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KNOWLEDGE EVALUATION OF MOSQUITO CONTROL PRACTICES WITHIN THE CENTRAL REGION OF JIGAWA STATE, NORTH-WEST NIGERIA

[1]Adeniyi, Kamoru A., [2]Abubakar, Abubakar Sodiq, *[3]Adesoye, Oluwaseun Adegbola, [1]Joshua Babalola Balogun,[4]Akinsete, Israel, [3]Adeogun, Adedapo O., [5]Ezeonuegbu, Blessing A., [6]Akinleye, Callistus A. and [1]Musa Mustapha Dogara

[1]Department of Biological Sciences, Federal University, Dutse, Nigeria
[2]Deparment of Biological Sciences, Sule Lamido University, Kafin Hausa, Jigawa State, Nigeria
[3]Molecular Entomology and Vector Control Unit, Nigerian Institute of Medical Research, Yaba, Lagos, Nigeria
[4]Department of Animal Biology, Federal University of Technology, Minna, Nigeria
[5]Deparment of Microbiology Technology, School of Science Laboratory Technology, University of Port Harcourt, Nigeria
[6]Department of Community Medicine, Osun State University, Osogbo, Nigeria

*Corresponding authors' email: oludesoye@gmail.com Phone: +2347038118580

ABSTRACT
In order to mitigate and manage life-threatening mosquito-borne diseases such as malaria, Dengue, and lymphatic filariasis, both socio-demographic factors and the collective vector control knowledge within the community are pivotal. Hence, the objective of the current study is to evaluate the awareness and understanding of mosquito control practices in specific communities located in Jigawa State, North-west Nigeria. A cross-sectional study was conducted in which 60 structural questionnaires were distributed in the three selected communities. In each village, 20 questionnaires were randomly shared and captured information on Demographical characteristics, House characteristics, Use of mosquito net etc. Among the 60 respondents, only 17(28.3%) of the respondents were participating in community sanitation, majority of respondents 56(93.3%) were found to keep water at home. However, usage of long-lasting insecticide nets (LLINs) on daily basis were recorded significantly highest 48(80%). We therefore recommend promotion of the significance of environmental sanitation as a primary measure for controlling mosquito-borne diseases among them.

