

Reported reasons for non-use of insecticide-treated nets in large national household surveys

Hannah Koenker^a, Marcy Erskine¹, Robert Opoku¹, Zainab Ali¹, Eleanore Sternberg^a, Cameron Taylor¹

^a*Baltimore USA*

Abstract

Insecticide-treated nets (ITN) are the cornerstone of modern malaria vector control, with over 2 billion ITNs delivered to households in endemic areas since 2000. ITN access, i.e. availability within the household, based on the number of ITNs and number of household members, is the sine qua non of ITN use. Once ITNs are in a given household, however, individuals may choose to use or not use them on a given night, with structural, cultural, opportunistic, and social barriers impeding optimal use. Factors determining ITN use are frequently examined in published literature, but to date, large household survey data on reasons given for non-use of nets have not been explored.

A total of 155 DHS, MIS, and MICS surveys since 2003 were downloaded with permission and reviewed for presence of questions on reasons why nets were not used the previous night, and twenty-four surveys were identified. The percent of nets that were reported used the previous night was calculated for 155 surveys, and frequencies and proportions of reasons for non-use were calculated within the twenty-four surveys. Results were stratified by household supply of ITNs in three categories (not enough”, “enough”, and “more than enough”).

The percent of nets used the previous night averaged 70.4% across the 155 surveys conducted since 2003. Stratifying by households ITN supply, this was 75%, 71%, and 53% for households with not enough, enough, and more than enough ITNs, respectively. Population ITN use within these households was 51%, 74%, and 76%, respectively. Reported reasons for non-use of ITNs were primarily nets being extra or being saved for later, followed by low perceived risk of malaria (no mosquitoes/no malaria). The least frequent categories cited as reasons for nets not being used were “net attributes” (size, shape, color, etc) and “fears”. Using continuous DHS data from Senegal, the proportions of nets used peaked during high transmission season, while “no/few mosquitoes” responses peaked during the dry season.

The proportion of nets used the previous night has averaged over 70% since 2003, with no discernible change over this period. Reported reasons for why a net goes unused fall largely into three categories - nets that are extra/being saved for future use; the perception that there is little risk of malaria (particularly

in dry season); and “other” responses. Net attributes such as color, size, shape, and texture, and fears related to chemicals were the least frequent reasons given. Classifying reasons for non-use into broader categories facilitates the design of appropriate social and behaviour change interventions to address the major underlying reasons for non-use, where this is feasible. Finally, national malaria programs should request the inclusion of this question in future surveys to provide actionable data to inform SBC programming. [Meant to be 350 words max; it’s over currently]

Keywords: insecticide-treated nets, long-lasting insecticidal nets, net use

1. Introduction

Insecticide-treated nets (ITN) are the cornerstone of modern malaria vector control, with over 2 billion ITNs delivered to households in endemic areas since 2000 [1]. Consistent use of ITNs provides the most protection from malaria vectors, but households may only have enough nets for all household members for the several months immediately following mass ITN distributions, as nets begin to wear out [2–5]. ITN access, i.e. availability within the household, based on the number of ITNs and number of household members, is the sine qua non of ITN use. Once ITNs are in a given household, however, individuals may choose to use or not use them on a given night, with structural, cultural, opportunistic, and social barriers impeding optimal use [6, 7].

Many papers evaluate determinants of ITN use, although not all control for ITN access. Primary factors influencing use of available nets include perception of risk of malaria, due to seasonality of transmission - ITN use among those with access is typically lower during long, hot, dry seasons, when malaria vectors and other nuisance biting insects are less abundant [8]. Perceptions of heat and feeling closed in are frequently cited alongside each other [6, 9]. ITN use is also affected by who within a given household can share a single ITN, as well as space available to hang ITNs [10–13]. The condition of an ITN, related to its age along with the development of holes and tears, is associated with early discarding of ITNs and therefore lack of use [14–17]; the decay rate of ITNs is a critical component of overall trends in ITN access, determining how quickly coverage declines following mass distribution campaigns and other large-scale distributions [2, 5].

Pulford et al [6] reviewed 22 available studies in 2011 for reasons why nets went unused, finding that discomfort due to heat and perceived low risk of malaria due to low mosquito density were the primary

*Corresponding author

Email addresses: hannah@trophealth.com (Hannah Koenker), marcy.erskine@ifrc.org (Marcy Erskine), robert.opoku@ifrc.org (Robert Opoku), zainab.ali@ifrc.org (Zainab Ali), eleanore@trophealth.com (Eleanore Sternberg), cameron.taylor@icf.com (Cameron Taylor)

reasons cited, but noted that findings were tentative given the dearth of published studies. Since this time, large national household surveys including Malaria Indicator Surveys and Demographic and Health Surveys have in several cases added questions about reasons for not using nets. This paper summarizes available data in these MIS and DHS surveys and explores trends in the percentage of ITNs used. Finally, recommendations are given for further exploration of reasons for non-use of ITNs.

1.1. Study objectives

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

1. What proportion of nets were used the night prior to the survey?
2. Of nets that went unused, what are the primary reported reasons for non-use, and how do reasons vary by country and net supply?

2. Methods

For the first study objective, 155 DHS, MIS, and MICS surveys since 2003 were downloaded with permission from dhsprogram.com and mics.unicef.org. Each dataset 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 indicator of percent of nets used the previous night was calculated for all surveys and linear regression used to assess temporal changes for each type of survey. To evaluate net use in the context of household ITN supply, a variable was computed with supply levels where “not enough” indicated less than 0.5 nets available per person (<1 ITN per 2 people), “enough” indicated 0.5 to 0.75 nets available per person (1 ITN per 2 people), and “more than enough” nets indicated a supply of 0.75 or more nets available per person (i.e. at least 2 nets per 3 people). Households consisting of one person with one net were categorized as ‘enough’, rather than “more than enough”. For this variable, both untreated nets and ITNs were included.

For the second study objective, all DHS and MIS surveys were reviewed and twenty-four surveys from nine countries were identified as having included a follow-up question for unused nets about why they were not used. All were Malaria Indicator Surveys, conducted during peak malaria transmission season, with the exception of the Madagascar 2021 DHS, Nigeria 2018 DHS, the Tanzania 2015-16 DHS/MIS, and eight

continuous DHS surveys from Senegal (2011-2019), where fieldwork is conducted throughout the year. Nets that were not observed by the interviewer were excluded from analysis. The “svy” family of commands in Stata 17 was used to appropriately weight results within each country. Plots were produced with R.

3. Results

The percent of nets used the previous night averaged 70.4% across all available (n=155) DHS, MIS, and MICS surveys since 2003 (Fig. 1). Linear regression stratified by survey type indicates that there was no significant change over time in the percentage of nets used the previous night for MIS ($p=0.772$), DHS ($p=0.499$) or MICS ($p=0.235$). MIS surveys, conducted during high transmission season, were associated with a 6.8-point increase in rates of net use when compared to DHS surveys ($p=0.046$), which are generally conducted during dry season when malaria transmission is lower. Net use rates in MICS surveys did not differ significantly from DHS surveys (0.872).

