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# “Before we used to get sick all the time”: perceptions of malaria and use of long-lasting insecticide-treated bed nets (LLINs) in a rural Kenyan community

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## Abstract

**Background:** Malaria is a leading global cause of preventable morbidity and mortality, especially in sub-Saharan Africa, despite recent advances in treatment and prevention technologies. Scale-up and wide distribution of long-lasting insecticide-treated nets (LLINs) could rapidly decrease malarial disease in endemic areas, if used properly and continuously. Studies have shown that effective use of LLINs depends, in part, upon understanding causal factors associated with malaria. This study examined malaria beliefs, attitudes, and practices toward LLINs assessed during a large-scale integrated prevention campaign (IPC) in rural Kenya.

**Methods:** Qualitative interviews were conducted with 34 IPC participants who received LLINs as part of a comprehensive prevention package of goods and services. One month after distribution, interviewers asked these individuals about their attitudes and beliefs regarding malaria, and about their use of LLINs.

**Results:** Virtually all participants noted that mosquitoes were involved in causing malaria, though a substantial proportion of participants (47 percent) also mentioned an incorrect cause in addition to mosquitoes. For example, participants commonly noted that the weather (rain, cold) or consumption of bad food and water caused malaria. Regardless, most participants used the LLINs they were given and most mentioned positive benefits from their use, namely reductions in malarial illness and in the costs associated with its diagnosis and treatment.

**Conclusions:** Attitudes toward LLINs were positive in this rural community in Western Kenya, and respondents noted benefits with LLIN use. With improved understanding and clarification of the direct (mosquitoes) and indirect (e.g., standing water) causes of malaria, it is likely that LLIN use can be sustained, offering effective household-level protection against malaria.

## Background

Malaria is one of the most significant global determinants of illness, death, and poverty [1], and has especially impacted health in the sub-Saharan African region [2]. Approximately half of the world's population is at risk of malaria, and one million deaths were attributable to malaria in 2006, with 90 percent of those deaths occurring in Africa [1]. With advances in medical

therapy [3] and prevention interventions, such as bed nets, malaria is increasingly both preventable and treatable [4]. Long-lasting insecticide-treated nets (LLINs) serve as a protective barrier against mosquito bites and have been found to be a highly-effective method for preventing malaria [5].

Kenya is especially impacted by malaria accounting for a disproportionate burden of the disease [4]. Though the proportion of children and pregnant women who regularly sleep under LLINs in Kenya has increased dramatically in recent years, with a reported decrease in disease burden attributable to malaria [6], insecticide-treated nets are not fully used in Kenya, particularly in

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Western Kenya. According to the 2008-9 Kenya Demographic and Health Survey, 71.4 percent of households in Western Province currently own an insecticide-treated net (ITNs), and but only about half (55.4 percent) of children slept the prior night under an ITN [7]. As such, Western Province falls short of the Africa-wide goal of 80 percent of children sleeping under ITNs by 2010, and also demonstrates two gaps: 1) about one-quarter to one-third of households in Western Province lack ITNs, and 2) about one-third of children in households with ITNs do not have access to sleeping under them. Increasing supply of ITNs to households in Western Kenya could potentially reduce both gaps, and indeed supporting expansion of ITNs in Kenya is one of the main strategic approaches promoted by the Kenya Ministry of Health in its National Malaria Strategy (2001-2010) [8]. Similarly, especially in sub-Saharan Africa, countries will struggle and likely will not reach the 2015 Millennium Development Goal to halt and reverse progress in malaria incidence [9], due to difficulties with both scaling-up and proper use of these interventions [10].

