Household Ownership and Use of Mosquito Nets in Yobe State, Nigeria: Implications for Malaria Control in Under-Fives in 2023

Ambe JP,[1] Asheikh MM,[1] Ayman SS,[2] Mohammed BA,[3] Mohammed GA,[3] Adamu H,[4] Oyefabi A,[4] Nglass IN[4]

ABSTRACT

Background: Malaria remains one of the leading causes of mortality among under-five children due to the transmission of the Plasmodium parasite through the bites of infected Anopheles mosquitoes in tropical regions. In Nigeria, where the distribution of Insecticide Treated Nets (ITNs) for prevention is high, suboptimal utilisation and misperceptions are major obstacles to effective malaria control. We conducted this study to assess the ownership and utilisation of ITNs, as well as the factors associated with their proper use, in Yobe State, Nigeria. **Methods:** A community-based cross-sectional survey was conducted among children aged 3-59 months in Yobe State, Northeastern Nigeria, during the implementation of the Seasonal Malaria Chemoprevention (SMC) program. A sample of 2,880 households with children aged 3-59 months was selected using a modified cluster sampling technique across six Local Government Areas. Data were collected through interviewer-administered, pretested, structured questionnaires to primary caregivers and household heads. Descriptive and regression analyses, using IBM SPSS version 25, were conducted to examine ownership and utilisation, as well as factors that affect ITN use. **Results:** Ownership of ITNs was reported by 84.9% of households, with most owners having multiple nets. Utilization was high, with 97% of the children having slept under nets the night before the survey. The prevalence of fever in children in the preceding month was 19.7%, of whom 87.4% tested positive for malaria parasitaemia. The main predictors of appropriate ITN use were female caregiver (OR = 0.579, 95% CI = 0.346 – 0.970, P = 0.038); occupation (OR = 3.783, 95% CI = 1.585 – 9.028, P = 0.003); number of nets owned; (OR = 4.611, 95% CI = 2.022 – 10.514, P < 0.001); source of the net; (OR = 2.677, 95% CI = 1.345– 5.392, P = 0.005) and mosquitoes not biting through the nets (OR = 0.508, 95% CI = 0.291 – 0.887, p = 0.017). Malaria was found to be more prevalent among net users. **Conclusion:** While the study showed a high level of ownership and utilization of ITNs in Yobe State, there are still some problems regarding proper malaria prevention. Some of the factors that need to be addressed include the education of the caregiver, maintenance of the nets, and behavioural practices through health education and community involvement to further improve the effectiveness of ITNs in the control of malaria. Interventions in the future should target net care and proper usage practices to sustain protection against malaria.

Key words: Malaria, Insecticide-treated mosquito nets (ITNs), utilisation, Children, prevention.

[1] Department of Paediatrics, College of Medical Sciences, University of Maiduguri, Nigeria. [2] Borno State Ministry of Health, Maiduguri, Nigeria. [3] Yobe State Ministry of Health, Damaturu, Nigeria. [4] WHO, North East Zone, Nigeria

Corresponding Author:

Ambe Jose Pwavimbo, Department of Paediatrics, College of Medical Sciences, University of Maiduguri, Maiduguri, Borno State, Nigeria

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Introduction

Malaria is an infectious protozoal disease caused by the bite of a female anopheles' mosquito. It is a common cause of under-five mortality, especially in tropical regions. Globally, there were about 249 million cases of malaria and about 608,000 deaths due to malaria in 85 malaria-endemic countries. Nigeria contributed about 60 million cases and 26.8% of the mortality in 2022.[1] Several preventive measures have

been implemented, including insecticide-treated bed nets (ITN), indoor residual spray, larval source management, seasonal malaria chemoprevention, and intermittent preventive therapy in pregnancy.[2] However, when these preventive measures are combined, they make a greater impact.