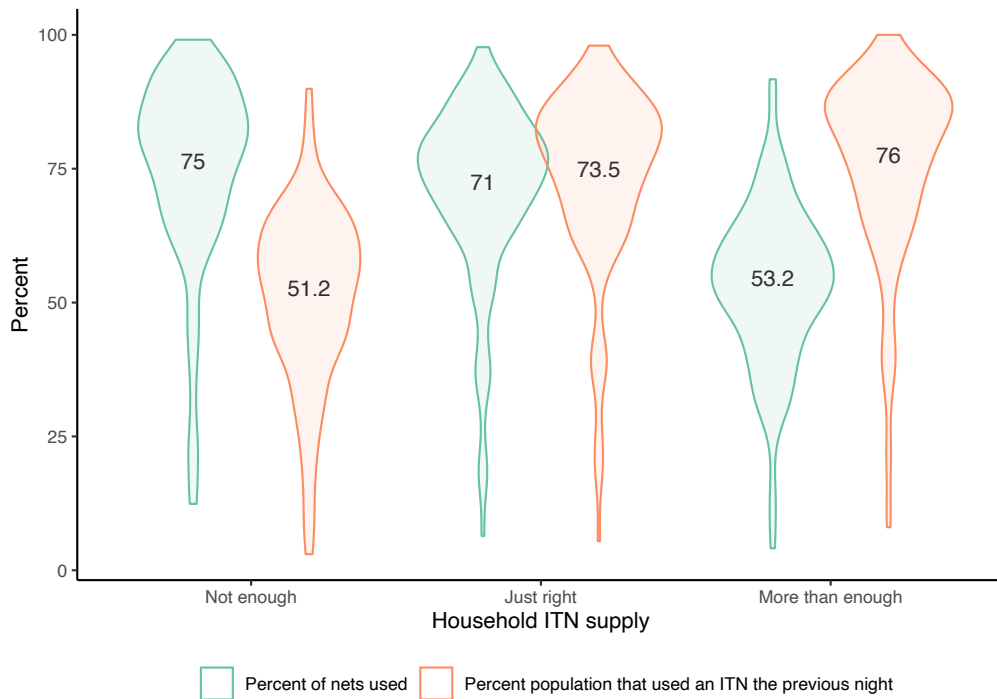
Figure 1: Percentage of nets used the night before, DHS, MICS, MIS surveys 2003-2020



The percent of nets used the previous night was 75% for households with not enough nets (at least one,

but less than 1 net for 2 people) and 71% for households with at least 1 net for 2 people but less than 2 nets for 3 people (net:person ratio between 0.5 and 0.75), shown in Fig. 2. In contrast, in households with at least 2 nets for 3 people 53.2% of nets were used, potentially reflecting excess nets within the household or different net use behaviours by households with excess nets. Nonetheless, in these same households with “more than enough” nets, the percent of individuals using an ITN the previous night was 76%, on par with those living in households with sufficient ITNs (73.5%). For people living within households owning at least one but not enough ITNs, population ITN use was 51.2%.

Figure 2: Violin plots with means for ITNs used the previous night and population use of ITNs, by household net supply level.



3.1. Reported reasons for not using nets

Response options for reasons why a net was not used the previous night were inconsistent between countries and sometimes changed over time within a given country. Table 1 summarizes the response options for the question “Why was this net not used the previous night?” and categorizes them into seven broad categories: ‘extra’ (nets being saved for later, or extra), ‘fears’ (chemicals are unsafe or toxic), ‘net attributes’ (size, shape, or textile), ‘objective’ (usual user not here; net being washed; no space to hang; net too torn), ‘risk perception’ (no mosquitoes or no malaria), ‘subjective’ (related to heat, smell, etc), and ‘other’ (capturing ‘other’ as well as ‘not hung’ and ‘net not needed last night’, all of which fail to provide useful information about the respondent’s reasoning). Risk perception and subjective reasons for a net going

unused may be more amenable to certain social behaviour change interventions, while objective reasons are not. In eight surveys, multiple responses were possible, while in sixteen, only a single response could be selected.

Table 1: Categorization of reasons why nets were not used

Category	Answer options from MIS
extra	extra; saving for later; stored away
fears	chemicals not safe; net is bad for health; superstition/witchcraft
net attributes	too rough/hard; too small; don't like color/shape/size; brought bedbugs; prefer other method
objective	too old/torn/dirty; no place to hang; usual user didn't sleep here; net being washed; too weak/difficult to hang
risk perception	no mosquitoes; no malaria; saving for rainy season;
subjective	too hot; don't like smell; feel closed in/afraid; no longer kills/repels mosquitoes; child doesn't like; net never used; causes itching/coughing; slept outdoors
other	not needed last night; not hung; other; don't know

Figure 3 below shows the proportion of nets used the previous night across twenty-four surveys in nine countries, and the reasons why certain nets were not used. The percentage of nets reported used ranged from 50% in Ghana 2019 to 85% in Mozambique 2018. Senegal's continuous DHS surveys showed the highest proportions of reasons related to risk perception, with up to 25% of nets going unused due to "no mosquitoes" or "no malaria". However, this category was relatively infrequent in other surveys, with the exception of Tanzania where up to 11% of nets were unused due to risk perception, and was more pronounced in lower-transmission areas (Supplemental Material). "Extra/saving for later" nets were reported most frequently in Ghana 2019 (19%), Liberia 2016 (19%), and in Tanzania (12-14% of nets). Senegal and Uganda had the highest rates of 'other' responses. In 2018, Uganda updated answer options for this question to be more detailed, resulting in the 'extra' and 'objective' categories becoming more prominent; 'extra' category was comprised largely of 'saving to replace other net', while 'objective' was a combination of 'usual user not here' and 'too old/torn' (Supplemental Material). Subsequent surveys (Ghana, Guinea, Mozambique, Madagascar) adopted similar answer options.

