International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Determinants of Long-Lasting Insecticide-Treated Nets Utilization among Community Households of Ngoma District, Rwanda

Mr. Kayijuka Protais

Mount Kenya University, Public Health, Mount Kenya University

ABSTRACT

Malaria remains a major public health challenge in sub-Saharan Africa, including Rwanda, where it continues to contribute significantly to morbidity and mortality despite ongoing control efforts. Long-Lasting Insecticidal Nets (LLINs) are widely promoted as an effective preventive intervention; however, their utilization remains inconsistent in many communities. This study aimed to assess the level of LLIN utilization and its determinants among community members in Ngoma District, Rwanda. A cross-sectional study design was used, combining quantitative and qualitative approaches to provide a comprehensive understanding of LLIN use. Quantitative data were collected from 430 adult household members using a structured questionnaire covering socio-demographic characteristics, knowledge, attitudes, perceptions, household and environmental factors, and LLIN utilization. Qualitative data were obtained through key informant interviews with the District Director of Health, Community Environmental Health Officers (CEHO), Community Health Workers (CHWs), and LLIN users to explore lived experiences and contextual factors influencing LLIN use. Quantitative data were coded and analyzed using SPSS version 21.0, employing descriptive statistics such as frequencies and percentages, as well as inferential statistics including Chi-square tests and logistic regression to determine associations and predictors of LLIN utilization. Qualitative data were analyzed using thematic analysis to identify recurring patterns and explanations supporting quantitative findings. The results showed that 54.2% of respondents slept under an LLIN the night before the survey, while 45.8% did not, and only 43.5% reported consistent use every night. A majority of households (64.7%) reported that not all members had access to LLINs. LLIN utilization was significantly associated with age (P=0.032) and gender (P=0.036). Knowledge of malaria transmission was relatively high (71.9%), but only 37.9% of respondents demonstrated good overall knowledge. Although attitudes toward LLIN use were generally positive (60.9%), utilization remained inconsistent. Environmental and behavioral barriers were prominent, with heat (92.1%), forgetfulness (88.8%), lack of awareness (87.4%), and inadequate sleeping arrangements (67.4%) reported as key challenges. Qualitative findings supported these results, revealing that inconsistent use is influenced by heat discomfort, seasonal changes, limited access to nets within households, and daily routines that affect regular use. The study concludes that LLIN utilization in Ngoma District is influenced by a combination of behavioral, environmental, and structural factors, highlighting a persistent gap between LLIN ownership and consistent use.

1.1 Background of the study

Malaria remains one of the most pressing public health challenges globally, particularly in sub-Saharan

Africa, where it accounts for the majority of cases and deaths. Despite significant progress in malaria control over the past decades, the World Health Organization (*Fact Sheet about Malaria*, n.d.) reports that over 400,000 deaths still occur annually, with the vast majority in Africa. Malaria transmission in the region is primarily caused by Plasmodium falciparum, transmitted by Anopheles mosquitoes, and poses a particular threat to children under five and pregnant women(*Fact Sheet about Malaria*, n.d)

Long-lasting insecticide-treated nets (LLINs) are a cornerstone of malaria prevention strategies. They provide a physical barrier and an insecticidal effect, significantly reducing human–mosquito contact and subsequent malaria transmission(Van Bortel et al., 2022). Studies indicate that consistent and correct use of LLINs can reduce malaria incidence by up to 60% and child mortality by approximately 17%(Pryce et al., 2018). However, LLIN effectiveness is heavily dependent on both universal coverage and proper utilization, as gaps between net ownership and usage are common in endemic regions(Ng'ang'a et al., 2021)

In Rwanda, LLINs distribution has been a key intervention in the national malaria control program. Supported by the Global Fund and the President's Malaria Initiative, Rwanda achieved universal LLIN coverage in several districts through mass campaigns, routine antenatal care distribution, and childhood immunization programs (Rwanda Biomedical Center [RBC], 2024). The Rwanda Malaria Indicator Survey reported that 75% of households had access to at least one LLIN per two individuals after the 2023 distribution campaigns. However, utilization rates lagged behind, with only 62% of individuals reportedly sleeping under LLINs regularly, highlighting a persistent gap between access and consistent use(Obeagu et al., 2025) .

Recent studies across sub-Saharan Africa show that LLIN utilization is influenced by multiple socio-demographic and behavioral factors. Age, gender, educational attainment, household socioeconomic status, and knowledge about malaria risks have been shown to affect whether individuals use nets consistently (Basiru et al., 2025a) . Behavioral and cultural factors also play a role; for example, seasonal temperature variations, perceived discomfort, and misconceptions about malaria prevention may reduce LLIN usage even in households that own nets(Basiru et al., 2025a)

In Rwanda, malaria remains heterogeneous across districts. Ngoma District, in particular, has reported fluctuating malaria cases despite repeated mass LLIN campaigns, suggesting that factors beyond net availability such as household practices, community awareness, and environmental conditions, may affect utilization(Niyoyita et al., 2023). Understanding these determinants is crucial because LLINs alone cannot achieve malaria elimination if community members do not use them consistently. Furthermore, integrating behavioral insights into malaria control programs aligns with WHO recommendations and Rwanda's Integrated Malaria Control Guidelines, which emphasize community engagement, behavior change communication, and monitoring of LLIN usage(Obeagu et al., 2025) .

Empirical evidence highlights that interventions targeting awareness, perceptions, and socio-cultural practices can significantly improve LLIN utilization(Iyer et al., 2019). For instance, behavior-change campaigns combined with routine LLIN distribution have improved nightly net use by up to 20% in high-risk areas. Identifying barriers and facilitators of LLIN use in Ngoma District was therefore to provide actionable insights to strengthen malaria control strategies, optimize net utilization, and reduce malaria morbidity and mortality(Okiring et al., 2025).

Therefore, it is imperative to explore the determinants influencing LLIN use at the community level. This study examined the socio-demographic, behavioral, and environmental factors affecting LLIN utilization among residents of Ngoma District between 2021 and 2026.