The use of ITN has been the cornerstone of most of the preventive programs. Studies have shown that the use of ITN provides significant protection against malaria. A Cochrane review showed the use of ITN reduced plasmodium falciparum-related malaria deaths by 17%.[3] Unfortunately, despite these benefits, studies in Nigeria have revealed suboptimal utilisation of the nets either due to misperception or poor awareness. Similarly, the Nigeria Demographic and Health Survey (NDHS) of 2018 also revealed the underutilization of ITN despite ownership by households,[4] thus, depriving the households of the evidence-based benefits of the ITN.[5]

A multi-state survey in which one state was selected from three geo-political zones of Nigeria revealed various misperceptions and misuse of the ITN in all the states.[6] Studies have reported factors associated with utilization of net to include sociodemographic factors like gender, level of education, place of residence and socioeconomic status.[7] Means of acquisition of the nets, condition of the nets, colour of the nets and caregivers' knowledge of the malaria being transmitted by mosquito were also associated with the utilisation.[8]

This study, therefore, aimed to assess the proportion of households with at least one under five child that own at least one ITN, utilisation of the ITN (proportion of children that slept under the ITN the night before this survey), and the factors associated with the utilisation. This will help in planning future malaria preventive activities – such as the distribution of ITN, health education, and other preventive measures in general.

Methods

This was a community-based cross-sectional survey that was conducted as part of the 2023 end-of-round survey for the seasonal malaria chemoprevention (SMC) in Yobe state, North-Eastern Nigeria.

Pre-fieldwork preparation:

This included the recruitment and training of field personnel (supervisors and surveyors) on the data collection tool (ODK), and evaluation of the data before submission.

Study Area

The assessment was conducted in representative enumeration areas (EAs) where Seasonal Malaria Chemoprevention (SMC) took place 4 weeks earlier in the state.

Study population

The assessment population were the primary caregivers or heads of households with children aged 3–59 months who were residents in locations sampled during the period of the SMC program implementation.

Inclusion criteria

All households with children aged 3–59 months who were residents in the assessment location during the period of the SMC program implementation were eligible for selection. The assessment adopted the definition of a household as used in the National Malaria Indicator Survey (NMIS)[9], i.e., a person or a group of persons, related or unrelated, who live together, share common cooking and eating arrangements, and recognise one adult member as the head of household.

Exclusion criteria

Households with caregivers who were too ill to participate in the assessment or did not participate in the previous SMC for other reasons were excluded.

Sample size

The sample size was calculated using the formula for a discrete outcome by Lwanga and Lemeshow.[10] To adjust for the design effect due to clustering, assuming an intra-cluster correlation (ICC) of 0.2 and an average cluster size (n) of 20 eligible children, we arrived at a minimum sample size of 2,160 households.

Sampling procedure

There are 3 senatorial districts in Yobe State (North, East and West). The state has 17 Local Government Areas (LGAs), and each LGA is divided into wards. In addition to these administrative units, during the 2006 national census, each locality was subdivided into convenient areas called census enumeration areas (EAs). These EAs are referred to as clusters for the SMC coverage assessment and are defined based on EAs from the 2006 census frame.

A modified cluster sampling design was employed to select 2,880 caregiver-child pairs in Yobe State. Two LGAs from each of the 3 senatorial districts in the state were selected using simple random sampling (SRS) after excluding LGAs with serious security concerns, making a total of 6 LGAs. In each LGA, 6 wards were selected using the SRS method. In each ward, two clusters were selected using SRS. In each cluster, a

systematic sampling was used to select a house. The starting point is determined based on the direction indicated by the tip of a pen after it has been rolled by the surveyor. Every fourth house is selected if the cluster has more than 20 houses, or every other house if the settlement has 20 houses or fewer. There were 6 supervisors, each covering one LGA. There were 8 surveyors paired to 4 teams (2 per team). The cluster size refers to the total number of households within an EA. Selected clusters that are security-compromised were replaced by randomly selected backup clusters. Information about security situations in assessment areas was requested from the appropriate authorities before selection. Thirty (30) eligible households were selected from each cluster using SRS. This stage was preceded by a household listing of all eligible households to generate a household sampling frame. A pretested questionnaire was administered to the primary caretakers of children under the age of five years and heads of households. In the absence of the head of household, the primary caretaker responded to the head of household's questions as much as possible. A primary caretaker in this assessment refers to any individual, aged 15 years or over, with the primary responsibility for the feeding and daily care of at least one child under the age of five, in a household where he or she has been resident before the start of the SMC program or one month before the last cycle of the SMC.

Study Instrument

A pretested interviewer-administered questionnaire was used through a mobile phone-based data collection tool, "Open Data Kit (ODK)".

Data collection

A pretested structured assessment questionnaire was administered to the caregiver or the head of household using ODK. This approach minimised errors in data collection and entry. It also helped in collecting Geographical Positioning System (GPS) information, which serves as part of the quality assurance and provides spatial data for geo-referencing of findings. The questionnaire was administered to households as the epidemiological unit. The questionnaire is composed of questions related to the selected household and the eligible child's demographics; quality of SMC administration; fidelity to the SMC protocol by CDDs; knowledge, attitude, and perceptions related to SMC, ownership, care, and utilisation of ITN.

