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Barriers of persistent long-lasting insecticidal nets utilization in Northwest Ethiopia: a qualitative study

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Abstract

Background Malaria continues a significant public health challenge in Ethiopia, with Long-Lasting Insecticidal Nets (LLINs) proving effective in reducing transmission. Despite their effectiveness, consistent LLIN utilization is influenced by various factors. While previous research has quantitatively analyzed LLIN ownership and usage, there is a lack of in-depth examination of the behavioral, sociocultural, socioeconomic, and distribution-related factors affecting their sustained use. This study aimed to explore barriers to persistent LLIN use among communities in northwest Ethiopia.

Methods The study area found in Northwest Ethiopia, specifically in East Belesa District, is located at 12° 14' 60.00" N latitude and 37° 44' 59.99" E longitude, with an altitude between 1,200 and 1,800 m above sea level. Thirty-nine community members from five focus group discussions, along with five key informants, were interviewed between February 1st and 30th, 2020, about their use of Long-Lasting Insecticidal Nets (LLINs). An interpretive description approach was employed to explore local contexts and factors affecting LLIN utilization. Focus group participants were selected based on residency status, pregnancy, caretaking of under-five children, and experience with LLINs. Key informants included health extension workers and the woreda malaria officer. Data were organized and analyzed using Open Code Version 4.03 software, with coding and theme identification conducted accordingly.

Results All 44 community members from the five focus group discussions and the five key informants participated fully in the study. The study categorized its findings into three main themes: knowledge of malaria and Long-Lasting Insecticidal Nets (LLIN) use, perception of malaria threat, and barriers to sustained LLIN utilization. It identified factors spanning individual, socio-cultural, institutional, and socio-economic realms that impede consistent LLIN usage. Key hindrances include cultural misinterpretations, discomfort from heat and bed bugs, diverse net shapes, insufficient sleeping spaces, lack of awareness, inadequate distribution, neglect of vulnerable groups, misuse of non-sleeping purposes, hesitancy to hang nets, and restricted accessibility.

Conclusions This study reveals that practical concerns, including inadequate access to LLINs, distribution issues, discomfort from net shape and warmth, and unintended uses for non-malaria purposes, impact LLIN utilization. Socio-cultural norms, housing conditions, and varied understanding of malaria also contribute to inconsistent

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LLIN use. Strategies like providing compatible nets and comprehensive education could improve the Long-Lasting Insecticidal Nets program's effectiveness in the area.

Keywords Barriers, Long lasting insecticide net, Ethiopia

Background

Malaria poses a significant global health risk, affecting nearly 3.2 billion people and contributing to a high disease burden worldwide [1, 2], particularly in Africa where it remains a major public health concern [3]. In Ethiopia, malaria is a central focus of public health efforts, with Long-Lasting Insecticidal Nets (LLINs) recognized as a key preventive measure against the disease [4, 5]. LLINs are considered highly effective in reducing malaria transmission in Africa and serve as a crucial strategy in Ethiopia to lower malaria risk [4, 6]. Despite these benefits, data from the 2015 National Malaria Indicator Survey [7], indicated that LLIN ownership and usage in Ethiopia fell short of targets, with only 64% of households possessing at least one LLIN and 40% of the population using them the previous night. The Amhara Region showed a higher LLIN ownership rate at 72.9%, but usage was still low at 43.4%, reflecting a utilization rate of just 56%, the lowest in the country. Research in rural areas has also revealed inconsistent LLIN coverage and usage [4, 7].

A study in the Adami Tulu district of southern central Ethiopia reported that only 12% of households owned one or more LLINs [8], with various factors affecting consistent LLIN use. These factors include inadequate access to LLINs, unequal distribution, seasonal variations, mosquito prevalence, and misconceptions about malaria risk and transmission. Additionally, community norms, values, and preferences, especially concerning gender and age, contribute to low LLIN utilization [4, 9–12]. In Ethiopia, LLIN usage is prioritized for children under 5 and pregnant women due to their higher vulnerability to malaria [5]. Other issues impacting utilization include net quality, efficacy perceptions, structural problems, practical considerations, and unintended uses of the nets [5]. Common reasons for irregular use include perceived low mosquito presence and discomfort, particularly in hot weather. Efforts to promote LLIN use have largely focused on malaria prevention, but in areas where malaria is less perceived as a threat, net usage may decline. LLINs also deteriorate over time, with their durability ranging from 18 months to 7 years, and an average expected lifespan of 3 years [13, 14]. A cohort study in south-central Ethiopia found that only 4% of LLINs remained functional by the end of the 24th month, with a median functional lifespan of 12 months [15]. In the Lake Tana region, matched case-control studies identified age, travel to malaria-prone areas, and limited malaria knowledge as factors linked to malaria risk, with LLIN ownership and usage remaining low. These studies highlight factors affecting

malaria prevalence but do not fully address the behavioral, sociocultural, and socioeconomic reasons behind inconsistent LLIN use [16, 17]. Therefore, investigating the factors influencing persistent LLIN utilization in specific areas, like east Belessa woreda (district), is essential for enhancing malaria elimination strategies.

This study aims to explore these context-specific barriers to inform more effective malaria control interventions. The findings will be pivotal for refining malaria strategies by identifying specific barriers to LLIN use in east Belessa woreda, enabling targeted interventions, improving distribution, and addressing issues related to access, net quality, and user misconceptions. Insights gained will support more effective resource allocation and policy adjustments, ultimately enhancing LLIN utilization and improving malaria prevention and control in the district.