RESEARCH METHODOLOGY AND DESIGN

Introduction

This chapter outlines the research methodology and design adopted to investigate the determinants of long-lasting insecticidal net (LLIN) utilization among community members in Ngoma District, Rwanda. It presents the research design, study location, target population, sampling procedures, and research instruments, as well as the piloting, data collection, and analysis procedures. Ethical considerations guiding the study are also described. The methodology is designed to ensure the validity, reliability, and applicability of findings, providing evidence that can inform malaria prevention strategies and health policy decisions at both district and national levels. By clearly specifying the methods and procedures, this chapter provides a transparent framework for replicating the study and ensuring that results accurately reflect the determinants influencing LLIN use in the local context.

Research Methodology

This study adopted a mixed-method design, both quantitative and qualitative research methodologies, to investigate the determinants of long-lasting insecticidal net (LLIN) utilization among community members in Ngoma District, Rwanda. Quantitative research focuses on collecting and analyzing numerical data to identify patterns, relationships, and associations between variables, providing empirical evidence for informed decision-making. While qualitative data conducted within Key Informants, Community health workers and LLIN users. This methodology is particularly suitable for this study because it allows for measurement of LLIN utilization rates and the statistical examination of how socio-demographic factors, knowledge, attitudes, perceptions, and household-environmental factors influence net use.

A mixed-method design was adopted, enabling the collection of data at a single point in time from a representative sample of households. This approach is efficient for describing the prevalence of LLIN utilization, examining associated factors, and testing hypothesized relationships between independent, intervening, and dependent variables. The methodology involved structured questionnaires administered to heads of households or adult members, ensuring that data are standardized, comparable, and suitable for quantitative analysis.

Research Design

This study adopted a mixed method design, which mixed both quantitative and qualitative approaches as particularly suitable for this study because it allows for the simultaneous assessment of socio-demographic factors, knowledge, attitudes, perceptions, household characteristics, and environmental influences on LLIN use and additional qualitative data to explain our statistical data. By analyzing these variables concurrently, the study can identify statistically significant relationships and provide insights into which factors are most strongly associated with consistent utilization.

Moreover, mixed approach designs are efficient, cost-effective, and practical for field-based surveys in resource-limited settings like Ngoma District, where large-scale longitudinal studies may be logistically challenging. Data collected using structured questionnaires administered to adult household members, ensuring standardization and comparability across respondents while qualitative data were analyzed using Interview guide for Key Informants and Community Health workers with LLIN users. The results allowed for evidence-based recommendations for malaria control interventions targeting behavioral and structural barriers to LLIN use.

Location of the study

The study conducted in Ngoma District, located in the Eastern Province of Rwanda. Ngoma is predominantly rural, with an estimated population of 361,000 people as of 2025, distributed across several

sectors, cells, and villages (National Institute of Statistics of Rwanda [NISR], 2025). The district experiences a tropical climate with distinct rainy and dry seasons, which influences mosquito breeding patterns and malaria transmission.

Malaria remains a significant public health concern in Ngoma District, with the local health authorities reporting consistently high incidences, particularly during the rainy season (Rwanda Biomedical Center [RBC], 2024). The district has implemented nationwide malaria control interventions, including the distribution of long-lasting insecticidal nets (LLINs), indoor residual spraying, and community health education programs. Despite these efforts, anecdotal evidence and local health reports indicate inconsistent use of LLINs among households, highlighting the need to investigate the determinants of utilization.

Ngoma District is selected for this study due to its high malaria burden, accessibility for field data collection, and representativeness of rural communities in Rwanda where malaria prevention remains a challenge. Understanding factors affecting LLIN utilization in this context provided valuable insights for improving malaria control strategies and enhancing the effectiveness of preventive interventions at both local and national levels.

Target population

The target population for this study comprised adult household members aged 18 years and above living in Ngoma District, Rwanda, who are responsible for the use and maintenance of long-lasting insecticidal nets (LLINs). These adults are chosen because they are typically the decision-makers regarding allocation and nightly use of LLINs within the household, and they are knowledgeable about household malaria prevention practices. while qualitative data, the study involved Key Informants from the district Level, (Director of Health), Community and Environmental Health (CEHO) from the district hospital, Community Health Workers and LLINs Users

Sampling techniques and Sample Size

A multistage sampling technique used to select households and participants. First, sectors within Ngoma District was randomly selected. Within these sectors, cells and villages randomly chosen, and finally, households within the selected villages was systematically sampled. One adult member per household interviewed. This method ensures a representative sample across geographic and socio-demographic variations.

The sample size is calculated using Cochran's formula for cross-sectional surveys:

$$n = \frac{Z^2 pq}{d^2}$$

Where:

Z=1.96Z = 1.96Z=1.96 (95% confidence level)

p=0.5p = 0.5p=0.5 (assumed proportion of LLIN utilization)

d=0.05d = 0.05d=0.05 (margin of error)

$$n = \frac{(1.96)2\ (0.5)\ (.05)}{(0.05)^2}$$

n = 384

Adding **10% for non-response**:

384+0.1(384) =422384 + 0.1(384) = 422384+0.1(384) =430

Thus, the study was include **430** adult respondents from selected households in Ngoma District

Sample of qualitative

Qualitative data were collected from the District Director of Health, community and environmental health staff, community health workers, and LLIN users. This information provided deeper insight into the statistical findings and helped explain the factors influencing LLIN use in Ngoma District.

Table 1: Sample of Qualitative study participants

Position	Institution	Number of Participants
Director of Health (KI)	District	1
CEHO	District Hospital	1
Community Health Workers (CHWs)	Community	5
LLINs users	Community Members	10
Total		**17**

Research Instruments

The primary data collection tool for this study was a structured questionnaire, designed to capture comprehensive information on all variables related to the utilization of long-lasting insecticidal nets (LLINs) among community members in Ngoma District. Structured questionnaires are appropriate for quantitative research as they allow for standardized data collection, facilitate easy coding, and enable rigorous statistical analysis.

The questionnaire and interview guides were organized into five interconnected sections. The first section collected socio-demographic information, including age, gender, education level, occupation, household income, and household size, which are key independent variables that may influence LLIN utilization. The second section focused on knowledge, attitudes, and perceptions (KAP), assessing respondents' awareness of malaria transmission, perceived susceptibility, attitudes toward LLIN effectiveness and comfort, and cultural beliefs regarding malaria prevention. The third section captured household and environmental factors, such as the number of LLINs per household, sleeping arrangements, housing structure, and proximity to mosquito breeding sites, all of which can affect consistent net use. The fourth section addressed LLIN utilization, including the frequency, consistency, and proper use of nets by household members, representing the study's dependent variable. Finally, the fifth section examined intervening variables, including exposure to health education programs, accessibility of LLINs, and the influence of seasonal and climatic conditions on net use.

