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Malaria vectors composition and vectorial transmission indices in selected rural and urban areas of Imo state, Nigeria

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Abstract

A combined field and laboratory investigation was conducted in selected communities from Obowo and Owerri North Local Government Areas of Imo State to determine the status of malaria in relation to mosquito vector for rainy and dry seasons. The pyrethrum knock down technique (PKD) was employed ones monthly in the morning hours (6:00am-10.00am) for collection of mosquitoes. The mosquitoes caught were taken to the Laboratory for identification, dissection and infectivity assessment using standard methods. Two malaria vectors *Anopheles gambiae* and *Anopheles funestus* sl were identified as major vectors of the disease. The proportions of indoor resting *An. gambiae* (53.6% vs 46.37%) and *An. funestus* (50.00% vs 50.00%) did not differ significantly for urban and rural areas ($P>0.05$). Similarly, their indoor resting densities (IRD) 1.43% vs 1.45% as well as average bite/person/night (0.95 vs 1.16) had no difference between rainy and dry seasons. The proportions of the vectors and human biting rates (HBR) 1.56% vs 1.25% were comparable. July (55.75%) and May (50.60%) had the highest mosquito for rainy season while December (56.4%) and October (47.3%) for dry season. In these areas, the proportions of the transmitting vectors could not differ ($P>0.05$). Overall, sporozoite infection rates were 83.33% and 16.33% for species from urban and rural areas respectively. Monthly variations in density and parity were 57.95% and 42.04% for *An. gambiae* and *An. funestus* while monthly entomological inoculation rates (EIR), monthly biting rate (MBR) and monthly sporosites rate (SPR) were 0.021, 1.86% and 1.17% accordingly. HBR, SPR and EIR between urban and rural areas were (0.87% vs 0.98%), (0.41% vs 1.85%), (0.003 vs 0.018) respectively. From the results of this study it appeared that *An. gambiae* and *An. funestus* had vectorial capacity in malaria transmission despite low infectivity rate of salivary glands. The comparable rates of infection between urban and rural areas is a serious concern and could indicate the dynamics of vectors and infection status. This put to rest discrepancies about the relationship between malaria transmission and vector composition and signals the scaling up of integrated strategy that includes good environmental sanitation.

Keywords: Malaria vectors, malaria transmission, transmission indices, urban and rural

Introduction

Despite impressive progress in malaria control interventions in many endemic countries, malaria remains the most important vector-borne parasitic disease worldwide and is endemic in more than 100 countries worldwide (WHO, 2009) ^[24]. Malaria caused by *Plasmodium falciparum*, and the mosquitoes *Anopheles gambiae*, *Anopheles funestus*, *Anopheles arabiensis*, and *Anopheles moucheti* are the major vectors that cause year-round transmission. It 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) ^[27]. Approximately 438,000 deaths were attributed to malaria in 2015, particularly in sub-Saharan Africa, where an estimated 90% of all malaria deaths occur (WHO, 2015) ^[27]. Nigeria suffers the world's greatest malaria burden, with approximately 51 million cases and 207,000 deaths reported annually (approximately 30% of the total malaria burden in Africa), while 97% of the total population (approximately 173 million) is at risk of infection (WHO, 2014) ^[26]. Moreover, malaria accounts for 60% of outpatient visits to hospitals and led to approximately 11% maternal mortality and 30% child mortality, especially among children less than 5 years (WHO, 2014, NFMH, 2009) ^[24]. The vectors of malaria is the most wide spread in Africa and

conducted to investigate the relative abundance, composition and roles of malaria vectors in malaria transmission in the study areas with contrasting characteristics

Study Area

[illegible]

Source: Wikipedia

during the hours of 6.00am and 10.00am (Mboera *et al.*, 2006) ^[14] modified by Amaechi, 2009) ^[1]. 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 pyrethrin insecticide and then left for 10 minutes with every opening (doors and windows) shut. Mosquitoes were collected thereafter with forceps and emptied 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 morphological features (Gilles and Coetzee 1987 and Gillies and De-Mellion, 1968) ^[9, 8]

Dissection and Fertility Rate Determination
After removing the wings and legs, the female mosquitoes were placed ventrally on a slide where dissection took place.