Methods

Research team and reflexivity

The key informant interviews were conducted by the investigators (ANY), (RB), (WA), (AN), (GL), (EG), and (MSM). (AN) From the Institute of Public Health, whereas (DG), (AAT) from the School of Pharmacy and AMRIF Ethiopia. All investigators are male. The investigators (ANY), (RB), (WA), (AN), (GL), (EG), and (DG) had extensive experience in qualitative research data collection and analysis. The credentials of the investigator, AN was PhD, whereas ANY, RB, WA, GL, EG, and AAT were Master of Public Health (MPH) and DG, MSM was MSc. All of the investigator's occupations are researcher and lecturer at the time of this study. Before the study's commencement, the investigators tried to establish a relationship with the study participants. In terms of reflexivity, the investigators disclosed their identities to the participants and provided an overview of the study's objectives, as well as the rationale behind conducting the research.

Study design

The current study utilized an interpretive description approach to investigate the local contexts and factors affecting consistent LLIN usage. An interpretive description approach serves as an effective methodological approach for thoroughly describing, interpreting, shedding light on, and qualifying and describing everyday human experiences [18, 19]. This approach was selected to investigate the behavioral, demographic, sociocultural, economic, livelihood, and housing situations, and

experiences related to net distribution within the community. The participants' experiences with LLIN utilization were summarized and analyzed thematically.

Theoretical framework

Methodological orientation and theory

Interpretive Description (ID) is a qualitative research methodology grounded in constructivist epistemology, making it well-suited for exploring the barriers to persistent Long-Lasting Insecticidal Nets (LLINs) utilization in Northwest Ethiopia. ID focuses on understanding complex, real-world phenomena through an interpretive lens, acknowledging that knowledge is co-constructed through interactions between researchers and participants. This methodology is particularly effective in applied health research because it aims to generate practical insights that can inform interventions. Its flexibility allows for the use of various data collection methods—such as interviews, focus groups, and observations—to capture the multifaceted nature of LLIN utilization barriers, including cultural beliefs, environmental conditions, and logistical challenges. The theoretical underpinning of ID, which emphasizes pragmatic understanding and mid-range theorization, ensures that the findings are not only contextually rich but also directly applicable to improving LLIN use in similar settings. By integrating these theoretical aspects, ID provides a comprehensive framework for examining and addressing the barriers to LLIN utilization, ultimately contributing to more effective malaria prevention strategies [20, 21].

Participant selection/description of sample

The study group comprised key informants and focus group discussions (FGD from different groups of the community in the study area.

Sampling

The study sites were deliberately chosen to encompass the perspectives and behaviors of residents residing in areas highlighted by the researchers as encountering obstacles in LLIN utilization. The sample comprised two groups: 5 focus group discussions (FGDs) and 5 key informants. The determination of the sample size was based on the richness, depth, and quantity of data collected; pertinent literature; study scope; and the level of valuable information provided by each participant [22]. persistent on saturation level., the commonly applied principle for determining qualitative sample sizes, as a result of the varied backgrounds of participants and the comprehensive scope of the study [23]. A purposive sampling technique used households selected from four kebeles. The community residents included households from diverse socioeconomic backgrounds, spanning various age groups, and genders, and pregnant and lactating

women were included in the sample. They were interviewed regarding their experiences and practices regarding LLIN utilization. All study participants, comprising 39 individuals across five focus group discussions with one FGD comprising [7–9] participants, reported owning LLINs. Key informants were individuals knowledgeable about malaria control, LLIN distribution, and barriers of, LLIN in the study communities, possessing an understanding of living conditions and beliefs. They were one woreda (woreda is an administrative unit equivalent to a district, encompassing multiple local administrative subunits known as kebeles). Each woreda is responsible for local governance and often contains multiple kebeles) health office PHEM officer and four health extension workers (HEW) who worked in the 4 selected kebeles(local administrative unit) were enlisted to recruit participants with support from a researcher.

Rationale for participant selection

In this study examining barriers to Long-Lasting Insecticidal Nets (LLINs) utilization, the rationale for participant selection is grounded in the need to capture diverse and in-depth perspectives from multiple stakeholders within the communities experiencing LLIN utilization challenges.

1. **Deliberate Site Selection:** The study sites were chosen deliberately to include areas identified by researchers as having notable obstacles to LLIN utilization. This purposive approach ensures that the research addresses relevant contexts where barriers are most apparent, thus enhancing the study's ability to provide actionable insights.
2. **Sampling Methodology:** A purposive sampling technique was employed to select households from four kebeles, ensuring a representative sample of the community's diverse socioeconomic backgrounds. This sampling method was chosen to include various age groups, genders, and particularly pregnant and lactating women, who may face unique challenges related to LLIN use. This diversity is crucial for obtaining a comprehensive understanding of the barriers from different perspectives within the community [24].
3. **Focus Group Discussions (FGDs):** Five FGDs were conducted, with each group consisting of 7–9 participants. The rationale for using FGDs was to gather collective insights and facilitate discussions that reveal shared experiences, cultural norms, and community-level barriers to LLIN utilization. FGDs allow for interaction among participants, which can surface more nuanced understandings of common barriers and potential solutions.

