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Sandflies vector abundance and transmission indices in some remote communities of Mbaise, Imo State Nigeria

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Abstract
This study was conducted to determine the biting rate, infection rate as well as the potential rates of sandflies (Diptera: Phychodidae) in some remote areas of Ahiazu, Aboh and Ezinihitte Mbaise Local Government Areas of Imo State from January to December, 2021. Collection of flies was done using human bait method. In areas where sandflies were endemic, result shows that flies were predominant during the dry seasons (January to March) with a break during wet seasons. Another breeding peak during the months of November and December. There was a significant variation (p<0.05) in the biting rates, potential biting rate as well as the infectivity rates between the wet season (June to September) and the dry season (January to March, October to December). Overall annual biting rates of 1,591, 1,834 and 9,448.5 were established in Aboh Mbaise, Ahiazu Mbaise and Ezinihitte Mbaise LGAs respectively. The study established the existence of the parasite *Leishmania* with a significant low rate of infectivity. Leishmaniasis is a tropical neglected disease observed among low income group with poor housing and other reduced environmental health standards, coupled with climate change. The findings of the study supplied baseline data on leishmaniasis in the study area and could be used by the government, communities and individuals in the planning of effective control and intervention programmes for leishmaniasis in the study areas to avert possibility of outbreak.

Keywords: Sandflies, leishmaniasis, infectivity rates, human baits, Mbaise

1. Introduction
Human leishmaniasis is a chronic parasitic disease caused by a protozoan of the genus *Leishmania* causing substantial morbidity and mortality in much of the world (McDowel *et al*., 2022) [11]. It is transmitted through the bites of blood sucking phlebotomine sandflies (Diptera: Psychodidae) which consist of over 800 species that are widely distributed from Southern Europe, Africa, the middle East and tridia (Doe *et al*., 2020) [12]. They are important vectors as the climate and vegetational habitats favour their breeding and adult resting sites. The flies inhabit a variety of ecological niches ranging from tropical climates to arid deserts. They colonize human housing and animal dwelling (Killick and Kendrick, 1999) [13] including shelters and rodent burrows, in masonry cracks, including microhabitats combining darkness, humidity and a supply of organic matter which serve as food for the larvae (El Moudi *et al*., 2020) [15].
Sandflies measure from 1.5 to 4mm in length, with hairy bodies and peculiar variation. They are mostly active at night and where there is little or no wind, seeking protection in shelters during the daytime.
Female sandfly bites to ingest blood meal needed for egg development (Singh and Doris, 2010) [10]. This predisposes the host to inflections with leishmaniasis as well as other viral and bacterial disease from bites of infected flies (Bailey and Lockwood, 2007) [16]. Dermis and subcutaneous tissues are affected during the bites and complications may arise due to opportunistic bacteria and fungal infections or HIV co-infections (Bailey and Lockwood, 2007) [16].
Although, the bite of female sandfly is not particularly painful, it is followed by an intensely, raised ulcerative lesions at the site due to irritations produced by the salivary secretions containing low molecular weight portieres that promote agglutin activity or serve as anti-co-agulant in the wound (Nwoke, 2007) [18].

This results to unbearable purities and scratching which might be so severe to cause insomnia and more infection.
Infected sandfly introduces the parasites through the proboscis as motile flagellated promastigote which transforms to non-flagellated amastigotes (Rodhair, 2015) [4]. They grow intracellularly in the host. Studies on the baiting pattern and infection rate are important to assess their effects of climate change as well as range expansion of the vector ecological ruche modeling.

2. Materials and Methods

2.1 Study Area

This study was carried out in some remote areas of Mbaise in Imo State, Nigeria, which lies between latitude 5°30¹ and 6°15 North and longitude 6°38¹ and 7°18 East. Vegetation of the area is typical rainforest. The main economic activity in this area is subsistence farming including animal rearing. Some of the populations are also involved in small scale trade. Mbaise comprises 3 Local Government Areas *viz* Aboh Mbaise 185 km^2, Ahiazu Mbaise 111 km^2 and Ezinihitte Mbaise 108 km^2 accounting for a total population of 611,204 (Census, 2006). The average annual temperature is 25.9 °C and estimated rainfall ranges from 11,650 mm to 11,900 mm and average annual humidity is 88%. There are two (2) major seasons of the year – rainy season (April to October) and dry season (November to March). Harmattan season normally falls within the months of December and February. These may vary due to climate change.
Study sites were selected based on the presence and biting intensity of sandflies in the study area. Four (4) study sites were mapped out from each of the 3 LGAs and 6 houses were selected from each study site. This is aimed at assisting in disease surveillance on the risk factors and implementation of control strategies by public health workers, students and entomologists during control programs to the disadvantage of sandflies without adverse ecological damages to the environment.