Figure 3: Summary of reasons nets were not used, across surveys

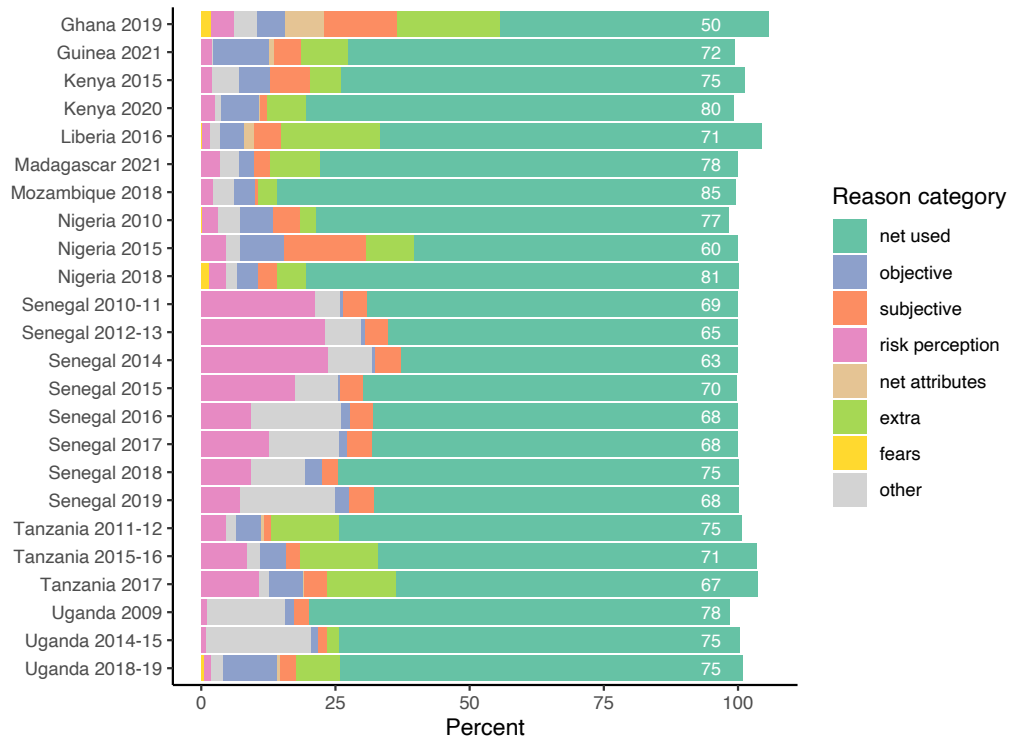
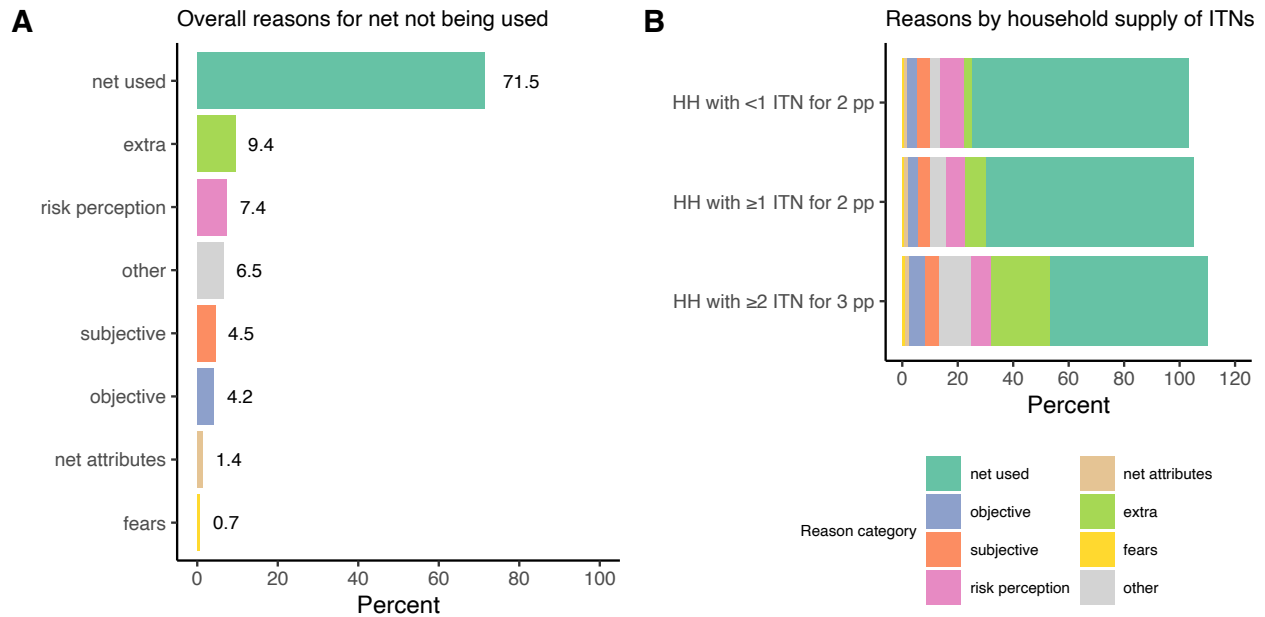


Figure 4A summarizes the categories of reasons for non-use across the twenty-four surveys, demonstrating that an average of 71.5% of nets were used, and that the leading category for non-use was “extra”, followed by “risk perception”. The least frequent categories cited as reasons for nets not being used were “net attributes” and “fears”. Figure 4B presents reasons for nets not being used in the context of household net supply.

Figure 4: Summary of reasons across surveys, by household supply of ITNs



Not surprisingly, “extra” nets comprised a higher proportion of reasons for non-use among households with at least 2 ITN for 3 people (21.6%) compared to households with not enough nets (3%) or households with at least 1 ITN for 2 people (7.7%). “Other” responses were more frequent in households with at least 2 ITNs for 3 people (11.4% vs 5.7% and 3.9%), indicating that ‘other’ reasons are likely related to having extra nets, particularly in surveys prior to 2018 when response options did not capture extra nets well. The “risk perception” category was stable across ITN supply categories, ranging between 6.8% and 8.4%, as were “subjective” reasons, ranging from 4.2% to 5%. Reasons for non-use related to net attributes or fears comprised less than 2% across all ITN supply categories.

In each of the eight surveys from Senegal 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” (5A below). The proportion of respondents reporting people in their household do use nets year-round increased from 47.4% to 72.9% over the 2008-2019 period ($p < 0.001$ for trend) and generally tracked with increasing levels of population access to ITNs. 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” (5B), which fell from a high of 29.1% in 2012 to 14.5% in 2019, as a proportion of all households in the survey. “Heat” was the next most common response, ranging between 2.1-4.9%. Not liking the net and forgetfulness were relatively uncommon (less than 2.6% and 1.2% of all households in any survey, respectively).

