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Emmanuel C. UTTAH

Biological Sciences Department, Faculty of Science, Cross River University of Technology, Calabar, Nigeria

Running title: House types and filariasis

Corresponding author: Dr. Emmanuel C. Uttah, drecuttah@yahoo.com.

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ABSTRACT:

This study was aimed at assessing both the quality of housing in the coastal and upland areas of Eastern Nigeria using a predetermined three-category house type approach, as well as the distance of the respective houses from major vector breeding sites, in relation to the prevalence of microfilaraemia. From each community, all individuals who were more than one year old or resident in the area for at least a year were screened. The target population was 1000 persons each for coastal and upland areas. Houses in the areas were categorized into three main types. Type I: mud houses built with thatched roofs, small windows and yawning eaves that hold no barrier for mosquitoes; Type II: mud houses built with zinc roofing sheets; Type III: modern-style houses built and plastered with cement and having large doors and windows. A total of 855 houses were screened, out of which 191 (22.3%) were Type I; while 430 (50.3%) and 234 (27.4%) were Type II and Type III respectively. An average of three and four persons per house was recorded for the Upland and Coastal populations respectively. Familial clustering was the settlement pattern in the former, while houses were adjoined one to another in the latter. In the Upland area, 10.0% of the houses had at least one Wuchereria bancrofti microfilaraemia (Wbmf) positive individual, and this comprised of 8.7% harbouring one mf positive individual each, and 1.3% housing two Wbmf positive individuals each. In total, 52% of all positive microfilaraemia cases were from Type I while 39% and 9% of positive microfilaraemia cases were from Type II and Type III respectively. Microfilaraemia was significantly higher among those that lived in poorest quality house type, and in proximity to major vector breeding sites such as streams.

KEYWORDS: Human settlement, filariasis, house type, breeding sites, Nigeria

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INTRODUCTION:

Bancroftian filariasis is a mosquito-transmitted parasitic nematode infection, which still ranks high globally among causes of debilitating morbidity in man [1]. Three decades ago about 20.6% of the world's population was at risk from lymphatic filariasis and the prevalence of infection was put at 9.2% [1]. It is one of the diseases of concern in the resource limited countries, particularly in sub-Saharan Africa, and is endemic in parts of Nigeria [2-6], where its public health implications have been of much concern to some scientists [6].

Although filariasis is preventable, the transmission and epidemiological quotients of the filarial infection appear to be sustained over a century in eastern Nigeria despite general improvements in basic hygiene [5]. This scenario therefore underlines the need to explore and understand other potential risk factors associated with Wuchereria bancrofti infection in the area, for further improvement in the control efforts. One of such possible risk factors is the house quality, which have strongly associated malaria transmission (vectored also by mosquito) with house types of residents in endemic areas [7-10]. Although malaria is caused by a parasitic protozoan Plasmodium, the fact that it is also transmitted by blood-sucking female mosquitoes, as is the case with Filariasis, suggests there could be similarities in vector ecology of these parasitic infections.

This study was aimed at assessing the quality of houses in the coastal and upland areas of Eastern Nigeria using a predetermined three-category house type approach, the distance of the respective houses from major vector breeding sites, and also to determine the proportion of positive microfilaraemics resident in each house type category.

SUBJECTS AND METHODS:

A total of eight communities were selected for the study in South-Eastern Nigeria. Two of the communities (Umuowaibu and Ndiorji) were chosen from the filariasis endemic Upland area, and are located near Okigwe in Imo State, from the Igbo speaking (a majority tribe) area of the country. Six communities (Oduoha, Rumuoro, Ahai, Rumuada, Okporoworo, and Rumuakani) were chosen from the filariasis endemic coastal rainforest area, and are from the Ikwerre speaking area near Port Harcourt in Rivers State, which is further south by the Atlantic Ocean.

Local authorities were consulted and properly briefed about the study, and these included the traditional heads (the Ezes of the Ndiigbo and the Nyewalis of the Ikwerre), the leaders of the respective Town Unions, and the officials of the two Local Government Areas (LGAs), Okigwe in Imo State and Emohua in Rivers State. Their consent was obtained, and their cooperation solicited in the mobilization of their subjects, before commencement of data collection. During the parasitological and clinical surveys, health personnel from the LGAs formed part of the team to ensure compliance with approved safety and ethical stipulations.

All individuals in the selected communities who were more than one year of age were included in the study population, which comprised of natives and non-natives who had resided there for at least one year. The target population for each of the two geographical entities was 1000 persons. Houses were given identification numbers, and their appropriate locations noted; in addition markets, religious places, major roads and some track roads, as well as water bodies (such as rivers, streams, et cetera) in the respective communities were noted. Each consenting individual admitted into the study, was given a card bearing a personal identification number, and their residential number.