4. **Key Informants:** The study included five key informants—one Woreda health office PHEM officer and four health extension workers (HEWs)—who were selected based on their expertise and familiarity with LLIN distribution and malaria control. These individuals were chosen for their in-depth knowledge of the local health system, barriers to LLIN use, and understanding of community living conditions and beliefs. Their insights provide valuable context and help interpret the data gathered from community members.
5. **Sample Size Determination:** The sample size was determined with consideration of data richness, depth, and saturation, aligning with common qualitative research practices. The focus on saturation ensures that the data collected is comprehensive and that emerging themes and patterns related to LLIN utilization barriers are thoroughly explored. The varied backgrounds of participants and the study's scope necessitated a sample size that could adequately address the research questions and provide a well-rounded understanding of the barriers [24].
6. **Saturation Principle:** Adhering to the principle of saturation, which is commonly applied in qualitative research, helps ensure that data collection continues until no new themes or information emerge. This approach confirms that the study findings are robust and reflective of the experiences and challenges faced by the community in LLIN utilization [24–26].

Participant description

The participants in this study comprised two key groups: community residents and key informants. The community residents were selected using purposive sampling from four kebeles, ensuring diversity in socioeconomic backgrounds, age, and gender, with particular inclusion of pregnant and lactating women. A total of 39 individuals participated in five focus group discussions (FGDs), each consisting of 7–9 participants, all of whom owned LLINs and provided insights into their experiences and practices regarding LLIN utilization. The key informants included one woreda health office PHEM officer and four health extension workers (HEWs), all of whom had extensive knowledge of malaria control, LLIN distribution, and the barriers to effective LLIN utilization in the selected kebeles. These informants provided critical perspectives on the health system's role and challenges in promoting consistent LLIN use.

Participant selection criteria

The participant selection criteria for this study involved purposive sampling of community residents from four

kebeles, ensuring diversity in socioeconomic background, age, and gender. Pregnant and lactating women were specifically included due to their unique vulnerability to malaria. All participants in the focus group discussions (FGDs) were households that owned LLINs, to gather their experiences and barriers to use. Key informants were selected based on their expertise in malaria control and LLIN distribution, including one woreda health office PHEM officer and four health extension workers (HEWs) familiar with the study areas [27, 28].

Method of approach

The participants were approached face-to-face using an interview guide. Health extension workers (HEWs) facilitated initial contact by visiting households in the selected kebeles, explaining the study's purpose, and inviting participants to engage in the focus group discussions (FGDs) and key informant interviews. During these face-to-face interactions, the interview guide was employed to ensure consistent and focused conversations around LLIN utilization and the barriers encountered by the participants, fostering open and structured dialogue.

Sample size

The study sample comprised a total of 44 individuals, including 39 participants in five focus group discussions (FGDs), with each group consisting of 7 to 9 participants. Additionally, 5 key informants were included: one PHEM officer from the Woreda health office and four health extension workers (HEWs) from the selected kebeles. The sample size was determined based on the principle of data saturation [29, 30], ensuring that sufficient depth and richness of information were gathered to comprehensively explore the barriers to LLIN utilization.

Key informants

The key informants for the study included five individuals selected for their expertise in malaria control and LLIN distribution. These informants comprised one Woreda health office PHEM officer and four health extension workers (HEWs) from the study's selected kebeles. Their inclusion was critical due to their deep understanding of the local health system, malaria control strategies, and community challenges related to LLIN use. The key informants provided valuable insights into the logistical and administrative barriers to LLIN distribution, as well as their observations of community behaviors and beliefs regarding LLIN utilization.

Focus group discussions (FGDs)

Five focus group discussions (FGDs) were conducted with a total of 39 participants, each group consisting of 7 to 9 individuals. The participants were community members from diverse socioeconomic backgrounds, including

various age groups and genders, with a particular focus on households that owned LLINs. Pregnant and lactating women were specifically included to capture their unique experiences with LLIN use. The FGDs provided a platform for participants to discuss their collective experiences, challenges, and practices regarding LLIN utilization. This method encouraged open dialogue and interaction, allowing for the identification of shared barriers within the community.

Saturation in qualitative data collection

Saturation in qualitative data collection refers to the point at which no new information or themes emerge from additional data. It is a commonly applied principle used to determine when data collection can cease because sufficient depth and richness of the phenomenon under study have been captured. Saturation ensures that the study has adequately explored the research questions and that further data gathering would likely yield redundant insights rather than novel findings. In practice, researchers often assess saturation by continuously analyzing data as it is collected, ensuring that emerging themes are fully developed and that participant contributions no longer introduce new patterns or variations. Saturation is essential for ensuring the validity and completeness of qualitative research findings [24–26].

Non-participation

No individuals refused in this study.

Study setting and populations

The study was conducted in the East Belessa District of Northwest Ethiopia, specifically in four kebeles (local administrative units): Gohalla, Shamish, Zuy-Hamsit, and Achikane. It took place from February 1st to February 30th, 2020. The district is situated at a latitude of 12° 14' 60.00" N and a longitude of 37° 44' 59.99" E, with an altitude ranging between 1,200 and 1,800 m above sea level [31].

The population of East Belessa District is predominantly Amhara, and agriculture is the primary economic activity. Most residents engage in farming, cultivating key crops such as teff, maize, and barley, while livestock rearing is also widespread, supporting household livelihoods. The majority of the population practices Orthodox Christianity (97.25%) [32].

Malaria is a significant health risk in this district, with the disease being the leading cause of illness in 2019. By June 2019, Long-Lasting Insecticidal Nets (LLINs) had been distributed to nearly all households [33]. The district experiences two malaria transmission seasons: the major season from September to December and the minor season from April to May. During these periods, many residents migrate to lowland malaria-prone areas

for work. A trend analysis (2015–2019) in an east Belessa district showed 33,594 malaria cases, predominantly *Plasmodium falciparum* (81%) and *P. vivax* (19%). The analysis indicated a shift, with *Plasmodium falciparum* cases decreasing and *P. vivax* cases increasing from 2015 to 2016 [34].