Most questions closed-ended, employing Likert scales and dichotomous responses to ensure the data are quantifiable and suitable for statistical analysis. To enhance validity and reliability, the questionnaire was pre-tested in a neighboring district prior to the main survey to confirm clarity, cultural relevance, and consistency of responses.

Piloting of research instrument

To ensure the reliability and validity of the research instrument, the structured questionnaire was undergoing a pilot study prior to the main data collection. The pilot was conducted in Kirehe a neighboring district with characteristics similar to Ngoma District, including rural setting, malaria prevalence, and socio-demographic composition. A sample of approximately 10% of the calculated study participants (around 40 respondents) was included in the pre-test to identify potential ambiguities, unclear wording, or culturally inappropriate questions.

The piloting process allowed the research team to assess the clarity, relevance, and comprehensiveness of the questions, as well as the estimated time required for respondents to complete the questionnaire. Feedback from the pilot used to refine question phrasing, response options, and sequencing, ensuring that all items accurately capture the intended variables. Additionally, the pilot enabled the calculation of reliability statistics, such as Cronbach's alpha, to confirm the internal consistency of Likert-scale items measuring knowledge, attitudes, and perceptions.

By conducting a thorough pilot, the study aims to minimize measurement errors, enhance data quality, and ensure that the questionnaire is culturally appropriate, clear, and reliable. This process strengthens the overall validity of the study and increases confidence that the collected was data accurately reflect LLIN utilization and its determinants in Ngoma District.

Testing for Validity, Reliability, and Establishment of Trustworthiness

To ensure the credibility and accuracy of the study findings, the research instrument was undergoing rigorous testing for validity and reliability. Content validity was established by consulting a panel of experts in public health, malaria control, and survey research. These experts reviewed the questionnaire and interview guides to confirm that the items adequately cover all aspects of LLIN utilization, socio-demographic factors, knowledge, attitudes, perceptions, household characteristics, and environmental determinants relevant to Ngoma District. Adjustments were made based on expert feedback to ensure that each question is clear, relevant, and culturally appropriate.

Construct validity addressed during the pilot study, where statistical tests, including correlation analyses, was assess whether the questionnaire items accurately measure the intended constructs, such as knowledge, attitudes, and perceptions (Creswell & Creswell, 2023). Reliability evaluated using Cronbach's alpha for Likert-scale items to determine internal consistency. A Cronbach's alpha of 0.7 or above was considered acceptable, indicating that the scale items consistently measure the same underlying concept.

Trustworthiness was further enhanced by ensuring standardized data collection procedures, including the use of trained research assistants, structured interviews, and daily supervisory checks for completeness and accuracy. Clear documentation of the data collection process, including consent procedures and ethical adherence, was also strengthen dependability and credibility. These measures collectively ensure that the findings of this study are valid, reliable, and trustworthy, providing a sound basis for informing malaria prevention interventions and policy decisions in Ngoma District.

Data Collection Methods and Procedures

Data for this study was collected using structured questionnaires administered through face-to-face interviews with adult household members in selected households of Ngoma District. Trained research assistants fluent in Kinyarwanda and familiar with the local context were conducting the interviews to ensure accurate communication and comprehension. Prior to data collection, the research team briefed participants about the study objectives, voluntary participation, and confidentiality measures, obtaining informed consent from each respondent.

The data collection process followed a systematic schedule, beginning with selected sectors and progressing through randomly chosen cells and villages. The enumerators visited households during appropriate hours when adult members are likely to be available, ensuring maximum participation and response rates. Each interview is expected to take 20–30 minutes, depending on household size and respondents' familiarity with LLINs. Completed questionnaires were reviewed daily by the field

supervisor to ensure completeness and accuracy, with immediate clarification or follow-up where necessary.

The method ensures that quantitative, standardized data are obtained directly from household members, capturing both behavioral and environmental determinants of LLIN utilization. This approach allows for reliable, representative, and actionable findings that reflect the actual practices and perceptions of community members regarding LLIN use in Ngoma District. By following a structured and supervised procedure, the study minimized errors, bias, and missing data, ensuring high-quality information for subsequent analysis.

Data Analysis techniques and presentation

The collected data was coded, entered, and analyzed using Statistical Package for the Social Sciences SPSS version 21.0, which allows for accurate management and statistical examination of quantitative data. Data cleaning was performed prior to analysis to identify and correct errors, missing values, or inconsistencies. Descriptive statistics, including frequencies, percentages, means, and standard deviations, used to summarize socio-demographic characteristics, knowledge, attitudes, perceptions, household and environmental factors, and LLIN utilization patterns among respondents.

To assess the relationships between independent variables and LLIN utilization, inferential statistical tests applied. Chi-square tests examined associations between categorical variable. Multivariate analysis, particularly binary logistic regression, was employed to identify the most significant predictors of consistent LLIN utilization, adjusting for potential confounding variables. Odds ratios with 95% confidence intervals were reported to quantify the strength of associations.

The study findings were presented using a combination of tables, graphs, and charts to enhance clarity and interpretation. Textual explanations were accompanying visual data presentations to describe patterns, highlight key results, and link them to the research objectives. This approach ensures that the analysis is transparent, comprehensive, and interpretable, providing evidence-based insights into the determinants of LLIN utilization among community members in Ngoma District.

Ethical Considerations

Ethical considerations are fundamental in research involving human participants to ensure respect, protection, and integrity throughout the study. This section outlines measures to safeguard participants' rights, privacy, and well-being, including obtaining informed consent, maintaining confidentiality, and ensuring voluntary participation. Adherence to institutional and international ethical standards were guide all stages of data collection and reporting in Ngoma District.

Access to Research Sites

Ethical Approval

The study thesis was submitted for approval to the School of Postgraduate Studies at Mount Kenya University-Rwanda. Ethical clearance was obtained from the Institutional Review Board (IRB) and relevant district authorities in Ngoma. Particular attention was paid to the principles of respect for persons, beneficence, justice, and research integrity, ensuring compliance with both institutional and international standards. Ethical approval was safeguard participants, including adult household members, community leaders, and local health personnel, promoting responsible research conduct throughout the study.