Figure 5: Year-round net use and reasons for not using nets, Senegal 2008-2019

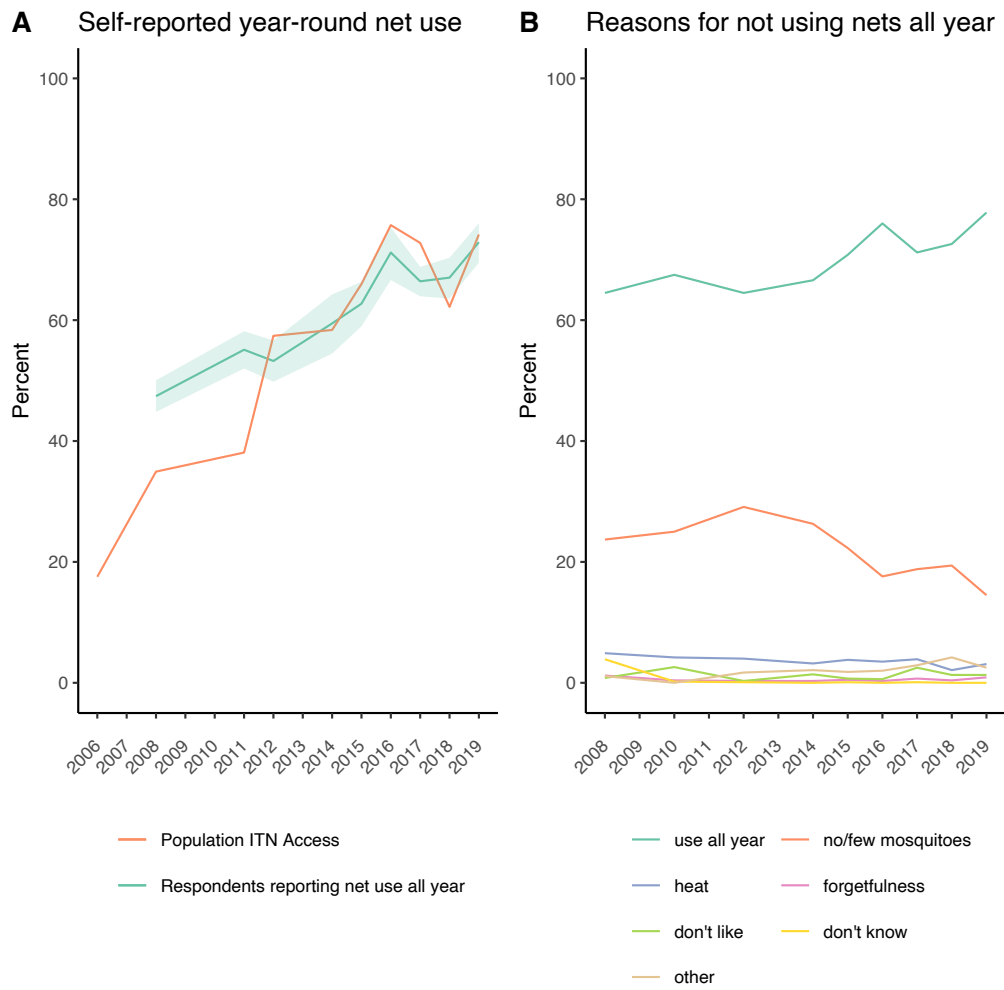
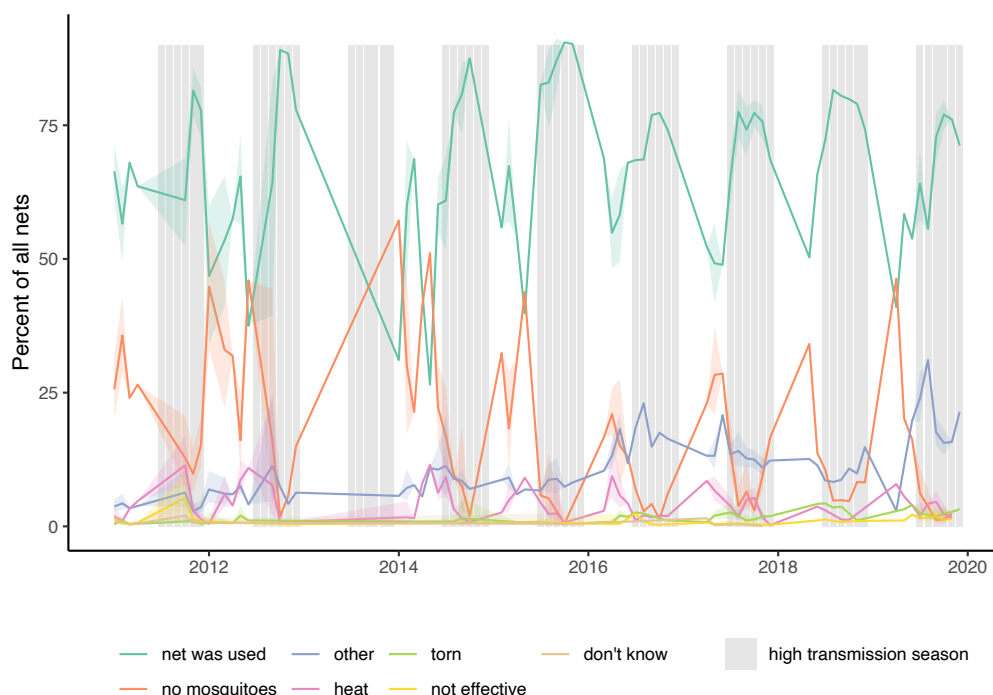


Figure 6: Reported net use and reasons for non-use, Senegal 2011-2019



Seasonal trends in reasons for not using nets in Senegal were apparent, as illustrated in Fig. 6 above. The percentage of nets used the previous night peaked during high transmission season (shown approximatively above as July-December), falling to lower levels during the drier months of February-May. Correspondingly, the proportion of nets not used due to “no mosquitoes” peaked during the drier months.

4. Discussion

Over the past nearly twenty years, an average of over 70% of ITNs were reported used the previous night in large household surveys. Questions about why nets go unused have only been included in twenty-four surveys from nine countries, but among these, the primary reasons given are that unused nets are surplus to immediate requirements, or not needed due to perceived low risk of malaria and/or mosquito bites. Responses related to extra nets were more frequent among households owning more ITNs than strictly deemed necessary by WHO (1 ITN per 2 people) [18]. Unsurprisingly, the proportion of nets used the previous night in households with “more than enough” nets was lower than for households with less than enough or “enough” nets, while at the same time, the proportion of people that used an ITN the previous night was highest in households with “enough” or “more than enough” ITNs. Households with more than one ITN per two people may have acquired additional nets to cover individual sleeping spaces or

to accommodate sleepers who cannot share a sleeping space; other households may have extra nets being saved for later use, when current nets wear out, and thus are able to have most household members sleep under one. Households with “not enough” ITNs had lower rates of population use, but high rates of nets being used - indicating that these households are using the nets they have, and are challenged primarily by not having enough for other members of the family. It should be noted that having ‘extra’ nets is reflective of the inherent inefficiencies of ITN distribution systems, wherein some households will have too few while others may receive additional nets slightly earlier than required [2]. The authors view having extra nets on hand within households as a positive, given the unpredictability of net replacement timing.

Reasons related to net attributes - including size, shape, color, texture, and mosquito-killing ability - were inconsistently included in survey questionnaires, but represented a negligible fraction of reasons for not using nets. While this does not preclude these issues from contributing to net non-use, it provides some evidence that these issues are not top of mind when families are making net use decisions. The 2011 Pulford review findings [6] that discomfort due to heat and perceived low mosquito density were the most widely identified reasons for non-use are partially confirmed here; heat per se was not widely reported in more recent surveys, but risk perception as a category, particularly for Senegal, was a key driver. Pulford et al also use categories such as “social factors” (sleeping elsewhere), “technical factors” (not being able to hang a net), which are considered “objective” reasons for non-use in our study. Pulford’s review, conducted just as universal coverage campaigns were scaling up, was limited to 22 studies between 1990 and 2010. Since this time, a number of qualitative research studies have also been conducted, in which respondents cite being bothered by net attributes including smell, itching, shape, and size [12, 19–21]. However, these reasons are only rarely cited during quantitative surveys included in this study. Research from Senegal indicates that initial itching or smell are transitory, noticeable when nets are first received, but subsiding over time, not impeding net use [20]. Other less preferable attributes of nets may similarly be less noticeable over time, and are no longer a key reason for non-use, particularly when, as in most countries distributing ITNs, there are seldom enough nets in good condition for everyone to use. Families are thus obliged to use the imperfect ITNs they have, or risk contracting malaria.

Nearly 80 unique answer options were included across the surveys. The categorization of responses into “extra”, “risk perception”, “objective”, “subjective”, etc., is intended to facilitate interpretation and guide national malaria programmes and their partners in designing appropriate responses for improving net use. Where the majority of unused nets are not used due to subjective reasons, social behaviour change may be able to change attitudes and behaviours; however, if most nets are unused due to being too old or

torn, programmes may need to focus on net maintenance behaviours and/or additional ITN distribution to improve ITN use rates.

As one example, Senegal has focused messaging over the last decade to address the perceived lower risk of malaria in the hot/dry season, in part because of findings in these surveys, through the “Trois Toutes” campaign (“Toute la famille, toutes les nuits, toute l’année” or “Every family member; every night; all year round”). Self-reported use of nets all year round has increased over time, although it remains unclear whether this is driven primarily by corresponding increases in overall access to ITNs with the household, or represent real changes in behaviour for more consistent ITN use. The continuous DHS in Senegal, conducted annually for the last eight years over multiple months, present a unique opportunity for assessing trends over time in year-round use as well as evaluating the associations between seasons and frequency of certain responses, notably “no/few mosquitoes”. Indeed, net use peaks in high transmission season, while the proportion of nets not used due to “no mosquitoes” peaks during the hot dry season when mosquito densities are substantially lower.