The mosquitoes were placed 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. Blood fed females were dissected to determine parity by observing the degree of ovarian tracheoles (Detinova, 1962) [4]. Determination of Entomological Inoculation Rate (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 were taken to be parous as described by WHO (1975).

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 WHO (2013) [25].

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

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

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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. 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:

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

Where

EIR = Entomological Inoculation Rates

HBR= Human Biting Rate. Which is the number of female *Anopheles* mosquitoes collected per house per night, and day

Data Analysis

Chi-Square was used to test for the significant difference in the species composition. Students t test was used to test the significant difference between IRD and HBR of the vectors in rainy and dry seasons. Anova was used to test the significant difference between IRD and MBR in the study areas.

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. Non malaria transmitting mosquitoes were predominant (37.17%) followed by *An. gambiae* (34.88%), while *An. funestus* was the least (27.94%) recovered mosquito. The differences between the malaria transmitting vectors were not statistically significant ($p > 0.05$). Indoor resting densities and Man-biting rates of malaria vectors (Table 2) showed that a total of 200 rooms harbouring 273 sleepers were surveyed. Of the 1224 number of mosquitoes collected, 395(100.0%) were blood fed with Average IRD of (1.44) and Average bite/person/night (1.05). Although variations existed on the blood fed mosquitoes between rural and urban (54.2% vs 45.8%), there average IRD and average bite/per person per night did not differ ($p > 0.05$). Adult mosquitoes composition and relative abundance (Table 3) indicated that the differences for rainy season and dry season catches (53.59% vs 46.40%) were not statistically significant ($p < 0.05$). Similarly, the proportions of *Anopheles gambiae* and *An. funestus* were not significantly different for the seasons ($p < 0.05$). Table 4 represented adult mosquito composition and relative abundance. July(55.75%) and May (50.0%) had the highest mosquito population for rainy season for both rural and urban respectively while for Dry season it was December (56.4%) and October (47.3%). In these areas the proportion of the transmitting vectors could not differ ($p > 0.05$). The overall population and distribution of sporozoites (Table 5) revealed that in malaria vectors 06(1.17%) out of 509 *Anopheles* mosquitoes dissected were positive. Species from Obowo (rural) 83.33% had the highest prevalence than those from Owerri-North (urban) 33.33%. In Obowo, species from Ehume (33.33%) were the highest followed by species from Umuriam and Amuzi (16.66% and 16.66%) while 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 ($P < 0.05$).

Table 6 summarized Monthly variations in density and parity of malaria vectors. From the table, *An. gambiae* had the highest population of species as well as more parous mosquitoes (424% and 57.95%) than *An. funestus* (342 and 42.04%) ($P < 0.05$). The majority of the parous mosquitoes were caught in July for *An. gambiae* (125 and 34.57%) followed by May (86 and 17.28%) while December (39 and 9.47%) produced the least ($P < 0.05$). 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 ($P < 0.05$).

Table 7 summarized the Monthly EIR for Anopheline mosquitoes collected by PSC in the study area. Overall, the

total Man Biting Rate was (1.86%), Sporozoite rate was (1.17%), while EIR (0.021). The month of July had the highest MBR (0.61%) followed by May (0.29%), while December had the least (0.19). Also for Sporozoite Rate (SPR), the month of July had the highest (1.77%) followed by November (1.63%), while October and December had zero SPR. Furthermore, the EIR for the study showed that

the month of July had the highest (0.010), followed by May (0.003), June (0.003), November (0.003), while October and December had (0.000) EIR ($P < 0.05$). Entomological Inoculation Rate between urban and rural communities (Table 8) showed that malaria vectors caught in rural area (0.018) had a higher Entomological Inoculation Rate compared to urban area species (0.003) ($P < 0.05$).