Keywords: ITNs, Mosquito-borne diseases, Public health, Sanitation, Vectors, IRS

INTRODUCTION
Mosquitoes of the Culicidae family, including *Anopheles gambiae* (which transmits malaria), *Aedes aegypti* (responsible for dengue fever transmission), and *Culex quinquefasciatus* (associated with lymphatic filariasis transmission), serve as the primary vectors of mosquito-borne diseases in sub-Saharan Africa, particularly in Nigeria (Dambach *et al.*, 2018; Adesoye *et al.*, 2023). The region, encompassing countries such as Nigeria, the Democratic Republic of Congo (DRC), the United Republic of Tanzania, and Mozambique, contributes significantly to global mosquito-related fatalities, accounting for approximately 53% of all mosquito-related deaths worldwide. Annually, around 700 million cases of mosquito-borne illnesses are reported, leading to over 725,000 deaths on a global scale (Shehu *et al.* 2022; Khezzani *et al.* 2023). Vector control is therefore essential to curb the menace of mosquito transmitted diseases in endemic countries such as Nigeria (Khezzani *et al.*, 2023; Olagundoye & Adesoye, 2023).
One of the primary methods for controlling various mosquito-borne diseases is mosquito vector control (Olagundoye and Adesoye, 2023; Maimuna *et al.,* 2021). Additionally, for certain diseases like dengue, where a licensed vaccine exists but faces limited usage due to safety concerns (Sridhar *et al.*, 2018), mosquito vector control stands as the sole available approach to safeguard populations. The objective of vector control is to minimize pathogen transmission by either reducing or eliminating human contact with the vector. A diverse array of vector control tools broadly categorized into chemical and non-chemical options (Adeniyi *et al.,* 2023). Tools directed at immature vectors function by eliminating the immature stages through means such as chemical or biological larvicides and predator species such as *Bacillus thuringiensis* and *B. istraelensis* (Oduola *et al.,* 2017), or by eliminating suitable aquatic habitats through techniques like habitat modification or manipulation (Adesoye *et al*., 2024). Tools targeting adult vectors work by either killing the vectors, as seen in indoor residual spraying (IRS) and space spraying, and/or by diminishing vector human-contact, including blood-feeding success with human and/or animal preferred hosts (Adesoye *et al*., 2024). This involves the use of chemical repellents, house screening, insecticide-treated bed nets (ITNs) as obtained in long-lasting insecticide nets (LLINs), and insecticide-treated dog collars. Furthermore, ongoing developments include various novel vector control tools like genetic manipulation of mosquitoes, bacterial infection of vectors (e.g., Wolbachia), and insecticide-treated eave tubes (Liu, 2015; Wilson *et al.*, 2020).
The efficacy of various previously mentioned methods for mosquito vector control has been documented as successful in diverse regions worldwide, including Nigeria. For instance, Tula *et al.* (2023) highlighted the effectiveness of Insecticide-Treated Nets (ITNs) in preventing malaria in northeastern Nigeria. However, within their study, 42.13% of the population did not possess ITNs, suggesting a significant proportion lacking protection. This notable percentage of individuals without ITN usage may stem from a lack of awareness or understanding of mosquito control methods.
In contrast, a significant portion of the population in Northern Gujarat, India, was reported to adopt preventive measures, such as the use of insecticide spray, to control mosquito-borne diseases. (Mahalakshmi *et al.,* 2022). Conversely, individuals with limited or no formal education were found to have a lower level of knowledge regarding mosquito larval source management (LSM) in Mwanza district, Malawi (Kamndaya *et al.,* 2022). In order to mitigate and manage life-threatening mosquito-borne diseases such as malaria, Dengue, and lymphatic filariasis, both socio-demographic factors and the

collective vector control knowledge within the community are pivotal (Mobin *et al.,* 2022; Coetzee, 2020). Hence, the objective of the current study is to evaluate the awareness and understanding of mosquito control practices in central region of Jigawa, North-west Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in three selected communities: Warwade located within latitude 11°44′ 3″ N and longitude 9°13′38″ E; Baranda latitude $11^0 38'$ 29″ N and longitude $9^0 26'$ 48″ E; and Gurungu latitude $11^0 43'$ 2″ N and longitude 9^0 21′ 45″ E all within Dutse Local Government Area located in central part of Jigawa State. This region is characterized by a tropical climate featuring both wet and dry seasons, with an average annual temperature of 26°C. The mean daily temperature during the rainy season is 31°C, while the dry season experiences a mean daily temperature of 20°C. Dutse L.G.A. was projected to have a population of about 431,800 inhabitants and exhibits a range of relative humidity, starting at 17% in January and peaking at 68% in August, followed by 95% in September and 56% in July. Annual rainfall falls between 600 to 1000mm, occurring from April to October (Muhammed *et al*., 2023).

Sample Size Determination and Study Design

A cross-sectional study was conducted in Dutse L.G.A. The sample size for the study was calculated using Leslie Fischer's formula for sample size determination:

$n = z^2pq/d^2$

where n=sample size; z=the standard normal deviation which corresponds to the 95% confidence level (1.96); p=estimate of key proportion (24% or 0.24). The knowledge of mosquito control was derived from a similar study (Mohammed *et al.*, 2023): q=0.38-p (0.38-0.24=0.14); d=degree of accuracy desired (0.05) resulting in a sample size of 52. To account for knowledge and attribute of attrition, the possibility of non-response, improperly filled questionnaires and to promote generalization of findings, the calculated sample size was increased to 60. Therefore, 60 participants were recruited for this study.