Another example of refining this question to better inform programming is Uganda. Following the 2009 survey Uganda implemented “hang up campaigns” to ensure nets were hung and used, partially in response to low hanging rates observed in the 2009 and other surveys. Operational research showed that these hang-up campaigns did not improve hanging or use rates, as net hanging increased at similar rates over time in control and intervention groups [22]. In its most recent surveys, Uganda teased apart the nebulous “not hung” answer option to better focus on specific barriers to net use, enabling the programme to understand what lies behind the non-use of nets; key reasons for non-use in 2018 were “saving net for later”, “user not here”, and “too old/torn”, none of which are best addressed with SBC efforts to hang up nets. This pragmatic specification of reasons for non-use enables programmes and their SBC partners to better design and target net use interventions. However, the absence of these types of questions even in many recent surveys is a missed opportunity, particularly as ITNs remain the primary tool for malaria vector control across the globe. National malaria programmes would do well to ensure this question is included in their upcoming household surveys, following the lead of Uganda, Mozambique, Nigeria, and Madagascar.

These findings also highlight that there may be more limited “room for improvement” in ITN use than previously thought. Nets not used for ‘objective’ reasons and those that are ‘extra’ are relatively impervious to social behaviour change communication, leaving the areas of ‘risk perception’, ‘subjective’, ‘fears’, ‘net attributes’, and some portion of ‘other’ left to address. These “objective” and “extra” categories explain non-use for, on average, 14% of all nets in the included surveys, but range from 0.5% to 24.6% of all nets

depending on the country and survey. Even with highly effective social behaviour change, not all nets can be reasonably expected to be used.

4.1. Limitations

The study has several limitations. First, the question of reasons why nets were not used was included in only twenty-four surveys in nine countries. It is not possible to generalize reasons for non-use of nets to other countries; however, the present findings show that there are substantial similarities in overall percentage of nets used and relative importance of certain types of reasons. Second, response options vary considerably across surveys that do include this question, and number of reasons vary by country, from seven in Senegal to seventeen in Liberia and Mozambique. Nonetheless, some of the differences in response options are minimal changes in wording, and major categories of reasons are generally included in each survey. Third, the categorization of the reasons for non-use into broader categories relies on assumptions about which barriers are similar, and opinions may differ depending on subject familiarity, lived experience, and other factors. Some reasons may also belong in multiple categories. Fourth, around half the surveys posed the question about reasons for why a net wasn't used the previous night as a multiple choice question, while the other half restricted it to a single response. This may introduce some unequal weighting into the results, or put more emphasis on single-choice responses to the exclusion of other possible reasons for not using nets. Finally, there were a substantial number of responses recorded as "other" in many of the surveys; it cannot be determined what type of reason this may have been, although it seems likely that they are at least in part related to extra nets or saving for future use, given the increase in other responses among households with "more than enough" nets.

5. Conclusion

The proportion of nets used the previous night has averaged over 70% since 2003, with no discernible change over this period. Reported reasons for why a net goes unused fall largely into three categories - nets that are extra/being saved for future use; the perception that there is little risk of malaria (particularly in dry season); and "other" responses. Net attributes such as color, size, shape, and texture, and fears related to chemicals were the least frequent reasons given. Classifying reasons for non-use into broader categories facilitates the design of appropriate social and behaviour change interventions to address the major underlying reasons for non-use, where this is feasible. Finally, national malaria programs should request the inclusion of this question in future surveys to provide actionable data to inform SBC programming.

6. References

7. Supplemental Material

Figure 7: Reported net use and reasons for non-use by low and high transmission zones, Tanzania 2017-18 MIS

