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ORIGINAL RESEARCH ARTICLE

Assessment of Indoor Resting Density of Female Mosquitoes in Dutse, Jigawa State, Nigeria: Implications for Disease Transmission and Community-Based Mosquito Control Measures

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ABSTRACT
Mosquito is a major vector of humans and other animals globally, especially in Africa. This study assessed female mosquitoes' Indoor Resting Density (IRD) in Dutse L.G.A., Jigawa State. Mosquitoes were collected using the Pythrum Spray Caught method from three communities (Gurungu, Baranda, and Warwade) for seven months (April to October 2022). The highest IRD of female *Anopheles* was recorded in September at Baranda (33.3) and the lowest IRD at Gurungu (0.0) in June. The highest IRD of Female *Culex* was recorded in July at Gurungu (13.7), while the lowest was recorded in June at Baranda (0) and Warwade. The findings of this study revealed the idle spraying time of insecticide in all the study sites, which was found to be April because the IRD was beyond the normal (0.05)per house, which was related to epidemic transmission of the diseases. I recommended further study on community involvement in mosquito control measures.

INTRODUCTION

Mosquitoes of the order Diptera remain one of the key vectors of human and animal diseases worldwide, especially in tropical and subtropical regions. They transmit several harmful diseases, including malaria, dengue fever, and lymphatic filariasis (Evule *et al.,* 2018). According to Coetzee e*t al.* (2019), out of 300 mosquito species identified and recorded, over 100 are known to cause human diseases.

The Burden and threat of mosquito-borne diseases have translated to large economic losses, social disgrace, low productivity, and sleepless nights in many parts of the world (Achee *et al.*, 2015). Mosquito-borne disease transmission is influenced by several factors, including poor sanitation, mosquito resting density, feeding behaviour, blood-meal preference, environmental modification, and other anthropogenic activities (Abubakar *et al.,* 2016).

Above 97% of Nigeria's population is at risk of malaria, while the remaining 3% live within high altitudes, with 60% of hospital outpatient visits and 30% of hospitalization among children under five years and pregnant women (Nigeria Malaria Report, 2019).

Collection and identification of indoor resting mosquitoes are imperative in entomology research to monitor disease vectors, especially in an endemic region of certain diseases such as malaria, filariasis, and viral infections (Achee *et al.,* 2015).

Mosquitoes' indoor resting and feeding habits result in physiological and behavioral changes (Machani *et al.*, 2020). Malaria vectors have been shown to adjust to environmental changes because of behavioural avoidance or selection of mutation and recombination that led to their survival in the presence of insecticide, thus threatening the efficacy of the current indoor-based vector control and this increase in mosquito disease transmission (Machani *et al.*, 2020). Understanding the nature of resting habits of malaria vectors based indoors is vital for vector control sustainability. More so, this study seeks to provide and compare the Indoor resting density of mosquitoes resting indoors responsible for the transmission of viral infection, filarial worms, and Malaria (*Aedes* sp., *Culex* sp., and *Anopheles* sp.)

Indoor resting studies of mosquitoes were conducted by Irikanmu *et al.* (2020) in Southeast Nigeria, Abdullahi *et al.* (2024) at Kano, and Machani *et al.* (2020) at Kanya.

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This study is designed to provide baseline information on the indoor resting mosquito in the study sites. This will also help the government and other non-governmental agencies provide them with the necessary help to reduce the disease's menace.

MATERIALS AND METHODS

Study area

The study was conducted in some selected Dutse local Government Area communities. Dutse is situated in the central part of the Jigawa State (latitude 11⁰45'22"N and longitude 9⁰20'"31" E) with a total area of 738 km² (Figure 1) (Mansur, 2014). The city is tropical, with rainy and dry seasons with an average yearly temperature of 26°C (Zangina, 2015). According to Mohammed (2018), the rainy season's mean daily temperature is 31⁰C, and the dry season's mean daily temperature is 20°C. The relative humidity in Dutse fluctuates throughout the year, with January recording the lowest at 17% and August reaching the highest at 95%, as reported by World Weather Online (2022). September and July also experience significant humidity levels at 68% and 56%, respectively. The annual rainfall ranges from 600 to 1000mm. The yearly rainfall usually is between April and October. The type of vegetation in Dutse L.G.A. is Sudan savannah, which ranges from dense woodland and shrub to barely degraded farms, with few scattered trees in the dry season.