Procedure

The data collection process and fieldwork lasted for 3 days in the state. Two data collectors (surveyors) constituted a team. The supervisors were responsible for ensuring that the data collected was uploaded to the server daily. Questions were asked exactly the way they were written in the translated language, and in situations requiring interpretation, enumerators would ensure that the meaning of the questions was not altered. An average of 30 households was covered per team per day. Data uploads were made to a central cloud-based database daily and reviewed by a quality assurance team.

Data management

Data was analysed using the statistical software IBM SPSS version 25. All indicators are presented in proportions and an average across all the LGAs using probability weights. Ownership and utilisation of ITN were expressed as percentages. Bivariate logistic regression was used to assess the association between the utilisation of ITN with the socio-demographic and other characteristics of the households. p-values of <0.05 were considered statistically significant at a 95% confidence interval.

Results

The distribution of children in the sampled households revealed that most of the children were between the age range of 12 – 59 months and were males.

Most of the household respondents were females. The majority of the primary caregivers were between 20 and 39 years old. The literacy level (ability to read and write in any language) is high (70.2%) among the respondents, even though only about 9% have attended a senior secondary school and beyond. Most of the caregivers are unemployed. Details of the socio-demographic characteristics of the children and their primary caregivers are shown in Table 1.

Table 1: Sociodemographic characteristics of the children and primary caregivers

Variable	Frequency	Percentage
Child's age group		
3 – 11 months	569	19.8
12 – 59 months	2311	80.2
Child's sex		
Male	1527	53
Female	1353	47
Age group of primary caregivers		
< 20 Years	113	3.9
20 – 29 Years	935	32.5
30 – 39 Years	1197	41.6
40 – 49 Years	468	16.3
50 – 59 Years	138	4.8
60 Years and above	29	1.0
Gender of primary caregiver		
Female	1681	58.4
Male	1199	41.6
Caregiver's level of education		
Post Sec. sch.	429	14.9
Senior Sec. Sch.	459	15.9
Junior Sec. Sch.	120	4.2
Primary Sch	165	5.7
Infor. Or Rel. Edu	925	32.1
None Or Pre-primary	782	27.2
Is the caregiver literate?		
Yes	2021	70.2
No	859	29.8
Caregiver's occupation		
Civil servant	273	9.5
Agriculture	898	31.2
Sales/services	260	9.0
Manual worker	265	9.2
Unemployed	1184	41.1

Ownership of ITN

The ownership of mosquito nets was 84.9% (ranging from 74.7% - 99.2% across the LGAs). The details are shown in Figure 1.

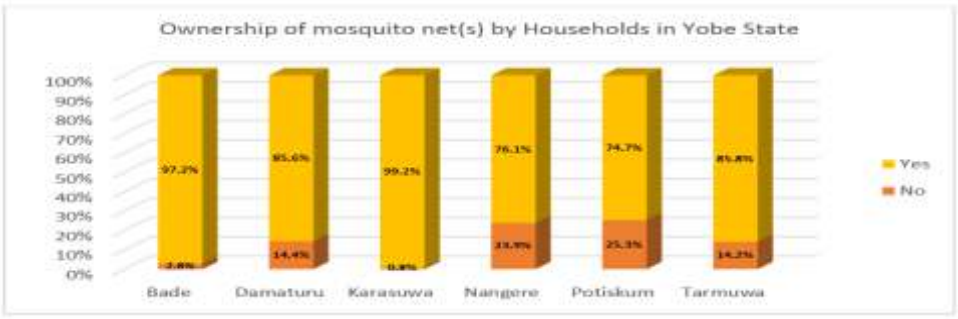

Figure 1: Ownership of mosquito net(s) by households in LGAs

Most of the households have more than one mosquito net as shown in Figure 2.

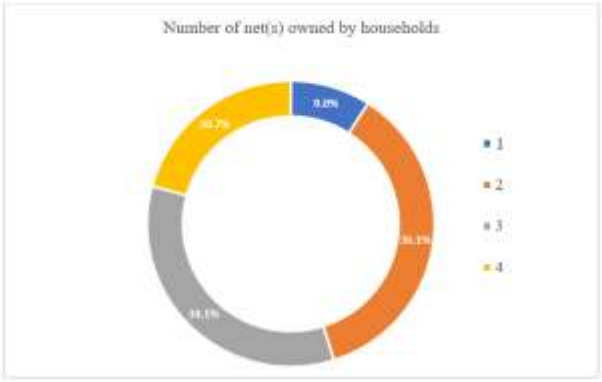

Figure 2: Number of mosquito nets owned by households.