The setting of the data collection

The data were collected in a quiet, secure, and comfortable place with minimum sound disturbance and voice to maintain the quality of the recording and facilitate open discussion. Interviewees determined the time and place of the interview.

The setting of the study area

The study was conducted in four kebeles within a specific region of Northwest Ethiopia known for its malaria-endemic areas and challenges in Long-Lasting Insecticidal Nets (LLINs) utilization. These kebeles were deliberately chosen based on the researchers' assessment of significant obstacles to LLIN use among community members. The area is characterized by diverse socioeconomic conditions, with residents facing various environmental and behavioral barriers to malaria prevention. The local health infrastructure, including the presence of health extension workers (HEWs) and a woreda health office, provided essential support for both malaria control efforts and the study. The rural setting, coupled with its unique cultural and socioeconomic dynamics, made it an ideal site for investigating the persistent barriers to LLIN utilization.

Presence of non-participants

There are no other participants in the study except the participants and researchers.

Data collection

Interview guide

The guide was adopted from previous research and modified in a suitable way considering research objectives [35]. The interview guides included broad questions with suggested probes for KIIs and FGDs (additional file 1) separately. The interview guide was first prepared in English and then translated into the local language, Amharic. The interviews were carried out in Amharic and each interview. The interview questionnaire centered on exploring factors contributing to inconsistent LLIN usage, disparities in LLIN usage among household members, suitability of nets with sleeping areas, duration of LLIN use during sleep, accessibility and distribution of ITNs, perceived advantages and shortcomings of LLINs, perceived threat, knowledge of malaria and malaria prevention and correct LLIN utilization. Interviewees received training on employing the questionnaire,

asking open-ended questions, and probing for more detail. Questions were asked consistently across all interviews. Each interview session was recorded using a digital voice recorder.

Number of interviews conducted

A total of **five key informant interviews** were conducted with individuals knowledgeable about malaria control and LLIN distribution. Additionally, **five focus group discussions (FGDs)** were held with community members, comprising 39 participants in total. These interviews and FGDs were designed to gather comprehensive insights into the barriers to LLIN utilization in the selected kebeles.

Repeat interviews

Repeat interviews were not carried out.

Audio recording

The research used audio recording to collect the data.

Field notes

The investigators made field notes during and after the interview. We made field notes for documenting needed contextual information. We contributed rich descriptive detail about the context of statements made, supplementing the recorded and transcribed participant statements and infusing the record with more significant meaning. In addition, we made field notes to clarify who the speaker was when recorded voices sounded similar. And to describe changes in body language, long pauses, facial expressions, making or losing eye contact, or other events that can help interpret the meaning from the context of what is said.

Duration of the interview

The duration of the interviews, on average, from 20 min to one and a half hour.

Data saturation

In the current study, the term data saturation refers to the point in data collection when new interviews produce little or no new information to address the research question. No new information shall exist to get a higher degree of saturation. Based on the existing literature, a minimum of 12 interviews is typically needed. We also applied the more conservative approaches of operationalizing saturation to be confident enough in our conclusion of reaching saturation [36].

Transcripts returned

The transcripts were not returned to participants for comment and correction because the principal

investigators had a prolonged engagement in the data collection process.

Data analysis

Two experienced researchers conducted the data analysis. One held an MPH in Health Promotion and Health Behavior, and the other was an Assistant Professor of Health Promotion. Both had received formal training in qualitative data analysis using software and had extensive experience in the field. Their expertise included teaching qualitative research methods and analysis to students, as well as facilitating and delivering qualitative data analysis training for public health professionals, lecturers, and researchers.

The first author, alongside local translators, transcribed the interviews verbatim from Amharic to English (supplementary File 1). Thematic analysis, a flexible method for identifying, examining, and presenting data patterns, was used. It is suitable for both essentialist (realist) and constructionist approaches [37]. The data were content-coded for thematic analysis, with coding conducted using a hybrid approach that incorporated both insights from existing literature and emergent data [38, 39]. Themes were then derived from the data.

The coded data were analyzed by conducting queries to assess the frequency of key concepts, themes, and relationships. Themes were used to summarize participant responses, with quotes taken from interviews to provide context. Word Clouds were also generated to visually illustrate key findings. Both textual and structural analyses were employed to gain deeper insights into the barriers to Long-Lasting Insecticidal Net (LLIN) utilization [40]. **Textual analysis**, explored the meaning, themes, and patterns within the responses, examining how language reflects cultural and social contexts [41]. **Structural analysis**, meanwhile, focuses on the organization and framework of the content, analyzing the underlying relationships within the text [42]. Additionally, thematic analysis was employed to understand participants' experiences with the inconsistent use of LLINs and how they interpreted these experiences [43]. To ensure the study's trustworthiness, a rigorous process was followed to confirm the credibility, transferability, dependability, and conformability of the findings.

Number of data coders

Two individuals have performed the coding independently after repeatedly reading the transcribed document.

Description of the coding tree

All tape-recorded data interviews and field notes were transcribed verbatim to Amharic (the local language) after repeatedly listening to the records and then translated into English. The translated transcription

documents were imported into Open Code 4.03 software for coding.

The analysis used the four theme development phases: (1) Familiarization with the data, (2) Revisit research objectives, (3) Develop a framework, and (4) Identify patterns and Connections. Central themes were constructed based on the natural meaning of the categories. The investigators cross-checked the themes that emerged after analysis with the respective quotes in each theme. The findings were reported by a detailed description and interpretation of the themes' meanings. Direct quotes from the participants were also included in the write-up of the findings to provide clear images for readers. The overall data analysis used an inductive approach, i.e., a data-driven coding process through the research team discussion was performed to identify themes. Finally, these study findings were reported based on the consolidated criteria for reporting qualitative research (COREQ) guidelines (additional file 2).