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

Communities	Mosquitoes Species <i>An. gambiae</i> <i>An. funestus</i> Others			Total No collected	Percentage (%)
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

*Others *Aedes* species, *Culex* species

Table 2: Indoor resting densities and Man-Biting Rates of malaria vectors

Communities	No of rooms surveyed	No of sleepers	No of fed mosquito	Average IRD	Average bite/person/night
Avutu	25	48	51(12.91)	1.06	0.55
Umuariam	25	43	48(12.15)	1.16	0.67
Ehume	25	27	53(13.41)	1.96	1.81
Amuzi	25	31	62(15.69)	2.0	1.61
Sub Total	100	149	214(54.17)	1.43	0.95
Orji	25	33	48(12.15)	1.45	0.52
Akwakuma	25	26	53(13.41)	2.03	1.95
Amakohia	25	29	39(9.87)	1.34	1.15
Works layout	25	36	41(10.37)	1.13	0.78
Sub Total	100	124	181(45.82)	1.45	1.16
Total	200	273	395(100.00)	1.44	1.05

Table 3: Adult mosquitoes composition and relative abundance

Communities	Species	Rainy season Dry season May June July Octo Nov Dec						Total
Avutu	<i>An. gambiae</i>	13(10.92)	16(12.59)	29(15.34)	11(16.17)	11(12.64)	06(9.09)	86(13.01)
	<i>An. funestus</i>	09(7.56)	08(6.29)	11(5.82)	09(13.23)	08(9.19)	06(9.09)	51(7.77)
	Others	15(12.60)	13(10.23)	18(9.52)	06(8.82)	11(12.64)	08(12.11)	71(10.82)
Umuariam	<i>An. gambiae</i>	12(10.08)	09(7.08)	13(6.87)	06(8.82)	07(8.04)	09(13.63)	56(8.53)
	<i>An. funestus</i>	07(5.88)	06(4.72)	11(5.82)	07(10.29)	05(5.74)	03(4.54)	39(5.94)
	Others	14(11.76)	16(12.59)	24(12.69)	08(11.76)	13(14.94)	07(10.60)	82(12.5)
Ehume	<i>An. gambiae</i>	06(5.04)	09(7.08)	11(5.82)	03(4.41)	03(3.44)	04(6.06)	36(5.48)
	<i>An. funestus</i>	05(4.20)	08(6.29)	06(3.17)	01(1.47)	02(2.29)	02(3.03)	24(3.65)
	Others	11(9.24)	09(7.08)	18(9.52)	05(7.35)	06(6.89)	03(4.54)	52(7.92)
Amuzi	<i>An. gambiae</i>	11(9.24)	08(6.29)	18(9.52)	05(7.35)	03(3.44)	04(6.06)	49(7.46)
	<i>An. funestus</i>	08(6.72)	13(10.23)	16(8.46)	03(4.41)	09(10.34)	08(12.11)	57(8.68)
	Others	08(6.72)	12(9.44)	14(7.40)	04(5.88)	09(10.34)	06(9.09)	53(8.07)
	Sub total	119(50.0)	127(52.26)	189(55.75)	68(52.71)	87(55.06)	66(56.41)	656(53.59)
Orji	<i>An. gambiae</i>	11(9.24)	09(7.75)	13(8.66)	04(6.55)	07(9.85)	06(11.76)	50(8.80)
	<i>An. funestus</i>	11(9.24)	07(6.03)	11(7.33)	05(8.19)	03(4.22)	02(1.70)	39(6.86)
	Others	13(10.92)	14(12.06)	18(12.00)	07(11.47)	11(15.49)	09(7.69)	72(12.67)
Akwakuma	<i>An. gambiae</i>	11(9.24)	13(11.20)	17(11.33)	06(9.83)	09(12.67)	04(3.41)	60(10.56)
	<i>An. funestus</i>	13(10.92)	18(15.51)	15(10.00)	11(18.03)	08(11.26)	07(5.98)	72(12.67)
	Others	06(5.04)	09(7.75)	17(11.33)	02(3.27)	04(5.63)	03(2.56)	41(7.21)
Amakohia	<i>An. gambiae</i>	08(6.72)	07(6.03)	13(8.66)	04(6.55)	04(5.63)	02(1.70)	38(6.69)
	<i>An. funestus</i>	04(3.36)	06(5.17)	09(6.00)	05(8.19)	02(2.81)	03(2.56)	29(5.10)
	Others	11(9.24)	08(6.89)	11(7.33)	04(6.55)	08(11.26)	06(11.76)	48(8.45)
Works layout	<i>An. gambiae</i>	14(11.76)	09(7.75)	11(7.33)	05(8.19)	06(8.45)	04(3.41)	49(8.62)
	<i>An. funestus</i>	04(3.36)	09(7.75)	07(4.66)	6(9.83)	03(4.22)	02(1.70)	31(5.45)
	Others	13(10.92)	07(6.03)	08(5.33)	02(3.27)	06(8.45)	03(2.56)	39(6.86)
	Sub total	119(50.0)	116(47.73)	150(44.24)	61(47.28)	71(44.93)	51(43.58)	568(46.40)
	Total	238(19.44)	243(19.85)	339(27.69)	129(10.53)	158(12.90)	117(9.55)	1,224(100.00)