Collection of Demographic Data

60 structural questionnaires were distributed in the three selected villages. In each village, 20 questionnaires were randomly shared and captured information on Demographical characteristics, House characteristics, Use of mosquito net, Mosquito abundance factors, Exposure factors to mosquitoes and Mosquito preventing measures of the respondents. A rapport and oral consent of the respondents were sought prior to the study.

Community and House selection

Community and houses were selected through random sampling

Ethical Clearance

Ethical approval was obtained from Ministry of Health, Jigawa State (MOH/SEC/I. S/681/VI).

Community Sensitization

Communities involved were sensitized with granted permission from head of each village. A series of sensitization to the resident was conducted in Places of gathering like Juma'at Mosque, Tea and bread seller joints and in the Market to enlighten the residents on the study and Mosquito borne diseases, importance of environmental hygiene and other preventing measures of mosquitoes.

Informed Consent

Informed consent was obtained from the head of the selected houses. Privacy and confidentially were maintained throughout the study.

Data analysis

Data were subjected to Statistical Package for Social Sciences (SPSS version 20.0, Inc., Chicago, IL, United State of America, USA) and Graph Prism Statistical software (Prism, GraphPad Software, San Diego, CA, USA) software. The results were presented in tables and expressed in percentages, Chi square test was used to determine the association between the relevant variables and was considered statistically significant when P≤0.05.

RESULTS AND DISCUSSION

Socio-Demographic Characteristics of the respondents

Table 1 described the outcomes of the socio-demographic characteristics of the participants. Among the sixty respondents, 56(93.3%) were males which was significantly higher (P <0.05) than 4 (6.6%) females. The majority of respondents identified as farmers, constituting 22 (36.7%), followed by teachers at 18 (30%). There was no statistically significant difference (P>0.05) observed in other respondents' occupations. Regarding household characteristics, those residing in mud houses were significantly more prevalent (P=0.03) than those living in other forms of housing.

Table 1: Social-Demographic Characteristics of the respondents

Characteristics	Frequency	Percentage	P-value	χ^2
Gender				22.53
Female	4	6.7	0.60	
Male	56	93.3	0.001*	
Total	60	100		
Ages (Years)				
15-25	10	16.7	0.50	
26-35	12	20	0.045*	
36-45	4	6.7	0.60	
46 and above	14	56.6	0.03*	17.26
Total	60	100		

Educational level				
Primary	14	23.4	0.045*	
Secondary	12	20	0.045*	
Tertiary	2	3.3	0.80	
Informal	30	50	0.02*	
Others	2	3.3	0.80	15.6
Total	60	100		
Occupation				
Farmer	12	36.7	0.03*	
Trader	4	6.7	0.60	
Teacher	18	30.0	0.03*	
Others	18	26.6	0.045*	4.667
Total	60	100		
Households				
Mud	46	76.7	0.03*	
Cement	10	16.7	0.04*	
Others	4	6.6	0.60	28.8
Total	60	100		

* Values along the column that are significantly higher at P<0.05; χ^2 = Chi square

Possible anthropogenic drivers of mosquito vectors in the study sites include dams, temporary pools, abandoned wheel-tires, and unscreened windows and doors. The results of household-contributed behaviors to mosquito abundance are detailed in Table 2. The majority of respondents (93.3%) were found to keep water at home. A significant difference (P<0.05) was observed in the respondents' contributing habits to mosquito abundance.

Table 2: Household contributing behaviors to mosquito abundance

Characteristics	Frequency	Percentage	P-value	χ^2
Open containers in the house?				48.06
Yes	56	93.3	0.001*	
No	2	3.3	0.60	
No response	2	3.3	0.60	
Total	60	100		
Water containers use?				
Bucket	32	53.3	0.02* 22.67	
Jerry can	10	16.7	0.04*	
Tank	6	10	0.90	
Others	2	3.3	0.80	
No response	10	16.7	0.04*	22.67
Total	60	100		
Proximity of Residence to Bush				
Far	28	46.7	0.02*	
Close	26	43.3	0.02*	
very close	6	10	0.90	7.4
No response	0	0		
Total	60	100		

* Values along the column that are significantly higher at P<0.05; χ^2 = Chi square

View of respondents on the use of long-lasting insecticide ne is present in Table 3. There was significant number (P=0.001) of respondent sleeping under bed net.

