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Assessment of mosquito mesh sizes available in Enugu metropolis

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Abstract

Introduction: The mosquito-vector is known to be associated with a number of parasitic and arboviruses that have been known to cause human diseases. Control of mosquito-borne diseases depends heavily on our capacity to regulate the vector that causes these diseases.

Method: A cross-sectional study was carried out on 240 different houses within Enugu metropolis between October and December 2021. The mesh sizes of windows and door nets were measured using the meter rule in mm.

Result: A total number of 240 houses were covered by mesh sizes ranging between 1.0 and 4.0 mm, and the statistical analysis revealed a higher percentage of 56% for mesh sizes ranging between 1.6 mm and 4.0 mm, a moderate percentage of 31% for mesh sizes ranging between 1.2-1.5 mm, and the lowest percentage of 13% for mesh sizes ranging between 1.2-1.5 mm.

Conclusion: This finding from this study revealed a need to improve community knowledge and perception of the various mesh sizes available and the standard mosquito mesh size required to reduce threats posed by mosquito vectors and preclude the spread of diseases caused by mosquitoes. Such awareness will increase the willingness of householders to implement other approaches and modifications, which include obstructing portals of entry for mosquitoes and shutting doors and windows at night.

Keywords: Mosquitoes, vector, mesh sizes, disease, house, door net

Introduction

Malaria remains a public health challenge that is endemic in some tropical countries [1]. Malaria is the leading public health burden in Nigeria, causing over 33% of all childhood deaths among children under the age of five [2] and [3]. This occurs primarily because of the bites from numerous kinds of the Anopheles mosquito [4]. The prevalence of malaria in the southern eastern part of Nigeria, for example, in Abia State, has been reported to be on the rise, from 61.4% in 1999 to 83.0% in 2003 [5]. Mosquitoes that transmit malaria prefer to feed indoors, particularly those found in Africa, such as *An. gambiae* (sensu stricto) and *An. funestus* (s.s.) [6] as well as the Asian vector *An. stephensi* (s.s.), whereas others, such as *An. arabiensis*, can feed both indoors and outdoors. Minimizing the risk of exposure from human-mosquito vector contact is paramount to minimizing the burden of malaria in endemic areas [7]. This has been accomplished through the utilization of bed nets treated with insecticide (ITNs), and this physically shields people sleeping inside the net. Recently, the use of mosquito nets and mosquito repellents is considered the most popular means of reducing human-mosquito vector contact [8]. Over the years, mosquito nets have been used to shield people against bloodsucking insects at night and other creatures such as spiders, cockroaches, beetles, lizards, snakes, and rats. According to WHO 2002 [9], the ideal mesh size for mosquito nets is between the ranges of 1.2-1.5 mm, and this helps to stop the incoming mosquitoes from gaining entrance. Smaller insects, e.g., biting midges and phlebotomine sandflies, may gain entrance. Jersey nets, which are opaque and very fine with a mesh size of 0.2 mm, and impregnated nets, can protect against the insects earlier mentioned. Those in hot climates are disadvantaged due to poor ventilation from fine mesh nets since any mesh size of about 1.5 mm can allow entrance to mosquitoes.

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Seidlein *et al.* (2012) noted that if the discomfort that arises from the use of bed nets outweighs its benefits for the prevention of insect entrance and bites, then in the future, due to a decrease in the utilization of bed nets, there will not be use of these bed nets in Sub-Saharan Africa. In Nigeria, the population of people at risk of malaria continues to be on the rise due to low coverage of bed nets owing to airflow obstruction [10]. Residual indoor spraying of insecticides (RIS), insecticide-treated nets (ITNs), and artemisinin-based combination therapies (ACTs) are the main intervention tools endorsed by WHO in recent years that are also used in malaria control campaigns [11]. The disadvantages of malaria control measures that are based on these insecticides and therapeutic drugs include the emergence of vector resistance to insecticides and drug-resistant parasites [12]. When there is pervasive use of potent IRS and ITNS, over time, it results in resistance [13]. There is a growing concern that insecticide resistance against mosquitoes could lead to a rising incidence of malaria and an increase in fatalities in mosquito endemic areas such as Nigeria. Hence, supplementary control measures are required to ease the stress on the current ones. Thus, an effective and environmentally friendly process that is not dependent on insecticides could be a superior alternative to help reduce the selection pressure for insecticide resistance. Screening houses have long been practiced in climatic countries, majorly designed to keep insects away, and they were found to protect people against malaria when implemented in mosquito control studies in malaria endemic areas [14]. Kirby *et al.* 2009 [15] evaluated the medical implications of utilizing house screening in Africa and established that door and window screens and shut roof spaces minimized the occurrence of children suffering from anemia. A similar study by Diabate *et al.* (2013 [16], combining mosquito trap and house screening methods as a tool for the control of the populations of mosquitoes, indicates a drastic reduction in the mosquito populations of mosquitoes indoors and the killing of the mosquitoes trapped. Celli's research work on physical means for the control of borne diseases from mosquitoes indicated that porches and chimneys that are screened gave rise to significant reductions in malaria incidence (4% with screens vs. 92% without the intervention [17]. Recent research on house screening has shown a significant reduction in the number of malaria-carrying mosquitos and illness, and communities have overwhelmingly supported the intervention. Regardless of the importance of house screening, its use is still sparse and underutilized, most likely due to a lack of awareness about selecting the right standard screen mesh size for doors and windows in the house [18].