Access to Research Sites

Formal authorization to access selected sectors, cells, and villages in Ngoma District obtained from local authorities and the district health office. Permission letters were also being secured from community leaders to facilitate smooth data collection and cooperation from households. This ensures that the study

is conducted in accordance with local administrative and ethical requirements and promotes mutual trust with community members.

Informed Consent

All participants provided with consent forms written in simple, culturally appropriate language to ensure comprehension. Only individuals who voluntarily provided signed consent participated. This process aligns with international ethical guidelines for research involving human subjects and ensures that participants are fully aware of the study's purpose, procedures, risks, and benefits.

Voluntary Participation

Participation was entirely voluntary, and respondents were informed of their right to withdraw at any stage without facing any negative consequences. This protects participants' autonomy and decision-making capacity, particularly in settings where some individuals may feel obligated to participate due to community hierarchies.

Freedom from Coercion

No participant was coerced or unduly influenced to join the study. The researcher avoided offering excessive incentives, applying authority, or creating pressure, ensuring that participation is based solely on informed choice and willingness.

Confidentiality and Privacy

All personal data collected were managed with strict confidentiality. Identifiable information did not appear on questionnaires, and unique codes assigned to each respondent. Data reported in aggregated form only, preventing any traceability to individual participants.

Anonymity

Participants' identities remain anonymous throughout the research process. Responses were presented without personal names or other identifiers, ensuring the protection of participants' privacy, security, and social standing.

Intellectual Property and Plagiarism

The researcher was upholding academic integrity by properly acknowledging all sources and respecting intellectual property rights. The final thesis complied with Mount Kenya University's plagiarism policy, maintaining a similarity index below 15% and adhering strictly to APA 7th edition referencing standards.

Data Storage and Security

All collected data was securely stored in password-protected digital files and locked physical cabinets. Data was retained for at least five years to allow for verification and future reference, after which it was appropriately destroyed according to ethical guidelines.

Professional Conduct and Cultural Sensitivity

The researcher was maintained professionalism, cultural sensitivity, and respect when interacting with household members, community leaders, and local health personnel. Proper attire, courteous communication, and awareness of local norms was helped build trust, minimize potential harm, and ensure ethical engagement throughout the study.

RESEARCH FINDINGS AND DISCUSSION

Research Findings

A total of 430 questionnaires were distributed to selected respondents, and 408 were successfully completed and returned, giving a response rate of 94.9%. This response rate was considered high enough to ensure the reliability and validity of the study findings. The results are presented using descriptive

statistics to summarize the characteristics of both male and female respondents who participated in the study.

Social Demographic characteristics of study participants

This table (1) presents the social demographic characteristics of the study respondents who participated in this study. A total of 430 participants, both male and female, participated in this study.

Table 2: Social Demographic characteristics

Variables	Frequency (%)
Age group	
18-25 Years	65(15.1)
26-25 Years	193(44.9)
36-45 Years	63(14.7)
>45 Years	109(25.3)
Gender	
Male	199(46.3)
Female	231(53.7)
Martial status	
Single	33(7.7)
Married	300(69.8)
Divorced/Separated	27(6.3)
Widowed	70(16.3)
Educational Level	
No Formal Education	94(21.9)
Primary Level	234(54.4)
Secondary Level and above	102(23.7)
Occupation	
Farmer	246(57.2)
Trader	42(9.8)
Government employee	57(13.3)
Unemployed	60(14.0)
Others	25(5.8)
Household Income	
<50,000 RWF	350(81.4)
50,000-100,000 RWF	45(10.5)
101,000-200,000 RWF	25(5.8)
>200,000 RWF	10(2.3)

The table of social demographic characteristics shows that the majority of respondents composed of adults, with nearly half (44.9%) aged 26–35, followed by 25.3% who are above 45 years, while smaller proportions fall within 18–25 (15.1%) and 36–45 (14.7%). Females (53.7%) slightly outnumber males (46.3%). A strong majority of respondents are married (69.8%), with fewer being widowed (16.3%), single (7.7%), or divorced/separated (6.3%). In terms of education, over half (54.4%) have only primary

education, 23.7% have secondary education or higher, and 21.9% have no formal education. Farming is the main occupation for most participants (57.2%), while smaller groups are unemployed (14.0%), government employees (13.3%), traders (9.8%), or engaged in other activities (5.8%). This is further reinforced by income levels, where the vast majority (81.4%) earn less than 50,000 RWF, compared to 10.5% earning 50,000–100,000 RWF, 5.8% earning 101,000–200,000 RWF, and only 2.3% earning above 200,000 RWF.

level of long-lasting insecticide-treated net (LLIN) utilization among community members in Ngoma District, Rwanda

This Figure (2) is presenting findings towards level of LLIN utilization among community members through highlight use and its access.

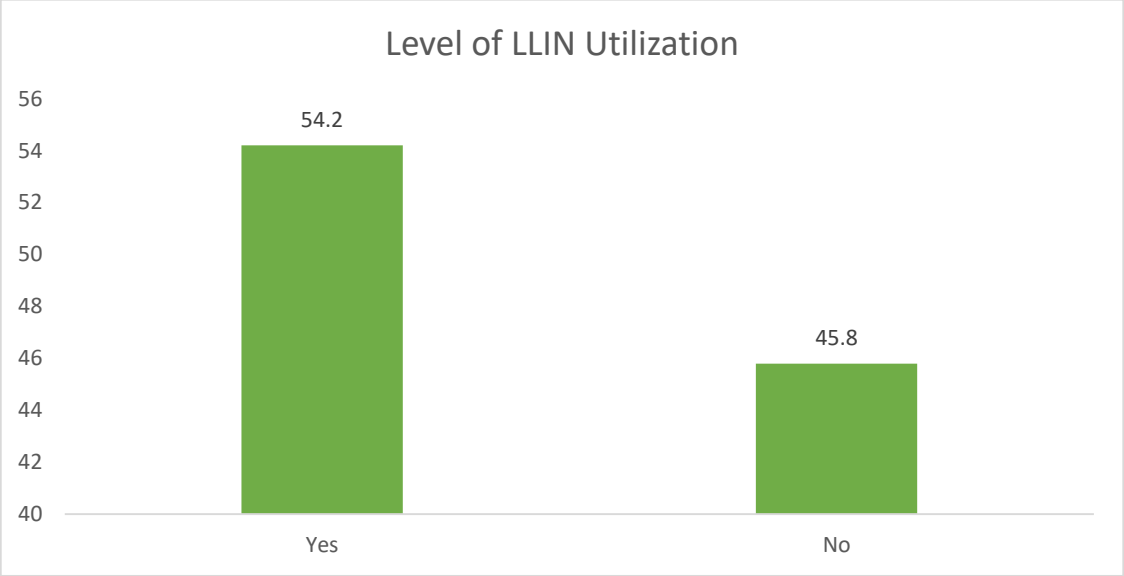

Figure *2*: Level of Utilization of LLINs among community members

This figure 2 shown that just over half of the respondents (54.2%) slept under an LLIN the previous night, while a large proportion (45.8%) did not utilize LLIN.