Most of the study site respondents live in mud houses (Field Study, 2021). This study was conducted in three villages of Dutse L.G.A.: Baranda, Warwade, and Gurungo. Warwade and Baranda were purposively selected because they have Dams and rivers, respectively, while Gurungu was randomly selected among the villages without water in Dutse L.G.A.

Study design

House selections

Three research assistants were involved in this study, and they were trained and taught on house selection, mosquito collection, and identification using dichotomous keys. Thirty houses were sampled, ten from each three communities. Each house was selected randomly. Firstly, houses were selected by giving an identical number. The number of the houses was written on paper, folded and put in a container, then shuffled, among which ten folded papers were picked randomly. The houses whose number was picked were selected for the study. A rapport and consent of the respondents were sought prior to the study. The communities were likewise briefed on the modalities and significance of the study.

Mosquito Collection

The selected thirty houses were used to collect indoor resting adult mosquitoes. The Pyrethrum Spray Catches method was used to collect indoor resting adult mosquitoes for seven months, April to October 2022, in the morning (6:30 to 8:00 am). Prior collection, food, water, and domesticated animals were moved out of the room, door and window were also closed. A sheet of large white cloth was spread on the floor in the room, followed by a spray of pyrethrum baygon (0.05% Imiprothrin, 0.05% Prallethrin, and 0.015% Cyfluthrin). The white sheet was carefully taken outside after 15 minutes. The mosquitoes that fell on the sheet were collected with forceps and stored in a petri dish. A separate petri dish for each house of communities was used and all the Petridis were labeled with time, date, and location (Umar *et al.,* 2012).

Morphological Identification of Mosquitoes

The microscope was used for detailed observations and identification of the mosquitoes with particular reference to the palps, proboscis, antenna, wings, and legs, according to Gillet (1972) and Coetzee (2000).

Data analysis

Mosquito Density was calculated as the total number of mosquitoes of a particular Genera per number of houses sampled (Okorie *et al.*, 2015). Indoor Resting Density (IRD) was presented in charts, and the Analysis of Variance (ANOVA) two-way factor was used to test significant differences across the sample locations and months and was considered significant at $P \geq 0.05$.

$$\text{Mosquitoes Density} = \frac{\text{Total Number Of Mosquito Of Each Genera}}{\text{Total Number Of Houses/Room Used for Collection}}$$

Ethical Clearance and Sensitization

Ethical approval was obtained from the Ministry of Health, Jigawa State (MOH/SEC/I.S/681/VI) and granted permission from the head of each community. Informed consent was obtained from the head of the selected house. A series of sensitizations w**ere** conducted in places such as Juma'at Mosque, tea and bread vendor joints**,** and the market to enlighten the residents on the study and mosquito-borne diseases, the importance of environmental hygiene**,** and other preventive measures against malaria. Privacy and confidentially were maintained throughout the study. Ethical consideration outlines are the research should be conducted within the approved date granted by the Jigawa State Health Research Ethics Committee (JGHREC), all informed consent forms used in this study must carry the HREC assigned number**,** and no changes are permitted in the research without approval by the HREC except in the circumstances in the code. Risks encountered by participants were inhaling insecticide, which was minimized by giving the participants a facemask and was asked to leave the house for some minutes.