Despite growing efforts at the global level to increase malaria knowledge [11], many communities throughout the world lack even a rudimentary understanding of the natural history of malaria, its relationship with mosquitoes, and the mechanisms for its treatment and prevention [12]. Understanding malaria's aetiology and relationship with the mosquito's life cycle is essential to properly implement prevention strategies [13] and effective treatment regimens [14]. Some studies have shown that even when prevention and treatment are accessible, some populations do not effectively implement those strategies, in part due to their misunderstanding of the causes of malaria [15] and to social-behavioural barriers to using products like bed nets [16]. Uptake in procurement and use of bed nets in Kenya is challenging, and modalities of distribution other than free mass distribution have not generally improved equity of access [17]. Further, Chuma *et al* showed that access and use of insecticide-treated nets in Kenya is a complex combination of supply chain difficulties, social preferences, and beliefs, going beyond simply affordability and cost [18]. Additionally, Widmar *et al* demonstrated in Tanzania that use of insecticide-treated nets requires reinforcement of proper practice regarding care and maintenance of the nets and attitudes toward their use [19]. Undoubtedly, understanding local circumstances, knowledge, and reactions to nets and other interventions is essential for building sustained action against malaria.

With the goal of rapidly improving one rural Kenyan population's ability to prevent malaria, this study examined beliefs and attitudes toward malarial illness, its prevention, and in particular the use of long-lasting

insecticide-treated nets (LLINs) distributed in a mass campaign.

## Methods

The LLINs were distributed as part of an integrated prevention campaign (IPC) organized over one week's time in Lurambi Division of Kakamega District, Western Province, Kenya, in September 2008. Lurambi is a poor, inland farming area of the district, where approximately three-fourths of the population subsisted on less than \$0.50 per day in 2004 [20]. Approximately 47,000 people from the region attended the campaign, which included the following components: HIV voluntary counseling and testing (VCT), distribution of a bundled package of interventions (condoms, long-lasting insecticidal-treated nets (LLINs), water filters (LifeStraw® Family or Personal), and cotrimoxazole prophylaxis for those with HIV), and health education and advice. The campaign was conceived by Vestergaard Frandsen, adapting past campaign approaches. A team of local, national, and global public and private sector partners, including the Kenya Ministry of Health and the Kenya Medical Research Institute, implemented IPC. Additional details of the overall campaign and the IPC procedures can be found elsewhere [21].

The qualitative assessment of the IPC addressed participants' perceptions of malaria and its causes, LLIN practice, and perceptions of benefits and risks of using LLINs. In total, 34 in-depth qualitative interviews were conducted two months post-campaign. Individuals participating in the campaign were informed about the study as they left the product distribution point and, if they consented to participate, were registered for inclusion and their locator information taken. At the start of the interview, participants were informed of the study purpose, reassured of confidentiality of information divulged, and verbally consented to be interviewed. Local interviewers underwent thorough training on asking sensitive questions and also signed confidentiality agreements before the study commenced.

The qualitative interviews lasted an average of nearly 1.5 hours and were audio-taped, transcribed and translated from Kiswahili (82 percent of the interviews) and local languages (nine percent) into English. Text sections were coded by a pair of experienced social scientists and analysed using NVivo 8 (QSR International, Cambridge, MA). Code lists were developed both from study objectives and from the data. Specific codes related to this topic were then selected and text examined for recurring themes and to find illustrative quotes to elaborate on specific findings from the analysis [22]. Approximately half of the participants were female, with an average age of 38 years. Most participants were farmers with some secondary school education.

**Table 1 Malaria causation beliefs among participants, and among other villagers as described by participants, IPC, Kenya**

Malaria is caused by:	Total (N = 34)
<b>Self<sup>1</sup></b>	
Mentioned mosquitoes as cause	33 (97.1%)
Mentioned environmental cause <sup>2</sup>	9 (26.5%)
Mentioned bad food/water consumption as cause	8 (23.5%)
Mentioned cold temperatures/rain as cause	13 (38.2%)
Mentioned mosquitoes solely as cause	15 (44.1%)
Mentioned mosquitoes plus additional cause	18 (52.9%)
Mentioned both an accurate and an inaccurate cause	16 (47.1%)
<b>Others</b>	
Mentioned mosquitoes as cause	20 (58.8%)
Mentioned environmental cause	5 (14.7%)
Mentioned bad food/water consumption as cause	6 (17.6%)
Mentioned cold temperatures/rain as cause	6 (17.6%)
Mentioned mosquitoes solely as cause	14 (41.2%)
Mentioned mosquitoes plus additional cause	6 (17.6%)
Did not mention mosquitoes; mentioned other cause	9 (26.5%)
Did not know cause	5 (14.7%)