About a third of the households have been using their nets for about two years, and up to a quarter have used them for three years and above, as shown in Figure 3.

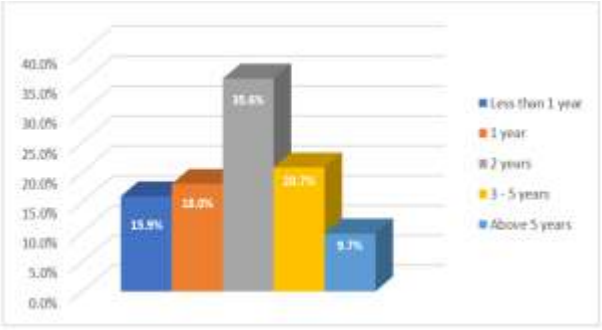

Figure 3: Duration of usage of the currently owned mosquito nets.

Almost all the households reported that their children slept under mosquito nets the night before this survey. Despite this claim, coupled with the just-concluded SMC round, almost 20% of the children had a fever in the preceding month. Of these children, up to 87.4% tested positive for malaria. Details are shown in Figures 4 to 6.

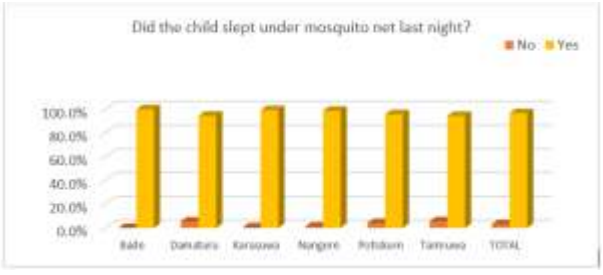

Figure 4: Distribution of children who slept under mosquito net.

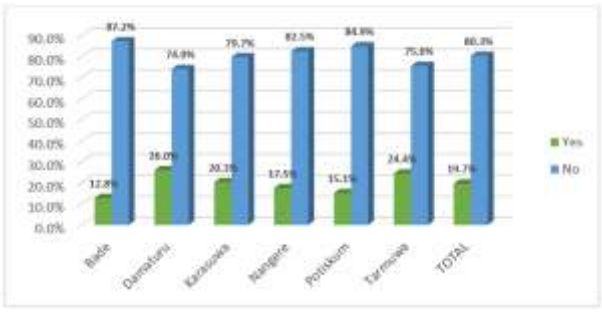

Figure 5: Distribution of children who had a fever the month before this survey

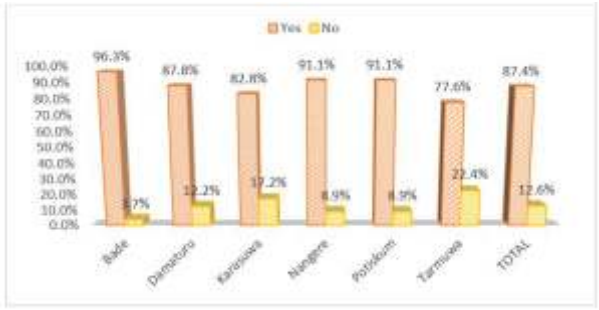

Figure 6: Distribution of children who tested positive for malaria in the month before this survey.

The high number of children sleeping under mosquito nets who tested positive for malaria could be due to the wrong practices of washing the nets with detergent and drying them under the sun, as seen in Figures 7 and 8.

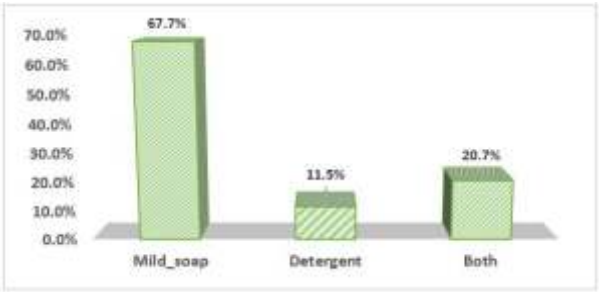

Figure 7: Means of washing the nets by households.