Table 3: Household access to LLIN

Variables	Frequencies	Percentage
Any family member experienced malaria in the last 6 months prior to the study		
Yes	269	62.6
No	161	37.4
All household members have access to LLINs		
Yes	152	35.3
No	278	64.7
Often, household members sleep under an LLIN		
Every night	187	43.5
Most Night	38	8.8
Occasionally	101	23.5

Rarely	104	24.2

This table (3) shown that Most households (62.6%) reported that at least one family member had experienced malaria in the six months before the study, compared to 37.4% who had not. In terms of access, only 35.3% of households said all members have LLINs, whereas the majority (64.7%) reported that not everyone in the household has access. When looking at usage patterns, 43.5% of respondents reported sleeping under LLINs every night, while others reported less frequent use, with 8.8% using them most nights, 23.5% occasionally, and 24.2% rarely.

Socio-demographic factors influencing LLIN utilization among community members in Ngoma District.

This table is presenting bivariate analysis to present socio-demographic factors influencing LLIN utilization among community members with Bivariate analysis.

Table 2: Bivariate Analysis

Variables	Sleep Under LLIN last night		P-Value
	Yes n(%)	no n(%)	
Age group			0.032
18-25 Years	34(14.6)	31(15.7)	
26-25 Years	103(44.2)	90(45.7)	
36-45 Years	26(11.2)	37(18.8)	
>45 Years	70(30.0)	39(19.8)	
Gender			0.036
Male	97(41.6)	102(51.8)	
Female	136(58.4)	95(48.2)	
Marital status			0.717
Single	17(7.3)	16(8.1)	
Married	159(68.2)	141(71.6)	
Divorced/Separated	17(7.3)	10(5.1)	
Widowed	40(17.2)	30(15.2)	
Educational Level			0.151
No Formal Education	57(24.5)	37(18.8)	
Primary Level	117(50.2)	117(59.4)	
Secondary Level and above	59(25.3)	43(21.8)	
Occupation			0.384
Farmer	136(58.4)	110(55.8)	
Trader	17(7.3)	25(12.7)	
Government employee	31(13.3)	26(13.2)	
Unemployed	36(15.5)	24(12.2)	
Others	13(5.6)	12(6.1)	

The table 4 shows that the majority of respondents who slept under an LLIN come from the 26 –35 age group (44.2%), and this same group also forms the majority among those who did not (45.7%). Those aged above 45 made up a larger share among users (30.0%) compared to non-users (19.8%), while the 36–45 age group appears more among non-users (18.8%) than users (11.2%); this difference across age groups has a P-value =0.032. In terms of gender, the majority of LLIN users are female (58.4%), whereas the majority of non-users are male (51.8%), with a P-value =0.036.

For marital status, the majority in both groups are married, accounting for 68.2% of users and 71.6% of non-users, and the distribution across categories remains similar, with a P-value = 0.717. Regarding education, the majority of respondents in both groups have primary education (50.2% among users and 59.4% among non-users), followed by those with secondary education and above and those with no formal education; this pattern shows a P-value = 0.151. Looking at occupation, the majority in both groups are farmers (58.4% of users and 55.8% of non-users), while other occupations appear in smaller and comparable proportions, with a P-value = 0.384.

During qualitative interviews, it was reported that LLIN use varies across different population groups, with younger individuals and men being less consistent users due to mobility, late working hours, and perceived lower risk, while women were described as more responsible in ensuring household and children's protection, and daily livelihood activities such as farming also affecting consistent use. *"Young people are often busy or stay out late, so they are less consistent in sleeping under nets compared to older people."* (Female CHW-005) *"Men tend to be less consistent because they come home late or don't feel as vulnerable to malaria."* (CEHO staff) *"Women are usually more careful; they make sure children and the whole family are protected under nets."* (District Director of Health (DH)) *"It's not just education; how people live and work daily affects whether they use nets or not."* (LLIN user-010)

Perceptions regarding malaria prevention using LLIN

This table is presenting knowledge regarding to malaria prevention and their impact on LLIN use among our study respondents.

Table 5: Knowledge towards Malaria prevention and their impact on LLIN use

Variables	Frequency (n)	Percentage (%)
Knowledge		
Know that malaria is transmitted by Mosquitoes		
Yes	309	71.9
No	121	28.1
Know that LLINs prevent malaria		
Yes	251	58.4
No	179	41.6
Know the often should LLINs be used to be effective		
Every night	333	77.4
Occasionally	69	16.0
Don't know	28	6.5

The findings show that 309 respondents (71.9%) knew that malaria is transmitted by mosquitoes, while 121 (28.1%) did not have this knowledge. Regarding prevention, 251 (58.4%) reported knowing that

LLINs prevent malaria, whereas 179 (41.6%) did not know this. On the frequency of use, 333 (77.4%) stated that LLINs should be used every night to be effective, while 69 (16.0%) believed they should be used occasionally and 28 (6.5%) did not know the correct frequency.
This table (5) is presenting attitudes and perceptions of study respondents towards malaria prevention and their impact on LLIN use.