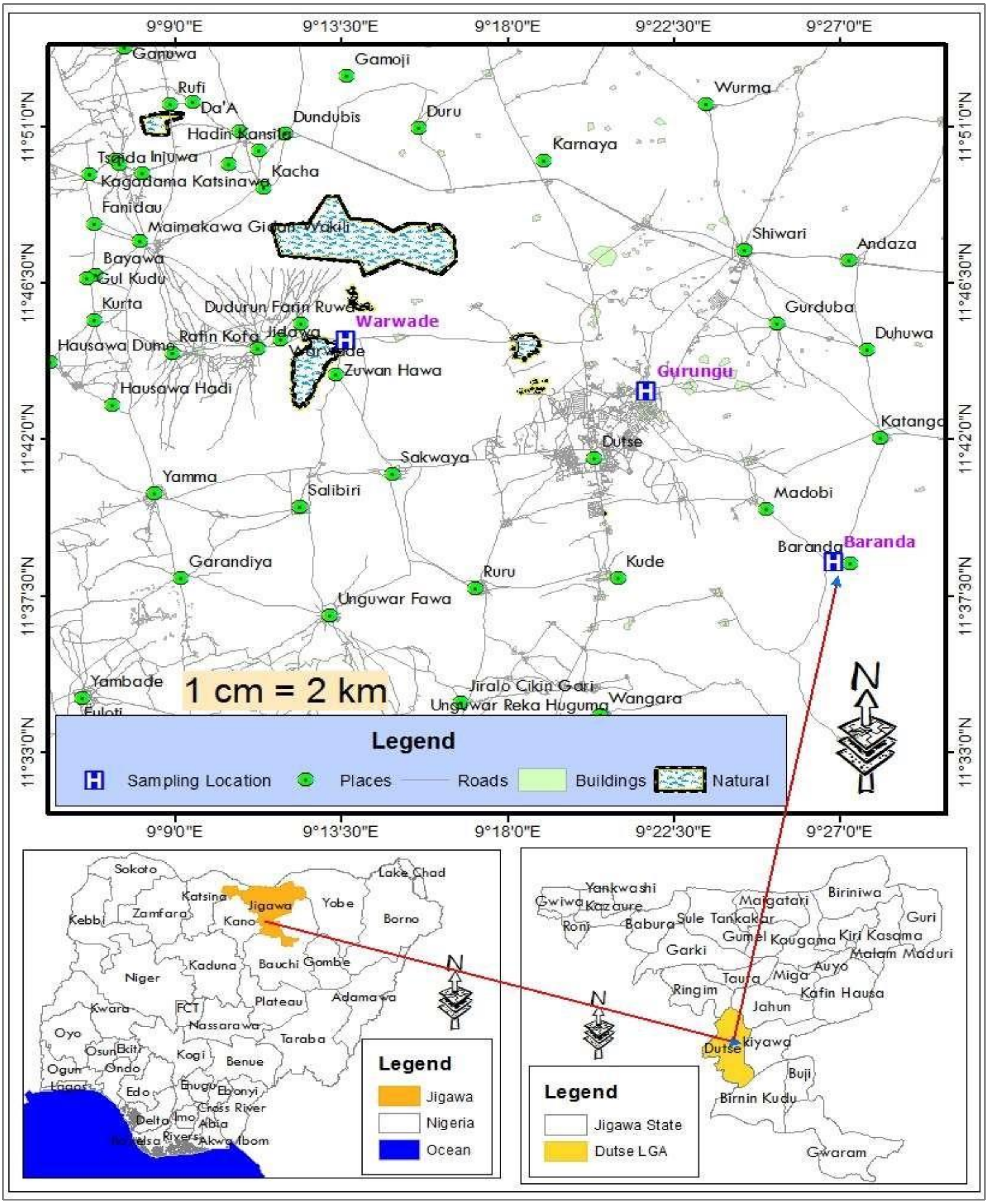

Figure 1:Map of DutseL.G.A. Jigawa State Showing Sampling Locations.

RESULTS

Indoor resting density of female mosquitoes collected in three communities of Dutse L.G.A., Jigawa State

A total of 3563 mosquitoes comprising 2883 female Anophelesand 680 femaleCulex were collected in thirty households in Gurungu, Baranda and Warwade over seven months. The Indoor resting density of Female *Anopheles* sp. Collected in three communities of Dutse L.G.A., Jigawa State is presented in Table 1 and Figure 2. Lower IRD was recorded in Gurungu (0.0 in June and 0.1 in May). Relatively higher IRD were recorded in Warwade (23.3 in April and 26.1 in August). The highest IRD was significantly (P=0.029)recorded in Baranda (33.0 in

September and 34.4 in August).The result of Indoor resting density of Female *Culex* sp. Collected in three communities of Dutse L.G.A., Jigawa State is presented in Table 2 and Figure 3. Lower IRD of female *Culex* were recorded in June at Baranda (0) and Warwade (0), while in Gurungu (2.5), lower IRD was recorded in April. Relatively higher IRD were recorded in August at Gurungu (9.8), followed by Warwade (3.3) in September and Baranda (0.5) in July and September. The highest IRD was recorded significantly (P=0.002) in July at Gurungu (13.7), while October recorded the highest IRD in both Baranda (2.8) and Warwade (5.5), respectively.

