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POPULATION DENSITY OF MOSQUITO WITHIN YAWURI FLAT AREA SOKOTO STATE, NIGERIA

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Abstract
Mosquitoes are known to be vectors of various diseases, including malaria, dengue fever, Zika virus, and West Nile virus. The aim of this research is to determine the population density of mosquito within Yawuri Flat Area, Sokoto state. Light trap and outdoor sampling method was employed for a period of three days (3 days) at a time interval of 6pm to 7am. Pyrethrum spray catch was employed using white spread materials at early morning for a period of three days (3 days) from 6am to 7am interval. All data were analyzed using IBM SPSS Statistics 22 software (Version 22.0). The number of insects encountered was counted and recorded. The distribution of mosquito species based on gender showed that male mosquitoes had the highest prevalence than female mosquito. The distribution of mosquito species based on number of bedrooms showed that First bedroom had the highest prevalence, followed by Second bedroom and the least was pallor. The occurrence of these species of mosquitoes in the study areas shows that the communities are at risk of contracting mosquito-borne diseases since all of them are proven vectors of dreadful diseases. The use of insecticides treated bed nets and replant are highly recommended.

1. Introduction

Mosquitoes are known to be vectors of various diseases, including malaria, dengue fever, Zika virus, and West Nile virus, understanding the population density of mosquito species is crucial for implementing effective control and prevention strategies, assessing mosquito density provides valuable information for monitoring disease transmission potential, evaluating the impact of control measures and designing targeted interventions, this study aims to investigate the population density of mosquitoes and its implications for disease transmission (WHO, 2017). Mosquitoes are widespread insects that thrive in diverse environments, ranging from tropical rainforests to urban areas, they have a significant impact on public health due to their ability to transmit pathogens to humans and animals, mosquito-borne diseases cause a considerable burden on global health, particularly in regions where these diseases are endemic (WHO, 2020). The population density of mosquitoes is influenced by various factors, including climate, habitat availability, breeding sites and human activities, understanding the relationship between these factors and mosquito density is essential for predicting and managing disease outbreaks. Additionally, population density data can aid in identifying high-risk areas and implementing targeted interventions to reduce mosquito populations and mitigate disease transmission (Adelman *et al.,* 2013). Several studies have investigated mosquito density and its relationship with disease transmission. For example, he conducted a systematic review and meta-analysis on the effect of insecticide-treated bed nets on the incidence and prevalence of malaria, the study highlighted the importance of reducing mosquito density as a key strategy for malaria control (Bhatt *et al.,* 2015). He examined the lethal and sublethal effects of mosquito bed nets on the malaria vector Anopheles gambiae, their findings emphasized the significant impact of bed nets in reducing mosquito populations and interrupting disease transmission (Eisele *et al.,* 2012). The issue of pyrethroid resistance in African Anopheline mosquitoes and its implications for malaria control, the study highlighted the need for alternative control strategies to combat mosquito populations that have developed resistance to insecticides (Ranson *et al.,* 2011). By conducting a comprehensive assessment of mosquito density in this study, we aim to gain insights into the spatial and temporal patterns of mosquito populations, identify environmental factors influencing their abundance, and assess the potential risk of disease transmission (Bhatt *et al.,* 2015). The findings will inform targeted interventions and contribute to the development of effective strategies for mosquito control and disease prevention

2. Materials and methods

2.1 Study Area

Yawuri flat is among the metropolitan areas of Wamakko Local Government Area sokoto. It is a Government Residential Area within Sokoto. Most of the in habitant of the area are civil servant. Yawuri flat was established in 1975 by Major General Umaru Muhammad, it has 28 houses with seven boy's quarters and each house is attached to one bedroom in the boy's quarters and a parking space. Sokoto is located in the North West of

Nigeria, between latitudes 13° 4' 07''North and longitudes 05° 14' 49''East and above 265m the sea level. The State accounts for 2.3% of Nigeria's total population. Situated in the North Western corner of Nigeria, Sokoto State territory occupies 25,973 square kilometers. Sokoto shares its borders with Niger Republic to the North, Zamfara State to the East, Kebbi state to the South-West (MOCIT, 2002). The State has an estimated population of about 4,742,459 people as of 2015 with 95.9 persons per square kilometer and 3% growth rate annually based on 2006 population census. Occupation of city inhabitants includes farming, trading, commerce, with a reasonable proportion of the population working in private and public sectors (MOCIT, 2002).