<sup>1</sup>Participants could mention more than one cause

<sup>2</sup>Environmental cause: pollution, standing water, garbage, dirty, brush

All participants provided informed consent. The Institutional Review Board of the Kenya Medical Research Institute (KEMRI) approved the study.

## Results

### Causes of malaria

As shown in Table 1 all but one participant indicated that they believed mosquitoes were at least one of the causes of malaria, and for 15 participants (44 percent), mosquitoes were, in fact, named as the only cause of malaria. For other participants, however, several mediating factors were listed along with mosquitoes as causing malaria. For example, nine participants believed that mosquitoes combined with environmental factors related to shrubbery, standing water, and pollution provided more complete explanations for the cause of malaria, sometimes with a detailed and accurate description of the role of such factors in the mosquito's life cycle (see Figure 1). As displayed in Figure 1 several participants noted that standing or stagnant water creates an environment that breeds mosquitoes. Additionally, a few participants indicated an inaccurate

attribution of the environment, particularly the role of pollution and "dirt":

*"Malaria is caused by dirt that is thrown about outside."* (man, late 40s)

*"Malaria is brought about by dirty things."* (woman, late 40s)

Two specific components of weather (cold and rain) were commonly perceived as causes of malaria (in addition to mosquitoes) by 13 (38 percent) participants, and often characterized (Figure 1) as the type of cold requiring warm clothing, or a dampness that enters the body through exposed feet. Finally, eight participants (24 percent) indicated that consumption of bad food or water can - sometimes along with exposure to mosquitoes - cause malaria, though as shown in Figure 1 participants do not generally implicate specific foods beyond "bad" and "dirty" in this explanation.

Overall, 16 participants (47 percent), while indicating that mosquitoes caused malaria, also indicated that some other cause - such as cold temperature, rain, consumption of bad food - causes malaria, independent of those items' relationships to mosquito breeding conditions (for instance, "water" is implicated causally in local notions of malaria beyond its role as a breeding condition, for example in consumption).

When asked what other people in their villages believed about the causes of malaria, participants were less clear and were less likely to name mosquitoes as part of what the respondents perceive that other people think causes malaria. Mosquitoes, however, remained the most commonly named cause attributed to others; other categories named included environmental elements, weather, and consumption of bad food and water:

*"Eating of young maize which has a lot of water they think brings malaria, also this other newly harvested food, that is what they think."* (woman, late 50s)

*"According to the people in Lurambi, the cause of malaria is dirty environment and also dirty waste water and water that is not treated."* (man, mid-40s)

*"It is mostly mosquito bites and cold weather. It reaches a time when the weather is too cold then malaria gets its way into the body."* (man, early 40s)

*"Dirty water brings malaria. Using dirty utensils and other things too. It is grass that brings mosquito."* (woman, early 20s)

Several respondents, however, indicated that while these conceptions were common in former times, now most people knew that mosquitoes caused malaria:

### Mosquitoes

- *“When there are many mosquitoes, they bite you and you catch malaria.”* (woman, late 50s)
- *“What I was told, in fact, is that is the reason they gave me a net is because of mosquitoes. If mosquitoes bite you, you get malaria.”* (man, early 40s)

