# Title

Why are nets unused? Reported reasons for non-use of Bed Nets in fourteen surveys from sub-Saharan Africa

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# Abstract

# Background

Malaria has remained a life-threatening public health problem globally in spite of advances in treating cases, and in understanding and eliminating the complex interrelated factors that contribute to risk, transmission, and illness. Infection with malaria has deleterious effects beyond the physical health of individuals of all ages; malaria also negatively influences individual and family quality of life, productivity, and economic development. The global malaria burden is disproportionately concentrated in sub-Saharan Africa (SSA) where 90% of cases, and 91% of all malaria-related mortality is found (WHO 2017). In addition, 15 countries, of which 14 are in SSA, bear 80% of the global malaria burden (WHO, 2017). Use of insecticide-treated bed nets (ITN) is anau essential prevention strategy for successful malaria prevention programs, and there is much clear evidence regarding the positive impact of ITNs on malaria-related morbidity and mortality, and its contribution to gains made by prevention and control programs (Wotodjo et al., 2017; Schellenberg 2001). Nevertheless, data from SSA shows that by 2016 household ownership of at least one ITN increased appreciably to 80%, however, the proportion of households with sufficient nets (i.e. one net for every two people) remained below expectations at 43% (WHO, 2016).

Effectiveness of ITNs is based on correct and consistent use of the nets, including among priority populations with increased risk of malaria, and malaria case resurgence has been associated with a significant decrease in the use of LLINs among malaria cases (Wotodjo et al., 2017). Appropriate and consistent use of ITNs among vulnerable populations in malaria endemic areas often lags behind net ownership and remains a global public health issue for many behavior change programs (Vanden Eng et al., 2010). There is some evidence regarding the non-use of nets. For instance, among communities in Myanmar with endemic malaria and active malaria prevention programming, the use of ITNs was low, including when the net was available, and only 15% of households in urban areas, and 7% from rural areas, had all members sleeping under an ITN (Aung et al., 2016). In Ethiopia, a study by Baume et al., (2009) showed that only 65% of participants who owned an ITN had used the net the prior night, and much of the data on net use was unchanged over the span of a decade. Qualitative exploration identified reasons for non-use as absence of mosquitoes, saving it for later, ITN perceived to be ineffective, or in poor condition. Another more recent study (Tassew et al., (2017) showed that in areas with high incidence of malaria, nearly a third of nets (30%) owned by households were out of use or in need of repair. A study in Ghana that explored net use in relation to household supply among 12 communities showed that while 88% of the sample households had an ITN, only 43% of them had used it the night prior to the survey (Zuradam 2012), and a 5-country study (Vanden Eng et al., 2010) on net use among children under the age of five years showed that 16% of vulnerable children lived in households that had a net but did not hang it, or that had hung a net but did not use it.

Other studies have described factors that underlie the non-use of ITNs, including from countries focused on in this paper. In Tanzania, use non-use of bed nets was associated with households that had window screens, well-fitting doors, and that used other malaria prevention options such as insecticidal sprays (Msellemu et al., 2017). In Uganda, good understanding of the protective effects and benefits of nets against malaria promoted net use (Acosta et. Al., 2012) however this was not so in Nigeria where a study showed decreased odds of using LLIN was correlated with higher education level and increased knowledge of malaria (Russell et al., 2015). In Uganda, non-use was associated with discomfort, heat, feelings of suffocation, chemical smell, perceived inconvenience, perceived not necessary, number of children in the household, insufficient quantity of nets, and children between 6 – 14 years of age (Wanzira et al., 2016; Acosta et al., 2012; Sangare et al., 2012). In Nigeria, several studies showed that net ownership did not necessarily translate to net use and that low net use was a persistent problem: A study in South-East Nigeria showed that 86% of participants owned nets but only 54% were using them (Bisi-Onyemaech et al., 2017); another study among 18 states showed that while 65% owned a net, less than a fifth (19%) used them (Ezire et al., 2015 a study in Rivers State (Ordinioha et al., 2012) showed that 60% of households with nets had hung nets correctly, but only 27% had slept under the net the prior night; and among households in there states with at least one bed net, 43% of respondents consistently used a bed net every night while 18% of them rarely used the net (Babalola et al., 2018). A summary of reasons for non-use of bed nets included inconvenience of setting up and dismantling nets, cost, perceived effectiveness, safety concerns, type of accommodation, sleeping arrangements, and humidity (Galvin 2011).

