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ASSESSMENT OF INDOOR RESTING DENSITY OF FEMALE ANOPHELINE MOSQUITOES IN HUMAN RESIDENCE AT BIRSHIN FULANI VILLAGE, BAUCHI, BAUCHI STATE

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Abstract

In Nigeria, malaria accounts for 60% of outpatient visits to health facilities, 30% of childhood death, 25% of death in children under one year and 11% maternal death in addition to the about 132-billion-naira financial loss in form of treatment costs, prevention, loss of man-hours etc. in Nigeria (FMOH/ NMCP, 2009). The pyrethrum spray collection (PSC) was conducted weekly between 0600 and 0800 hrs. for assessments of IRD of female Anopheles mosquitoes using the WHO protocols (WHO, 1992). Higher indoor resting density (IRD) of female Anopheles mosquitoes were observed during the wet season in the month of September and lower IRD was recorded in the month of October. *Anopheles gambiae*, *Anopheles funestus*, Anopheles coustaniand Anopheles niliwere identified during the study. One spray circle is sufficient in the rural community since irrigation facilities are not available.

INTRODUCTION

About 3.2 billion people, almost half of the world's population are at risk of malaria and in 2013, there were about 198 million cases and an estimated 584,000 deaths due to malaria. Also 90% of all malaria deaths occurred in the WHO African Region, mostly among children under 5 years of age (WHO, 2014). However, it is encouraging to note that increased prevention and control measures have led to a reduction in malaria mortality rates by 47% globally since 2000 and by 54% (58% among children) in WHO African Region (WHO, 2014). This significant progress in reducing malaria mortality and morbidity was mainly due to the Roll Back Malaria (RBM) initiative, which aimed to reduce at least by 50% the number of malaria deaths in 2010 and 75% by 2015 (WHO, 2010).

In Nigeria, malaria accounts for 60% of outpatient visits to health facilities, 30% of childhood deaths, 25% of death in children under one year and 11% maternal death in addition to the about 132 billion Naira financial loss in form of treatment costs, prevention, loss of man-hours etc. in Nigeria (FMOH/ NMCP, 2009).

In recent years, Indoor Residual Spraying (IRS) is being adopted and scaled up to protect entire households and community members who possibly have no access to treated bed nets in Africa (Beier *et al*., 2008). In Nigeria the Federal Government Policy on Malaria Control focuses on LLINs, IRS, Intermittent Preventive Treatment (IPT) and Environmental management (NMCP, 2014). In line with these strategies, NMEP has scaled up IRS in seven World Bank Supported Malaria Booster States (Bauchi, Gombe, Kano, Jigawa, Rivers, Anambra, Akwa Ibom) and Lagos States Nigeria from 2009 to 2014 to supplement LLIN and environmental management.

The World Health Organization recommended that the planning, execution and evaluation of any anti-vector measures have to be based on a perfect knowledge of the bionomics of the vector species (WHO, 1975). Therefore, planning of IRS intervention may among other factors, include

the assessment of IRD of female Anopheles mosquitoes in human dwellings as it is known to influence the vectorial role of mosquitoes in transmission malaria (Noutcha and Anumudu, 2009; Mboera *et al.*, 2010).

The IRD of Anopheles mosquitoes were investigated in some parts of northern Nigeria (Olayemi et al., 2011; Suleiman, 2012; Onyido et al., 2014) and Southern Nigeria (Ebenezer et al., 2013; Amaechi *et al.,* 2014; Okorie *et al*., 2014). However, there is dearth of information on the IRD of female Anopheles mosquitoes in Northeastern Nigeria (Yariyo *et al*., 2013). This necessitated the present study to investigate the IRD of female Anopheles mosquitoes to guide IRS intervention Bauchi State.