Derivation of themes

The theme and sub-themes were derived from the data.

Software used

Open code 4.03 software was used to manage the data.

Participant checking

Participant checking, also known as member checking or respondent validation, involves returning to participants to review and confirm the accuracy of the data or interpretations derived from their contributions. In the context of this study, participant checking would involve sharing key findings or summaries of the interviews and focus group discussions with the participants to ensure that their views were accurately represented and interpreted. This process helps validate the research findings, enhances the credibility and trustworthiness of the data, and provides participants with an opportunity to clarify

or expand upon their responses, ensuring that their perspectives are fully and accurately captured.

Trustworthiness

In the current study on barriers to persistent Long-Lasting Insecticidal Nets (LLINs) utilization in Northwest Ethiopia, **trustworthiness** is ensured through multiple strategies. **Credibility** is achieved by conducting face-to-face interviews and focus group discussions with a diverse sample of community members and key informants, and by employing member checking to validate data accuracy. **Transferability** is supported by providing detailed descriptions of the study setting, participant demographics, and contextual factors, enabling readers to assess the relevance of the findings to other similar settings. **Dependability** is maintained through thorough documentation of the research process, including participant selection, data collection methods, and analytical procedures, ensuring transparency and replicability. **Conformability** is addressed by using triangulation to cross-verify findings from different data sources and maintaining detailed field notes and an audit trail to document research decisions and minimize bias. These strategies collectively enhance the study's reliability and validity, ensuring that the findings accurately reflect the participants' experiences with LLIN utilization.

Results

Socio-demographic characteristics of participants

A total of five Focus Group Discussions (FGDs) involving 39 participants, with an average of 7–9 participants in each, were conducted. Aged between 20 and 53 years (Table 1). Sixteen (41%) of the FGD participants had received formal education. The majority (89.8%) of the FGD participants identified as Orthodox Christians, while the remaining 10.2% were Muslims. Among them, 32 (82%) were housewives and the remaining seven (18%) were farmers, with seven (18%) being male and 32 (82%) female. Additionally, five Key Informant Interviews (KIIs) were conducted as part of the study. All of the key informants were literate, with ages ranging from 26 to 32 years. 40% of the KII participants identified as Orthodox Christians, and all of them (100%) were employed in government positions.

Key findings

Based on the data from this study, the primary focus of the study was categorized broadly into three key themes, namely knowledge about malaria and Insecticide-treated net utilization, perceived threat of malaria, and Barriers to consistent LLIN use (Table 2). In addition, each key theme was categorized into eight sub-themes namely: Understanding of malaria causes, symptoms, and prevention, Awareness of LLIN utilization and benefit,

Table 1 Demographic interviews of participants in FGDs and KIIs on LLIN utilization in East Belessa District, Northwest Ethiopia, 2020($n = 44$)

	Number of participants	Age years old	Sex	
			M	F
FGD	7	27–50	0	7
FGD	9	20–38	0	9
FGD	7	21–38	0	7
FGD	9	20–38	0	9
FGD	7	30–53	7	0
5 FGDs (total participants)	39	20–53	7	32
KII	5	26–32	0	5
ALL	44	20–53	7 (15.9%)	39 (84.1)

Misconceptions and lack of knowledge about malaria, Perception of malaria severity and susceptibility, Access and Distribution Barriers, Cultural and Behavioral Barriers, preference for shape and sleeping arrangements, Beliefs and Attitudes.

Knowledge about malaria and insecticide-treated net utilization

In our focus group discussion and key informant interview, the majority of participants are knowledgeable about the causes, symptoms, transmission, and prevention methods of malaria, including the advantages of using LLINs.

The focus group discussion indicated that the participants had a clear understanding of the effectiveness of LLINs for protection against mosquitoes.

One participant remarked on the protective benefits of LLINs, saying,

*"It helps us avoid being infected by mosquitoes."
(Male farmer, FGD).*

Another participant highlighted the broader usefulness of LLINs, stating,

"The bed net is used to protect us from spiders, flies, and other insects." (FGD, WDA).

In contrast to this from focus group discussion and KII, some of the participants don't know the importance of malaria prevention, dispelling myths or misconceptions about LLINs. Insufficient knowledge about malaria and motivation to hang LLINs. Malaria was caused by starvation, overwork, food shortage/starvation, Cold, water pollution, and drowning in tap water.

*"Causes of malaria are starvation, and overwork"
(FGD, WDA).*

They also said that LLINs are used for other purposes rather than malaria prevention such as for wrapping, screwdrivers, camshafts, brackets, and troubleshooters.

"Used for wrapping, screwdriver, camshaft, bracket, and troubleshooter" (FGD, Pw, and Uf caretaker).

Perceived threat (susceptibility and severity) of malaria

With focus group discussion findings in the district, malaria was commonly recognized as a serious illness, leading to active community engagement. Many participants acknowledged their vulnerability to malaria and understood its potentially fatal consequences if left untreated. Pregnant women and children under the age

of five were particularly acknowledged as highly susceptible to malaria.

"Malaria is a very serious disease that can lead to death" (Female FGD, WDA).

In contrast to that some focus group discussions think they are not vulnerable and that malaria is not a serious disease, they think even when they get malaria I am not going to a health facility because malaria can be treated by eating food.

"Malaria isn't a serious illness in my view, so when I or my family members get sick, we don't go to health facilities. Instead, we use traditional medicines and eat specific foods, believing that malaria is a minor disease that can be easily treated this way" (female FGD, WDA).