The houses were categorized into three main types:

House type I: Mud houses built with locally-made thatch roofs, normally with small windows, enormously yawning eaves that hold no barrier for mosquitoes.

House type II: Mud houses built with zinc roofing sheets. These houses were similar to Type I but may have ceiling that constitute barrier for mosquitoes gaining entrance through the ceiling.

House type III: Modern-style houses built and plastered with cement, having standard doors, windows, and good ceiling.

For the parasitological survey, about 50 μl blood was collected, after finger-prick, on a grease-free microscopic slide for a thick smear. It was stained with Giemsa using the standard methods of Uttah et al. [11].

Ethical approval was obtained from the Ministry of Health in the Okigwe and Emohua Local Government Areas for the studies in the Upland and Coastal rainforest areas respectively. The Ethical Committee of University of Port Harcourt (where the laboratory work was carried out) approved the protocols.

The Epi-Info version 6 .0 was used in entering data from parasitological survey, and SPSS for windows (1995 version) was used for data analysis. The geometric mean intensity (GMI) of microfilaraemia was calculated as antilog (∑log (x+1)/n), with x being the number of mf per ml of blood in microfilaraemic individuals and n was the number of microfilaraemic individuals examined.

The odds ratio (OR) of becoming microfilaraemic in the three categories of house Types (I, II, III), and in the Upland and Coastal rainforest areas was calculated. The geospatial distribution of houses with positive microfilaraemic cases in relation to proximity to major breeding sites was also assessed.

RESULTS:

When results from both the Upland and Coastal rainforest areas are pooled together, about 50% of all houses were of the house Type II category; house Types III and I accounted for 28% and 22% of the other houses respectively. Analysis of the data indicated that 52% of all wbmf positive cases were living in House type I, 39% were living in House type II and 9% were living in House type III.

A total of 381 houses were recorded in the two Upland communities: 216 in Umuowaibu and 165 in Ndiorji, giving an average of three persons per house. A familial settlement pattern was evident as houses were in clusters according to familial relationships. Each cluster was separated from another by arable farmlands of varying sizes. About 53.5% of the houses were of the type II. Types I and II houses had kitchen just adjacent to the room belonging to the 'woman of the house' in the same building. At night, livestock, mostly fowls, goats and sheep, were kept in the kitchen. Most of the types 1 and II houses had just two living rooms each. Type II houses comprised 49% of all houses in the Upland area, while house type III and house type I made up 26% and 25% respectively.

In the coastal rainforest communities a total of 474 houses were recorded, giving an average of four persons per house. Ahai had the most number of houses (25.1%), while Okporoworo had the least (11.8%). Ahai had the least number of persons per house (3). The settlement pattern was urban with houses adjoining one another. The houses in the coastal area were relatively of better quality than those in the upland area in terms of number of rooms and modernization. However, all the three types of houses were represented. Type II houses comprised 51% of all houses in the Coastal rainforest area, while type III and type I houses made up 30% and 19% respectively.

The Prevalence and risk of Wbmf in relation to house types:

The overall 'House-prevalence' (proportion of houses with residing positive microfilaraemic persons) of Wbmf in both areas combined was 14.7% (Table 1). Wbmf Prevalence among type I occupants (34.6%) was significantly higher than among type II (11.4%) and type III occupants (4.7%, χ^2-test; $p < 0.05$ for both) respectively. The risk of developing Wbmf was significantly higher among type I occupants than among occupants of other House types (OR 5.32, 95% CI 1.272 to 2.070). The risk of contracting Wbmf was reduced by 29% among type II occupants (OR 0.71, 95% CI 0.727 to 0.041), and by 78% among type III occupants (OR 0.22, 95% CI -2.167 to -0.889).

In the Upland area, the 'House-prevalence' for type I houses was 22.8%, which was significantly higher than 7.4% for type II and 2.4% for type III houses (χ^2-test; $p< 0.05$). The risk of contracting Wbmf was high among type I occupants (OR 4.73, 95% CI 0.864 to 2.244), but reduced by 51% among type II (OR 0.53, 95% CI -1.319 to 0.049), and by 83% among type III occupants (OR 0.17, 95% CI -3.217 to -0.327).