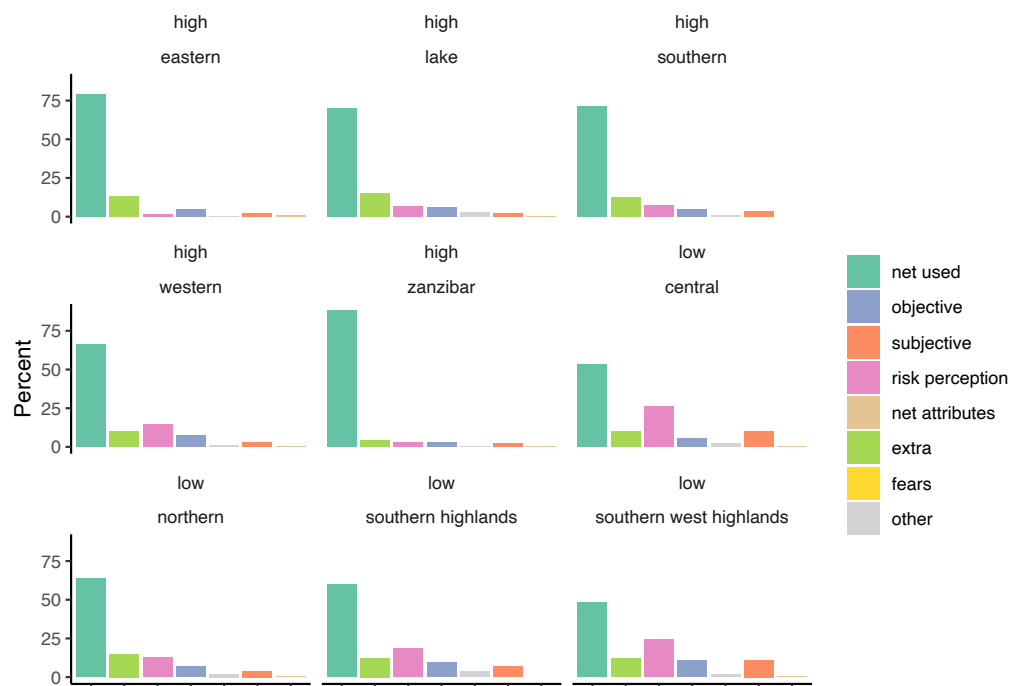


Figure 8: Reasons nets were not used the previous night, Ghana, Guinea, Kenya

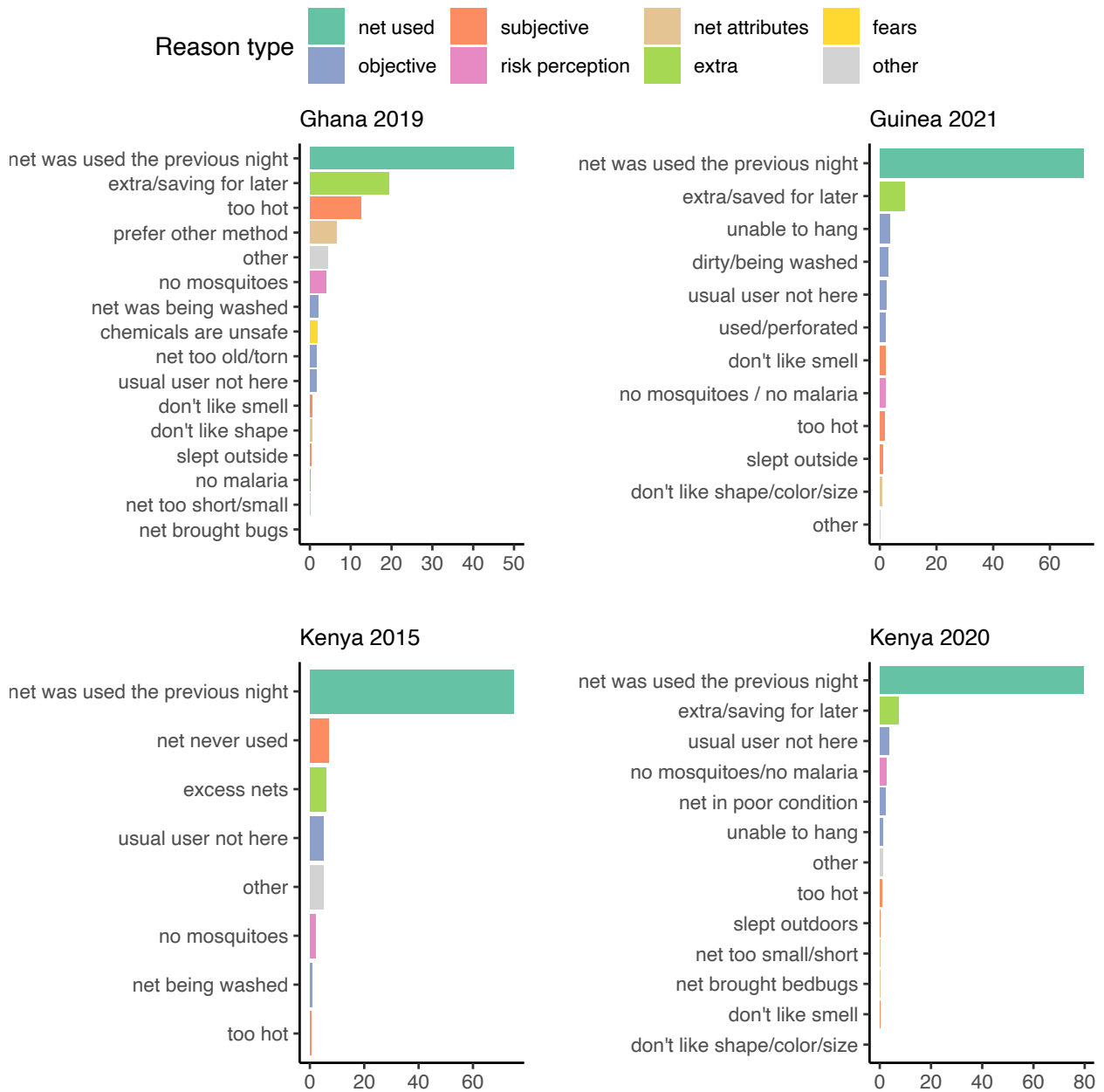


Figure 9: Reasons nets were not used the previous night, Liberia, Madagascar, and Mozambique