Key *Others: *Aedes* species, *Culex* species

Table 4: Seasonal distribution and Human Biting Rate of indoor resting mosquitoes

Mosquito species	Seasons Rainy Dry		Total
Seasonal Distribution			
<i>An. gambiae</i>	291(35.48)	133(32.42)	424(34.64)
<i>An. funestus</i>	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)
Human Biting Rate			
Mosquito species	Total No of mosquitoes	Total number of occupants	HBR
<i>An. gambiae</i>	427(34.88)	273	1.56
<i>An. funestus</i>	342(27.94)	273	1.25
Others	455(37.17)	273	1.66

*Others: *Aedes* species, *Culex* species

Table 5: overall population and distribution of sporozoites in malaria vectors

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

Key: HBR: Human Biting Rate SPR: Sporozoites Rate EIR: Entomological Inoculation Rate

Table 6: Monthly variation in density and parity of malaria vectors

Months	<i>An. Gambiae</i> Density Parity		<i>An. Funestus</i> 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 7: Monthly EIR of anopheline collected by PSC in the study area

1	No Examined	Blood Fed	MBR	SPR	EIR
May	147	81	0.29	01(1.23)	0.003
June	155	74	0.27	01(1.35)	0.003
July	211	169	0.61	03(1.77)	0.10
October	91	72	0.26	00(0.00)	0.000
November	90	61	0.22	01(1.63)	0.003
December	72	52	0.19	00(0.00)	0.000
Total	766	509	1.86	06(1.17)	0.021

Table 8: Entomological Innoculation Rate between urban and rural communities in the study area

Area	Months	No Ex	Blood fed	HBR	SPR	EIR
Obowo (Rural)	May	78	46	0.16	01(2.17)	0.003
	June	83	41	0.15	01(2.43)	0.003
	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
Owerri-North (Urban)	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
	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 study revealed that 62.8% of the 1,224 mosquitoes caught were *Anopheles* species which are capable of transmitting malaria. Overall, 37.2% of the mosquitoes were either *Culex* or *Aedes* species ie (non *Anopheles* species). They do not transmit malaria but are responsible for the transmission of other diseases of great public health concern. They could expose population of both rural and urban to the possibility of acquiring other infections like yellow fever, filarial worms, And Dengue fever etc. Similar to previous studies (Ikpa *et al* 2017; Manyi *et al* 2014) ^[13, 10] which used morphological and dissection tools, our study identified *Anopheles gambiae* and *Anopheles funestus* as malaria transmitting vectors with no significant difference in distribution. Their indoor resting densities (1.43% vs 1.45%) could not differ between urban and rural. This is in line with CDC/USAID in Nigeria 2010 (Ezigwe *et al.*, 2014) ^[7]. July (27.69%) had the highest number of malaria vectors while December had the least (9.55%). These observations differ from earlier survey where the densities increased with increasing rainfall (Onyirioha, 2004) ^[17].

One common agreement is that these studies identified *An gambiae* and *An funestus* as the main malaria transmitting vectors. Elsewhere another study that used enzyme linked Immunosorbent assay (ELISA) showed that the infectivity rate of *Anopheles* species varied 4.3% in the wet and 2.3% in the dry seasons (Oyewale *et al* 2007) ^[20]. The study equally recorded four *Anopheles* species in contrast to our findings. However, the similarity was that *An gambiae* was found to be the most abundant species. In another study, *An gambaie* was found to be abundant vector in four different ecological zones of Nigeria (Okwa *et al* 2009) ^[16]. All these findings point to the fact that *An gambiae* remains the dominant malaria vector in Nigeria. One major limitation of this study was the use of morphological techniques in the identification of malaria vectors and in the assessment of mosquito infectivity rates. More sensitive methods like PCR could have given more reliable results in characterizing the local malaria vectors as has been applied elsewhere (Oyewole *et al* 2005) ^[19]. This technique could be employed in the near future to re-characterise the malaria vectors composition in the study communities.