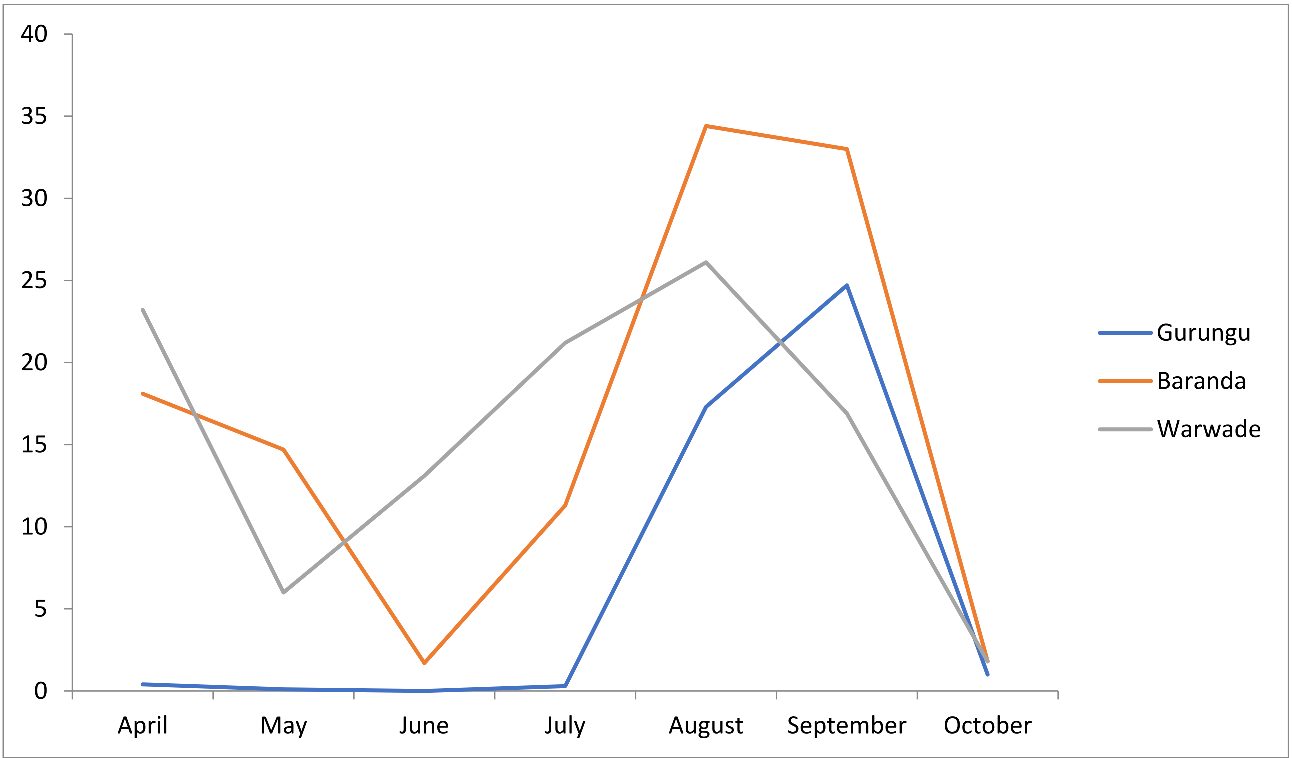

Figure 2: IRD of Female *Anophelessp.* Collected in Dutse L.G.A.

