

Householders' perception about sustaining the useful life of long-lasting insecticide-treated nets in Ghana

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Background: This article explores the multifaceted perceptions among householders about the care, efficacy and disposal of long-lasting insecticide-treated nets (LLINs), especially those regarding the end of the useful life of LLINs, and their implications for malaria control.

Methods: We used a cross-sectional qualitative design. Data were gathered in the Shai-Osudoku District in the Greater Accra Region of Ghana using focus group discussions and in-depth interviews. A thematic analysis technique was applied to analyse the data.

Results: Four findings emerged. First, participants were familiar with LLINs and the issues concerning the end of their useful life. However, the application of this knowledge was deficient. Second, characteristics of effectiveness (e.g. torn beyond repair) other than the age of a net determined the end of the useful life of LLINs. Third, social desirability and other social practices had positive and negative influences on perceptions about LLIN use and the end of their useful life. Fourth, repurposing of LLINs signified the end of their useful life.

Conclusions: Policies and strategies to position LLIN use as the leading resource for malaria control need to be innovative to accommodate the perceptions and practices of targeted households.

Keywords: malaria, long-lasting insecticide-treated nets, perception, social practices, end of useful life, Ghana.

Introduction

The World Health Organization (WHO) estimates that about half of the world's population are at risk of contracting malaria, with approximately 90% of all global malaria cases and 91% of malaria-related deaths found in sub-Saharan African nations such as Ghana.¹ Ghana has one of the highest rate of malaria morbidity and mortality in the world. According to the National Malarial Control Programme (NMCP), in 2017, 34% of all reported outpatient diseases in Ghana were malaria cases.^{1,2} Accordingly, the global fight against malaria has, over the past decade, involved the implementation of several interventions to fight the disease, with some success. For instance, in 2017 there were about 20 million fewer reported malaria cases than there were in 2010.¹ Prominent among the interventions is the promotion of the use of insecticide-treated nets (ITNs), particularly long-lasting insecticide-treated nets (LLINs).^{1,3} However, poor user

practices, misconceptions and insufficient knowledge affect the longevity of the LLINs (i.e. user-determined end of the useful life), and this threatens the sustainability of gains made thus far.²⁻⁴

Consequently, in the quest to reduce the incidence of malaria through LLIN use we must ascertain the perceptions and practices of householders on the end of the useful life of the nets to inform appropriate strategies to ensure the adoption, proper use and longevity of nets.³ This is particularly critical in Ghana, where the NMCP aims to achieve a minimum of 75% reduction in the incidence of malaria morbidity and mortality by the end of 2020. Therefore we explored the nuances of householders' perception of LLINs, particularly regarding the end of their useful life (the point when a net loses its efficacy in protecting people from being bitten by mosquitoes) and the implications of these perceptions for malaria prevention. This article addresses the following questions: What are householders' perceptions of the uses and

effectiveness of LLINs? How do householders perceive the end of the useful life of LLINs?

The article is based on an empirical study in the Shai-Osudoku District, a predominantly fishing and crop farming enclave in the Greater Accra Region in Ghana.⁵ In the past decade, the district has been a part of the geographic areas chosen for the distribution and promotion of LLIN interventions, as it is an area with one of the largest malaria burden in the Greater Accra Region. The district has benefited from free LLIN distribution through mass campaigns in 2013, 2015 and 2018.⁶ The Shai-Osudoku District is, therefore, an ideal place to examine householders' perceptions on the end of the useful life of LLINs.