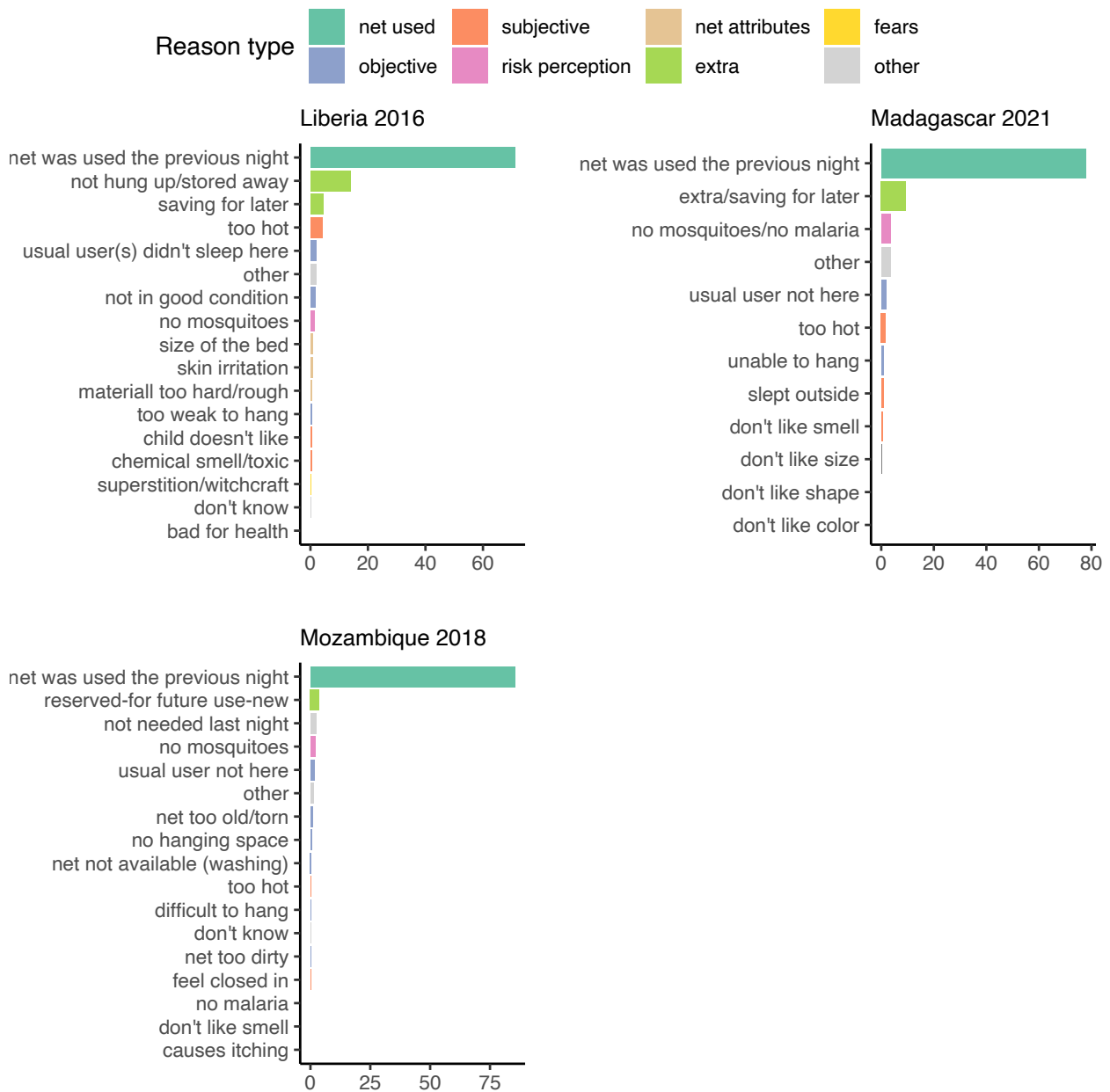


Figure 10: Reasons nets were not used the previous night, Nigeria

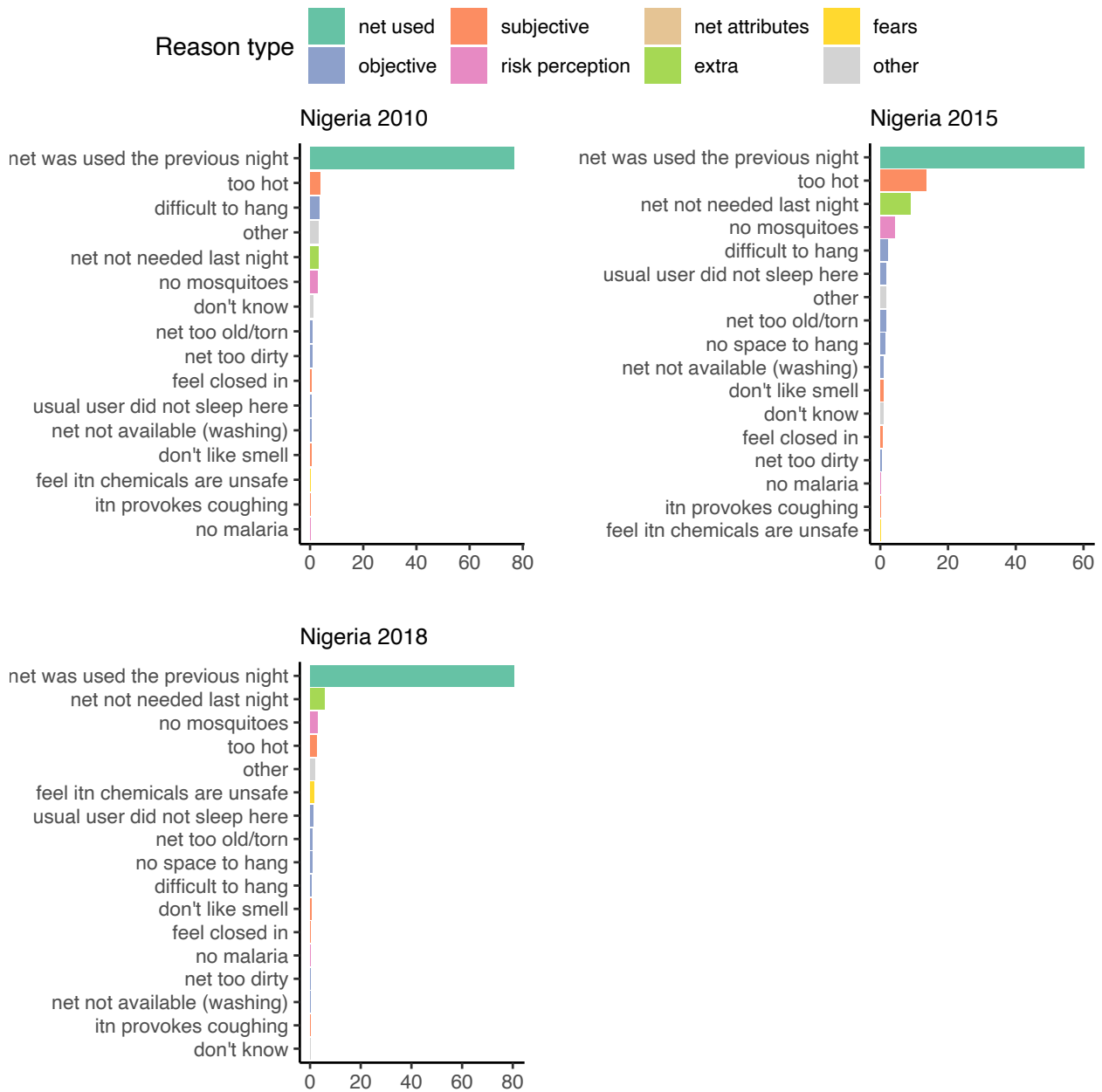


Figure 11: Reasons nets were not used the previous night, Senegal

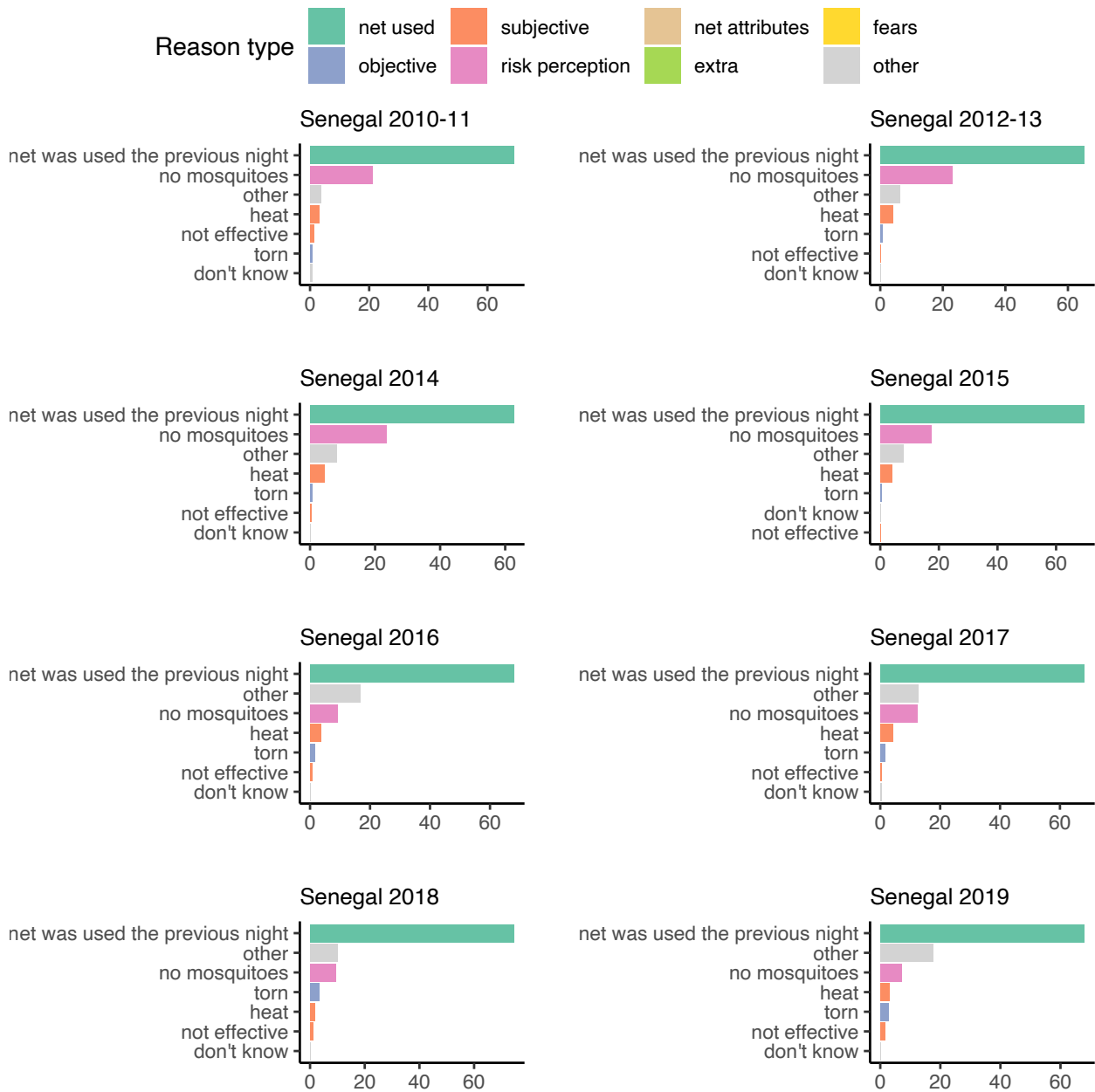