MATERIAL AND METHOD

Study Area

The study was conducted from September to October 2019 in Birshin Fulani (latitude10^0.14'50.9N and longitude 09.44'52.92E) along Bauchi-Dass road, which is about 500m from the federal polytechnic Bauchi and 3km from the state headquarter Bauchi state, Nigeria. The vegetation of Birshin Fulani is Sudan Savanna type. Birshin Fulani is an agricultural area by virtue of its vegetation type, the inhabitants are mainly subsistent farmers and cultivated crops include maize, groundnut, beans, rice, soya beans and guinea corn. The farmers also keep and rear animals such as cattle, sheep and goats. The housing structures are made of sand screed blocks, mud and thatched. The inhabitant sleeps indoor during the nights, but some sleep outdoors during the hot dry season. The sources of water for the community are bore holes and hand dug wells. During the rainy season, transient pools of water bodies are available in the area thus providing stagnant water bodies during the dry season serving as breeding habitat for mosquitoes.

Selection of Houses

The area was divided in to four segments using North-South, West-East transects. In each segment, five (5) households were randomly selected among different available building types (sand screed blocks, mud, etc.) In each household, one room where person or people slept the previous night was selected for the PSC. The community leaders were involved in community sensitization on the basis and procedures for the PSC.

Collection of Mosquitoes and Preservation

The PSC was conducted weekly between 0600 and 0800 hrs for assessments of IRD of female Anopheles mosquitoes using the WHO protocols (WHO, 1992). The procedures are briefly; all animals were removed while food items were covered with bed sheets. The floor and bed of each selected room was covered with white bed sheets (4 X 4 meters). Thereafter, windows and doors were closed and the room was sprayed with commercial pyrethrum-based aerosol until the room was filled with the insecticidal mist. After 10 minutes the room was opened and the sheet was carefully picked up at the corners by two collectors and removed outside. All female Anopheles mosquitoes were sorted and preserved in a plastic container containing silica gel, while the males and other mosquito species were discarded.

Identification of Anopheles Mosquitoes

The preserved adult female Anopheles mosquitoes were identified using the morphological keys of Gillies and Coetzee (1987).

Data analysis

The IRD of female Anopheles mosquitoes was computed using WHO (2003) criteria, via: IRD=Number of females collected / number of houses sampled x number of nights.

Results

A total of 932 mosquitoes were collected in forty households at Birshin Fulani community over the periods of 2 months (Table 5). In all the segment sites, lower IRD of female Anopheline spp were recorded in the North segment (6.2 in the month of October and 8.6 in the month of September) followed by south segment (8.8 in the month of September and 7.0 in the month of October), respectively. Relatively higher IRDs were recorded in the East segment (10.2 in the month of September and 8.0 in the month of October) followed by West segment (7.8 in the month of October and 10.8 in the month of September) respectively.

Table 1: Indoor Resting Density of *Nili* Spp in Birshin Fulani in Bauchi Local Government area, Bauchi State

Month	Segment	No. of house	No. of mosquitoes	No. of female anopheles	No. of *Nili* Specie	I.R.D
September	North	5	132	43	7	1.4
	South	5	121	44	10	2
	West	5	150	54	8	1.6
	East	5	145	51	9	1.8
October	North	5	69	31	10	2
	South	5	108	39	10	2
	West	5	99	35	13	2.6
	East	5	110	40	12	2.4
Total		**40**	**932**	**337**	**78**	**1.98**

Table 1; represent the result of Indoor Resting Density of *Nili Spp* collected from the segments of the study area. Out of the 932 mosquitoes collected from the 40 houses of all the segments of the study area in September and October indicated that the total number of female anopheles *spp* is 337 and the total number of *Nili* Specie is 78, leaving the I.R.D of the total sample at 1.98.

Table 2: Indoor Resting Density of *Coustani* Spp in Birshin Fulani in Bauchi Local Government area, Bauchi State

Month	Segment	No. of house	No. of mosquitoes	No. of female anopheles	No. of *Coustani* Specie	I.R.D
September	North	5	132	43	6	1.2
	South	5	121	44	9	1.8
	West	5	150	54	8	1.6
	East	5	145	51	8	1.6
October	North	5	69	31	11	2.2
	South	5	108	39	9	1.8
	West	5	99	35	12	2.4
	East	5	110	40	14	2.8
Total		**40**	**932**	**337**	**77**	**1.93**

Table 2; represent the result of Indoor Resting Density of *Coustani Spp* collected from the segments of the study area. Out of the 932 mosquitoes collected from the 40 houses of all the segments of the study area in both September and October indicated that the total number of female anopheles is 337 and the total number of *Coustani Spp* is 77, leaving the I.R.D of the total sample at 1.93.

