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Assessment of Indoor Resting Density of Female Anopheline Mosquitoes in Human Dwelling at Malaria Vector Sentinel Sites in Bauchi State, Nigeria

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Abstract

Background: The Nigerian National Malaria Elimination Programme (NMEP) implemented Indoor Residual Spraying (IRS) in 2009 and gradually scale-up to achieve 85% coverage in 20% of eligible structures in 2014 to supplement Long lasting Insecticidal Nets (LLIN) and environmental management. The Bauchi State

Malaria Control Booster Project (BSMCBP) implemented IRS in Misau and Giade Local Government Areas from 2009 to 2014. In 2012, BSMCBP established malaria vector sentinel sites at Madachi and Gambaki Villages of Katagum Local Government Area to guide planning of IRS activities in the State. This study presents the indoor resting density (IRD) of Anopheles mosquitoes at the sentinel communities.

Methods: The Pyrethrum Spray Collection (PSC) was conducted monthly for 12 months between 0600 and 0800 hrs to assess the IRD of female Anopheles mosquitoes in human dwellings in the sentinel sites according to standard WHO protocol.

Results: Higher IRD of female Anopheles mosquitoes were observed during the wet season in the months of July, August and September and lower IRD was recorded in the dry season in January, February, March, April, May, June, October, November and December. *Anopheles gambiae*, *Anophelus fenustus* and *Anopheles nili* were identified during the study.

Conclusion: Sparying of structures in Bauchin State should commence in May or June and the the insecticides should persist for six months and one spray cycle is suffice in the rural communities where irrigation facilities are not available.

Keywords: Indoor Resting Density, Indoor Residual Spraying, Malaria, Anopheles mosquitoes, Bauchi State, Nigeria

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 Organisation 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 (Rishikesh et al., 1985; Olayemi et al., 2011; Suleiman, 2012; Onyido et al., 2014) and Southern Nigeria (Alaribe *et al.,* 2002; Oyewole et *al.,* 2007; Onyido *et al.,* 2009; Oringanje et al., 2011; Okwa et al., 2007; 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 in Bauchi State.

Materials and Methods

Study Areas

The study was conducted from April, 2012 to March 2013 in two rural communities of Madachi (Latitude 11^o 50’ longitude 10^o 43’) and Gambaki (Latitude 11^o 58’ longitude 10^o 33’), Katagum LGA, Bauchi State, Nigeria. The sentinel sites has tropical savanna vegetation. Gambaki has annual temperature of 26.0^{o}C and precipitation of 777mm while Madachi has annual temperature of 25.7^{o}C and precipitation of 791mm (Climate Data, 2014). The inhabitants are mainly subsistent farmers and cultivated crops includes sorghum, millet, maize, groundnuts and cowpea. 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 communities are bore holes and hand dug wells. During the rainy season, transient pools of water bodies are available in the sentinel communities thus providing stagnant water bodies during the dry season serving as breeding habitat for mosquitoes.

Selection of Houses

Each sentinel community was divided in to four segments using North-South, West-East transects. In each segment, ten (10) households were randomly selected among different available building types (sand screed blocks, mud, thatched 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 rationale and procedures for the PSC.

Collection of Mosquitoes and Preservation

The PSC was conducted monthly 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 are covered with bed sheets. The floors and beds of each selected room is 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 were carefully picked up at the corners by two collectors and removed outside. All female Anopheles mosquitoes sorted and persevered in 1.5 ml Eppendorf tube 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 DeMeillon (1968) and Gillies and Coetzee (1987).

Data analysis

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

Results

A total of 3797 female Anopheles mosquitoes were collected in forty households at Madachi and Gambaki sentinel communities over the periods of 12 months (Table 1). In both sentinel sites, lower IRD of female Anopheline spp were recorded in the months of January (0.85 and 0.96), February (0.58 and 0.50), March (0.40 and 0.23), April (0.03 and 0.00), May (0.10 and 0.00) and June (0.35 and 2.63) for Madachi and Gambaki sites, respectively. Relatively higher IRDs were recorded in the month of October (5.50 3.33), November (3.45, 2.53) and December (1.05, 1.03). However, higher IRD was observed in July (10.85 and 13.28), August (14.00 and 11.55), September (9.10 and 12.65) for Madachi and Gambaki sites, respectively.

The morphological identifications of preserved female Anopheles samples indicated that species composition was dominated by *Anopheles gambiae* constituting 72%, followed by *Anophelus fenustus (*23%), *Anopheles nili* (2%) and unidentified Anopheles species (3%).

Table 1: Indoor Resting Density of Female Anopheline Mosquitoes in Two Sentinel Sites in Katagum Local Government area, Bauchi State

		Sentinel site			
		Madachi		**Gambaki**	
Month	**Number of Houses/Rooms sampled**	**No. Female Anopheles Mosquitoes collected**	**Indoor Resting Density (IRD)**	**No. Female Anopheles Mosquitoes collected**	**Indoor Resting Density (IRD)**
April, 2012	40	01	0.03	00	0.00
May, 2012	40	04	0.10	00	0.00
June, 2012	40	14	0.35	105	2.63
July, 2012	40	434	10.85	531	13.28
August, 2012	40	560	14.00	462	11.55
September, 2012	40	364	9.10	506	12.65
October, 2012	40	220	5.50	133	3.33
November, 2012	40	138	3.45	101	2.53
December, 2012	40	42	1.05	41	1.03
January, 2013	40	34	0.85	39	0.96
February, 2013	40	23	0.58	20	0.50
March, 2013	40	16	0.40	09	0.23
Total	**480**	**1850**	**3.85**	**1947**	**4.06**

Discussion

The sentinel sites are 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 (9.10 - 14.00) of female Anopheles mosquitoes during the wet seasons (July, August, September). 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 suprising becouse the field environment in the sentinel sites 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, 2008b; Imbahale *et al*., 2011). Although the present study has not captured the rainfall and temperature profile of the sentinel sites, earlier studies have 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).

The present investigation revealed lower (0.00 - 5.50) IRD of adult female Anopheles mosquitoes during the dry seasons (January to June and October to December). These is consistent with previous findings (Alaribe *et al.*, 2002; Adeleke *et al*., 2010; Suleiman, 2012; Oduola *et al*., 2013; Amaechi *et al.*, 2014; Okorie *et al*., 2014; Onyido *et al*., 2014) that separately documented lower number of Anopheles mosquitoes during the dry seasons. The low populations of female anopheles mosquitoes could be attributed to fever breeding habitats exist in the sentinel communities during the dry season.

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 current investigation revealed that IRD in the months of April and May are below the critical density of 0.02 per house per night required for maintaining transmission (Lindblade and Walker, 2000). The IRD of female Anopheles mosquitoes in all other months are sufficient to cause malarial transmission in the communities. 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 *A. gambiae* and *A. 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 vectors 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 State.

The findings of the present study in the light of IRS intervention in Bauchi State 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 insentensive transmission during the wet season. One spray cycle during the wet season is suffice in rural communities of Bauchi state except in situations where irragtion and other water related projects that provide breeding habitats exist. It also merits further identifications of the *An gambiae* complex and *An funestus* group in the state.

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