Table 6: Attitudes and perception of study respondents towards Malaria prevention and their impact of LLIN use

Variables	Frequency (n)	Percentage (%)
Sleeping under LLINs is comfortable		
Strongly agree	334	77.7
Agree	13	3.0
Neutral	24	5.6
Disagree	41	9.5
Strongly disagree	18	4.2
Using LLINs every night is important for my family's Health		
Strongly agree	343	79.8
Agree	17	4.0
Neutral	15	3.5
Disagree	41	9.5
Strongly disagree	14	3.3
LLINs are effective even if my house has few mosquitoes		
Strongly agree	324	75.3
Agree	12	2.8
Neutral	34	7.9
Disagree	40	9.3
Strongly disagree	20	4.7
Cultural or traditional beliefs influence LLIN use in my household		
Strongly agree	28	6.5
Agree	28	6.5
Neutral	15	3.5
Disagree	328	76.3
Strongly disagree	31	7.2

This table (6) presents attitudes and perceptions toward malaria prevention, showing generally positive views toward LLIN use. Regarding comfort, 334 respondents (77.7%) strongly agreed that sleeping under LLINs is comfortable, while 13 (3.0%) agreed, 24 (5.6%) were neutral, 41 (9.5%) disagreed, and 18 (4.2%) strongly disagreed. On the importance of consistent use, 343 (79.8%) strongly agreed that using LLINs every night is important for family health, 17 (4.0%) agreed, 15 (3.5%) were neutral, 41 (9.5%) disagreed, and 14 (3.3%) strongly disagreed. For perceived effectiveness, 324 (75.3%) strongly agreed that LLINs remain effective even when there are few mosquitoes, 12 (2.8%) agreed, 34 (7.9%) were neutral, 40 (9.3%)

disagreed, and 20 (4.7%) strongly disagreed. Regarding cultural influence, 28 (6.5%) strongly agreed, and 28 (6.5%) agreed that cultural or traditional beliefs influence LLIN use in their household, while 15 (3.5%) were neutral, 328 (76.3%) disagreed, and 31 (7.2%) strongly disagreed.

During qualitative discussions, it was found that although most community members are aware that mosquitoes transmit malaria and understand that LLINs are protective, this knowledge does not always translate into consistent use. Participants expressed that some people only use nets when mosquito density is high, while others believe occasional use is sufficient, despite generally positive attitudes toward LLIN comfort and effectiveness. *Most people know mosquitoes cause malaria, but not everyone turns that knowledge into daily action."* (Female CHW-002) *"Awareness is there, but many still don't fully understand the importance of using nets every single night."* (District Director of Health (DH)) *"For many people, sleeping under a net is not uncomfortable anymore, they are used to it now."* (LLIN user-003) *"Some households only use nets when mosquitoes are many, but stop when they think the risk is low."* (Female CHW-004)

Household and environmental factors that affect the consistent utilization of LLINs.

Figure 3: This figure is presenting the factors limit the consistent use of LLIN among house hold as factors contributing to their utilization.

Figure 3: limit the consistent use of LLINs Among household

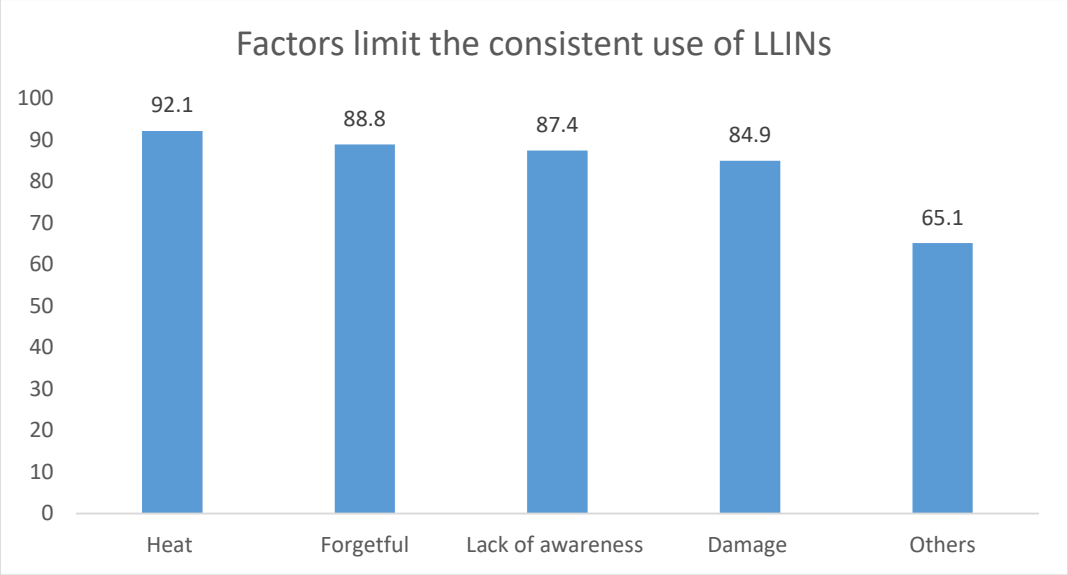

Figure (3) presents the factors that limit consistent use of LLINs. The majority of our participants reported heat (92.1%) followed by Forgetful (88.8%), Lack of awareness were reported with (87.4%), damage reported with (84.9%) while other factors reported with (65.1%)

During the qualitative study, participants reported that although LLINs are widely distributed, consistent nightly use remains a challenge, with some household members not sleeping under nets regularly due to heat, inadequate access for all family members, and inconsistent usage habits observed during home visits. *"People often say they have nets in their homes, but when you look closely, not everyone actually sleeps under them every night, especially when it is hot."* (Female CHW-001) *"Even though LLINs are distributed widely, there is still a gap between having a net and using it consistently."* (CEHO staff) *"During home visits, we find that some people used the net the previous night, but their use is not*

consistent every day." (Male CHW-001) *"We still see malaria cases in homes where nets are available, but people do not always use them properly or regularly."* (LLIN user-005)

This table (7) is presenting the environmental factors that affect the consistent utilization of LLINs among our study participants.