Access and distribution barriers

The findings from our focus group discussions and key informant interviews shed light on a significant issue regarding the accessibility and distribution of LLINs within households in our study areas. While nearly all households possess at least one LLIN, our research indicates that these nets often fail to adequately accommodate the entire family, resulting in a disparity between the number of nets available and the size of the household.

This gap in accessibility directly correlates with the number of sleeping spaces within the household. Despite the presence of LLINs, a majority of family members are left without protection, as the nets do not cater to the full extent of the household's sleeping arrangements. Additionally, the situation was exacerbated by certain individuals, particularly men engaged in farming and pastoralist activity. Out of the total population of 149,100 in the district [44], approximately 9,001 individuals are pastoralists. Given the significance of this subgroup, we acknowledge that their LLIN usage might differ from that of the predominantly sedentary farming population. Who opt to sleep outdoors due to the demands of their work. Consequently, they forego the use of LLINs, further reducing the overall coverage and effectiveness of malaria prevention efforts.

A common sentiment expressed by participants in our discussions was the inadequacy of LLIN's accessibility and distribution in our study areas. Key challenges include the failure to align distribution with household size and sleeping arrangements, resulting in unequal protection among family members. Furthermore, there was a notable lack of prioritization for vulnerable groups in the distribution process, exacerbating the issue of underutilization.

“All family members do not sleep on ITN because the bed net is not accessible for in family size, example I have seven families but I received only two” (Female FGD, WDA).

Cultural and behavioral barriers

The majority of focus group discussions and key informant interviews Address cultural obstacles to encourage acceptance and consistent utilization of LLINs, while also tackling alternative purposes for LLINs that could hinder their effective deployment for malaria prevention. In the majority of focus group discussions and key informant interviews misconceptions regarding LLINs such as concerns about generating warmth and attracting bed bugs, and discomfort due to the shape of LLIN.

“Most of the time the communities said that it creates bed bug and warm (female KII, Shamash kebele).

Preference for shape and sleeping arrangements

In households where there was limited space for sleeping, hanging LLINs can be difficult. Crowded sleeping areas may not have enough room to properly hang and use LLINs for all family members, leading to uneven protection against mosquitoes and malaria.

“Some family members sleep on the floor, so we don’t use LLINs because it’s uncomfortable to stretch out on the floor with them” (female FGD, WDA).

Traditional rectangular-shaped LLINs are commonly used and distributed. They provide coverage over beds or sleeping mats and can accommodate multiple sleepers. However, conical-shaped LLINs, which taper towards the bottom, have gained popularity due to their ease of installation and improved airflow due to this most of the participants in FGD and KII said that they selected conical-shaped LLINs rather than rectangular by this reason most participants do not use the available and the distributed LLINs.

“It would be ideal if bed nets came in a circle rather than a rectangular shape. And it’s good to have bed net every year” (female FGD, WDA).

Beliefs and attitudes

LLINs for purposes beyond malaria prevention emerged as a notable challenge during our FGDs and KIIs. Alongside factors like cultural beliefs that discourage LLIN use,

this phenomenon poses an additional barrier to consistent LLIN utilization across our study sites.

Participants shared instances where LLINs were repurposed for tasks unrelated to malaria prevention, such as using them for wrapping, as tools, or for general household needs. This diversion of LLINs away from their intended purpose reflects a broader issue of awareness and understanding regarding their significance in combating malaria. Most participants in both FGDs and KIIs stated that LLINs were being utilized for alternative purposes, such as carrying donkey loads, making straw strips, constructing camshafts, assembling straws for storage, and spinning vegetables, rather than preventing malaria.

“They use it for many purposes for other purposes than expected e.g. straw, rope, and padding” (female KII, Woreda malaria officer).

In our focus group discussion and key informant interview, most of the participants believed that GOD prevents malaria and even if malaria has a chance to happen we prevent it with GOD’s permission due to this most people do not use malaria prevention strategies including ITN utilization.

“They think that they may not acquire a disease if God does not permit and GOD will treat the disease” (female KII, Shamash kebele).

Discussion

This study offers valuable insights into the barriers to LLIN utilization, which are essential for advancing malaria control efforts in Ethiopia. The findings can aid the National Malaria Control Program (NMCP) and other partners in designing more effective, localized interventions by addressing specific issues such as access barriers, net quality, and user misconceptions. Improved resource allocation and targeted strategies will enhance the efficiency and impact of malaria control programs. Additionally, the results can refine national policies, boost community engagement, and guide future research. Health professionals, managers, administrators, and policymakers can use these insights to develop strategies that enhance LLIN effectiveness. Furthermore, these findings are applicable in various settings with similar socio-political contexts, both within Ethiopia and in other regions facing analogous challenges [45].