### Mosquitoes, mediated by environment

- *“During the rainy season, when water collects somewhere then stays for a long time it breeds mosquitoes then when they bite someone they bring malaria.”*(woman, late 20s)
- *“Malaria is brought by mosquitoes, if they are many and there is stagnant water somewhere that is not poured out...”* (woman, mid-30s)
- *“Failure to clear bush outside leads to mosquitoes.”* (woman, early 20s)
- *“In my opinion, malaria is caused by mosquitoes or dirty water if it is stagnant somewhere. Mosquitoes breed from there where they bite people causing malaria. It is mosquitoes and dirty water that cause malaria.”* (man, mid-30s)

### Bad Food and water consumption

- *“If you eat something bad, that which has stayed for a long time brings malaria.”*(woman, late 20s)
- *“One can drink water which is contaminated, but you cannot know. If you drink this water, it can cause malaria in your body. What I know that can also cause malaria is when you eat dirty food.”* (man, early 50s)
- *“According to me, it is not mosquitoes alone that bring malaria. I do not know how to explain that, but what I can say is that if you use bad food, you will get malaria.”* (woman, mid-40s)

### Cold and rain

- *“If it has rained, it is advisable that you wear warm clothes so that you do not contract malaria.”* (woman, early 20s)
- *“Cold, when it is very cold and you step down, the cold gets in through your feet.”* (woman, early 20s)
- *“When it has rained and there is dirty water all over, if you walk in those dirty puddles you get malaria. Also the morning dew causes malaria, and it passes through the cracks of your feet and brings malaria.”* (man, mid-40s)
- *“Sometimes if you walk in the evening, particularly me, I feel cold if I have not worn a sweater. If I use cold water without warming it, I get malaria.”* (woman, mid-40s)

**Figure 1** Malaria Causation Beliefs (self), Qualitative Responses.

*“Previously they have been thinking of different things, maybe they say, they have drunk water somewhere. They used to think that drinking water in some places can cause malaria. Sometimes they have thought that if you have new harvests and the moment they start*

*testing the new harvest they used to think that you get malaria. But now they know that it is only mosquitoes that can cause malaria.”* (man, early 50s)  
*“You know, there’s that talk that people like telling their children that when they play in the rain they*

*will get malaria, the say cold rain. But when we go for the lessons, we are told that cold can't cause malaria."* (woman, early 40s)

In some cases, misguided beliefs regarding malaria causation led participants to report actions or other concepts that did not relate to the biomedical understanding of malaria:

*"You see, sometimes you could make love to your husband and after that you feel your body has malaria. You then start feeling what has come to me."* (woman, mid-40s)

*"One way of protecting myself is to avoid moving in company of people who are involved in bad activities. We have drunkards and smokers who are not using protective package that was given. Anyone who uses what was given cannot get malaria."* (man, late 40s)

Additionally, one participant who reported not currently using the LLIN responded when asked "What do you do to protect against malaria" said:

*"We used to boil water, put in a clean pot and cover it with a piece of cloth. Once the water cools we used to sieve it before pouring the water in another clean pot for drinking. [Interviewer: What are you doing to protect yourself against malaria:] Currently, we just boil our water for drinking because we were not given a water filter."* (woman, mid-30s)

#### LLIN practice and attitudes

As shown in Table 2 overall 20 participants (59 percent) had LLINs before this campaign. After the campaign, 30 participants (88 percent) used the LLIN received from the campaign themselves, with another three participants indicating that someone else (their children or grandchildren) was using the new LLIN they received.