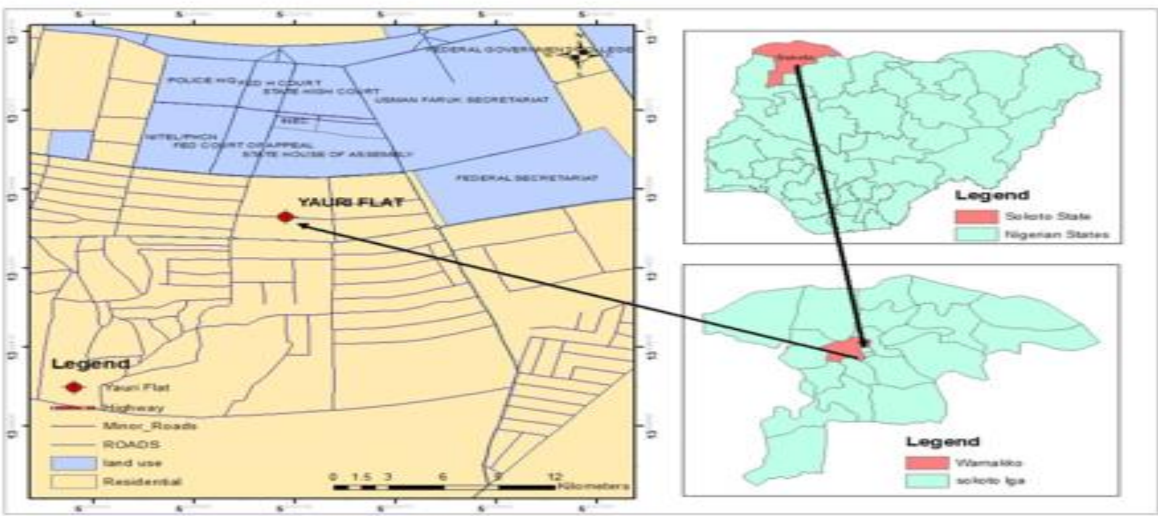

Figure 1: Map of Sokoto state showing the study area (Department of Geography, Sokoto State University, Sokoto)

2.2 Mosquito sampling

Two methods were employed for mosquito sampling. Light trap method was employed for indoor and outdoor sampling for a period of three days (3 days) at a time interval of 6pm to 7am. Pyrethrum spray catch was employed using white spread materials at early morning for a period of three days (3 days) from 6am to 7am interval.

2.3 Mosquito collection

Collection of mosquito was done after each and every hour for light trap and mosquitoes collected were identified using their morphological features which differentiate each and every species of mosquito. On the other hand, pyrethrum spray catch (PSC) was done based on the blood digestion. Mosquitos were collected after each 15 minutes and the mosquitoes collected are identified base on the type of species and nature of blood digestion of mosquitoes sampled and identified are counted per each Bedroom/collection site and divided by the total number and multiply by 100.

2.4 Morphological Identification and Sorting out of Mosquitoes

Anopheline were separated from Culicine mosquitoes according to the morphological characteristics of their maxillary palps the patterns of spots on the wings, thorax and terminal abdominal segments, scales of the legs using dissecting microscope following the taxonomic keys (WHO, 2003).

The thorax/head and abdominal regions of identified Anopheles were collected into properly labeled Eppendorf tubes and preserved over silica gel (Danabalan *et al*., 2013).

2.5 Data Analysis

All data were analyzed using IBM SPSS Statistics 22 software (Version 22.0). The number of insect's encounter was counted and recorded. The number of occurrence of each species was presented as mean percent density of flies per sampling unit. Mean Standard deviation and standard error was used to analyze the data on the percentage of pupal and larval survival development time to evaluate the effect of density and rearing substrate.

3. Results

3.1 Distribution of Mosquito Species Based on Gender in the Study Area

The distribution of mosquito species based on gender showed that males had the highest prevalence of 109 (68.55%) than females with 50 (31.45%) mosquito in the study area as seen in Table 1.