A culture of net use study in Senegal identified characteristics of the net, feelings of suffocation, cost, access through distribution programs, perceived effects of chemicals, and to a lesser extent, prevailing season, perceived mosquito density, and habitual out-door sleeping, as barriers to net use (Berthe et al., 2014; Arnold et al., 2013). Other factors included misconceptions about the effects of chemicals on children and pregnant women, and that the effectiveness of ITNs varied with bed types (Zegers de Beyl 2012). In Liberia, non-users of nets were typically older children, teenagers, and men, and the barriers to net use included increased household size, perceptions that nets generated too much heat, and old and damaged nets (Babalola et al., 2016; Bawo, 2012).

While there is much data on proportions of people using bed nets, there is little data on how decisions regarding net use are made in relation to net supply at household level. [Pulford](https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-10-83) et al., (2011) examined these reasons in the context of available net supply, using published data and a review of several post-campaign household surveys. The results showed that the main reasons for non-use of nets in malaria endemic countries were discomfort from heat under the net, perceived low density of mosquitoes, and technical challenges to hang the nets. However, the author concludes that quality of the available evidence may not reliably inform interventions for the target population. In a related paper, Koenker and Yukich (2017) showed that use of nets was not significantly related to user preferences regarding net attributes and suggested that reasons for non-use may be related in part to other factors such as mosquito density, heat, and number of nets owned.

Some, but not all, DHS and MIS surveys now collect population-level data on the reasons why a particular net in the household went unused the previous night. Identifying and understanding reasons for nets are not used is key for planning interventions that effectively target specific behaviors and types of non-use, and also to help prevent malaria case resurgence that threatens to reverse advances in elimination efforts. Data collected through DHS, MIS, and other national household surveys may increase understanding of perceptions of nets, barriers to use, and the person, product, environmental, and structural factors influencing decisions to use a net consistently.

This paper explores the reasons for non-use of nets using DHS MIS survey data from five countries - Senegal, Uganda, Liberia, Tanzania, and Nigeria. Using serial national survey data also provides an update to Pulford’s (2011) study and show multi-country comparative trends. This information has potential to inform evidence-informed behavior change communication strategies and targeted messaging for malaria prevention.

## Study objectives

The study objectives are to use national population-based household survey data to understand better the reasons underlying non-use of ITN in Liberia, Senegal, Nigeria, Tanzania, and Uganda. The goal of the analysis is to explore the reasons for not using an ITN during the previous night in relation to net supply, and how these reasons vary over time (where possible) and by country. The primary research questions were:

1. What proportion of nets were not used the previous night prior to the survey?
2. How do the primary reasons for non-use of nets the previous night, and how do reasons vary by country, net supply, and demographics?

# Methods

Secondary analysis was conducted on data from fourteen DHS MIS surveys from seven countries as follows: Uganda 2009, 2014; Liberia 2016; Tanzania 2015; Senegal 2011, 2014, 2015, 2016; and Nigeria 2010, 2015. Data from Liberia, Uganda, and Nigeria were from females, while data from Tanzania and Senegal included information from males and females. Datasets were obtained from dhsprogram.com and are publicly available.

## Design

For each dataset, the variables identifying each net in the household were identified. The data for each net in the household was reshaped to a long format to create a net file that included whether the net was observed by the interviewer, its age, whether it was an ITN, the number of users, and whether it was reported to have been used the previous night. The Roll Back Malaria indicators for proportion of households that own at least 1 ITN for 2 people and for proportion of ITNs used the previous night were calculated according to RBM Monitoring and Evaluation Reference Group (MERG) guidelines. To provide further detail on household ITN supply, a variable was computed with supply levels where "not enough" supply of nets indicated less than 0.5 nets available per person, “enough” supply of nets indicated 0.5 to 0.75 nets available per person, and "too many" nets indicated a supply of 0.75 or more nets available per person (i.e. at least 2 nets per 3 people). Households of one person with one net were then recategorized as ‘enough’. For this variable, both untreated nets and ITNs were included.

The variable for reasons the net was not used the previous night was identified in each dataset. Table 1 shows the reasons the net was not used the prior night collated from all the datasets, by country. This variable was recoded such that the denominator was all nets in the survey households. Nets that were not observed by the interviewer were excluded from analysis.

Other variables explored in relation to the reasons for not using a net included household net supply (not enough, just right, more than enough), type of place of residence (urban, rural), ITN/person ratio, and wealth index (poorest, poorer, middle, richer, richest).

