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Original Research Paper

Malaria vectors composition and malaria transmission indices in some parts of Imo State.

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ABSTRACT:
To assess Malaria vectors composition and malaria transmission indices in some parts of Imo State. Mosquitoes were caught indoors using pyrethrum spray catches twice monthly during the hours of 7.00am and 10.00am. Species were morphologically identified: *Anopheles gambiae, An. funestus,* (malaria transmitting vectors) and other *mosquitoe species*. Only malaria transmitting vectors were dissected and processed for transmission indices. Of 1,224 mosquitoes, malara transmitting vectors (*Anopheles gambiae* and *An. funestus)* represented 34.88% and 27.94 while non-malaria transmitting vectors (*Aedes* and *Culex* species) represented 37.17%. More mosquitoes were caught during rainy season than during the dry season (66.99% and 33.00%). The month of July had the highest mosquito density and parity (27.69%). Of the 509 Anopheles mosquitoes species dissected, 509 were blood fed while 6(1.17%) were positive. The study recorded a Sporozoite Infection Rate (SR) of (1.17) and Entomological Inoculation Rates (EIR) was (0021%) per person per night. Malaria risk indices in the study area is highlighted.

Keywords: Malaria, Vector, An.gambaie, An. funestus

INTRODUCTION:

Despite impressive progress in malaria control interventions in many endemic countries, malaria remains the most important vector-borne parasitic disease worldwide (Shiff et al., 2011) and is endemic in more than 100 countries worldwide (WHO, 2009). Malaria continues to be a major public health problem in 97 countries and territories in the tropics and subtropics. Globally, approximately 214 million cases of malaria occur annually and 3.2 billion people are at risk of infection (WHO, 2015). The entomological inoculation rate (EIR) estimates the risk of contracting malaria in a particular area by expressing the number of infective bites a person may receive per unit time (MacDonald 1957). It is the most important entomological parameter for assessing the level of malaria endemicity and the intensity of transmission in a given area (Burkot & Graves 1995, Rubio-Palis et al. 1992). The EIR is highly valuable for monitoring the suitability of vector control operations (Coosemans et al. 1992) and the risk of development of an epidemic (Onori & Grab 1980). It is particularly relevant in areas with more than one species of vectors, such as the municipality of Sifontes, to estimate the contribution of each species to malaria transmission (Galardo et al. 2007).

MATERIAL AND METHODS:

Study Area:

The study was conducted in Four (4) selected communities each from two Local Government Areas (Obowo and Owerri North) in Imo state (Figure 1). Obowo LGA is found between Latitude 5º10[1]N-5º5[1]N and Longitude 6º35[1] E-7º28[1] E while Owerri North Latitude 5°15[1] N-5°34[1] N and Longitude 7°15[1]E-7º30[1] E. The rainy season begins in April and lasts until October, with annual rainfall varying from 1,500mm to 2,200mm. An average annual temperature above 20 °C (68°F) creates an annual relative humidity of 75% with humidity reaching 90% in the rainy season. The chief occupation of the local people is farming, but due to over-farming and high population density, the soil has greatly degraded. The cash crops include oil palm, raffia palm, groundnut, melon, rubber, and maize. Consumable crops such as yam, cassava, cocoyam and maize are also produced in large quantities. Their houses are made of brick walls with corrugated metal sheets/roofs, few live in mud houses with thatched roofs for those in rural areas. Source of water in these area include village stream, boreholes and roof catch water which are stored in buckets, cans etc. Refuse are heaped around houses, schools, roads, and market square constituting complementing poor drainage systems as a result of this, the sanitation is poor. Hence, it can encourage the transmission or dissemination of parasites. They also cause flood during rainfalls and contribute to the breeding of mosquitoes leading to high malaria transmission rate and prevalence.

Ethical considerations:

Ethical approval for the study was gotten from the Post Graduate Board of the Department of Zoology, Imo State University Owerri ethics committee and the Imo State Ministry of Health Consent were sought and obtained from the village heads. Also, Informed consent were obtained from the participants.

Data Collection:

Data collection involved Malaria vector collection.

Malaria vectors collection, preservation and Identification

Twenty five (25) households (at least 10 mud and 15 bricks) were selected from each study area. This was to represent the houses in the area. Anthropophilic mosquitoes were collected using pyrethrum spray catches (types used were snipper flying insect) twice monthly during the hours of 7.00am and 10.00am (Mbora et al 2006) modified by Amaechi, 2009). The proportion of indoors mosquitoes were sampled by covering the floor with a white sheet of 5mX5m each edge held to the wall by a masking tape. The rooms were spread with the insecticide and then left for 10 minutes with every opening (Doors and Windows) shut. Mosquitoes were collected thereafter with forcepts into petridish lined with normal saline and transported to Entomology laboratory of Imo State University Owerri for identification and processing. Upon collection, Anophelines were sorted from other mosquitoes and identified to species based on morphologyical features (Gillies and De-Mellion, 1968; Gilles and Coetzee 1987; Amaechi et al 2019)