*"I am still using the mosquito net. I also used to use some tablets for treatment of malaria but I am currently using a mosquito net, cleaning my compound, and avoiding stagnant water."* (man, mid-40s)

*"Before we had the health campaign, I in person had already had a net. The family was also using a net to prevent malaria. I was also trying to get people educated to clear around their places so that we avoid mosquitoes harboring there we were also using insecticides to spray in the houses, mosquito coils and at least clearing the bush around where we stay. And also destroying where we feel that mosquitoes can breed. In one way it was helping. Because of poverty people were*

**Table 2 Malaria prevention practice by participants, IPC, Kenya**

Prevention Practice	Total (N = 34)
<b>Had a Bed net Before this Campaign</b>	20 (58.8%)
<b>How do you protect against malaria?</b>	
Use bed net	32 (94.1%)
Clean up household environment	3 (8.8%)
Eliminate standing water	3 (8.8%)
Eliminate mosquitoes	2 (5.9%)
Use tablets or drugs	6 (17.6%)
Something else	3 (8.8%)
<b>Who uses the net received from campaign?</b>	
Self	30 (88.2%)
Other	3 (8.8%)
Not mentioned	1 (2.9%)
<b>Benefits of using a bed net</b>	
Does not get sick from malaria anymore	23 (67.6%)
Keeps mosquitoes and bugs away	14 (41.2%)
Warmth	6 (17.6%)
Mentioned something positive	30 (88.2%)
<b>Mentioned complications of using bed net</b>	
Self	2 (5.9%)
In others	2 (5.9%)

*not doing it the way it is supposed to be done. But it was at least helping in one way."* (man, early 50s)

Participants reported benefits from using the LLIN. In total, shown in Table 2, 88 percent of all participants (n = 30) reported a positive benefit, most commonly that they and their family did not get sick from malaria any more (68 percent). For instance, participants frequently mentioned that they no longer became sick with malaria when using the LLINs, and that costs associated with malaria treatment previously were reduced or eliminated (see Figure 2). In addition to noting reduced malarial illness through use of LLINs, participants also commonly mentioned that protection from insects (and other creatures) while sleeping was an additional LLIN benefit. Further, participants also commonly note that they and others feel more comfortable and "warmer" when sleeping under an LLIN, as detailed in Figure 2.

### Prevents Sickness

- *“Right now my children aren't getting as sick as they used to get before.”* (woman, early 20s)
- *“I am now spending very little money to go for treatment. I used to go for treatment at least twice a month. Since that time when I got the net I have gone for treatment once.”* (man, early 50s)
- *“You know, before we used to get sick all the time and buy drugs and take and when one gets so sick we take him to the hospital but now we don't get sick that much.”* (woman, mid- 20s)
- *“Yes we have benefits because we now take long before somebody falls sick from malaria. We do not go to hospital from time to time because we rarely get sick. The other benefit is you can rest under a net if it is not cold and you have not covered yourself with a blanket. The net also protects me from insects and even snakes. If the net is not well tied a snake can fall on you. If it is well tied a snake can fall down giving time to check and find out what it was.”* (man, mid-30s)
- *“Yes, I have noted some benefit because I do not feel cold, mosquitoes do not bite me and my body is fine... I do not fall sick I am just working. I am doing work on the farm thus I am feeling well.”*(woman, mid- 40s)

### Reduces insects

- *“There are many advantages, the first one is the mosquitoes they hum from the top but there is nowhere they will get through to touch you. The second one, there are a lot of insects in our houses that crawl, you will find them trapped at the top, that is a big advantage I see.”* (woman, late 50s)
- *“The benefits are to protect against diseases like malaria. Mostly it's the protection against being bitten by mosquitoes all the time.”*(man, early 40s)
- *“Caterpillars can no longer pass through the net to walk on us. It helps to protect me from the cold weather. When you look at the net in the morning, OH! I get surprised, so there are insects that were crawling, even if I get out at night, it just stays on top of the net. When they crawl they fall down but don't get through the net.”*(woman, late 40s)

### Warmth

- *“The benefit is the prevention against malaria that it provides. Another one is when there is a lot of heat like now you don't need to cover yourself at night using a blanket, it provides enough heat.”*(man, mid-40s)
- *“You feel that you have slept in a good place, it also contributes to warmth.”*(woman, late 50s)
- *“Yes - even if you do not have a blanket you will just sleep and you feel good. It also prevents malaria. Mosquitoes will not be able to go through.”*(man, mid-20s)
- *“The benefit is that everyday if I sleep in this bed net that thing that when you are sleeping enters the ear and cannot get through the net, and if you sleep in the bed without covering yourself that will disturb you.”* (man, early 30s)