Seasonal distribution and human biting rate tends to be on the increase during rainy season than dry season (66.99% vs 33.00%). This is in agreement with Efe and Ojoh (2013) ^[5]. Rainy season which presents favourable environmental condition that enhances mosquito breeding, survival and

biting rates could explain this. Among the malaria transmitting vectors *An. gambiae* was the principal and predominant vector found indoor compared to other species. The endophagic and endophilic habits remains the basic prerequisite for the implication. The presence of both *Anopheles gambiae* and *Anopheles funestus* indoors suggest vector feeding and resting habits rather than environmental condition. The implication is that competent vectors are available and possibility of dwellings both urban and rural areas and being co-infected with malaria transmission all year round. These vectors co-occurrence also indicate suitable breeding sites and need to incoportae environmental management strategies as a component of the integrated vector control.

Significantly, low infectivity rate of salivary glands of female anopheline were reported when compared with the study of Jande and Amuta (2015) ^[12] in Benue State Nigeria though their study involved only sixty two female mosquitoes. Contrary to his study which shows that the higher, the infectivity rate, the higher the chances of malaria transmission, our study is remarkable. It shows that the values for IRD, HBR, PR, SPR, EIR and annual biting rates/personal year were comparable between the seasons and among malaria vector species. Parasite prevalence is malaria-specific and can provide an adequate measure of transmission (Beier *at al* 1999) ^[3]. Revi and Nibhay (2003) ^[21] posited that during the development of *Plasmodium* in the mosquito midgut, sporozoite burst out of the oocysts into the haemocoel to locate and invade salivary glands prior to transmission. This process facilitates complete maturation of infection competent sporozoites. This is suggestive that people are prone to malarial infection since pressure of matured sporozoites in the salivary glands reveals that mosquitoes have malaria transmission potential. The absence of differences in the urban-rural entomological indices could explain prevalence in the human population and in the vectors in addition to longevity and density of the vector population to ensure effective malarial transmission to humans during blood meal.

Conclusively, human population density and man biting rates being parts of components of vectorial capacity/efficiency of malaria vectors, *Anopheles gambiae* and *Anopheles funestus* were found as the malaria transmitting vectors all factors being equal. The study areas (both urban and rural) need to be given equal treatment in intervention to malaria control and prevention.