Dissection and Parity rate determination:

The female mosquitoes were dissected by removing the wings and legs and placed the mosquito ventrally on a slide with the head on the left hand side. The mosquitoes were held in place by the thorax with the right hand needle while a small cut was made between the sixth and seventh sternite. The second needle was then used to extract the ovaries, thereby examining the stomach for sporozoites from posterior to anterior using a microscope. Blood fed females were dissected to determine parity by observing the degree of ovarian trachioles (Detinova, 1962). Determination of Entomological Innoculation raee (EIR) necessitated two other measurements; the sporozoite rate and the human biting rate. The abdominal and ovary dissection was conducted following the standard of WHO (1975). Ovaries with coiled tracheal skeins were considered as nulliparous while those stretched out tracheoles was taken to be parous as described by WHO (1975) and Fils et al (2010).

Sporozoite rate determination:

This is the number of sporozoites found in the salivary gland of dissected Anophelin. The dissection of the salivary gland followed the technique of Olayemi and Aude (2008) and WHO (2013).

Sporozoite rate which is the proportion of mosquitoes that tested positive for sporozoites.

$$SR = \frac{\text{No of mosquitoes with sporozoites} \quad X\ 100}{\text{No of dissected mosquitoes.}}$$

Calculation of annual entomological inoculation rate

The EIR was calculated as the product of the sporozoite rate and the man biting rate (MA). The MA being the number of anopheline biting per person per night ie per human bait. EIR"h" where h equals MAS and is the daily number of infective bites received per person; M is the anopheline density in relation to human, A is the average number of person bitten by one mosquito in a day and S is the proportion of female anopheline with sporozoite (Hay et al 2000). EIR is expressed as infective bites per person per month. Estimates of EIR by PSC are the product of sporozoite rate and MBR. MBR is obtained by multiplying the density per person of fed female mosquitoes (ie dividing the number of fed anopheline mosquitoes caught by number of occupants in the household) by the HBI.

$$M = \frac{F}{W}$$

Where F = total number of freshly fed mosquitoes in house

M = human biting rate

W = total number of human occupants.

Briefly, the *Pf*EIR was calculated using the following formula:

$$EIR = \frac{HBR\ X\ SR\ (\%)}{100}$$

where
EIR = Entomological Inoculation Rates
HBR= Human Biting Rate. Which is the number of female *Anopheles* mosquitoes collected per house per night, and

Data Analysis:

Data obtained from the study was analyzed statistically using Chi-Square and percentages.

RESULTS:

Table 1 demonstrated the Adult indoor malaria vectors and other mosquitoes in the study area. A total of 1,224 mosquitoes species were collected out of which 655(53.51%) were gotten from Obowo while 569(46.48%) were gotten from Owerri-North. Other (Non malaria transmitting mosquitoes) was the predominant (37.17%) followed by *An. gambaie* (34.88%) while *An. funestus* was the the least (27.94%). In Obowo, Avutu community recorded the highest number of mosquitoes species collected (16.99%) followed by Umuariam (14.46%), while Ehume had the least number of mosquitoes collected (9.06%). Also in Owerri-North, Akwakuma (14.21%) had the highest number of mosquito collection followed by Orji (13.15%) while Amakohia (9.39%) was the least. Furthermore in both LGAs, Avutu (16.99%) and Akwakuma (14.21%) had the highest mosquito collected while Ehume (9.06%) and Amakohia (9.39) was the least. Table 2 summarized Monthly variations in density and parity of malaria vectors. From the table, *An. gambaie* had the highest population of species as well as more parous mosquitoes (424 and 57.95%) than *An funestus* (342 and 42.04%) The majority of the parous mosquitoes were caught in July for *An. gambaie* (125 and 34.57%) followed by May (86 and 17.28%) while December (39 and 9.47%) produced the least.Similarly, more populations and parous *An. funestus* were caught in the month of July (86 and 31.30%) followed by June (75 and 16.35%) while December (33 and 11.21%) had the least. Table 3 summarized seasonal distribution and human biting rate of indoor resting mosquitoes. Although mosquitoes were caught in both seasons, Rainy season (66.99%) catch was twice the population of Dry season (33.00%). The variation between the seasons were significant ($P<0.05$). In rainy season non malaria transmitting mosquitoes species (37.43%) recorded the highest seasonal proportion followed by *An. gambiae* (35.48%) while *An. funestus* (27.07%)was the least. Table 4 demonstrated the overall population and distribution of sporozoites in malaria vectors. Out of the 509 *Anopheles* mosquitoes dissected, 06(1.17%) were positive with species from Obowo (83.33%) having the highest prevalence than those from Owerri-North (33.33%). Also, in Obowo, species from Ehume (33.33%) were the highest followed by species from Umuariam and Amuzi (16.66% and 16.66%). Mosquito species caught from Avutu recorded (0.00) prevalence. On the contrary, in Owerri-North, species caught in Orji recorded (16.33%) while those from Akwakuma, Amakohia and Orji recorded zero prevalences. Table 5 demonstrated the Entomological Inoculation Rate between urban and rural communities. From the table, malaria vectors caught in rural area (0.018) had a higher Entomological Inoculation Rate compared to urban area (0.003) species.