Figure 12: Reasons nets were not used the previous night, Tanzania

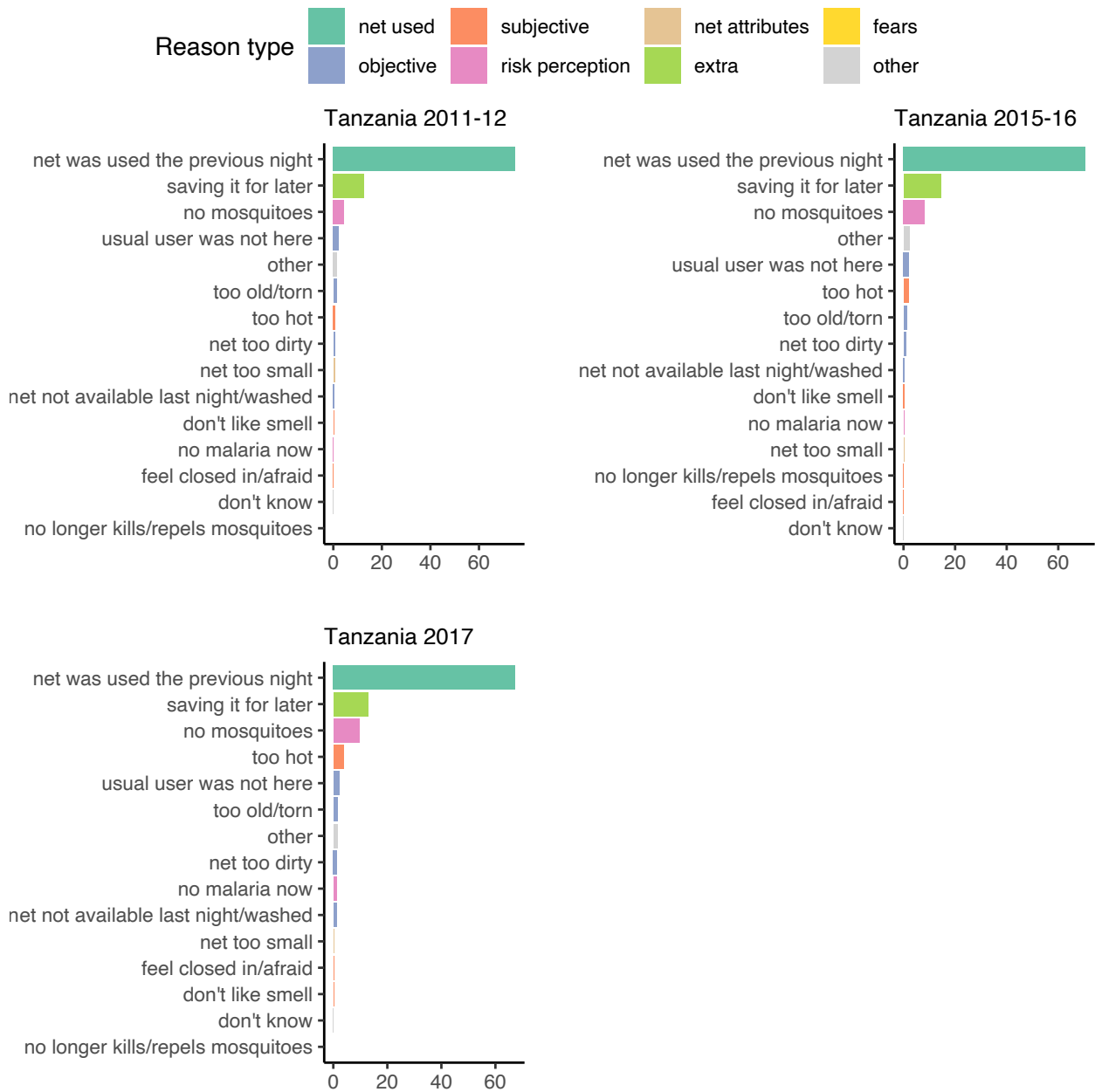
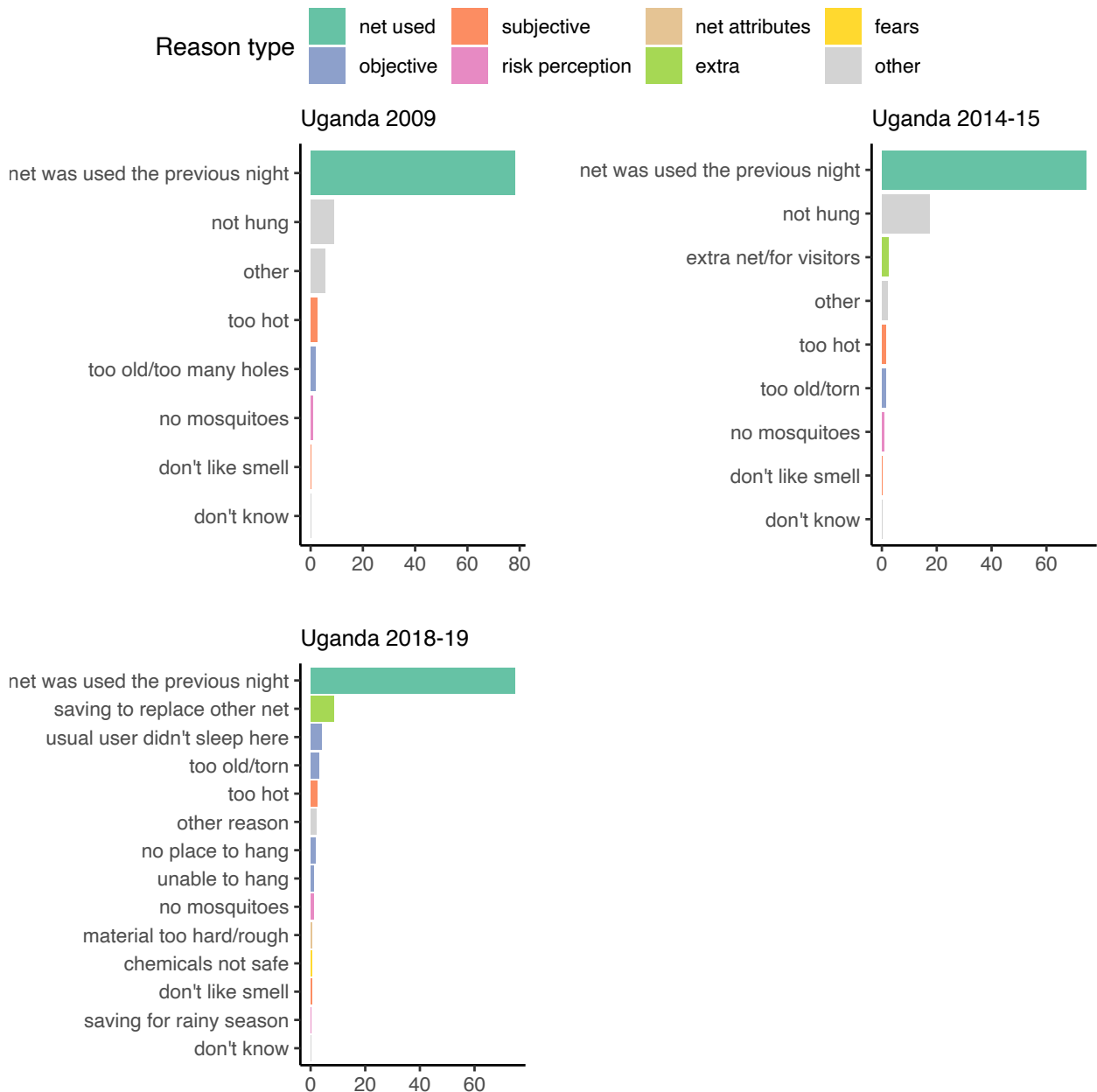


Figure 13: Reasons nets were not used the previous night, Uganda



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