Table 3: View of Respondents on the usage of long-lasting insecticidal net

Characteristics	Frequency	Percentage	P-value	χ^2
Sleeping under LLIN?				
Yes	50	83.3	0.001*	
No	8	13.3	0.90	34.2
No response	2	3.3	0.60	
Total	60	100		
Reasons for not sleeping				
Causes irritation to skin	0	0		
Create heat	6	10	0.90	
Uncomfortable to use	2	3.3	0.80	
Others	4	6.6	0.60	
No response	48	80	0.001*	48.667
Total	60	100		
Frequency of net usage				
Daily	32	53.3	0.02*	
Three days interval	16	26.7	0.04*	
Weekend	6	10	0.90	
Others	0	0		
No response	12	20	0.045*	
Total	60	100		5.6
Other use of LLIN				
for goalpost	2	3.3	0.80	
Window	0	0		
Others	0	0		
No response	58	96.7	0.001*	26.133
Total	60	100		
Source of acquiring LLIN?				
Market	4	6.6	0.60	
House-to-house distribution	52	86.7	0.01*	
Others	2	3.3	0.80	
No response	2	3.3	0.80	60.933
Total	60	100		

* Values along the column that are significantly higher at $P<0.05$; χ^2 = Chi square

The results of factors contributing to human exposure to Mosquitoes' bite are presented in Table 4. Significant percentage ($P<0.05$) of the respondents were staying outside in the night (93.3%) and only 2 (3.3%) of the respondents were not staying outside in the night. More so, significant percentage (80%) of them were staying outside in the night from 10pm upward, followed by respondents staying 9-10pm (6.7%) and the least of the respondents were staying from 6-8pm (3.3%) and 8-9pm (3.3%), respectively.

Table 4: Factors contributing to Human Mosquito biting exposure

Factors contributing to Human biting exposure	Frequency	Percentage	P-values	χ^2
Do you stay outside in the night				48.6
Yes	56	93.3	0.001*	
No	2	3.3	0.80	
No response	2	3.3	0.80	
Total	60	100		
How long do you stay outside in the night				
6-8pm	2	3.3	0.80	
8-9pm	2	3.3	0.80	
9-10pm	4	6.7	0.60	
10 pm upwards	48	80	0.03*	
No response	6	6.7	0.60	
Total	60	100		

* Values along the column that are significantly higher at $P<0.05$; χ^2 = Chi square

The results that have to do with community preventive practice for mosquito control is presented in Table 5. Only (26.7%) of the respondents were participating in community sanitation. There was significant (P= 0.045) difference in the respondents view on participating in community sanitation. Clearing of refuse/waste disposal was most cited as possible ways of controlling mosquito proliferation by the respondents, followed by filling of the breeding sites (20%) and the least mentioned possible ways to control mosquito proliferation by the respondents was clearing of canals and vegetation (6.6%).

Table 5: Community preventive practices for mosquito control

Characteristics	Frequency	Percentage (%)	P-value	χ^2
Participating in community sanitation?				20.60
Yes	16	26.6	0.045*	
No	42	70	0.03*	
No response	2	3.3	0.80	
Total	60	100		
Possible ways to control mosquito proliferation				
Clearing refuse/waste disposal	42	70	0.03*	34.77
Sanitation/breeding sites destruction	12	20	0.045*	
Others	4	6.6	0.60	
No response	2	3.3	0.80	
Total	60	100		

* Values along the column that are significantly higher at $P<0.05$; χ^2 = Chi square

The results on the use of insecticide by the respondents is presented in Table 6. Mosquito coils usage was significantly higher ($P<0.05$) as the most used insecticide means by the respondents and (40%) of the respondents were not using any form of insecticide.