Among others, user-determined end of useful life is considered a significant factor in the coverage and impact of LLINs.³ The processes involved in handling and using LLINs can limit or enhance their utility based on a household's knowledge, experiences and expectations.^{3,7} The literature suggests various perspectives on householders' perceptions regarding LLINs and their end of useful life. These include the physical integrity of the nets, age of the net, availability/acquisition of new nets, availability of alternative mosquito control mechanisms, cost of acquiring LLINs and alternative uses of the nets.^{3,8-10}

The physical integrity of LLINs (such as the number and sizes of holes in a net) is potentially the most characteristic determinant of the end of useful life of nets.^{8,11} For instance, as of 2014, about 55% of households in Ghana dispose of their treated nets after using them for less than 2 years, mainly (83% of cases) because the nets were torn.¹² Householders' practices such as poor washing (more than three to four times per year or 20 times throughout its lifespan with strong detergents), children playing with nets, and drying nets in the sun can compromise the physical and chemical integrity of the nets.^{8,13-15} Continuous protective care behaviours are associated with perceptions of net effectiveness and foster consistent use.⁴

The perception of LLINs and the end of their useful life is also attributed to a net's age.^{3,9} Householders tend to discard LLINs only when they become old, torn beyond repair or ineffective in repelling and killing mosquitoes.⁹ Thus, while LLINs are designed to last for 3-4 years, households may either discontinue or prolong their use depending on their perception of the relationship between a net's age and its efficacy.^{10,16}

Also, perceived alternative uses of nets influence their end of useful life.^{3,9,10} Many households across sub-Saharan Africa use LLINs for purposes other than preventing mosquito bites both during and after their perceived efficacy period.¹⁷ Some alternative uses when a net is torn beyond repair or no longer considered effective include crop farming activities, bed covers, table cloths and drying grains.^{3,9,10} Others use active nets for non-conventional purposes such as fishing.^{17,18} There are also reports of households passing on old nets (regardless of age) to other family members when they receive new nets.⁹

Householders' perceptions of the effectiveness of alternative mosquito prevention, particularly alternatives that are socio-culturally accepted (including burning herbs and reliance on orange peels and dried palm nuts), affect efforts to promote effective and optimum use of LLINs—and the end of the useful life of a net.^{19,20} Often this stems from a historically integrated use of both conventional and unconventional mosquito control methods that introduces householders to various modalities, as

observed in Ethiopia, Ghana and Uganda.¹⁸⁻²¹ Relating to the use of alternative methods of malaria control is access and capacity to acquire new nets. Evidence suggests that there is an inverse relationship between the cost of LLINs and the perception of the end of the useful life of a net.^{3,10} While the evidence above presents important perspectives on the end of the useful life of LLINs, more contextual studies such as this one will help to expand current knowledge about the prevailing socio-cultural, environmental and economic conditions in Ghana and similar places that affect LLINs use and longevity.

Methods

Study design

This article emerged from a broader study that used a cross-sectional qualitative design.²² It leaned towards the interpretivist epistemology, which ensured that the views and experiences of participants took centre stage of the discussions.²³ Two data collection techniques, focus group discussions (FGDs) and in-depth interviews (IDIs), were used. These two techniques provided ample opportunities to cross-validate the views and experiences of participants.²³

Sampling and participants

A purposive sampling technique²³ was used to select participants based on the aims of the research and relevant geographical and household characteristics. Participant selection was done in two stages. In the first stage, two communities (one urban and one rural) were selected from the two sub-districts (Dodowa and Osudoku).⁵ This helped to incorporate rural and urban characteristics in terms of healthcare access, health outcomes and health-related knowledge in the study.²⁴ Participants were selected to ensure a balanced sample according to their age, sex and net ownership. Household heads or spouses were also preferred, but the study included other adults (≥ 18 years of age). In stage two, an average of nine participants were included in the four FGDs (one in each of the four communities). A total of 38 participants (20 males and 18 females) were involved in the FGD study. The ages of the participants ranged from 22 to 72 years, with a mean age of 43 years. The IDIs were conducted with four household heads (one in each community).

