *et al*., 2023) [1].

This result, however, is in contradiction to those of Youmsi G. *et al*. (2020) [15], who identified *An. coustani* as the most prevalent malaria vector that serves as a significant local malaria vector in Madagascar. The local ecology provided an ideal habitat for the mosquito vectors to continue reproducing and surviving. Therefore, the relatively higher abundance of anopheline species in Imawa community may be as a result of the favorable tropical weather and abundant breeding sites (rice field).

Throughout the course of the study, *An. pharoensis* and *An. gambiae S.L.* were present. Three of the five anopheline species found in the Imawa community. *Anopheles gambiae S.L.*, *Anopheles pharoensis*, and *Anopheles funestus* are important malaria vectors. Given that *Anopheles gambiae* is known to be an effective malaria vector, the high abundance of the vector (*Anopheles gambiae*) found in this study suggests that not only the Imawa community but also the communities nearby are susceptible to malaria infection (Awolola, Ibrahim, Okorie, Hunt & Coetzee, 2003) [5].

Anopheles species distribution within the Imawa community is unequal, which implies that species occurrence changes according to macro and micro environmental variances displayed by distinct bio-ecological zones. There were extremely low numbers of the other species. *An. funestus* and *An. rufipes* are two of the other recognized secondary vectors. Because of their high zoophilic inclinations, these animals have been deemed to be of insignificant significance. The comparatively low proportions of *An. rufipes* and *An. funestus* abundance indicated that both species breed in larger, more permanent bodies of water, such as lakes, rivers, and ponds. According to research by Molineux and Gramiccia (2013) [19], this is the case.

It is also contrary to the findings of (Simon-Oke & Ayeni, 2015) who reported high incidence of *Aedes aegypti* in Akure. Also, in 2019 Simon-Oke discovered four mosquito genera (*Aedes*, *Anopheles*, *Culex*, and *Toxorhynchites*) with the exception of *Toxorhynchites* encountered in Akure South Local Government Area and considered well-known vectors of parasites and help in transmission of diseases such as yellow fever, malaria, and filariasis in the region (Afolabi *et al*. 2019) [2].

This result indicates that CDC LT is more efficient collection method compared to PSC method. This is because; CDC LT can be used for both Outdoor and Indoor resting mosquitoes collections unlike PSC method that can only be used to catch host seeking indoor resting mosquito species (Table 1 and 2) respectively.

The number of *Anopheles* mosquito collected in these periods of the study is very high (4565), most of which are *An. gambiae S.L* (96.62%/4411). This is related to the availability of rice field (potential breeding site of *An. gambiae S.L*) that surrounds Imawa community and this coincides with the study of Coluzzi, *et al.* (2002) [10] in that the most important vector of malaria parasite in sub-Saharan Africa is *An. gambiae S.L.*

Table 3 shows monthly distribution and related abundance of *Anopheles* species. The maximum number of mosquito were collected in May (60%) following the onset of rainfall. This is because; precipitation tends to create more breeding sites which in turn increase mosquito population, longevity and hence increase malaria transmission.

There were more mosquitoes outdoors than indoors in April and May but, more mosquitoes were sampled indoor than Outdoor in June by CDC LT. This could be related to the changes in the weather conditions (particularly temperature. This is because higher temperature was recorded in both April and May which is why most of the community people sleep outside (outdoor) their rooms. This in turn caused the malaria vectors change their biting behaviors for even endophagic mosquitoes might change to exophagic ones. But in June, due to the sudden decrease in the temperature, people in the community tend to sleep indoors. This is the reason why host seeking malaria vectors predominated indoors than outdoors. This coincides with the finding of (CDC, 2015).

Summary

Malaria is known to be carried by anopheline mosquito species. Reducing the transmission of malaria is mostly achieved through vector control. In order to ascertain the malaria vector, species composition, relative abundance, and distribution in Kura L.G.A. in Kano State, Nigeria, Anopheles mosquitoes were sampled from April to June. Ten randomly chosen residential residences five of which were brick and five of which were mud were utilized to gather adult mosquitoes using Pyrethrum Spray Catch (PSC), and two of the houses were used to test Centers for Disease Control Light Trap (CDC LT) techniques. A total of 5322 *Anopheles* belonging to five different species were identified. 4565 *Anopheles* mosquito species were collected by CDC LT method. 4411 (96.6%) were *Anopheles gambiae S.L*, 143 (3.1%) were *An. pharoensis*, 7 (0.2%) were *An. coustani*, 3 (0.06%) were *An. funestus* and 2 (0.04%) were *An. rufipes*. Whereas a total of 755 *Anopheles* mosquitoes were collected by PSC, but all were *Anopheles gambiae S.L*. 568 (75%) *An. gambiae S.L* were collected from mud houses whilst 189 *An. gambiae S.L* collected from brick houses. *An. gambiae S.L*. were the most abundant mosquitoes over other species followed by *An. pharoensis*, *An. funestus*, *An. coustani and* the least *An. rupfipes.* There is significant difference between *Anopheles* mosquitoes in relation to house type in the month of April as the significant level (0.000) is less than p-value (0.05) while in May and June there is no significant difference as the significant level (0.143 and 0.560 respectively) is greater than the p-value (0.05). Comparing the two collection methods used, a greater number were collected using CDC LT (4565) than with Pyrethrum spray sheet (757). The highest number of mosquito collections occurred in May 2723 (60%) and the least number was collected in June 748 (16%). Therefore, *An. gambiae S.L* acts as major malaria vector (at Imawa communit), followed by *An. pharoensis*, *An. funestus*, *An. coustani* and *An. rufipes* which acts as minor malaria vector in the community.

Conclusion

The study has revealed that, five different species of *Anopheles* mosquitoes abound the study area with *An. gambiae S.L* showing the highest preponderance over other species followed by the *An. pharoensis* while *An. coustani, An. funestus* and *An. rufipes* were the least in abundance. It was concluded that there is significant difference between house type and *Anopheles species* distribution and abundance in the month of April as the significant level (0.000) is less than p-value (0.05) while in the month of May and June there is no significant difference as the significant level (0.143 and 0.561) were greater than the p-value (0.05) respectively.

Furthermore, CDC LT was found to be more efficient collection method than PSC. It was also concluded that the maximum number of *Anopheles* mosquitoes were collected in May (60%) than In April (24%) following the onset of rainfall which tends to create more breeding sites that in turn increase mosquito population, longevity and hence increase malaria transmission.

Recommendation

It is recommended that;

1. Research should be carried out (at Imawa community) to identify Anopheles Mosquitoes breeding sites and determine distance from houses
2. Research should be conducted to identify Anopheles Mosquitoes siblings species using Polymerase Chain Reaction (PCR)
3. Further research should be undertaken to determine plasmodium infection through detection of Circumsporozoite protein by Enzyme-Linked Immunosorbent Assay (ELISA)

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