**Figure 2** Long-lasting Insecticide-treated nets (LLINs) benefits.

Two participants reported they experienced a minor adverse reaction themselves in using the LLIN, both relating to skin reactions:

*“The contact of the mosquito net made me itch before I followed the instructions.”* (man, mid-40s)

*“The problem was at the time I was given it, it was written on the net that I finish 24 hrs. The time I opened and removed it was at night. When I did that I started scratching myself. That is when I was told that I got to see the instructions. The instructions were that I leave it for 24 hours before I cover myself.”* (woman, mid-40s)

Additionally, two participants reported that they heard of others who experienced complications:

*"But some of my friends who got those mosquito nets were saying the nets had got some drugs in them that affected their stomachs. That they felt bad in their stomachs when using the net. I have personally not experienced that. In my house there has been no such a thing and even my wife has not complained."* (man, early 50s)

*"Other people just said that when they used it their bodies were itching but I did not feel itchy, no, I followed the instructions I was given."* (woman, late 40s)

### **Suggestions to increase LLIN usage**

Finally, as participants commonly noted that LLINs were helpful and that their use should increase, a variety of suggestions provided ideas about how best to increase LLIN usage, including:

#### **Continue to increase LLIN awareness**

Participants suggested several ideas around increasing LLIN awareness and their utility:

*"People should be told the uses of the net when they go to the hospital to seek treatment, also they can be told when they go to church."*

*"I advise them if they received a bed net they should sleep under it because it reduces malaria and mosquito bites."*

*"There are people who get malaria but they don't know why they should use a net. They should be convinced to use them and they will provide themselves the goodness of using the net. They should be told the truth about the use of the net. Some are not aware how they should use it even if it is possible, the way you people are coming back, you need to tell them to use the net."*

#### **LLIN champions**

Some participants suggested that having "champions" or "witnesses" promoting LLIN use would be effective, and offered specific examples for programme planners:

*"By those examples, like me, I can get my friend and tell him or her that when I started using the net, I have ceased to get malaria so it is better for you to use a net, if possible."*

*"Acting as the example I will make them to admire according to my illustration of how I am safe by using a net. I would love you to advise and also tell those people that already have nets to be witnesses and give advice to those who don't want to use the net."*

*"Maybe people should be told that the best way to stop malaria is by using the net, also they should be*

*given nets for free and be told to be taking them for treatment for free. I think this will make them use nets every time."*

*"They [others who don't use nets] need to be told to use it because it helps us so much, there is no malaria on the children."*

Finally, participants discussed the perception that LLIN recipients were obligated to use them ("If you were given one, then you need to use it") and also the perceived intransigence of resistance to using LLINs if someone opposes them:

*"The clever ones use it, only a few of them don't use it. Trying to convince those ones to use it is like 'playing a guitar to a goat' if they don't want to use it they will never appreciate the fact that it is useful, even if you tell them."*

Though not designed as a quantitative assessment, this study did not detect statistical variation in comments by gender or age.

### **Discussion**

Access to and proper use of LLINs are main components of effective malaria control in sub-Saharan Africa. Many countries have started scaling up free or subsidized provision of bed nets, though overall coverage remains short of the WHO goal of reaching at least 80 percent of those at risk of or suffering from malaria [1]. The distribution of bed nets coupled with social marketing has proven able to achieve proper usage by the population [6]. Such campaigns educated the population so that nets were not resold, were used properly, and were maintained effectively [23]. Success in reaching the MDG Goal 6 and other global malaria goals depend upon educating populations regarding the health value of using LLINs and on providing access to effective nets [10].