## Analysis

Using the ‘svy’ family of commands as the sample weight, descriptive analysis for participants were analyzed for each data file. Next estimates were derived for the first key outcome of percent of nets used the previous night for each country and compared for three different levels of net supply within households: ‘not enough’ (net:person ratio less than 0.5); ‘enough’ (net:person ratio of 0.5 but less than 0.75); and ‘too many’ (net:person ratio greater or equal to 0.75 – 2 nets for 3 people). Second, estimates were calculated for the different reasons why nets were not used the previous night for each survey. Third, the reasons the net was not used were analyzed in relation to three levels of household ITN supply. Further analysis was conducted to understand better the demographic profiles and characteristics of households associated with specific reasons for non-use of nets the night before.

# Results

The percent of nets used the previous night was calculated for all available DHS and MIS surveys since 2003 (Figure 1). Linear regression stratified by survey type (DHS or MIS) indicates that there is no significant change (p=0.819) in overall percentage of nets used the previous night since 2003 for MIS surveys, while there is a slight but not statistically significant decline (p=0.347) in the overall percentage of nets used the previous night for DHS surveys (which are generally conducted in the dry season). Over all surveys, mean percentage of nets used the previous night was 70.7.

Figure : Percent of nets used the previous night for XX DHS and MIS surveys

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For the countries included in the detailed analysis of reasons for non-use of nets, use of nets was explored in the context of household net supply. The results are summarized in Figure 2. The percent of nets used the previous night was similar for households with not enough nets (less than 1 net for 2 people) and for households with at least 1 net for 2 people but less than 2 nets for 3 people (net:person ratio of 0.75). For households with at least 2 nets for 3 people the percent of nets used was significantly lower, potentially reflecting excess nets within the household or different net use behaviors by households with excess nets.

Figure : Mean nets used the previous night, stratified by household net supply, for seven study countries



## Reported reasons for not using nets

Questions about why the net was not used the previous night were not consistent between countries and sometimes changed over time within a given country. Figure 3 summarizes the response options for the question “Why was this net not used the previous night?”. In X surveys, multiple responses were possible, while in Senegal, Nigeria, and Mozambique, only a single response could be selected.

In Senegal, the most commonly reported reason for a net not being used the previous night was “no mosquitoes”, followed by “other” for surveys between 2008-2015; in 2016 and 2017 the ‘other’ response became more common while ‘no mosquitoes’ declined slightly. In Nigeria, the most common reasons were “net not needed last night”, “too hot”, and “no mosquitoes”. In Liberia, the most common reason was “net not hung up or stored away”, followed by “saving for later” and subsequently “too hot”. In Kenya, “excess nets” and “net never used” were the most frequent responses, along with “usual user not here”. In Mozambique, “reserved-for future use-new” was the most frequent response, followed by “net not needed last night” and “no mosquitoes”. In Uganda, surveys in 2009 and 2014 reported “net not hung” as the most frequent response”; in 2018 the answer options were revised to provide additional detail and “saving to replace other net” was the most frequent response, followed by “usual user did not sleep here” and “too old/torn”.

Other response options were very infrequent: the smell of nets, feeling closed in, fear of chemicals, feelings that the net is not effective, the net being too small, the net being dirty, and the net being too torn represented less than X% of nets in any survey. The response of “no malaria” or “no malaria now” was nearly entirely absent.

Figure : Reported reasons for a net not being used the previous night

A close up of a street

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The reasons for nets not being used were next explored in the context of household net supply. There were clear differences in reasons provided in some surveys. “Net not needed” or “hung up/stored away” or “saving for later” was far more common for households with ‘too many’ nets (≥2 nets per 3 people) in Liberia, Mozambique, Nigeria, Tanzania, and Uganda. In Uganda 2009 and 2014, the ‘not hung’ response was more common in households with enough or ‘too many’ nets. In 2018 the ‘saving to replace other net’ was the most common reason provided in households with too many nets, while other reasons (too old/torn; too hot) took precedence in households with not enough nets. “No mosquitoes” was somewhat more frequent among households with not enough nets in Tanzania and in Senegal, compared to households with enough or too many nets. “Other” responses in Senegal were far more frequent for households with ‘too many’ nets, potentially indicating that ‘other’ in Senegal is related to having extra nets on hand, and highlighting a need for the ‘other’ response to be broken out into more detail following the Uganda 2018 example. “Too hot” in Nigeria, Senegal, and Uganda was not significantly different across net supply levels but was somewhat more common among households with not enough nets in Tanzania, compared to Tanzanian households with enough or too many nets.