Mosquito control is crucial in efforts to reduce, eliminate, or eradicate malaria, especially in the absence of a highly effective, long-lasting, and easily administered vaccine. To date, only two mosquito control strategies have proven effective on a large scale: indoor residual

Table 2 Themes, sub-them, and codes identified from interviews on LLIN utilization in East Belessa District, Northwest Ethiopia, 2020

Basic themes	Sub-themes	Codes
Knowledge about malaria and LLIN utilization	Understanding of malaria causes, symptoms, and prevention	Knowledge of malaria, including its causes, symptoms, and prevention methods, such as the use of LLIN
	Awareness of LLIN utilization and benefit	Knowledge of LLINs, their purpose in preventing malaria, and their advantages in protecting against mosquito bites.
Perceived Threat of Malaria	Misconceptions and lack of knowledge about malaria	Misconceptions, and lack of sufficient knowledge about the causes, symptoms, transmission, and prevention strategies of malaria.
	Perception of malaria severity and susceptibility	a serious illness, and vulnerability to the disease, among pregnant women and children under five.
Barriers to consistent LLIN use	Cultural and behavioral barriers	Cultural misconceptions, discomfort, beliefs opposing LLINs use, and alternative uses of LLINs beyond malaria prevention.
	Access and distribution challenges	Accessibility, distribution, availability of LLINs,
	Sleeping arrangements and shape preference	Sleeping places that preference more than two at the household level and shape preference conical, rectangular
	Beliefs and attitudes	Participants beliefs on LLIN, attitudes towards

spraying (IRS) and long-lasting insecticide-treated nets (LLINs) [46, 47].

LLINs as serving purposes beyond malaria prevention, particularly in providing a peaceful night's rest by effectively shielding sleepers from bothersome insects, demonstrates a multifaceted understanding among participants. This underscores the importance of considering the broader implications of LLIN usage beyond its primary objective of disease prevention. Incorporating such insights into public health strategies can lead to more comprehensive approaches that address the varied needs and priorities of communities affected by malaria and other vector-borne diseases. The current study revealed to explore Barriers to persistent long-lasting insecticidal nets utilization in northwest Ethiopia.

In east Belessa district, most participant's exhibit understanding regarding the causes, symptoms, transmission, and prevention methods of malaria, including the advantages of using LLINs. Participants recognized malaria as being transmitted through the bite of anopheles mosquitoes, manifesting symptoms such as fever, headache, chills, shivering, and joint pain. Prevention strategies mentioned by participants included eliminating stagnant water, appropriately disposing of waste materials, and using insecticide-treated nets. Comparable knowledge was reported in Ethiopia [48, 49]. and Nigeria [50].

In contrast, a minority of participants lack understanding about the causes, symptoms, transmission, and prevention methods of malaria. Some wrongly attribute malaria caused by factors such as starvation, overwork, food shortage, cold weather, water pollution, and drowning in tap water, while also holding misconceptions about its preventability. Additionally, there are misconceptions about malaria prevention being linked to maintaining cleanliness and dietary habits, as well as repurposing LLINs for household items like wrapping, screwdrivers, camshafts, brackets, and troubleshooting tools.

At the household level, nearly every household possesses at least one LLIN. However, not all members of the household have access to LLINs proportionate to the family size, similar to observations made in Nigeria [51].

In contrast, in certain regions, a portion of households lacks at least one LLIN within their premises. Research conducted in Nigeria, Ethiopia, and Malawi revealed that 13.2%, 19.3%, and 64.7% of the surveyed population, respectively, did not possess at least one LLIN during the study period [52–54]. LLINs were noted as generally available to community members throughout the region, although there were occasional cases where households were omitted from the household census list. Despite this, there were lingering concerns regarding whether there were enough nets to accommodate all family members who slept in separate beds. In addition to providing LLINs, it is important to conduct regular health education sessions with individuals to address community concerns regarding potential adverse reactions like burning, itching, and discomfort associated with using LLINs. These perceived side effects might impact the acceptance of Insecticide Treated Clothing, especially among children.

Malaria was commonly regarded as a significant illness and acknowledged as an issue of communal importance necessitating collective efforts within the district. Many participants held the belief that they were susceptible to contracting malaria and perceived it as a severe illness. They believed that if left untreated, malaria could result in fatalities. Malaria is severe in special vulnerable groups including pregnant mothers and under-five children.

Cultural and practical challenges surrounding Long-Lasting Insecticidal Nets (LLINs) were identified as significant barriers to consistent usage. These challenges include concerns about warmth, discomfort due to their shape, limited sleeping space, and misconceptions about their effectiveness. Additionally, issues such as unequal

distribution based on household size and insufficient prioritization of vulnerable groups also hinder LLIN use.

Further barriers, as highlighted in focus group discussions (FGD) and key informant interviews (KII), encompass a range of practical concerns including inadequate understanding of malaria, reluctance to hang LLINs, and the misuse of LLINs for non-malaria purposes.

In this research, both key informants and participants in focus group discussions expressed a preference for circular-shaped nets than rectangular ones because they are adaptable to any sleeping area and easy to use. This preference was also noted in other studies [39]. Other studies have also highlighted the difficulties and limitations associated with rectangular nets, including the complexities involved in their installation, the requirement for ample space, and their effectiveness primarily being restricted to beds within mud houses (despite the potential damage caused to mud walls during installation) [9, 38, 39].

Our research confirmed that the most frequent alternative uses of nets were linked to the current local livelihood and socio-economic circumstances, with these alternative uses being most prevalent during the harvest season and used for vegetable spinning rather than malaria prevention, donkey load purpose, and straw assembly and straw storages. Other studies have reported comparable instances of nets being repurposed for different uses [39, 55, 56].

In our study, participants repurposed LLINs for alternative uses when they felt that the nets were no longer serving their primary function effectively, either due to aging or a decrease in mosquito-killing effectiveness. Comparable observations were documented in other research studies as well [35, 39, 57]. The practice of repurposing LLINs is becoming more prevalent in villages located in East Belessa. Studies conducted in other regions of Ethiopia and across Africa have also found that residents repurpose nets for various purposes [9, 11, 35, 39, 58].