Table 3: Indoor Resting Density of *Funestus* Spp in Birshin Fulani in Bauchi Local Government area, Bauchi State

Month	Segment	No. of house	No. of mosquitoes	No. of female anopheles	No. of *Funestus* Specie	I.R.D
September	North	5	132	43	8	1.6
	South	5	121	44	9	1.8
	West	5	150	54	7	1.4
	East	5	145	51	10	2
October	North	5	69	31	12	2.4
	South	5	108	39	12	2.4
	West	5	99	35	13	2.6
	East	5	110	40	11	2.2
Total		**40**	**932**	**337**	**82**	**2.05**

Table 3; represent the result of Indoor Resting Density of *Funestus Spp* collected from the segments of the study area. Out of the 932 mosquitoes collected from the 40 houses of all the segments of the study area in both September and October indicated that the total number of female anopheles is 337 and the total number of *Funestus* Specie is 82, leaving the I.R.D of the total sample at 2.05.

Table 4: Indoor Resting Density of *Gambiae* Spp in Birshin Fulani in Bauchi Local Government area, Bauchi State

Month	Segment	No. of house	No. of mosquitoes	No. of female anopheles	No. of *Gambiae* Specie	I.R.D
September	North	5	132	43	8	1.6
	South	5	121	44	10	2
	West	5	150	54	8	1.6
	East	5	145	51	12	2.4
October	North	5	69	31	10	2
	South	5	108	39	13	2.6
	West	5	99	35	14	2.8
	East	5	110	40	13	2.6
Total		**40**	**932**	**337**	**88**	**2.2**

Table 4; represent the result of Indoor Resting Density of *Gambiae Spp* collected from the segments of the study area. Out of the 932 mosquitoes collected from the 40 houses of all the segments of the study area in both September and October indicated that the total number of female anopheles is 337 and the total number of Specie is 88, leaving the I.R.D of the total sample at 2.2.

Table 5: Indoor Resting Density of Female Anopheline Mosquitoes in Birshin Fulani Bauchi Local Government area, Bauchi State

Month	Segment	No. of house	No. of mosquitoes	No. of female anopheles	I.R.D
September	North	5	132	43	8.6
	South	5	121	44	8.8
	West	5	150	54	10.8
	East	5	145	51	10.2
October	North	5	69	31	6.2
	South	5	108	39	7.8
	West	5	99	35	7
	East	5	110	40	8
Total		**40**	**932**	**337**	**8.43**

The result of the survey carried out for IRD of female anopheline mosquitoes in human residence at malaria vector in Birshin Fulani in Bauchi Local Government area, Bauchi State, is as indicated in the tables above. The survey was carried out for two months, i.e. the month of September and October. The survey covers four segments of the study area, i.e. the North, South, West and East. Samples were collected from 5 houses in each segment of the study area and the number of all species of mosquitoes was recorded as seen in the tables above.

The result in table 5, shows that, the number of female anopheles collected from each of the 5 houses of the four segments of the study area were averagely the same, i.e. 337 which is by far more the number of *Nili* Specie (78), number of *Coustani Spp* (77), number of *Funestus* Specie (82) and *Gambiae* Specie (88). From table 5, the total I.R.D for the female anopheles is 8.43.

DISCUSSION

The study area is located in the Sudan savannah climatic zones of Nigeria where malaria is endemic due to availability of Anopheles mosquitoes all year round. The finding of the present study recorded higher IRD (9.1 – 9.3) of female Anopheles mosquitoes within the month of September and October. This confirm the earlier findings that recorded higher IRD of anopheline mosquito during the rainy season in Northern Nigeria (Olayemi *et al.*, 2011; Yariyo *et al*., 2013; Olayemi *et al*., 2014) and Southern Nigeria (Alaribe *et al.*, 2002; Oyewole *et al.*, 2007; Onyido *et al.*, 2009; Awolola *et al*., 2014).