Data collection

Semi-structured interview guides were used for the FGDs and IDIs. The topics discussed in the FGDs included perceptions about the longevity and efficacy, care and maintenance and disposal practices of LLINs. During the FGDs, participants were presented with two nets in different physical conditions to ascertain their perception relating to the efficacy and decisions about the nets. First, participants were shown an old and torn net and asked whether they thought the net was still useful and what they would do if the net belonged to them. In the second scenario, participants were asked to explain what they would do if they received a new LLIN (free of charge) while having a 1-year-old net

that had no or only a few small holes in it? The data collection took place between June and August 2017.

Data analysis

The FGDs and IDIs were audio-recorded (with permission from participants) and transcribed verbatim in Dangme and then translated into English. The data were analysed using NVivo version 11 (QSR International, Melbourne, VC, Australia) guided by the six-phase method for conducting thematic analysis outlined by Nowell *et al.*²⁵ and Braun and Clarke.²³ Details of this process and other aspects of the methods are provided as supplementary material (Appendix 1).

Findings

The findings are grouped under four themes: knowledge about the end of the useful life of LLINs; the efficacy of a net is not age bound; social desirability, norms and the end of the useful life of LLINs; and repurposing as an indication that the useful life of LLINs has ended.

Knowledge and awareness of the end of the useful life of LLINs

The participants had ample experiential knowledge of the functions and purpose of LLINs:

What I know is that it prevents mosquitos from biting me and preventing malaria. (IDI participant)

...when we did not have bed net we were often bitten by mosquitoes and malaria cases were very high, but with the introduction of the net, malaria cases have declined. (FGD participant)

Even though there was no definitive answer on when LLINs expire, most respondents agreed that the nets are active for a maximum of 3 years and their effectiveness largely depends on the care of the net:

The bed net will no longer be useful after washing it for 20 times within 2 to three 3 years period. (FGD participant)

Also, they were able to describe when an LLIN was ineffective. They realised that an LLIN become unusable when it failed to prevent mosquito bites even though it may appear to be useful:

When you go to bed, and your body comes in contact with the net and the following morning you realise that you have mosquito bites... that is how you get to know that the insecticide level is low. (FGD participant)

Given this, some respondents explained the measures they used to ensure the longevity of LLINs:

We do not dry it directly in the sun, and we do not use strong detergents to wash them. (FGD participant)

This knowledge and practical experience translated into the way in which participants cared for their LLINs. They often cited some recommended measures to prevent damage to LLINs. Washing a net too frequently and drying under the sun's rays were seen as ways to render the insecticide ineffective. Also, based on some social conventions, particular soaps were preferred for washing LLINs:

I do not allow anyone to hang clothes on the net when I arrange it over the bed.... It'll weaken quickly.... (FGD participant)

...I do not let the children play with it. (FGD participant)

We must remember to wash it... with 'key soap' [a popular soft soap] and dry it under a tree.... If it gets torn, we must immediately repair it. (FGD participant)

Although many participants learned about proper handling, washing and drying practices through their social circles and personal experiences, some received information from health professionals on how to maintain LLINs:

If you wash your net regularly, someone in your house or even the neighbourhood will warn you about it. (IDI participant)

We were taught by a nurse on how to wash it, and not drying it directly in the sun. (FGD participant)

The efficacy of a net is not age bound

Participants reported that the condition of LLINs diminishes with use and hence the actual age of the net is critical in determining whether its useful life has ended. However, a significant proportion of participants noted that while the age of a net matters, LLINs must be torn beyond repair before they are disposed of or used for something else. To them, indicators such as fading colour, tearing during washing or stretching of the material are critical factors in considering when to dispose of LLINs:

There is no date for deciding when to stop using the bed net.... You've to stop using when the colour fades. (FGD participant)

As for me and my family, the moment the net is dirty we wash it, but when the net is even less than a year and it starts developing holes, we change it. (IDI participant)

However, some participants did not rely on physical attributes to determine whether LLINs were still useful: they held the view that when the insecticide concentration in the net begins to wane, that is often a reason to either re-treat it or dispose of it:

The mosquito net loses its efficacy a year after its use, the mosquitoes die when they come into contact with a new net, but when it loses some of its efficacy, they can settle on it.... It does not matter how long the net has lasted. (FGD participant)

Social desirability, norms and end of the useful life of LLINs

Some social expectations and norms in the study communities shaped maintenance culture of LLINs. The concern of being stigmatised for using torn and unrepaired nets was regarded as a reason for users to replace or discontinue using a net:

Before I dispose of a net, it must be fragile and torn and to the extent that my friends may even ridicule me when they see it. (FGD participant)

Social practices such as sharing and ‘altruism’ were other factors that influenced perceptions about the end of the useful life of LLINs. There was a practice of giving ‘old’ or extra LLINs to other households, especially relatives and neighbours, instead of disposing of them as refuse:

The nurses gave us [malaria volunteers] additional one [LLIN], and so I gave it to a neighbour who was not having one. (IDI participant)

I recently acquired a new net, but my old net was still in good shape, so I gave the old net to my brother’s children. (FGD participant)

Another social factor involved a commonly practised seasonal use of the nets. The participants averred that mosquito breeding reduced drastically during the dry season, while their numbers increased exponentially during the rainy season. Consequently, they used LLINs in the rainy season when individuals were more susceptible to mosquito bites and kept the nets in safe places during the dry season when they were less vulnerable:

My friend told me that he sleeps in it [LLINs] in the rainy season when the mosquitoes are around and removes it in the dry season when the mosquitoes are not around... I also realised it is true and I have been practising it with my family... I’ve told other people and they have been following it too. (FGD participant)

Repurposing as an indication that the useful life of LLINs has ended

Participants in both the FGDs and IDIs disclosed that old LLINs could be used for purposes other than their original function of protecting against mosquito bites. They reported that LLINs that are due for disposal, either as a result of age, expiration or damage, can be put to an alternative use, such as fencing gardens, window screening, pillow stuffing, enclosing poultry farms, drying fish and pepper and covering cargo on mopeds:

We use it to fence our mango seedlings in the house to prevent the goats and sheep from destroying them. (FGD participant)

We sometimes use old nets to seal our windows and on our kitchen doors to prevent other insects. (FGD participant)

As the principal livelihood in the study area was fishing, old nets were repurposed as fishnets:

We use the damaged ones to fish.... It is better than dumping it on the compound. (IDI participant)

Thus, repurposing of a net marked the end of its useful life as an effective preventive against mosquito bites.

Discussion

This study explored householders’ perceptions about the end of the useful life of LLINs in the Shai-Osudoku District in Ghana. Participants were generally aware of LLINs, including their uses, causes of damage and ways to avoid early deterioration. In the context of the study area, this finding can be explained from two perspectives. First, it signifies the importance that householders assign to the role of LLINs in malaria prevention. Second, the depth of knowledge and use of LLINs demonstrate the substantial progress made in controlling malaria in Ghana. In fact, interventions to improve LLIN usage in Ghana have contributed significantly to reducing malaria-related morbidity over time, although several challenges, including limited coverage, remain.² Nevertheless, the actions of householders in this study, such as discarding nets as soon as they developed holes, demonstrate a gap in their knowledge regarding the maintenance and the end of the useful life of LLINs. Such perceptions often lead to situations where householders have little regard for the relationship between a net’s maintenance and longevity.⁴ Therefore, current efforts to promote awareness and the adoption of LLINs as a resource to control malaria must be improved and sustained, as they hold promise for meeting malaria eradication goals.