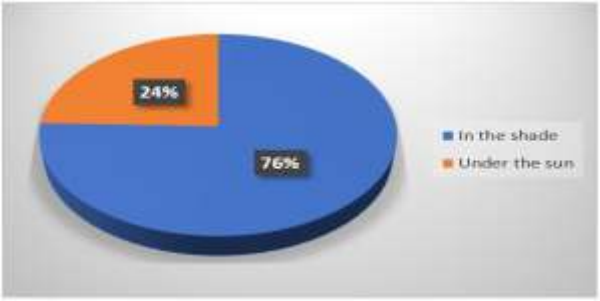

Figure 8: Ways of drying the nets after washing by households

Factors associated with the usage of the net

The age of the children's primary caregivers, educational status, occupation, number of under-five children, number of mosquito nets owned by the household, mosquito perching on the net, presence of holes in the nets, and having a child who had malaria in the preceding 1 month were subjected to regression analysis to determine if they are associated with sleeping under the net. The female primary caregiver, occupation, the number of mosquito nets, the absence of a family member who had ever reacted to ITN, mosquitoes not able to bite through the net, and the absence of holes in the nets owned by the household were significantly associated with the proper use of the nets. Details are shown in Table 2.

Table 2: bivariate regression analysis of the factors associated with the utilisation of nets.

Variable	Used net N (%)		OR	p-value
	Yes	No		
Child's age group				
12 – 59 months	1907 (80.6)	57 (74.0)	1.455 (0.865 – 2.445)	0.157
3 – 11 months	460 (19.4)	20 (26.0)	Ref	
Child's gender				
Female	1138 (48.1)	37 (48.1)	Ref	
Male	1229 (51.9)	40 (51.9)	0.999 (0.634 – 1.573)	0.996
Age of primary caregivers				
< 20 Years	75 (3.2)	4 (5.2)	ref	
20 – 29 Years	830 (35.1)	23 (29.9)	1.925 (0.649 – 5.712)	0.238
30 – 39 Years	957 (40.4)	30 (39.0)	1.701 (0.584 – 4.957)	0.330
40 – 49 Years	375 (15.9)	13 (16.9)	1.538 (0.488 – 4.848)	0.462
50 – 59 Years	105 (4.4)	7 (9.1)	0.800 *0.226 – 2.831)	0.729
60 Years and above	25 (1.1)	0 (0.0)	Undefined*	
Gender of primary caregiver				
Female	1474 (62.3)	57 (74.0)	0.579 (0.346 – 0.970)	**0.038**
Male	893 (37.7)	20 (26.0)	Ref	
Caregiver's level of education				
Post Sec. sch.	328 (13.9)	12 (15.6)	Ref	
Senior Sec. Sch.	364 (15.4)	13 (16.9)	1.250 (0.401 – 3.899)	0.701
Junior Sec. Sch.	93 (3.9)	0 (0.0)	1.124 (0.569 – 2.223)	0.736
Primary Sch	140 (5.9)	4 (5.2)	1.017 (0.509 – 2.032)	0.962
Infor. Or Rel. Edu	787 (33.2)	25 (32.5)	0.976 (0.439 – 2.170)	0.953
None Or Pre-primary	655 (27.2)	23 (29.9)	NC	
Caregiver's occupation				
Civil servant	212 (9.0)	11 (14.3)	Ref	
Agriculture	729 (30.8)	10 (13.0)	3.783 *1.585 – 9.028)	**0.003**
Sales/services	209 (8.8)	14 (18.2)	0.775 (0.344 – 1.746)	0.538
Manual worker	221 (9.3)	7 (9.1)	1.638 (0.623 – 4.305)	0.317
Unemployed	996 (42.1)	35 (45.5)	1.477 (0.738 – 2.954)	0.271
Number of mosquito nets owned				
1 net	204 (8.6)	17 (22.1)	Ref	
2 nets	850 (35.9)	32 (41.6)	2.214 (1.205 – 4.065)	**0.010**
3 nets	815 (34.4)	19 (24.7)	3.575 (1.825 – 7.000)	**0.000**
4nets	498 (21.0)	9 (11.7)	4.611 (2.022 – 10.514)	**0.000**
Source of the ITN				
Free	2242 (94.7)	67 (87.0)	2.677 (1.345 – 5.329)	**0.005**
Purchased	125 (5.3)	10 (13.0)	Ref	
Has any family member ever reacted to ITN?				
Yes	441 (18.4)	8 (10.4)	Ref	
No	1926 (81.4)	69 (89.6)	0.506 (0.242 – 1.061)	0.071
The child had malaria last month.				
Yes	355 (88.1)	7 (77.8)	2.113 (0.427 – 10.467)	0.359
No	48 (11.9)	2 (22.2)	Ref	
Mosquitoes bite through the ITN				