The high IRD of adult female Anopheles mosquitoes during the rainy season was not surprising because the field environment in the study site contains numerous transient natural breeding habitats that result from rain waters. Earlier studies confirmed that high proliferation of natural breeding sites during the rainy periods guaranteed faster developmental and higher survival rates of immature stages of Anopheles mosquitoes (Olayemi and Ande, 2008; Imbahale *et al*., 2011). Although the present study has not captured the rainfall and temperature profile of the studied site, earlier studies has shown that mosquito abundance have a positive relationship with rainfall and inversely related to temperature (Uttah *et al*., 2013). The higher IRD confirmed that in the rainy season, Anopheline mosquitoes tend to be more endophagic, endophilic and anthropophagic, in order to avoid the hash environmental outdoor conditions (Loaiza *et al*., 2008; Olayemi and Ande, 2008a). These could have been responsible for the higher IRD during the wet season reported in the present study. Other reasons for the high IRD of Anopheles mosquitoes could be due to the tradition of cooking, sleeping and tethering livestock inside residential houses which may increase indoor temperature and providing access to blood meal

sources (Animut *et al*., 2013). Other studies showed that higher densities of Anopheline mosquitoes during the rainy season are to a large extent, explains the seasonal pattern of clinical cases of malaria, with peak transmission shortly after maximum annual rainfall (Olayemi *et al*., 2009).

An IRD of 0.25 Anopheles mosquitoes per house was associated with epidemic transmission, whereas 0.05 mosquitoes per house were chosen as normal level expected during non-epidemic month (Lindblade and Walker, 2000). The IRD of female Anopheles mosquitoes that found in the study area are sufficient to cause malarial transmission in the community. Therefore, proactive malaria prevention and control strategies including IRS are imperative to halt both wet and dry season malaria transmissions in the State.

The results of species identifications revealed the dominance of *An. gambiae* and to a lesser extent *An. funestus*. The *An. gambiae* and *An. funestus* are strongly anthropophilic (Mbogo *et al*., 1993) and several studies have indicated that *An. gambiae* ss, *An. funestus* complexes are major vectors while *An. nili* is a secondary

Vector of malarial in Nigeria (Boreham *et al*., 1979; Molineaux and Gramiccia, 1980; Gillies and Coetzee, 1987; WHO, 1992) and other Africa countries (Mwangangi *et al*., 2003). The high IRD of *An. gambiae and An. funestus* populations may have serious implications in malaria transmission in the community. The findings of the present study in the light of IRS intervention in Birshin Fulani implies that spraying of structures should commence in May (dry season) as suggested by Oduola *et al*., (2013) and that the insecticides should persist for six months to adequately protect the population throughout the intensive transmission during the wet season. One spray cycle during the wet season is sufficed in community except in situations where irrigation and other water related projects that provide breeding habitats exist.

CONCLUSION

i. *Anopheles gambiae*, *Anopheles funestus,* Anopheles coustaniand *An. Nili* are the major *Anopheles* mosquitoes collected indoors in the study area.

ii. The *Anopheles species* were more abundant in the rainy season than the dry season due to the presences of ponds, swamps, rice fields and grassy ditches, in the study area.

iii. *Anopheles funestus, An. Gambiae, An. Coustani* and *An. Nili* were positive to *P. falciparum* and *P. malariae* ELISA assay. Therefore, are suggested to be the main malaria vectors.

iv. Spraying of structures in Birshin Fulani in Bauchi L.G.A, Bauchi State should commence in May or June and the insecticides should persist for six months and one spray cycle is sufficed in the rural communities where irrigation facilities are not available.

RECOMMENDATIONS

Malaria transmission in Birshin Fulani in Bauchi L.G.A, Bauchi State seems to be related to the *Anopheles* species present. The use of insecticide treated nets is recommended for local control. However, personal protection and treatment of breeding sites such as chemical larviciding, fogging or Area spraying should be the main control strategy, alongside any complementary indoor control activities such as residual spraying among others. Further studies should be carried on the hybrid to understand their population, biology and vectorial capacity and insecticide resistance.

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