Table 1 Adult indoor malaria vectors and other mosquitoes in the Study Area

Communities	Mosquitoes Species			Total No collected	Percentage (%)
	An. gambiae	*An. funestus*	Others		
Avutu	86(20.14)	51(14.91)	71(15.60)	208	16.99
Umuariam	56(13.11)	39(11.40)	82(18.02)	177	14.46
Ehume	38(8.89)	24(7.01)	49(10.76)	111	9.06
Amuzi	49(11.47)	57(16.66)	53(11.64)	159	12.99
Sub total	**229(53.62)**	**171(50.00)**	**255(56.04)**	**655**	**53.51**
Orji	50(11.70)	39(11.40)	72(15.82)	161	13.15
Akwakuma	61(14.28)	72(21.05)	41(9.01)	174	14.21
Amakohia	38(8.89)	29(8.47)	48(10.54)	115	9.39
Works layout	49(11.47)	31(9.06)	39(8.57)	119	9.72
Sub total	**198(46.37)**	**171(50.00)**	**200(43.95)**	**569**	**46.48**
Total	**427(34.88)**	**342(27.94)**	**455(37.17)**	**1,224**	**100.00**

Key *Others = *Aedes* and *Culex* species

Table 2: Monthly variation in density and parity of malaria vectors

Months	*An. gambaie*		*An. Funestus*	
	Density	Parity	Density	Parity
May	86	51(17.28)	61	30(14.01)
June	80	39(13.22)	75	35(16.35)
July	125	102(34.57)	86	67(31.30)
October	44	39(13.22)	47	33(15.42)
November	50	36(12.20)	40	25(11.68)
December	39	28(9.49)	33	24(11.21)
Total	**424**	**295(57.95)**	**342**	**214(42.04)**

Table 3: seasonal distribution of indoor resting mosquitoes

Mosquito species	Seasons			Total
	Rainy		Dry	
Seasonal Distribution				
An. gambiae	291(35.48)		133(32.42)	424(34.64)
An. funestus	222(27.07)		120(29.70)	342(37.94)
Others	307(37.43)		151(37.37)	458(37.41)
Total	**820(66.99)**		**404(33.00)**	**1224(100.00)**

Table 4: overall population and distribution of sporozoites in malaria vectors

Communities	Mosquitoe species	No Dissected	No Positive	Percentage (%)
Avutu	*An. gambiae*	51	00	0.00
	An. funestus	28	01	16.66
Umuariam	*An. gambiae*	38	01	16.66
	An. funestus	23	0	0.00
Ehume	*An. gambiae*	26	02	33.33
	An. funestus	18	0	0.00
Amuzi	*An. gambiae*	32	01	16.33
	An. funestus	39	0	0.00
	Sub total	**255**	**05**	**83.33**
Orji	*An. gambiae*	41	00	0.00
	An. funestus	27	1	33.33
Akwakuma	*An. gambiae*	42	0	0.0
	An. funestus	49	0	0.0
Amakohia	*An. gambiae*	23	0	0.0
	An. funestus	19	0	0.0
Works layout	*An. gambiae*	31	0	0.0
	An. funestus	22	0	0.0
	Sub total	**254**	**01**	**16.33**
	Total	**509**	**06**	**1.17**

Table 5: Entomological Innoculation Rate between urban and rural communities in the study area

Area	Months	No Ex	Blood fed	HBR	SNr	EIR
	May	78	46	0.16	01(2.17)	0.003
	June	83	41	0.15	01(2.43)	0.003
Obowo	July	109	83	0.30	02(2.40)	0.007
	October	49	39	0.14	00(0.00)	0.000
	November	52	33	0.12	01(0.00)	0.003
	December	41	28	0.10	00(3.03)	0.00
	Sub total	**412**	**270**	**0.98**	**05(1.85)**	**0.018**
	May	69	35	0.12	00(0.00)	0.000
	June	72	33	0.12	00(0.00)	0.000
	July	102	86	0.31	01(1.16)	0.003
Owerri-North	October	42	33	0.12	00(0.00)	0.000
	November	38	28	0.10	00(0.00)	0.000
	December	31	24	0.08	00(0.00)	0.000
	Sub total	**354**	**239**	**0.87**	**01(0.41)**	**0.003**
	Total	**766**	**509**	**1.86**	**06(1.17)**	**0,021**