Figure : Reported reasons for a net not being used the previous night, stratified by household net supply

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In each of the seven surveys from Senegal’s two questions were asked. First, in households that owned at least one net, respondents were asked “do members of this household use nets all year round” (Figure 5A). The proportion of respondents reporting people in their household do use nets year-round ranged from 47% to 71% over the 2008-2017 period and generally tracks with levels of population access to ITNs. Does this reflect an improvement in year-round net use behaviors over time? Not necessarily. This may reflect an understanding of the question to be ‘do all members use nets year-round’; for households with insufficient intrahousehold access to nets, the answer may be ‘no’ simply because there are no nets for certain members to use. On the other hand, the proportion of the population that used a net among those with access varies seasonally in Senegal {Koenker:2019id}. Next, for households responding “no”, a follow-up question was asked: “what are the reasons household members do not use nets year round?”. The most frequent answer was “no/few mosquitoes” (Figure 5B), ranging from 65% to 82% of households. “Heat” was the next most common response, ranging between 10-15%. Not liking the net and forgetfulness were relatively uncommon (less than 9% and 4% in any survey, respectively).

Figure : (A) Percent of respondents reporting their household uses nets all year-round. (B) Reported reasons why household does not use nets year-round, among households that don’t use nets year-round.

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# Discussion

Need for standard set of response options in surveys? C.f. the MBS? Variety of key responses by country.

Patterns in household net supply – fairly obvious that these would vary if household has ‘too many’, more likely to be saving nets for later/extra, etc.

How does this inform SBC programming….

People don’t cite malaria risk per se as a reason the net wasn’t used, perhaps because it’s a net-level question. But ‘no mosquitoes’ gets at this in Senegal. “Net not needed” is too vague a response (why isn’t it needed?).

In Senegal, the ‘other’ answers increase when the household has more nets – probably related to net not being needed/extra, but we can’t tell.

Long list of ‘not that important’ reasons, which we eliminated in the graphs. At the same time, qualitative research has found a lot of people complaining about smell, itching, size, etc, it just may be not the primary reason nets aren’t used.

Compare to ‘reason why person didn’t use a net’ in Madagascar surveys? Respondents answer different for ‘a net’ than for themselves.

Trend over time in Senegal is…..

Complaints of heat in Nigeria are stronger than in other countries…cf other research.

Need to investigate seasonal patterns….

Limitations

* reasons and number of reasons vary by country
* reasons not mutually exclusive ie not hung, smell, too old/torn, ineffective
* social desirability bias

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| Long list | Medium List | Short List |
| 1. Too hot 2. Don’t like smell 3. No mosquitoes 4. No malaria 5. Prefer other method (coils, spray, fan, etc) 6. Too old/torn 7. Unable to hang 8. No place to hang 9. Chemicals in net are unsafe 10. Don’t like texture 11. Net too short/small 12. Usual user didn’t sleep here 13. Saving net for rainy season 14. Extra net 15. Saving to use when other net wears out 16. Net was being washed/dried/aired 17. Slept outside 18. Net brought bedbugs | 1. Too hot 2. No mosquitoes 3. No malaria 4. Prefer other method (coils, spray, fan, etc) 5. Net too old/torn 6. Chemicals in net are unsafe 7. Don’t like smell 8. Net too short/small 9. Usual user didn’t sleep here 10. Extra net / saving for later 11. Net was being washed/dried/aired 12. Slept outside 13. Net brought bedbugs | 1. Too hot 2. No mosquitoes/malaria 3. Don’t like net shape/color/size 4. Don’t like smell/chemicals 5. Extra net/saving for later 6. Usual user didn’t sleep here 7. Net too old/torn |

Other reasons unclear

At the net level, it is useful to have data on the reason the household did not put the net to use the previous night, in order to inform social and behavior change efforts to improve net use. If the reason that most nets were not used was primarily ‘net is extra’, the action is different than if the reason is primarily ‘don’t like chemical’.

At the moment only five countries are measuring this question in multiple surveys. There are no significant trends that require monitoring, given the existing data. Countries would benefit from ‘unpacking’ the ‘not hung’ answer (Uganda), the ‘not needed’ answer (Nigeria), and the ‘other’ category (most countries), which this revision attempts to address.

Uganda spent a lot of money after 2009 on physical hang up campaigns, buying nails, string, hooks, and sending volunteers door to door to hang up people’s nets, as a direct result of this indicator. Ultimately an operational research study funded by PMI showed that hanging rates did not differ for households that were cluster-randomized to receive a hang-up intervention in 2013 vs households that did not receive visits. Most nets ended up being hung within 6 months post-campaign.

Data from these questions, if answer options are properly selected, can help social and behavior change programs identify and effectively address the key barriers to net use.

# Conclusion

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