Even when newly acquired, we noticed that nets were being utilized for a variety of unintended purposes. Similar misuse was observed in other Ethiopian communities and different parts of Africa [35, 59]. In our study, reasons given for the improper use of LLINs included the belief that malaria is not a severe illness, reliance on divine protection, skepticism about the efficacy of bed nets in preventing malaria, and the challenge of hanging nets in every sleeping area. Comparable perceptions leading to net misuse have been documented in other research studies as well [35, 39].

In our study, alternative uses for LLINs besides malaria prevention were noted, such as using them to eliminate and deter arthropods, shield against insects, and offer protection from dust and debris, particularly for infants. These alternative uses, especially in addressing bedbug

issues, motivated residents to regularly utilize nets in the early stages. Comparable studies conducted in African regions also observed similar patterns [35, 39].

A major obstacle to the consistent use of bed nets in the study communities was the nets' inability to effectively guard against bedbug and flea infestations after a short period. Similar studies in Ethiopia, Uganda, Ruanda [35, 38, 39, 58].

Our research identified the main hurdles concerning LLIN distribution, which encompassed inadequate provision of nets relative to household size, uneven allocation, and delays in timely replacements. Similar difficulties were documented in research conducted in Ethiopia and Zanzibar [9, 35, 60]. Additionally, the conclusions drawn from other research align with the observation that, in addition to factors such as soiling, aging, and degradation of LLINs, there exists a belief that the insecticidal potency of LLINs diminishes following washing [9, 39].

Residents' lack of understanding regarding LLINs, malaria transmission, and vectors led to misconceptions and indifference, resulting in non-adherence to net usage. Additionally, a shift in behavior away from using LLINs due to the perceived low risk of malaria, the habit of saving nets for later use, lack of awareness, and negligence were factors contributing to irregular LLIN usage. Moreover, ambiguous information regarding the longevity of LLINs hindered their utilization. Similar findings were echoed in comparable studies [11, 35, 39, 61]. Misinterpretations about the ongoing efficacy of insecticides following multiple washes presented substantial obstacles to consistent usage. Comparable misunderstandings were noted in other Ethiopian and Ghanaian communities [35, 39, 62].

The reluctance to consistently use mosquito nets was attributed to the lack of suitable sleeping arrangements, such as beds, and the presence of ill-fitting bed structures. Even in modest dwellings with thatched roofs, the use of rectangular nets was found to be impractical. Comparable observations were noted in other research studies [38, 55]. In our study, participants suggested that promoting more consistent LLIN usage could be achieved by distributing circular nets in red instead of rectangular ones in blue. A comparable suggestion was also recorded in research conducted in other areas like Ethiopia and Uganda [58, 63].

Limitations

The findings of this study are specific to the study area and should not be generalized to other regions.

Conclusion

This study identifies several key factors influencing the consistent use of Long-Lasting Insecticidal Nets (LLINs) in the study area. Practical concerns significantly impact

LLIN utilization, including issues related to access and distribution, such as insufficient availability of nets relative to family size and challenges with the distribution process. Additionally, preferences for net shapes other than rectangular, discomfort due to warmth, creating bed bugs, and the size of LLINs also affect their use. The study also highlights unintended uses of LLINs for non-malaria purposes as a significant barrier. Beyond these practical concerns, socio-cultural norms, housing conditions, working environment and varying levels of understanding about malaria and LLINs further contribute to inconsistent usage.

From this study, we recommend: [1] enhancing distribution networks is crucial to ensure that Long-Lasting Insecticidal Nets (LLINs) reach the most vulnerable populations, including children under five and pregnant women [2]. Distribution strategies should be tailored to meet the specific needs of different communities to improve access [3]. Addressing net quality is also essential; LLINs should be of high quality, durable, and effective throughout their expected lifespan to ensure user satisfaction and adherence [4]. Misconceptions about LLINs must be addressed through comprehensive educational campaigns that clarify their effectiveness and proper use while increasing community awareness about malaria vectors [5]. Engaging local leaders and community health workers in advocacy and education can help overcome cultural and socio-economic barriers to LLIN use, leveraging their influence to promote consistent usage [6]. Establishing a robust system for regular monitoring and evaluation of LLIN programs will help identify and address emerging issues promptly, using feedback to continually enhance the effectiveness of interventions.

Abbreviations

EDHS	Ethiopian Demographic Health Survey
FGD	Focus Group Discussion
HHs	Households
IEC	Information, Education, and Communication
LLIN	Long lasting Insecticide Treated Net
KII	Key Informant Interview
PW	Pregnant Women
RHB	Regional, Health, Bureau
UFC	Under Five Children
WHO	World, Health, Organization

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-024-20319-w>.

Supplementary file 1: English language version of the Transcribe

Additional file 1: KII & FGD interview guide and consent form

Additional file 2: CORQ checklist

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Author contributions

ANY: designed the study, performed analysis and interpretation of data, and drafted and revised the manuscript RB, WA, AN, GL, EG, DG & MSM: participated in the data analysis and revised subsequent drafts of the paper. All authors read and approved the final version of the manuscript.

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Data availability

The datasets employed in the current study can be available from the corresponding author upon reasonable request.

Declarations

Ethical consideration

The ethical clearance was obtained from the Institutional Review Board (IRB) of the University of Gondar (UOG) through the Department of Health Education and Behavioral Sciences, College of Medicine and Health Sciences. The formal letter has been written for East Belessa woreda health office. The ethical letter had been written to the Woreda Health Bureau. Written informed consent from the respondents was then obtained after giving respondents adequate information on the aim of the study, potential risks and benefits of being a participant, and the rights of the respondents. The privacy and confidentiality issues had been secured throughout the processes.

Consent for publication

NA.

Competing interests

The authors declare no competing interests.

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