Yes	806 (34.1)	16 (20.8)	Ref	
No	1561 (65.9)	61 (79.2)	0.508 (0.291 – 0.887)	**0.017**
The ITN has holes that allow mosquitoes in				
Yes	672 (28.4)	16 (20.8)	Ref	
No	1695 (71.6)	61 (79.2)	0.662 (0.379 – 1.156)	0.147

Sec. = secondary, sch. = school, Infor. Or Rel. Edu = informal or religious education, NC = Not Computed by the model. **Bold** = statistically significant p-values. * The OR and CI are undefined due to zero events in one group.

Discussion

Malaria remained on top of the causes of under-five mortality. Preventive measures such as the use of ITN are known to be effective. This study assessed the ownership and utilisation of ITN by selected communities in Yobe State. Most of the households in the surveyed communities owned mosquito nets, which is quite commendable considering that Yobe State is a malaria hyperendemic region. The net ownership observed in this study was higher than 73.4% reported in the Nigeria Demographic and Health Survey (NDHS) 2023-24,[11] and 76% reported in Nigeria Malaria Indicator Survey (MIS) 2021.[9] This could be due to continued effort in the free distribution of ITN by the government and non-governmental organizations, as attested by the respondents in this survey in whom 94.5% of their ITN were given to them either through mass distribution or targeted programs such as during Antenatal Care (ANC). The utilization of the ITNs was also good as most of the households that owned ITNs reported their children to have slept under the nets the night before this survey. This utilization level is also higher than the 51% reported in the MIS 2021.[9] This could result from health education on the importance of ITN which was part of the recently completed SMC campaign in the state. Unfortunately, despite the high ownership and utilisation of ITN, the proportion of children who used the nets and were diagnosed with malaria the month before this survey was high. Factors that possibly contribute to this include the prolonged period of use of the ITN, as it is known that the insecticide impregnated in the nets (commonly pyrethroid) loses its potency after about 3 years of use.[12] Inappropriate washing and drying practices, and the presence of holes in the nets through which mosquitoes gain access to bite the children, as observed in this survey are other factors. Ashikeni *et al*.[13] reported that proper usage of ITN has reduced malaria prevalence among under-five children by 93% in a community in Abuja, Nigeria. These further stress the need to ensure that households are educated on the proper use of ITN.

Children whose primary caregivers are females are more likely to use the ITN compared to those with male primary caregivers. This could be attributed to the cultural norm in most African cultures where females are considered the primary caregivers of children by default and are thus more likely to have better experience in all aspects of childcare at home. A similar finding was reported by Ujuju *et al*.[14] from a secondary analysis of the Nigeria DHS 2018. Andinda *et al*.[15] also reported a similar finding from Uganda. Our study found that the caregiver's occupation affects the utilization of ITN, with children of those in the agriculture sector more likely to use the nets compared to children whose caregivers are in other occupations. This could be because caregivers involved in agriculture may also grow crops and/or keep animals at home that can attract insects and hence use the ITN as a protective measure. Caregiver's occupation could also determine their access to information on the use of ITN and the means of purchasing the ITN. This is in keeping with the findings by Diabate *et al*.[16] in Burkina Faso. Malusha *et al*.[17] from Kenya also reported caregivers' occupations influence the use of ITN. Our study also found that the number of ITNs owned by households was directly proportional to the likelihood of utilization. This indicates that improved access to the nets is likely to positively improve their utilisation. Similar findings were reported from Southern Nigeria [18] and Ethiopia.[19] The physical integrity of the ITN also influenced its utilisation as nets with compromised physical integrity would not provide the needed protection, hence, owners of such nets may not use them. A similar finding was also corroborated by Diabate *et al*.[16]

Conclusion

In conclusion, our study highlighted the ownership, utilisation of ITN and the factors associated with appropriate utilisation. These could serve as a focus for health education and social marketing to improve the use of nets as a preventive measure against malaria.

Recommendations

We therefore recommend that efforts in the distribution of mosquito nets should be sustained and should be coupled with health education on the proper use of the nets.

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