The use of house screens in windows and doors as a physical barrier for mosquito vector control is most suitable because it is effective, affordable, the equipment and materials are locally gotten, easy to comprehend and smear, environmentally friendly, and mostly accepted and well-suited to the philosophies, customs, and attitudes of the people. It is observed that the screening of all windows and vents has successfully reduced human-vector contact and eliminated malaria [19]. The aim of this study is to determine the mesh sizes of door and window house screen nets used in Nigerian houses for mosquito vector control.

Materials and Methods

Type of study, area, and sample size

A cross-sectional study was carried out on 240 different houses within the Enugu metropolis for two months. The mesh sizes of windows and door nets were measured using a meter rule in mm.

Statistical analysis

The collected data were processed using the Statistical Package for Social Sciences (SPSS) version 21 software, which was used for data analysis. The statistical instrument was adopted to give the frequency and simple percentage of different mesh sizes.

Results

The results for mosquito mesh sizes obtained from 240 different houses are as shown in Table 1 and Figure 1. From Table 1, the majority of the houses screened had a mesh size of 2.0 mm, followed by a mesh size of 1.9 mm that recorded 31.25%, and finally a mesh size of 1.9 mm and 4.0 mm with the lowest percentage.

From our study (Figure 1), the number of houses with a mesh size of 1.5 mm and above constituted 56% of total houses (135 out of 240 visited), followed by 1.2 mm mesh constituting 31% with a and 13% for a mesh size range of 1.2–1.5 mm.

Table 1: Descriptive statistics of the mesh sizes

S/No	Mesh size (mm)	Frequency	Percentage (%)
1	1.0	75	31.25
2	1.2	3	1.25
3	1.3	3	1.25
4	1.5	24	10
5	1.6	6	2.5
6	1.8	8	3.33
7	1.9	1	0.42
8	2.0	109	45.42
9	2.5	4	1.66
10	3.0	6	2.5
11	4.0	1	0.42
Total		240	100