We also found that the end of the useful life of LLINs related to factors other than age, including physical condition and insecticide potency. This finding expands upon previous studies which reported that the age of a net is an essential determinant of the end of its useful life.^{3,10} Moreover, the relationship between the perception about the end of the useful life of LLINs and the physical condition and insecticide potency, while typical, can differ between households due to differences in operational conditions.¹⁸ Results from research in other countries such as Kenya⁹ endorse this assertion. This implies that programmes to enhance the capacity of householders to maintain LLINs properly—such as community educational workshops—can yield positive results. With knowledge on how to handle and repair LLINs, householders can alter their practices and prolong the efficacy of nets (or at least ensure efficacy until set expiration dates) by patching nets rather than discarding or misusing them.^{4,26}

Repurposing LLINs was a significant indicator of the perception that an LLIN had reached the end of its useful life as a mosquito preventive resource. However, unlike observations in other research,^{4,26} participants in this study mostly repurposed LLINs that were perceived as irreparably damaged or expired, as was also found in Senegal.³ Although the act of repurposing used LLINs is not novel,^{3,9,19} the findings of this study present some useful information on other uses of expired and damaged nets, particularly for fishing, stuffing pillows and covering cargo on mopeds.

However, these uses of LLINs, while imaginative,⁹ expose the limitations in the participants' understanding of the potential dangers of the misapplication of expired or damaged nets. The WHO and other agencies, including the Roll Back Malaria Partnership, caution strongly against the use of LLINs for fishing, as it constitutes misuse and has detrimental environmental and health consequences.¹⁷ Pyrethroid compounds, which are used in LLINs, bio-concentrate in aquatic organisms and can be extremely toxic to fish.¹⁷ Guidelines on the appropriate disposal of old LLINs are now emerging¹⁷ to prevent environmental and human health risks.^{9,19} Moreover, the tendency to repurpose old nets can contribute to their misuse. Those that intend to use the nets for other purposes may not have the patience to wait for the LLINs to reach the end of their useful life. Indeed, the fact that some participants were ready to discard a net even after a year of use supports this argument and supports the need to intensify capacity-building efforts to enable householders to use LLINs effectively and longer and to discard them appropriately.

Furthermore, social desirability (concerns about social standing and seasonal use of nets) emerged as an important influence on the perceptions, actions and decisions relating to the end of the useful life of LLINs. This finding extends the debate about the essential role of social norms and practices in health-related behaviours, knowledge and attitudes.^{24,27-29} It has been found that householders sometimes place more value on social practices such as the cleanliness and aesthetics of LLINs than the status of its primary function, so as not to be considered irresponsible.⁸ Thus social desirability holds the potential to promote undesirable practices, such as frequent washing, that can lead to early deterioration of nets, as well as unguarded preference for new nets,³ and hurried disposal of unexpired nets.⁴ Therefore, the phenomenon of social desirability offers the possibility of developing practical approaches to promote behavioural change in the use of LLINs.

Limitations of the study

The study targeted household heads as a proxy for the knowledge and practices held by all members of the households. This approach could lead to misrepresentation of the participants' perceptions and experiences. Also, some participants may have exaggerated or understated their experiences in order to conceal their limited understanding and malpractices regarding LLINs.

Conclusions

This study explored householders' perceptions and practices concerning the end of the useful life of LLINs. Overall, participants demonstrated an understanding of the use of LLINs and practices that destroy their efficacy. Notwithstanding, the participants' application of this knowledge was limited. Some householders were ready to dispose of nets or repurpose them, regardless of their age, as long as they perceived the physical condition was poor, without any attempt to repair them. Prevailing social expectations and norms partly influenced their perceptions and decisions on the end of the useful life of LLINs. Considering these findings, two conclusions can be drawn. First, householders are not entirely aware of appropriate methods for

disposal or repurposing of LLINs, leading to uses that could potentially harm the environment and reduce the longevity of nets. Second, householders' social norms and practices influence their perception about uptake, maintenance and attitudes relating to the end of the useful life of LLINs. Therefore, these factors should be given the needed attention in policies and programmes aimed at positioning LLINs as a leading resource for malaria control in the study area and places alike.

Supplementary data

Supplementary data mentioned in the text are available to subscribers in *INTHEA* online.

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