In the Coastal rainforest area, the 'House-prevalence' for type I houses was 45.5%, which was significantly higher than 15.0% for type II and 6.0% for type III houses (χ^2-test; $P < 0.05$ for all tests). The risk of developing Wbmf was high for the Type I houses (OR 6.43, 95% CI 1.354 to 2.368), but was reduced by 36% among type II occupants (OR 0.64, 95% CI -0.919 to 0.027), and by 80% among type III occupants (OR 0.20, 95% CI -0.889 to -2.329).

Comparative assessment of risk of infection between upland and coastal settlements:

The result indicates that Wbmf prevalence was higher in the coastal settlements than in the upland areas in all categories of house types ($\chi 2$-test; $P < 0.05$). The risk of contracting Wbmf in the Coastal rainforest area was as twice high as in the upland area (OR 2.06, 95% CI 0.310 to 1.134, $\chi 2$-test; $p < 0.05$). Living in the upland area conferred a level of protection, reducing the risk of developing Wbmf by 51%.

Number of Wbmf positive cases per house in relation to house types:

In all, 12.9% of houses had one Wbmf positive case each, 1.8% had two Wbmf positive cases each, while 0.1% had three Wbmf positive cases each. There was no observation of four or more Wbmf positive cases per house. In the upland area, 8.7% of the houses harboured one Wbmf positive case each, 1.3% harboured two Wbmf positive cases each, but there was no case of three mf positive cases per house. In the Coastal area, 16.2% of the houses harboured one Wbmf positive case per house, which was significantly higher than recorded in the Upland area ($\chi 2$-test; $p < 0.05$). A prevalence of 2.1% for two positive cases of Wbmf per house was recorded, which was comparable to what was recorded in the Upland area ($\chi 2$-test; $p < 0.05$). Three positive cases of Wbmf per house were recorded in 0.2% of houses.

When all Wbmf positive cases from both the Upland and Coastal areas are pooled together, one-positive-case per house constituted about 87.3% (86.87% in Upland area; 87.5% in Coastal area), double-positive-cases per house made up 11.9% (13.2% in Upland area; 11.4% in Coastal area), while triple-positive-cases constituted 0.8% (0% in Upland area; 01.1% in Coastal area).

Spatial clustering of positive cases of Wbmf in relation to major vector breeding sites:

Partitioning of the upland and coastal areas into proximal and distant sections in relation to major breeding sites, mainly streams and rivers showed significantly higher prevalence of Wbmf in the proximal sections in both areas ($\chi 2$-test; $p < 0.05$) (Table 2). The Odds ratio to be infected with Wbmf in the areas proximal to vector breeding sites was high (OR 3.51, 95% CI 0.84 to 1.674), with a risk reduction of 72% in distant areas.

The Odds to be Wbmf infected was thrice as high in the proximal section as in the distant section in the upland areas (OR 3.13, 95% CI 0.388 to 1.894). Similar result was obtained in the coastal area except that the odds were four times as high in the proximal section as in the distant section (OR 4.05, 95% CI 0.891 to 1.907).

There was positive relationship between geographical locations of houses with positive cases of microfilaraemia. Houses that were proximal to major vector breeding sites, such as rivers/streams, produced most cases of positive microfilaraemia, and consequently houses that were farthest from the major vector breeding sites, presented least cases of microfilaraemia.

Table 1: Prevalence of filarial infection in relation to house quality in south-eastern Nigeria

Suburb	House type I		House type II		House type III		Total	
	Exam.	Inf. (%)	Exam.	Inf. (%)	Exam.	Inf. (%)	Exam.	Inf. (%)
Okigwe	92	21 (22.8)	204	15 (7.4)	85	2 (2.4)	381	38 (10.0)
Port Harcourt	99	45 (45.5)	226	34 (15.0)	149	9 (6.0)	474	88 (18.6)
Total	191	66 (34.6)	430	49 (11.4)	234	11 (4.7)	855	126 (14.7)

Legend: Exam: Number examined; Inf.: Number infected;

Table 2: Prevalence of Wbmf in relation to proximity of houses to vector breeding sites in south-eastern Nigeria

Area	Proximal	Distant	χ^2-test
Upland prevalence (%)	14.7 (28/190)	5.2 (10/191)	$p < 0.05$
Coastal prevalence (%)	29.9 (63/211)	9.5 (25/263)	$p < 0.05$
Total prevalence (%)	22.7 (91/401)	7.7 (35/454)	$p < 0.05$

DISCUSSION:

Shelter is essential to man for resting, recuperation and sustenance. Unfortunately, some adult vectors such as mosquitoes do rest in human shelters from where they bite the inhabitants. In some cases, favourable condition for completing their life cycle is provided by human shelter. Vector-borne diseases transmissions are effected in houses [12], and are directly influenced by housing pattern [13-14]. Several factors relating to human shelter do influence transmission of vector-borne infections. Results from this study show that the location of human shelter in relation to its distance from major vector breeding sites could increase or decrease the chances of contracting microfilaraemia. Living in distant places from rivers and streams which are major vector breeding sites in South-eastern Nigeria could confer some degree of protective advantage against contracting bancroftian filariasis, reducing the risk of contracting microfilaraemia, when compared to living very close to the vector breeding sites. This is corroborated by findings elsewhere that Filariasis prevalence was significant among those living in close proximity to irrigated agriculture, the vector breeding site [15].