Table 7: Household and Environmental factors that affect the consistent utilization of LLINs

Variable	Utilize LLIN		P-value
	Yes n(%)	No n(%)	
Type of housing			0.962
Mud wall/thatched roof	138(59.2)	117(59.4)	
Bricks with thin roof	81(34.8)	67(34.0)	
Others	14(6.0)	13(6.6)	
Presence of stagnant water			0.099
Yes	154(66.1)	115(58.4)	
No	79(33.9)	82(41.6)	
Sleeping arrangements			0.517
Yes	79(33.9)	61(31.0)	
No	154(66.1)	136(69.0)	
Received health education on malaria prevention in the last 12 months prior the study			0.495
Yes	107(45.9)	84(42.6)	
No	126(54.1)	113(57.4)	
Accessible are LLINs in your community			0.803
Easy available	74(31.8)	59(29.9)	
Moderately available	130(55.8)	116(58.9)	
Not available	29(12.4)	22(11.2)	
Seasonal changes affect LLIN use in your household			0.031
Yes	126(54.1)	86(43.7)	
No	107(45.9)	111(56.3)	

The table presents environmental and contextual factors associated with the utilization of Long-Lasting Insecticidal Nets (LLINs), and most variables did not show a statistically significant association, as their p-values were greater than 0.05. Regarding the type of housing, LLIN utilization was distributed across mud wall/thatched roof houses (59.2%), brick houses with thin roofs (34.8%), and other types (6.0%), with a p-value of 0.962, indicating that housing conditions did not significantly influence net use. For the presence of stagnant water, 66.1% of respondents who reported stagnant water utilized LLINs, while the association was not statistically significant ($p = 0.099$), suggesting that environmental exposure alone did not strongly determine usage. In terms of sleeping arrangements, 33.9% of respondents with defined arrangements utilized LLINs, and this factor was not statistically significant ($p = 0.517$), indicating limited influence on utilization behavior. Similarly, health education on malaria prevention showed that 45.9% of

respondents who received education utilized LLINs, but the association was not statistically significant (p = 0.495), implying that education alone may not guarantee consistent use. The availability of LLINs in the community also did not show a significant relationship with utilization (p = 0.803), despite 55.8% of respondents reporting moderate availability, highlighting that access does not necessarily translate into use. However, seasonal changes demonstrated a statistically significant association with LLIN utilization (p = 0.031), with 54.1% of respondents reporting that seasonal variation influences their use of LLINs. This finding suggests that environmental factors such as weather conditions and mosquito density play an important role in shaping LLIN utilization. *"Hot nights make it difficult for people to sleep under nets, so many end up not using them."* (Male CHW-003) *"In poorly built houses, especially those with mud walls or less ventilation, people often avoid using nets because of heat and discomfort."* (CEHO staff) *"Mosquitoes are more common where there is stagnant water, but people still do not consistently use nets."* (District Director of Health (DH)) *"Some homes simply don't have proper sleeping setups, so hanging nets becomes a challenge."* (Female CHW-005) *"During hot seasons, many households reduce or completely stop using nets at night."* (LLIN user-006)

DISCUSSION

This study assessed LLIN utilization and the factors influencing its consistent use in Ngoma District, Rwanda using a mixed-methods approach. The findings show that LLIN utilization remains moderate but not universal, with only 54.2% of respondents reporting that they slept under an LLIN the night before the survey. Consistent use was even lower, as only 43.5% reported sleeping under LLINs every night, while 23.5% used them occasionally and 24.2% rarely. These findings are comparable with results from other sub-Saharan African settings where utilization remains below optimal levels despite high ownership. For instance, a study in western Kenya reported LLIN utilization of 58.6%(Nguyen et al., 2022) while in Ghana, utilization was reported at 52.3% and in Ethiopia at 56.8% The similarity in these proportions suggests that inconsistent LLIN use is a widespread regional challenge rather than a localized issue. Qualitative findings in this study reinforced this pattern, where participants noted that "not everyone actually sleeps under nets every night, especially when it is hot," reflecting the persistent gap between ownership and consistent use(Babalola et al., 2019).

Heat and discomfort emerged as the most dominant barrier to LLIN utilization in this study, reported by 92.1% of respondents. This aligns strongly with findings from other African studies where heat-related discomfort was also the leading barrier, including 88.4% in Tanzania et al., 2021) and 85.7% in Ethiopia(Yirsaw et al., 2024). The consistency across studies highlights that environmental comfort plays a major role in LLIN adherence. Similar qualitative evidence from Kenya showed that users frequently remove nets during hot nights due to suffocation and sweating concern. In the present study, participants similarly described that "hot nights make it difficult for people to sleep under nets," showing that physical discomfort remains a key behavioral deterrent even when awareness is high.

Behavioral factors such as forgetfulness (88.8%) and lack of awareness (87.4%) were also highly reported in this study, indicating that LLIN use is strongly influenced by cognitive and habitual patterns. Comparable findings were reported in Nigeria, where forgetfulness affected 84.2% of inconsistent users(Yirsaw et al., 2024) and in Uganda, where 81.5% reported irregular use due to low perceived risk and poor habit formation(Okello et al., 2022). These findings align with the Health Belief Model, which emphasizes that perceived susceptibility and cues to action determine preventive health behaviors. In this

study, qualitative evidence supported this explanation, as participants reported that "some households only use nets when mosquitoes are many," indicating that LLIN use is often reactive rather than routine.

Structural and household-level constraints were also significant in this study. Inadequate sleeping arrangements and insufficient LLIN access were reported by a large proportion of respondents, limiting universal coverage within households. Similar findings were reported in Rwanda DHS (2020), where only 38.9% of households had sufficient LLINs for all members, and in Malawi where 41.2% of households reported intra-household net shortages(*World Health Statistics 2023*, 2023). These limitations directly affect equitable utilization within families, as some members are left unprotected. Qualitative findings in this study reinforced this, with participants explaining that "some homes simply don't have proper sleeping setups, so hanging nets becomes a challenge," highlighting how physical household structure affects preventive health practices.

Environmental exposure further shaped LLIN utilization patterns in this study. A majority of respondents reported stagnant water presence (62.6%), increasing mosquito breeding risk; however, this did not translate into consistent LLIN use. Similar inconsistencies have been reported in Burkina Faso, where despite high mosquito density, only 55.1% consistently used LLINs(Tiono et al., 2023). and in Mozambique where utilization remained at 57.3% despite high malaria risk. Seasonal variation also influenced behavior in this study, with 49.3% reporting reduced LLIN use during certain seasons, a pattern also observed in Tanzania where utilization dropped to 51.0% during hot seasons due to discomfort (*World Health Statistics 2023*, 2023)This demonstrates that environmental risk perception does not always lead to protective behavior.