Lurambi, the setting for this present study in Western Province, is one of the most impoverished communities in Kenya, with substantial social inequity as demonstrated by the GINI index [24]. Prior experience suggests in such communities, free mass distribution of bed nets is the recommended approach to improve access and equity of access to malaria prevention interventions [17]. Accounting for local beliefs and resulting practices around use of bed nets is therefore important to help promote maximum prevention capacity in this community. Conceptual models of malaria among villagers reflected conflated understandings, particularly surrounding water, mosquitoes, and pollution, as well as notions of the impact of temperature and weather on malarial disease. Specifically, participants were aware

that mosquitoes were important in the transmission of malaria, and that bed nets provided protection from mosquitoes conferring the benefit of malaria prevention. Those correct ideas, however, around mosquitoes co-existed with other notions about malaria being caused by cold temperatures, rain, and consuming bad food and water, all of which may lead to other precautionary measures that may or may not affect actual malarial risk.

As has been shown elsewhere in Africa, ideas around causation and transmission of malaria could be associated with discontinuation or suboptimal use of LLINs if populations do not believe that LLINs are important prevention mechanisms based on their belief systems and world views [15]. Given the deep historical context within which populations co-evolved along with malaria and the mosquitoes that maintain its transmission, it is understandable that notions around weather, pollution, temperature, and spoiled food and water consumption have developed as causes of malaria, since malaria accompanies rainy seasons and prevention messages often stress the importance of eliminating water as a factor in the environment. As demonstrated in this present study, however, some villagers believe that strategies such as boiling water can prevent malaria, which although a healthy public health practice in areas where water quality is questionable, will not impact malaria incidence. It is unclear whether or not such statements of belief represent misunderstanding of multiple campaign messages addressing different preventive topics (of which clean water and prevention of water-borne illness was one).

The study was limited in several ways. First, while redundancy was reached with participants on salient issues, sample size was small and may not reflect the range of variation in response on all topics. Secondly, as a qualitative study, findings are limited to identifying concepts and models rather than quantifying magnitude of variables. As such, this study may not necessarily be directly generalizable across populations.

The findings of this study could potentially be used to improve proper bed net usage and other prevention strategies around malaria. First, the study showed that aetiologically correct biomedical perceptions of malaria co-exist with more traditional beliefs around the impact of cold temperature and efforts can be made to continue to promote proper understanding of malaria, the role of mosquitoes, and the importance of creating a physical barrier against them. Secondly, participants demonstrated that bed nets are acceptable and generally used, endorsing Norr *et al's* findings [17] that once cost as a barrier to access is removed, impoverished populations in Kenya can successfully adopt bed nets as a prevention strategy. Finally, additional other benefits of bed net usage mentioned from the population's perspective

should be promoted as motivations for consistent and widespread use - savings in medical and other expenses associated with malaria care, extra warmth, and barrier to other insects (and snakes) while sleeping - all could reinforce the use of bed nets within the household.

## Conclusions

Regardless of villagers' perceptions of malarial disease, LLINs were viewed positively by the participants and were directly credited by their users with reduced malarial disease and other benefits, such as warmth and protection from insects disturbing their sleep. Most participants used the LLINs they received themselves, with few complications or difficulties. Providing scaled-up access to LLINs for populations at-risk of malaria clearly could rapidly offer protection from preventable disease and mortality; further, their usage could likely be sustained with clear education about malaria's causes and contributing factors.

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## Authors' contributions

TD was principal analyst and primary author of this manuscript. RA and EL designed and carried out the qualitative data collection. JGK, JS, and CO drafted sections of the manuscript. All authors read and approved the final manuscript.

## Competing interests

Vestergaard-Frandsen manufactures the long-lasting insecticide-treated bed nets that were donated as part of the Integrated Prevention Campaign. Beyond funding, Vestergaard-Frandsen did not participate in analysis or manuscript development except to ensure accurate description of the Campaign and the products distributed within it. The authors declare that they have no competing interests.

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