3.2 Distribution of Mosquito Species Based on Bedroom Number in the Study Area

The distribution of mosquito species based on number of bedrooms showed that (First) 1st bedroom had the highest prevalence of 72 (45.28%), followed by (Second) 2nd bedroom with 66 (41.51%) and the pallor recorded the lowest prevalence of 21 (13.21%) as seen in Table 2.

Table 1: Distribution of Mosquito Species Based on Gender in the Study Area

Gender	No. Mosquitoes	Prevalence (%)
Male	109.00	68.55
Female	50.00	31.45
Total	159.00	100.00

x^2 = 3.8415, df =1 and P-value = 0.0000 Reject

Table 2: Distribution of Mosquito Species Based on Bedroom Number in the Study Area

No. Bedroom	An. Gambiae	M. Uniformis	C. Quinque	Ae. Aegypti	An. Coustani	Total	Prevalence (%)
1st	10.00	4.00	35.00	20.00	3.00	72.00	45.28
2nd	9.00	3.00	25.00	27.00	2.00	66.00	41.51
Pallor	6.00	2.00	3.00	10.00	0.00	21.00	13.21
Total	25.00	9.00	63.00	57.00	5.00	159.00	100.00

x^2 = 5.9915, df =2, P-value = 0.0000. Reject

Key: An. Anopheles, M. Mansonia, C. Culex and Ae. Aedes

3.3 Distribution of Mosquito Species Based on Number of Houses in the Study Area

The distribution of mosquito species and density based on number of houses showed that, house number 6 has the highest frequency of (44.03%) with Density of (100.00) while house number 3 has the lowest frequency of (1.26%) with Density of (40.00) as seen in Table 3.

3.4 Relative Abundance of Mosquito Species in the Study Area

Among 159.00 mosquitoes collected in Yawuri flat *Culex quinquefasciatus* were predominant with 63 (39.62%), followed by *Aedes aegypti* 57 (35.85%), followed by *Anopheles gambiae* 25 (15.72%), then followed by *Mansonia Uniformis* 9 (5.66%) and *Anopheles Coustani* 5 (3.14%) as seen in Table 4.

Table 3: Distribution of Mosquito Species and Density Based on Number of Houses in the Study Area

No. Houses	No. Mosquitoes	Density	Frequency (%)
House No 1	28.00	15.00	8.18
House No 2	23.00	20.00	1.88
House No 3	38.00	40.00	1.26
House No 4	25.00	60.00	22.01
House No 5	15.00	80.00	40.88
House No 6	30.00	100.00	44.03
Total	159.00	315.00	118.24

x^2= 11.0705, df =5, P-value = 0.0499. Reject

Table 4: Relative Abundance of Mosquito Species in the Study Area

Mosquito species	A	(%)	B	(%)	C	(%)	Total (%)
Anopheles gambiae	8.00	14.29	11.00	20.00	6.00	12.5	25 (15.72)
Mansonia uniformis	5.00	8.93	1.00	1.82	3.00	6.25	9 (5.66)
Culex quinquefasciatus	22.00	39.29	25.00	45.45	16.00	33.33	63 (39.62)
Aedes aegypti	19.00	39.93	17.00	30.91	21.00	43.75	57 (35.85)
Anopheles coustani	2.00	3.57	1.00	1.82	2.00	4.17	5 (3.14)
Total	56.00	100.00	55.00	100.00	48.00	100.00	159 (100)

x^2= 9.4877, df =4, P-value = 0.0000. Reject

3.5 Abundance of Mosquito Species Identified Based on Sex

The Male mosquitoes predominated in the catches made; Aedes aegypti recorded the highest male mosquito (43) while Anopheles coustani recorded the lowest male mosquito (4). The highest female mosquito was recorded in Culex quinquefasciatus (23) while Anopheles coustani recorded the lowest male mosquito (1) as seen in Table 5.

3.6 Blood Digestion of Mosquito Species in the Study Area

The 159 mosquito collected unfed 75 (47.17%) recorded the highest digestion stage among all the mosquito species while gravid 12 (7.55%) recorded the lowest digestion stage of mosquito species as seen in Table 6.