Conclusion

The study concludes that although ownership and general awareness of Long-Lasting Insecticidal Nets (LLINs) are relatively high among community members in Ngoma District, consistent utilization remains suboptimal. Slightly over half of respondents (54.2%) reported using LLINs the previous night, despite a high burden of malaria (62.6%) and limited household access, where only 35.3% had sufficient nets for all members. Socio-demographic factors such as age ($p = 0.032$) and gender ($p = 0.036$) significantly influenced utilization, with older individuals and women more likely to use LLINs, while other factors like marital status, education, and occupation were not significant. Although knowledge and attitudes toward malaria prevention were generally positive, they did not consistently translate into proper use. Furthermore, most environmental and household factors were not statistically significant except for seasonal variation ($p = 0.031$), while practical barriers such as heat, discomfort, and inadequate access within households limited consistent use.

1. References

2. Babalola, O. J., Sambo, M. N., Idris, S. H., Ajayi, I.-O. O., Ajumobi, O., & Nguku, P. (2019). Factors associated with utilization of LLINs among women of child-bearing age in Igabi, Kaduna State, Nigeria. *Malaria Journal*, *18*, 412. https://doi.org/10.1186/s12936-019-3046-x
3. Basiru, A., Alozieuwa, U. B., Aboh, M. I., Usman, U. Y., Nwaefulu, O. N., Okeke, O. P., Akinsolu, F. T., & Sobande, O. O. (2025a). Utilization of insecticide-treated nets for malaria prevention among children in Africa: A systematic review and meta-analysis. *Malaria Journal*, *24*, 358. https://doi.org/10.1186/s12936-025-05599-w

4. Basiru, A., Alozieuwa, U. B., Aboh, M. I., Usman, U. Y., Nwaefulu, O. N., Okeke, O. P., Akinsolu, F. T., & Sobande, O. O. (2025b). Utilization of insecticide-treated nets for malaria prevention among children in Africa: A systematic review and meta-analysis. *Malaria Journal, 24,* 358. https://doi.org/10.1186/s12936-025-05599-w
5. *Fact sheet about malaria*. (n.d.). Retrieved April 13, 2026, from https://www.who.int/news-room/fact-sheets/detail/malaria
6. Iyer, M., Skelton, J., de Wildt, G., & Meza, G. (2019). A qualitative study on the use of long-lasting insecticidal nets (LLINs) for the prevention of malaria in the Peruvian Amazon. *Malaria Journal, 18,* 301. https://doi.org/10.1186/s12936-019-2937-1
7. Ng'ang'a, P. N., Aduogo, P., & Mutero, C. M. (2021). Long lasting insecticidal mosquito nets (LLINs) ownership, use and coverage following mass distribution campaign in Lake Victoria basin, Western Kenya. *BMC Public Health, 21,* 1046. https://doi.org/10.1186/s12889-021-11062-7
8. Nguyen, T. T., Nguyen, X. X., Wilson-Barthes, M., Sawada, I., Muela, J., Hausmann-Muela, S., Pham, T. V., Van Nguyen, H., Van Nguyen, V., Tran, D. T., Gryseels, C., D'Alessandro, U., Grietens, K. P., & Erhart, A. (2022). Why using bed nets is a challenge among minority populations in Central Vietnam. *Malaria Journal, 21,* 87. https://doi.org/10.1186/s12936-022-04114-9
9. Niyoyita, J. C., Nyirazinyoye, L., Hakizayezu, F., & Ntaganira, J. (2023). Magnitude of Malaria and its Associated Factors among Febrile Patients Aged Five Years and above: A cross-sectional Study in Ngoma District, Rwanda. *Rwanda Journal of Medicine and Health Sciences, 6*(1), 27–35. https://doi.org/10.4314/rjmhs.v6i1.4
10. Obeagu, E. I., Obeagu, G. U., & Iduh, M. U. (2025). Behavioral health interventions in malaria control: Efficacy and implementation. *Medicine, 104*(31), e43762. https://doi.org/10.1097/MD.0000000000043762
11. Okello, I., Mafie, E., Eastwood, G., Nzalawahe, J., Mboera, L. E. G., & Onyoyo, S. (2022). Prevalence and Associated Risk Factors of African Animal Trypanosomiasis in Cattle in Lambwe, Kenya. *Journal of Parasitology Research, 2022,* 5984376. https://doi.org/10.1155/2022/5984376
12. Okiring, J., Katamba, P., Kamya, C., Namugaya, F., Lavoy, G., de Broucker, G., Ssebagereka, A., Kiracho, E. E., Mak, J., & Patenaude, B. N. (2025). Inequity in the use of long-lasting insecticidal nets before and after nationwide mass distribution campaign in 48 districts of Uganda: VERSE toolkit analysis. *BMC Public Health, 25,* 2269. https://doi.org/10.1186/s12889-025-23386-9
13. Pryce, J., Richardson, M., & Lengeler, C. (2018). Insecticide-treated nets for preventing malaria. *The Cochrane Database of Systematic Reviews, 2018*(11), CD000363. https://doi.org/10.1002/14651858.CD000363.pub3
14. Tiono, A. B., Konaté, A. T., Kargougou, D., Diarra, A., Ouedraogo, I. N., Ouedraogo, A., Pagnoni, F., Modiano, D., & Sirima, S. B. (2023). Hospital-based surveillance of severe paediatric malaria in two malaria transmission ecological zones of Burkina Faso. *Malaria Journal, 22,* 6. https://doi.org/10.1186/s12936-022-04433-x
15. Van Bortel, W., Mariën, J., Jacobs, B. K. M., Sinzinkayo, D., Sinarinzi, P., Lampaert, E., D'hondt, R., Mafuko, J.-M., De Weggheleire, A., Vogt, F., Alexander, N., Wint, W., Maes, P., Vanlerberghe, V., & Leclair, C. (2022). Long-lasting insecticidal nets provide protection against malaria for only a single year in Burundi, an African highland setting with marked malaria seasonality. *BMJ Global Health, 7*(12), e009674. https://doi.org/10.1136/bmjgh-2022-009674

16. *World health statistics 2023*. (2023). World Health Organization. https://www.who.int/publications/b/69040
17. Yirsaw, A. N., Gebremariam, R. B., Getnet, W. A., Nigusie, A., Lakew, G., Getachew, E., Getachew, D., Tareke, A. A., & Mihret, M. S. (2024). Barriers of persistent long-lasting insecticidal nets utilization in Northwest Ethiopia: A qualitative study. *BMC Public Health*, *24*, 2828. https://doi.org/10.1186/s12889-024-20319-w