2.2 Ethical Consideration

Ethical approval for the study was obtained from the ethics committee of state ministry of health and the Department of Environmental and Applied Biology. Consent were sought and obtained from the village heads and from the participants.

2.3 Site Selection and Collection of Sandflies

Sandflies were collected twice a week for a period of 1year, from January to December, 2021. They were collected using human bait method by volunteers to establish the entomological indices. Three (3) trained volunteer entomological scouts were recruited and trained on how to bait and catch sandflies using aspirators as the flies land on their legs and arms to feed. Inside the house and outside, not more than 50meters off the building). The traps were operated for 14 hours (4 pm to 6 am). Human bait collection using volunteers to capture sandflies before, during and after blood meal. Sandflies collected were placed in plastic with 70% ethanol transported to the laboratory for preservation and dissection.

2.4 Dissection of Sandflies

The detection of promastigote stages in the sandflies were carried out by dissection and examination under a steromicroscope according to Lawyer *et al.* (2011) [17].

2.5 Statistical Analysis

Data were analyzed by Chi-Square using Epi Infor 6 Computer Software statistical program to compare sandflies infection rates, biting rates and transmission potentials.

Table 1: Entomological indices of sandflies in Aboh Mbaise

Aboh Mbaise													
Month	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**Total**
No. of flies caught	15	16	10	10	10	1	-	8	1	2	13	19	105
No. of days caught	2	2	2	2	2	2	2	2	2	2	2	2	24
No. dissected	13	16	8	10	8	1	-	-	1	2	13	15	87
MBR	232.5	224	155	150	155	15	-	124	15	31	195	294.5	1,591
No. infected	6	4	3	6	2	-	-	3	-	-	3	2	29
Infection rate	93	56	46.5	90	31	-	-	46.5	-	-	45	31	439
Monthly potential rate	107.31	56	58.13	90	38.75	-	-	-	-	-	45	39.27	

Results of the monthly biting rates of sandflies at the three catching zones namely Aboh Mbaise, Abiazu Mbaise and Ezinihitte Mbaise. For the months from January to December 20. One shown in tables 1-3. In all the 3 catching centres flies were more abundance at the peak of the dry seasons, the MBR measures between January and May with the peak in January and relatively increased MBR in August. Reduction in the density during the months of June to October. Table 1 shows the monthly biting rates, infectivity rates and monthly potential rates of sandflies in Aboh Mbaise L.G.A. The annual biting rate, infection rates as well as annual potential rates were 1,591,439 and 455 respectively. Flies abundance were relatively very low during the peaks of rain; that is, in the months of June to July, September to October.

Table 2 shows the entomological indices of sandflies collected at Ahiazu Mbaise Local Government Area. A total of 121 flies were collected, 103 were dissected. MBR was on the increase during the months of January to April, again during the months of October to December. Also, a high monthly potential rate was recorded during the month of December. The rate of infection was higher during the months of January (68.89%) and December (75.08%). Table 3 shows the relative abundance of sandflies, the infectivity, biting and potential rates. Out of the 120 flies collected, 95 were dissected. The total annual biting rate was 9,448.5, infection rate was 33.5, which the monthly potential rate was 671.8. The highest monthly biting rates and monthly potential rates were recorded during the month of January and November.

Table 2: Entomological Indices of Sandflies collected at Ahiazu Mbaise Local Government Area

Ahiazu Mbaise													
Month	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**Total**
No. of flies caught	20	18	11	13	-	-	-	9	-	10	16	24	121
No. of days caught	2	2	2	2	2	2	2	2	2	2	2	2	24
No. dissected	18	18	11	10	-	-	-	9	-	1	16	20	103
MBR	310	252	170.5	195	-	-	-	139.5	-	155	240	372	1,834
No. infected	4	1	3	3	-	-	-	-	-	1	6	3	21
Infection rate	62	14	46.5	45	-	-	-	-	-	15.5	90	46.5	319.5
Monthly potential rate	68.89	14	46.5	58.5	-	-	-	-	-	155	90	55.8	488.69

Table 3: Entomological Indices of Sandflies collected in Ezinihitte Mbaise LGA.