References

1. Amaechi AA. Studies on the insecticide treated bed nets on the control of mosquito-vectors of human lymphatic filariasis in parts of Ebonyi State, Nigeria. Owerri, Nigeria: Imo State University; 2009.
2. Amaechi A, Iwunze J, Onyenakazi P, Ezike M, Nwachukwu M. Assessment of mosquito biting activities, community protection and treatment seeking behaviours in malarious communities of Mbaise and Obowo, Imo State, Nigeria. PPSN South-East Symposium Book of Proceedings. 2024;2:22-29.
3. Beier K, Killen GF, Githure JJ. Short report: entomological inoculation rates and *Plasmodium falciparum* malaria prevalence in Africa. *An Trop Med Hyg.* 1999;11:109-113.
4. Detinova TS. Age grading method in Diptera of medical importance. Geneva: WHO Monogr Ser No. 47; 1962.
5. Efe S, Ojoh C. Climate variation and malaria prevalence in Warri metropolis. *Atmospheric and Climate Sciences.* 2013;3:132-140.
6. Egejuru NJ, Nwoke BEB, Ukaga CN, Amaechi AA. Schistosomiasis and soil-transmitted helminths in relation to anthropometric indices of school children in Owerri North L.G.A, Imo State, Nigeria. *Int Sci Res J.* 2016;2006-1730.
7. Ezeigwe N, Inyama PU, Samdi CM, Akila JD, Awolola TS, Nwansat GS, *et al.* *Anopheles* species diversity, behavior and sporozoite rates in six states of Nigeria. Report submitted to CDC/USAID's Presidential Malaria Initiative; 2014.
8. Gillies MT, De Meillon B. The *Anophelinae* of Africa south of the Sahara (Ethiopian zoogeographical region). Johannesburg: South African Institute for Medical Research; 1968.
9. Gillies MT, Coetzee M. A supplement of the *Anophelinae* of Africa south of the Sahara. Johannesburg: South African Institute for Medical Research; 1987. p. 1-55.
10. Ikpa GI, Mafuyai HB, Ikpa TE. Distribution and infectivity of *Anopheles* mosquitoes and asymptomatic malaria infection in a home setting of Gboko, Nigeria. *Niger J Parasitol.* 2017;38(1):98-103.
11. Iwunze JJ, Amaechi AA. Malaria prevalence and preventive measures among pregnant women in Obowo LGA Imo State, Nigeria. *Innov J Med Sci.* 2021;6(4):1-4.
12. Jande EH, Amuta EA. Malaria preventive practices and vector infectivity studies in Benue State, Nigeria. *Niger J Parasitol.* 2015;36(2):101-107.
13. Manyi MM, Vajimo GC, Immadeh GN. Sporozoite infection rates of female anopheline mosquitoes in Makurdi and endemic areas for malaria in Central Nigeria. *Int J Entomol Res.* 2014;2(2):103-115.
14. Mboera LEG, Magesa SM, Molteni F. Indoors man-biting mosquitoes and their implication on malaria transmission in Mpwapwa and Iringa District, Tanzania. *Tanzan Health Res Bull.* 2006;8(3):141-149.
15. National Federal Ministry of Health (NFMH). National Malaria Control Programme: strategic plan 2009-2013 - A roadmap for malaria control in Nigeria (abridged version). Abuja: Yalian Press Ltd; 2009.
16. Okwa OO, Akinmolayan EI, Carter V, Hord H. Transmission dynamics of malaria in four selected ecological zones of Nigeria in the rainy season. *Ann Afr Med.* 2009;8(1):1-9.
17. Onyirioha CU. Studies on mosquitoes associated with human activities and their local control in Imo State, South Eastern Nigeria [Ph.D. first progress report]. Owerri, Nigeria: Imo State University; 2004.
18. Onyindo AE, Ezike VI, Nwosu EO, Ozumba NA, Ikpeze OO, Obiukwu MO, *et al.* Crepuscular man-biting mosquitoes of a zoological garden, Enugu, South Eastern Nigeria. *Int J Parasit Dis.* 2009;4(11):1-9.
19. Oyewole IO, Ibidapo AC, Oduola AO, Obansa JB, Awolola ST. Molecular identification and population dynamics of the major malaria vectors in a rainforest zone of Nigeria. *Biokemistri.* 2005;17(2):171-178.
20. Oyewole IO, Awolola TS, Ibidapo CA, Oduola AO, Okwa OO, Obansa JA. Behaviour and population dynamics of the major *Anopheles* vectors in malaria endemic areas in southern Nigeria. *J Vector Borne Dis.* 2007;44:56-64.
21. Revi D, Nibhay K. Role of mosquito salivary glands. *Curr Sci.* 2003;85(9):1234-1236. (Page number inferred - please provide if known.)
22. World Health Organization (WHO). Malaria on practical entomology in malaria. Part I, Ch. 1-5. Geneva: WHO Division of Malaria and Other Parasitic Diseases; 1975.
23. World Health Organization (WHO). WHO technical report series 892. WHO Expert Committee on Malaria. Geneva: WHO; 2000.
24. World Health Organization (WHO). Report on the twentieth WHOPEs working group meeting. WHO/HTW/NTD/2009. Geneva: WHO; 2009.
25. World Health Organization (WHO). World Malaria Report 2013. Geneva: WHO Global Malaria Programme; 2013.
26. World Health Organization (WHO). World Malaria Report 2014. Geneva: WHO; 2014. p. 36-37.
27. World Health Organization (WHO). World Malaria Report 2015. Geneva: WHO Global Malaria Programme; 2015.