DISCUSSION:

The result herein identified two mosequito species; *An. gambiae and An.funestus* These species are vectors of Malaria and have been previously reported (Okwa *et al*., 2006; Awolola *et al* ., 2003). The absence of other spices reported by others might be due the time of collection, sampling methods used and study areas which determine the type of species (Amaechi, 2009). The study identified *An. gambiae sl. (34.88%)* as the commonest mosquito spieces. This observation is consistent with previous findings by Amaechi et al (2019) in Ebonyi State, Nigeria, Okwa *et al.*, (2006) in Lagos, Nigeria, Mboera *et al* (2002) and (2006) in Mpwapwa and Iringa District of Tanzania, Awolola *et al.*, (2003) in mid western Nigeria made similar observations respectively. Their abundance in the villages suggests that the prevailing habitats support the breeding of a range of these species. Gilles and Coetzee (1987) and Bruce-Chwalt (1975) made similar observation elsewhere. *An. gambiae* have been described as Omimipresent" in Nigeria due to its indiscriminate breeding habit as well as the highly endophilic and anthrophagic wet season vector by these researchers. Their abundance could be linked with environmental condition of the study areas and their feeding habits (host feeding increases the more frequently a host was available). These areas represented a typical rural area and are found with littered materials and water storage in and around homes (personal observations). These observations and agricultural practices have been noted to create permanent breeding habits for these vectors (Nwoke, 2000). The disparity in proportions when compared with previous studies could be due to change in climate and environmental factors. The second abundant species was *An. funestus* (27.94%). They co-breed with *An.gambiae* and the number observed probably tells that they are exopligic but endophilic and this habit has implications for their control (Chadee, 1992). Despite this proportion, there is cause for concern as they are efficient vectors of malaria, LF and virus elsewhere (Gillet, 1972). Their presence could also be linked to favourable environments as the breed in bodies of clear water that are large and semi parmenent such as wamps, weedy sides of streams etc. The Adult mosquitoes composition and relative abundance (Table 10) showed that July (27.69%) had the highest number of mosquitoes while December (9.55%) had the least. However, earlier entomological survey showed that mosequito densities increased with increasing rainfall (Nwoke and Ebo, 1992; Onyirioha, 2004). With regards to the possible impact of weather variables on seasonal distribution and human biting rate of indoor resting mosquitoes (Table 11) tends to be on an increase during the rainy season (from May to July) (66.99%) than dry season (October to December) (33.0%). The findings of this study is in agreement with a previous work Efe and Ojoh (2013) which opined that the rainy season presents favorable environmental conditions that enhance mosquito breeding, survival and biting rates. Additionally, the results confirm that malaria transmission in Imo State is characterized by substantial inter-monthly variations. More so, this study showed that malaria prevalence increases as relative humidity increases as stated by the International Institute for Sustainable Development

(IISD, 2013). The findings herein indicated that entomological indices of malaria transmission (EIR and SR) were well established in the area, thus explaining endemicity. Beier *et al*., (1999) opined that the intensity of malaria parasite transmission is normally expressed as EIR and that in Africa it is highly variable ranging from <1 to >1,000 infective bites per person per year. The sporozoite rates *reported* in the present study was 1.17. Similar results have been reported by Aju-Ameh et al., (2016); Msugh-Tur et al., (2014); Massebo et al., (2013); Awolola et al.,(2003). However, it was lower when compared to those of Amaechi et al., 2019; Omulu et al., (2015); Olayemi and Ande, (2008) and elsewhere in Africa. This probably points to malaria vectorial system being more complex than expected. The comparable sporoziote rates for the cohorts may not be unconnected with human activities. This suggests that infective females that are compromised with *Plasmodium* parasites can put the inhabitants at risk of malaria disease. The Man bitting rate for the present study was (1.86 bites/ person/night). The over- all biting rate in the study area is very. It is important to point out that the abundance of mosquitoes in a particular area depends on the complex interactions of several factors such as rain fall, the river's water level and the availability of suitable larval habitats, among others (Magris et al. 2007, Moreno *et al*., 2007, Charlwood 1996). The Entomological Inoculation rate which is the product of the sporozoite rate and the biting rate (WHO 1975) and describes the intensity of transmission (Burkot & Graves 1995). The estimated EIR was (0.084) infective bites/person/year, i.e., a person in the study area might get one infective bite every three months. The result showed that the prevalence of malaria was influenced by weather variables with the highest incidence in the rainy seasons. It is therefore recommended that people in endemic areas should adopt preventive practices in all seasons with emphasis on the rainy seasons in order to prevent the scourge of malaria. The Community and Government at all levels should synergistically work together to ensure a reduction in the high prevalence of malaria mainly in rural areas.

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