Results in the present study indicate that the prevalence of Filariasis was significantly affected by the house type in both the Upland and Coastal rainforest communities. Type I and Type II houses that are poor quality houses recorded significantly higher prevalence of Filariasis in both areas, compared to the Type III houses. This is congruent with findings reported elsewhere [16]. Significantly higher wbmf rates were found in huts/thatched house type, which are equivalent to type I in this study, than in better quality house types [16]. Higher densities of mosquitoes are generally found in poorly constructed houses such as Type I and Type II, than in well-constructed houses, the Type III [17]. House construction also plays important role in the vector resting preferences as poorly constructed houses, especially those made of mud, represented by Type I, avail more darker places for mosquito vectors [16,18]. Different housing structures have been found to post significant differences in vector density, infection rate, infectivity rate, and microfilaria prevalence [18]. The density of mosquitoes and transmission of filarial is highly correlated with the type of house construction standards [19]. Highest infection and infectivity rates were recorded from the poorly-constructed group of houses [20]. It was observed in Ghana that people living in poorly constructed and unscreened houses in slum areas of Accra were more exposed to mosquito biting than those living in more modern and salubrious areas, and this was attributed to house quality [21]. Health authorities in Awash Valley, Ethiopia, had difficulty in controlling malaria, another mosquito-borne parasitic infection, malaria. This was attributed to some factors, which included re-plastering of houses [22]. House types, standard, house density, and other factors such as the location can have profound effect on the prevalence of vector-borne diseases [16, 23]. Living in the poorest type of houses increases the risk of malaria 2.5 folds when compared with better houses constructed with complete bricks, plastered walls and tiled roofs, [7-10]. It is found that house structure with cross ventilation, white painted walls, meshed doors, and windows are most likely to reduce mosquito-resting places and filariasis transmission, as a large reduction of indoor biting could have a significant effect on reducing morbidity [18]. This indicates that there is a need to modify housing structures, to reduce the man-mosquito contact [24], which has a direct impact on the vector density and transmission dynamics of filariasis [18]. Another dimension to this is that poorly constructed houses are owned by low income people who normally live in less hygienic conditions and thus are more prone to the infection [19]. This may explain why low income people are more at risk to lymphatic Filariasis and the disease burden is relatively higher in this demographic group [25].

Another factor that could explain the relatively higher wbmf prevalence in Coastal rainforest than in the Upland area is possibly the higher average number of house inmates in the coastal area than the Upland area. Human population flocculation does affect vector efficiency in endemic areas as overcrowding increases the number of infective bites given by a single infected vector in its lifetime as less time would be needed for host seeking. This could be very significant in increasing transmission, and implies that less efficient vectors could become significant in a situation where all other factors favoured high transmission [26]. More persons per room at a particular time also attract more mosquitoes because they produce and release more carbon dioxide blooms [16].

The implication of the high frequency of infective bites per person is that for control of the parasitic infection to be achieved, there must first be drastic reductions in mosquito populations for there to be any effect at all [26]. In high density human populations, large numbers of positive cases of W. bancrofti infection are likely to be produced even when the biting rate of a vector is relatively low. However, each individual in such high density human population will have a relatively low risk of being bitten by the vector [27]. The variation in transmission of filariasis in a particular geographical zone depends on differences in the human and vector populations and on their degree of interaction [28]. If the human population exceeds a certain threshold determined by vector population, intensity of transmission is limited. This is because it would give a much lower fly-to-man ratio and this should result in a significant dilution of transmission with a much lower force of infection and less severe disease. On the other hand, a major fall in the human population density will intensify transmission and aggravate the severity of disease. For instance high onchocercal blindness rate of over 5% are generally found on small, isolated communities [29].

In conclusion, the important risk factors of Wbmf in the Upland and Coastal rainforest areas of South-eastern Nigeria are House Type 1 (mud houses built with thatched roofs with enormously yawning eaves), and proximity to vector breeding sites. Living in the Upland area tends to confer significant reduction in the risk of developing bancroftian filariasis in endemic south-eastern Nigeria.

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