Table 6: Usage of insecticide among the respondents

Characteristics	Frequency	Percentage	P-value	χ^2
Insecticide used in previous night				25.5
None	24	40	0.03*	
Mosquito coil	32	53.3	0.02*	
Pyrethroid spray catches	2	3.3		
Others	2	3.3		
Total	60	100		

* Values along the column that are significantly higher at $P<0.05$; χ^2 = Chi square

Discussion

Community involvement and a comprehensive understanding of prevailing knowledge and practices related to mosquito control are recognized as essential factors for devising a successful vector control strategy in certain communities (Otubanjo *et al.*, 2016; Kumaran *et al.,* 2018; Fagbohun *et al.* 2021). In this study, we evaluated the community's awareness of mosquito control strategies in specific areas. This approach differs from the predominant focus of public health scientists on epidemiology, morbidity, and behavior research related to mosquito-borne diseases such as malaria.

In our current investigation, there is a notable increase in household human behaviors, particularly regarding water storage, which could significantly contribute to the proliferation of mosquito vectors. This aligns with the findings of Diakaridia *et al.* (2022), where household water storage containers were identified as enhancing mosquito breeding in specific communities in Abidjan, Côte d'Ivoire. Moreover, a study (Ng'ang'a *et al.,* 2021) reported a significantly higher capture of mosquitoes in villages and bush areas compared to those captured in cleared environments. Therefore, the considerably high percentage of households located close to the bush in our study holds significant public health implications for individuals residing in such environments.

The findings of the current study indicate a high level of awareness among respondents regarding the use of long-lasting insecticide nets as a tool for vector control to prevent malaria and other mosquito-borne diseases within the surveyed population. This mirrors the findings of Ng'ang'a *et al*. (2021), who reported that long-lasting insecticidal nets (LLINs) are extensively employed as a malaria prevention and control measure, particularly in Africa and the Lake Victoria basin of Western Kenya. Consequently, it can be inferred that the residents/respondents within the present study area are likely to have good access to LLINs, possibly facilitated through government-sponsored mass-distribution of bed nets (Aguma *et al.*, 2023; Omonijo & Omonijo, 2019; Maiteki-Sebuguzi *et al.*, 2023), percentage of which was significant in this study. However, significant percentage of respondents do not sleep under the bed despite their access to it. Unfortunately, certain percentage of these set of individuals do not give reason for this attitude.

While a considerable number of respondents in the selected communities may have effectively reduced the human biting rate of mosquitoes through the use of LLINs, there could be inadvertent increases through alternative means. This is particularly attributed to a significant portion of the population staying outdoors during the night. Mosquito vectors tend to prefer biting during dusk and nighttime hours (Degefa *et al.,* 2021; Bradley *et al.,* 2015). As humans have increasingly adopted sleeping under nets to prevent mosquito bites, vectors have adapted by seeking blood meals before hosts sleep under insecticide-treated nets (Ndenga *et al.,* 2016; Ferreira *et al.,* 2017).

Significant percentage (70%) of respondents under this study indicate non participation in community sanitation/breeding sites destruction. This will in-turn increase the abundance of mosquito in the study community. It has been previously reported that sanitation programme limits the proliferation and abundance of mosquito in any environment (Agyemang-Badu *et al.*, 2023). Environmental sanitation is a major means to destroying mosquito breeding site in the environment (Sovi *et al.*, 2013). Regrettably, the substitution of sanitary supervisors with environmental management campaigns in the post-independence era has worsened the challenge of mosquito vector control in Nigeria. The original purpose of the former was to maintain an environment devoid of mosquito breeding sites and prevent life-threatening diseases through their routine activities (Aigbodion & Anyiwe 2005; Adeleke *et al.*, 2013)

CONCLUSION

While residents in selected communities under this study possess knowledge of major vector control practices, there is a crucial need to promote the significance of environmental sanitation as a primary measure for controlling mosquito-borne diseases among them. Additionally, there should be increased awareness about the importance of sleeping under LLINs and avoiding mosquito bites during the evening times.

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