Table 5: Abundance of Mosquito Species Identified Based on Sex

Mosquito species	An. gambiae		M. uniformis		C. quinque		Ae. aegypti		An. coustani	
	Male	Female	Male	Female	Mal	Female	Mal	Female	Mal	Female

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A	5.00	3.00	4.00	1.00	14.00	8.00	15.00	4.00	2.00	0.00
B	7.00	4.00	1.00	0.00	16.00	9.00	12.00	5.00	1.00	0.00
C	3.00	3.00	2.00	1.00	10.00	6.00	16.00	5.00	1.00	1.00
Total	15.00	10.00	7.00	2.00	40.00	23.00	43.00	14.00	4.00	1.00

x^2 = 5.9915, df =2, P-value = 0.0000. Reject

Keys: An. Anopheles C. Culex Ae. Aedes M. Mansonia

Table 6: Blood Digestion of Mosquito Species in the Study Area

Abdominal condition	Mosquito species					
	An. gambiae	Mansonia uniformis	Culex quinque	Aedes aegypti	Anopheles coustani	Total (%)
Unfed	14.00	5.00	32.00	21.00	3.00	75 (47.17)
Fed	5.00	0.00	15.00	24.00	1.00	45 (28.30)
Half Gravid	3.00	3.00	10.00	10.00	1.00	27 (16.98)
Gravid	3.00	1.00	6.00	2.00	0.00	12 (7.55)
Total	25 (15.72)	9 (5.66)	63 (39.62)	57 (35.85)	5 (3.14)	159 (100)

x^2 = 7.8147, df = 3, P-value = 0.0041. Reject

4. Discussion

This study was conducted at yawuri flat community of Sokoto state in different location as demarcated A, B and C. *Culex quiquefasciatus* had been recorded to be predominant mosquito species in yawuri flat community as found in this study. The prevalence of Culex in this study is also in line with the work of other researchers in other states of Nigeria especially Katsina and Kwara state (Calba *et al.*, 2013). The prevalence of Culex in this study is also in line with the work of other researchers in other states of Nigeria especially Katsina and Kwara States which is 93.3% (Calba *et al.*, 2013). Notwithstanding that the species of mosquito genera collected were not diverse; the identified species were those that were dominant species in the previous research in Taraba state, Bali town inclusive. The predominance of *Culex quiquefasciatus* among the Culex species, *Mansonia uniformis* and *Aedes aegypti* that only featured among other Mansonia and Aedes genera in other research authenticate the findings of this study within the limited study period (CDC, 2017). All the mosquito species collected in this study are proven vector of some human diseases. Culex and Mansonia species are vectors of Bancroftian filariasis (Leopoldo, 2004). Aedes aegypti which lives in tropical climates is a vector of yellow fever and zika virus (Leopoldo, 2004). Anopheles gambiae identified in this study is a vector of malaria and filariasis (Leopoldo, 2004). Seasonal variation of abundance of mosquito species showed that mosquitoes were more abundant in wet season than in dry season is in line with the findings of other researchers (WHO, 2016; Stone *et al.,* 2012). This might be due to the favourable ecological conditions for breeding of mosquitoes in wet seasons unlike the case of dry season (WHO, 2016). The dry season mosquitoes were very low in this study not just because of lack of rain and availability of various stagnant waters, but because it was a cold/harmattan period that the collection was made. Low temperature increases the duration of mosquito metamorphosis (Dammo *et al.,* 2015). The female: male mosquito ratio was very high. This is in contrast with the study conducted in Nguru Yobe state (Brogdon and Chan, 2010). This might be because male mosquitoes are not anthropophilic so they need to stay outdoor in most times to feed on flower nectar and mate with exophilic/exophagic mosquitoes also. The Anopheles gambiae collected were anthropophyhilic as it was found in previous research in this area even with other identified Anopheles species (Lamidi *et al.,* 2017).

5. Conclusion

The occurrence of these species of mosquitoes in the study areas shows that the communities are at risk of contracting mosquito-borne diseases since all of them are proven vectors of dreadful diseases. The intervention efforts should be geared up mostly in the wet/hot season which is of epidemiological significance especially to malaria disease

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