Table 1: Indoor resting density of Female *Anopheles* sp. Collected in three communities of Dutse L.G.A., Jigawa State

Months	**No. of Houses sampled**	**Communities**					
		Gurungu		Baranda		Warwade	
		No. of Female *Anopheles* collected	Indoor Resting Density	No. of Female *Anopheles* collected	Indoor Resting Density	No. of Female *Anopheles* collected	Indoor Resting Density
April	10	4	0.4	181	18.1	232	23.2
May	10	1	0.1	147	14.7	60	6.0
June	10	0	0	17	1.7	131	13.1
July	10	3	0.3	113	11.3	212	21.2
August	10	173	17.3	343	34.4	261	26.1
September	10	247	24.7	330	33.0	169	16.9
October	10	10	1	18	1.8	18	1.8
Total	70	451	6.4	1149	16.4	1083	15.5

IRD, P= 0.029 across the sampled locations, P= 0.004 across the months, Significant at P≤0.05

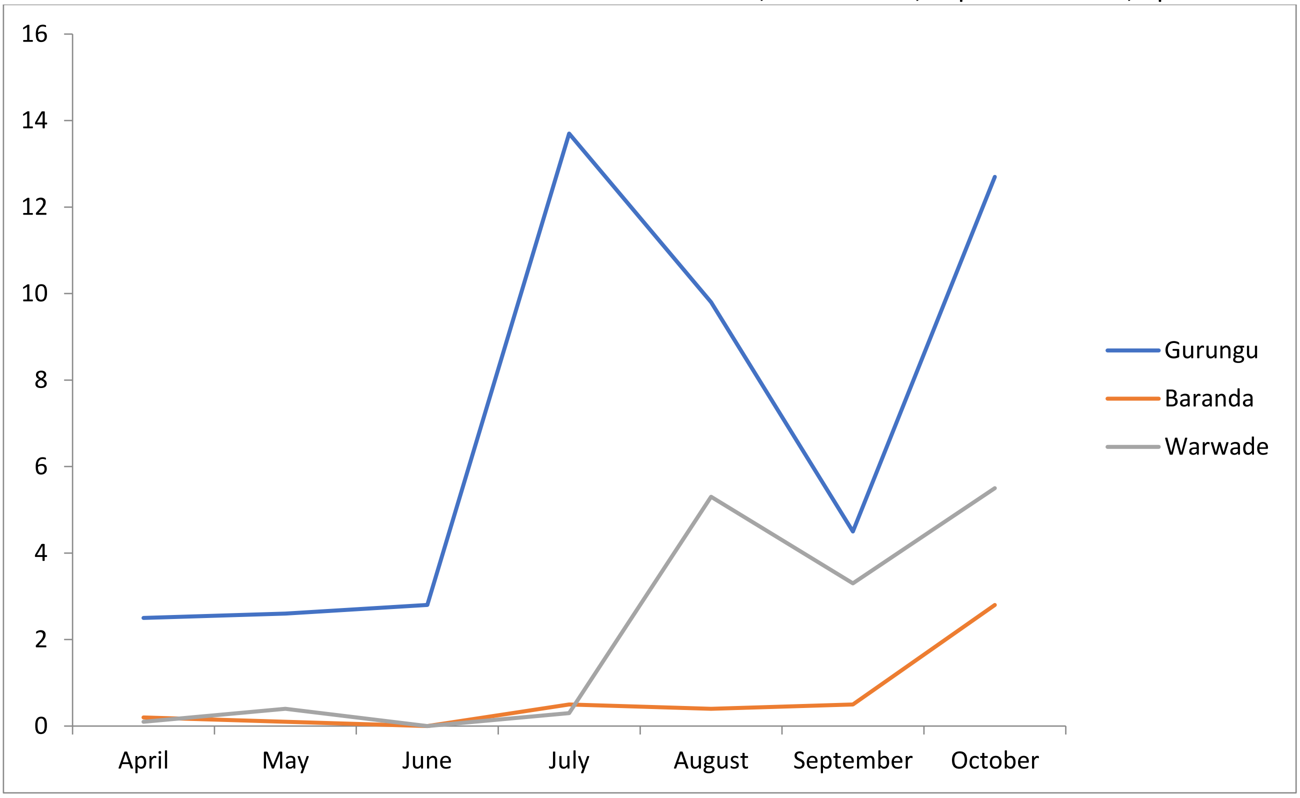

Figure 3: IRD of Female *Culex sp.* collected from Dutse L.G.A.