Ezinihitte Mbaise													
Month	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**Total**
No. of flies caught	25	16	3	14	5	-	-	11	2	10	14	20	120
No. of days caught	2	2	2	2	2	2	2	2	2	2	2	2	24
No. dissected	20	10	3	14	5	-	-	10	2	1	14	16	95
MBR	387.5	224	46.5	210	77.5	-	-	170.5	30	155	210	310	9,448.5
No. infected	6	3	-	2	1	-	-	2	-	2	4	2	22
Infection rate	93	42	-	30	15.5	-	-	31	-	31	60	31	333.5
Monthly potential rate	116.25	67.2	-	30	15.5	-	-	34.1	-	310	60	38.75	671.8

4. Discussion

4.1 Sandfly Breeding Sites and Abundance

Sandflies pose a significant public health concern in many remote parts of the communities in the tropics especially in the remote rainforest regions, these flies inhabit the richest ecological microhabitats that ensures their rapid spread and distribution (Asimeng, 2011) [1]. Cutaneous leishmaniasis is endemic in the study area. This was observed in the skin of the individuals in the local areas characterized by skin ulcer that seemed to have persisted for months as well as intense itching and scratching.

Most of the inhabitants reared domestic animals especially goats and sheep whose pens are situated very close to their living houses. These areas have been described as the major breeding sites of sandflies (Avid *et al*., 2012) [6]. Areas with high breeding sites are characterized ecologically by high humidity accompanied by moist and damp soils. For example in the 3 (three) LGA highest collection was made in remote and rich vegetation areas of Amumara in Ezinihitte, Amahuru in Aboh Mbaise and Okponkume in Ahiazu Mbaise. The quality of housing is relatively poor, made of old buildings with cracks and holes making it suitable for the breeding sandflies (Rodhain, 2015) [4]. Flies are very rare in most parts of the study area during the peak of the rainy season which is a unique characteristic of haematophogoris flies (Nwoke, 2007) [18] in the tropics. Biting rate are observed to be high in the dry months of December to March in all the study area though flies bites are at their peaks at the setting and rising of the sun on these days of the month which tallies with the active hours of the population at risk. They are exposed to the bite of the sandflies in their farms and other areas of outdoor activities.

4.2 Sandflies and Leishmaniasis Transmission

They are vectors of *Leishmania* Spp. and arboviruses that threaten human and animal health (Vit *et al*., 2020) [9]. The results of entomologic indices which gave clues to the transmission potentials of the biting pattern were low. Infectivity was standard for assessment of transmission. This may be attributed to distribution of meetizan in the treatment of other tilarial worms such as *Onchocerca volvulus* and *loa loa* (Siewe *et al*., 2019) [19]. However, itching and scratches persisted and are observed in the lower extremities of most of the population. There were also scars and fresh wounds that were present as the result of the intense itching from the bites of sandflies (Nwoke, 2007) [18] irritation as caused by the reaction of the human antigen and the saliva of the flies initiate the itching and scratching giving rise to open wounds (Ruja *et al*., 2013) [3]. These wounds are exposed to bacteria and other paterogen resulting to secondary infection in addition to injection of *Leishmania* (Fehaange, 2004) [5]. Sandflies are vectors of leishmaniasis found in the tropics, subtropics and Southern Europe (Adamu *et al*., 2017) [7]. This study observed the presence of *Leishmania* infection indication of leishmaniasis in the study area; although classified as a neglected tropical disease (Aviad *et al*., 2012) [6]. The disease is asymptomatic which may be one of the reasons it is neglected, unlike malaria.

It is also associated with people with poor housing and no access to clean water or safe ways to dispose of human waste. Sandflies can cause severe pain, long term disability and can lead to death. Infection can lead to malnutrition, cognitive impairment, stunted growth and inability to attend school.

Leishmaniasis is largely preventable even without vaccines (Singh and Doris, 2010) [10] through good sanitation and proper housing/accommodation as the disease is associated with low-income population in developing regions of Africa (Dembo *et al*., 2022) [8]. To prevent infection is to protect those at risk from sandfly bites (El Moudi *et al*., 2020) [15]. Preventive measures such as avoidance from outdoor activities especially from dusk to dawn, when sandflies generally are most active. Indoor residual spraying of orgenochlorines, organophosphate, carbamate and synthetic pyrethroids can be used to control sandflies (Vivero *et al*., 2015) [14]. Use of anti-parasite, antifungal, antibiotics and inflammatory and tropical anti-tumor medication are conventionally administered for leishmaniasis.

5. Conclusion

This study has established the presence of *Leishmania* in the study area. However, these parasites present in the vectors occur at low infectivity rate. Adequate control measures are required to prevent sudden outbreak of the disease, which might arise over a long period of time. Control measures for

sandflies require integrated approach such as use of insecticides in houses and animal shelters, and use of protective clothing, insect repellants and insecticide impregnated bed nets. Habitat reduction and modification and reservoir control may also help to reduce human sandfly contact.

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