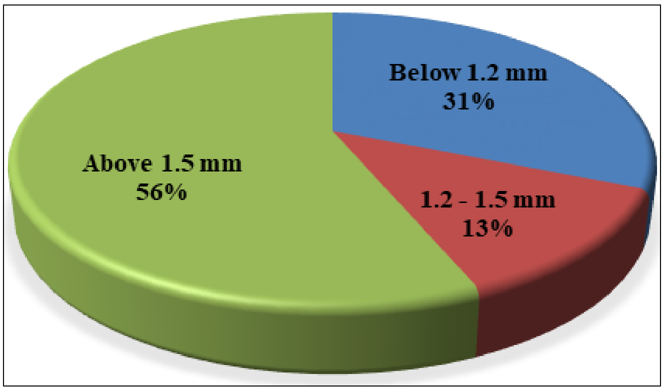

Fig 1: Percentages of the mesh size ranges

Discussion

The mosquito species responsible for transmitting parasitic and viral diseases to man are well established in Nigeria [20]. Some mosquito-vectors inhabit indoors and bite at night and are referred to as endophilic and endophagic, respectively. This shows that most malaria transmission occurs indoors [21]. Recent work has shown that vector control could provide effective interventions against mosquito-vector borne diseases such as malaria, leishmaniasis, yellow fever, dengue, zika virus, lymphatic filariasis, among others [22], and house screening has proven to be one of the factors influencing indoor vector densities and transmission of vector-borne diseases [23]. Results from this study demonstrated that screening of house doors and windows can provide a protective barrier for families, reducing the number of indoor vectors and the prevalence of malaria in mosquito endemic areas (Table 1 and Fig. 1). House screening, which involves the use of mosquito-netting (mesh) as a physical barrier to prevent mosquito entry, has been found to contribute immensely towards reducing the burden of mosquito-borne diseases [15]. Mosquito screens are typically made of metal wire, fiberglass, or other synthetic fiber stretched in a wooden or metal frame to cover window and door openings. It impedes mosquitoes from entering inside houses, thereby reducing the amount of discomfort householders receive indoors [24]. The use of house screening has registered tremendous progress in malaria control for the first time since the turn of the century, as reported by the World Health Organization (WHO) [25, 26]. In 2018, there were an estimated 228 million cases worldwide (3 million fewer cases than estimated in 2017), with 85% of cases occurring in 19 sub-Saharan African countries and India. The most widely recognized and effective measure for prevention of the transmission of mosquito-borne diseases involves eliminating human-vector contact through vector control, and it constitutes a core strategy for malaria control in the African region [26]. This can be achieved through the "mosquito-proofing" of houses with house screening. It appears that many homes that were covered during this research rely on the use of mosquito screens on doors and windows for protection against mosquito-borne diseases. One household-randomized trial reported that indoor mosquito density fell by 40% after screening doors and windows and closing wall openings and eave gaps with mud [27]. Houses with closed eaves had a lower mean number of mosquitoes in a related survey in Baringo, Kenya [28] than houses with open eaves in a related survey in Baringo, Kenya [29]. Again, poorly constructed houses were associated with a high prevalence of malaria in a cohort of young Ugandan children in East Africa [29]. Houses with poorly screened windows and doors are perceived to have high human-vector exposure compared with properly screened houses, resulting in a corresponding higher risk of mosquito entry and prevalence of mosquito-borne diseases [22]. The effectiveness of house screens is dependent on the mesh size, duration (usage), and how often they are maintained. House screening is developed in various types of design and mesh sizes (openings) to keep away insects while maintaining better ventilation as required. Generally, house screening with a reduced screen wire opening prevents insect pests from entering the house. Protection ability is reduced with an increase in screen wire openings. Bearing this mind, the major concern of an individual household would be the trade-off between effective insect protection and good ventilation [30]. The mesh size of the mosquito screen when it is too large allows mosquitoes to naturally fly in through the holes on windows and doors. Mosquito net screens are designed to last between 3 and 5 years and to prevent mosquitoes from invading the home. However, it was observed that some houses visited during this survey had their net fitted for over a decade and had undergone tears and holes owing to long-term usage. This accounts for the high prevalence of malaria and other mosquito-borne diseases. According to ISO criteria, the recommended mesh size for most tropical countries is between 1.2 and 1.5 mm. A mesh size of 1.2 mm stops mosquitoes from entering the house and maintains good ventilation. From Figure 1 above, only 13% (31 out of 240) of the houses visited during this survey had their mosquito net mesh size within the recommended standard range. The rest of the houses are either below or above the recommended standard. This could be attributed to a lack of knowledge of the standard mesh size required to screen mosquito entry. Reasons given for not screening the houses in a previous study included perceptions that it was costly and also a lack of awareness regarding its effectiveness in protecting against malaria [31]. The most widely used mosquito-vector control tools to date include indoor residual spraying (IRS) and insecticide-treated nets (ITNs). Studies have suggested that these tools have been associated with a lot of limitations, some of which include widespread insecticide resistance observed across Africa [32]. These limitations have led to decreased effective use of these interventions. In light of the challenges associated with the current vector control tool, there is a renewed interest in house screening and modification. Researchers are now re-examining how house screening may help protect people from mosquito-borne diseases.

House screening for vector control has several appealing advantages, which include: low risk of toxicity to humans and non-target insects, compared to ITNs or IRS (safe to the user); affordable and requiring low maintenance; lack of reliance on insecticide bio-efficacy and mosquito susceptibility (no risk of insecticide resistance); environmentally friendly and providing level protection to the entire members of households, unlike ITNs, which primarily give protection to those sleeping under a net during the night hours only [22].

Conclusion

In order to ensure the maintenance and sustainability of house screening interventions in reducing mosquito entry, there is a need to improve community knowledge and perception of the various mesh sizes available and the standard mosquito mesh size required to screen houses from mosquito entry. Those living in the houses need to understand the threats posed by mosquito vectors and the need to prevent the spread of diseases caused by mosquitoes. Such awareness will increase the willingness of householders to implement other approaches and modifications, such as closing doors and windows at night and blocking routes of entry for mosquitoes themselves.

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Conflict of Interest Statement

The authors of this article have had no conflict of interest.

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