Table 2: Indoor resting density of Female *Culex* sp. Collected in three communities of Dutse L.G.A., Jigawa State

Months	**No. of Houses sampled**	**Communities**					
		Gurungu		Baranda		Warwade	
		No. of Female *Culex* collected	Indoor Resting Density	No. of Female *Culex* collected	Indoor Resting Density	No. of Female *Culex* collected	Indoor Resting Density
April	10	25	2.5	2	0.2	1	0.1
May	10	26	2.6	1	0.1	4	0.4
June	10	28	2.8	0	0	0	0
July	10	137	13.7	5	0.5	3	0.3
August	10	98	9.8	4	0.4	53	5.3
September	10	45	4.5	5	0.5	33	3.3
October	10	127	12.7	28	2.8	55	5.5
Total	70	486	6.94	45	0.64	149	2.10

IDR, P= 0.002 across the sampled locations, P= 0.075 across the months, Significant at P≤0.05

DISCUSSIONS

In this study, higher IRD for both female *Anopheles* and *Culex* were recorded in the wet season. This is similar to the finding of Olayemi *et al.* (2014) in Minna and Awolola *et al.* (2014) in southwestern Nigeria. The presence of higher IRD in a wet season could be because the three communities have many man-made and natural breeding sites that harbour the rainwater, which is an idle condition for breeding. According to Imbahale et al. (2011), such conditions promote speed development and a higher survival rate of larvae and pupa stages of mosquitoes.

The higher IRD of female *Anopheles* recorded in this study (33.8) is higher than the findings of Umar *et al.* (2015) and Umar *et al.* (2021). This also confirmed collected mosquitoes' endophagic, endophilic, and anthropophagic characteristics (Loaiza *et al.,* 2008). This could be because the mosquito wants to avoid the harsh environmental conditions and feed on the host.

Moreso, Baranda, and Warwade accounted for the highest IRD. This may not be a surprise, as the former had a river and later had a dam, where irrigation farming, rice puddles, and water canals were confirmed as favourable breeding sites for *Anopheles* mosquitoes. Another reason for recording higher IRD in the study sites may be related to the lack of awareness of the preventive measures and the residents participating the activities that would attract mosquitoes in their rooms, like leaving windows and doors open, and also be related to puberty as the majority of the people cannot afford to buy insecticides. It may also be related that the majority of the houses in the study area were close to the dam, bush and indiscriminate practice of farming activities everywhere in the communities.

The highest IRD of female *Culex* recorded in this study is lower than the finding of Ebenezer *et al.* (2014), which recorded 47.0 in Yenagoa, Bayelsa state. This study's finding also confirmed Culex's endophilic and endophagic behaviour. The resting behaviour of *Culex* indicates that it may be a significant vector of filarial worms in rural areas. Gurungu recorded the highest IRD of female *Culex. This* may not surprise me because it is characterized by improper waste disposal, lack of drainage, and polluted water, which are ideal breeding sites for *Culexsp.* (Afolabi *et al.,* 2019). Another reason for having higher *Culex* IRD could be because of the nature of their houses and the type of animals in their home (Abdullahi *et al.,* 2018).

However, according to Animut *et al.* (2013), the higher IRD of female mosquitoes could be because of cooking style, sleeping, and tethering livestock in the houses, which may accelerate indoor temperature and provide more access to blood.

An IRD of 0.25 of *Anopheles*sp per house was associated with epidemic transmission, whereas an IRD of 0.005 per mosquito per house was regarded as a normal level expected during the non-epidemic month (Lindblade and Walker, 2000).

CONCLUSIONS

Based on the findings from these studies, the highest IRD of female *Anopheles sp.* was recorded at Baranda (34.3) in August, and the Highest IRD of female *Culex s*p. was recorded atGurungu (13.7) in July.

RECOMMENDATIONS

There is a need for sensitization and awareness of the activities that promote the breeding of mosquitoes in the study area. Also, further studies are of paramount importance as they will help identify the indoor resting mosquitoesat the molecular level.

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