

Insecticide-treated nets ownership, utilization, and associated barriers during the dry season among urban residents of Jabi Tehnan District, northwest Ethiopia

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Abstract

Background

Insecticide-treated nets (ITNs) are key components of malaria vector control in Ethiopia. However, their effectiveness depends on adequate household (HH) access and consistent utilization. This study assessed ITN ownership, utilization, and associated factors among urban HHs in Jabi Tehnan District, northwest Ethiopia, during the dry season.

Methods

A community-based cross-sectional study was conducted among 405 HHs in Finote Selam, Mankusa, and Jiga towns. Data on ITN ownership, utilization, and related HH characteristics were collected using a structured questionnaire. Factors associated with ITN utilization were assessed using logistic regression, with 95% confidence intervals (CIs). Because of sparse data and the low number of non-utilization events, Firth-penalized logistic regression was used to obtain stable adjusted estimates. A p -value < 0.05 was considered statistically significant.

Results

Of the 405 HHs included in the study, 84.0% ($n = 340$) owned at least one ITN, and 96.8% ($n = 329$) of HHs owning ITNs reported its utilization. Among the 76 (19.0%) respondents who reported non-utilization, the main barrier identified was the absence of ITNs in the HH (85.0%), followed by irritation and suffocation (12.0%). The Firth penalized regression analysis showed that HHs owning one ITN had lower odds of utilization (AOR = 0.297, 95% CI: 0.098–0.901; $p = 0.032$), as did HHs in Mankusa town (AOR = 0.128, 95% CI: 0.032–0.519; $p = 0.004$). In contrast, HHs owning two ITNs had higher odds of utilization (AOR = 2.244, 95% CI: 3.145–15.311; $p = 0.002$).

Conclusions

Insecticide-treated net ownership and reported utilization were relatively high among urban HHs in Jabi Tehnan District. Nevertheless, gaps in ITN availability persisted, particularly among HHs with fewer ITNs and in Mankusa town. Ensuring adequate ITN availability and addressing context-specific barriers to consistent utilization may strengthen malaria prevention efforts during the dry season.

Introduction

Insecticide-treated nets remain one of the most effective and cost-efficient interventions for malaria prevention. They provide dual protection, serving as a physical barrier against mosquito bites and reducing mosquito survival through their insecticidal activity [1, 2]. Large-scale distribution of ITNs has

reduced malaria transmission, morbidity, and mortality across endemic countries. Insecticide-treated nets continue to be a central component of the World Health Organization-recommended malaria control strategy [3, 4]. However, the public health benefits depend not only on universal HH coverage but also on their consistent and correct use. Sustaining high ITN utilization throughout the year is therefore critical for maintaining malaria control achievements [1, 5, 6].

Despite remarkable progress in expanding ITNs coverage, a persistent gap has been witnessed between HH ownership and actual utilization. Studies from malaria-endemic countries show that many individuals who have access to ITNs do not use them regularly, particularly during the dry season when mosquito density and perceived malaria risk decline [4, 6]. Reduced mosquito nuisance, hot sleeping conditions, seasonal behavioral changes, and low risk perception are among the most commonly reported reasons for decreased ITN use during the dry season. However, malaria transmission often persists in areas where permanent or semi-permanent breeding habitats maintain *Anopheles* populations. This sustained vector presence leaves communities vulnerable to continued exposure to infectious mosquito bites and contributes to residual malaria transmission [7, 8].

Malaria remains a major public health challenge in Ethiopia despite significant progress in its prevention and control. Approximately three-fourths of the landmass of the country is malaria-endemic, and more than two-thirds of the population is at risk [9]. Malaria transmission is unstable and spatially heterogeneous, varying with altitude, rainfall, temperature, and local ecological conditions. Although transmission peaks following the main rainy season, low-level transmission persists during the dry season in areas where environmental conditions support continuous vector breeding [10, 11]. To reduce malaria transmission, Ethiopia has implemented integrated control strategies that include mass ITN distribution, indoor residual spraying (IRS), prompt and effective case management, larval source management, and strengthened surveillance systems [9, 12]. These interventions have considerably reduced the malaria burden; however, their effectiveness depends on sustained community uptake, particularly the consistent use of ITNs during both high- and low-transmission seasons [13].

In recent years, urbanization is reshaping malaria epidemiology in Ethiopia. Historically considered a predominantly rural disease, malaria is now emerging as an important public health concern in urban settings because of rapid population growth, unplanned settlement expansion, inadequate drainage systems, construction activities, irrigation, and water-storage practices that create suitable breeding habitats for *Anopheles* mosquitoes [14, 15]. Many of these habitats persist throughout the dry season, enabling vector populations to survive beyond the main transmission period. Furthermore, frequent movement of people between rural endemic areas and urban centers facilitates parasite importation, increasing the potential for sustained urban malaria transmission [16].

Although repeated nationwide ITN distribution campaigns have substantially increased HH ownership, utilization remains below national and international targets [13, 17]. Previous studies have identified socioeconomic status, educational attainment, HH size, housing characteristics, malaria risk perception, access to malaria prevention services, net availability, and sleeping arrangements as important

determinants of ITNs utilization [18, 23]. National indicator survey findings further demonstrate considerable regional disparities in ITNs access and use [23].

Despite growing evidence on factors influencing ITNs utilization in Ethiopia, important knowledge gaps persist. Most previous studies have been conducted in rural communities or have examined overall ITNs utilization without contextualizing into the dry season, when declining net use may sustain residual malaria transmission. Evidence describing HH ITNs ownership, utilization, and barriers among urban populations during the dry season is limited. This lack of evidence constrains the ability of malaria control programmes to design context-specific interventions that promote year-round ITNs use.

Jabi Tehnan District in northwest Ethiopia provides an important setting for addressing this evidence gap. Although malaria transmission in the district is seasonal, rivers, dams, ponds, swamps, and other permanent or semi-permanent water bodies may sustain *Anopheles* breeding during the dry season [24, 25]. Rapid urban expansion, inadequate drainage infrastructure, and small-scale irrigation may further increase the availability of breeding habitats within and around urban settlements, creating conditions for residual malaria transmission. Although ITNs are regularly distributed through Ethiopia's National Malaria Elimination Programme, evidence on HH ownership, utilization, and barriers to consistent ITN utilization during the dry season among urban residents of the district is lacking. Therefore, this study aimed to assess HH ITN ownership, utilization, and associated barriers during the dry season among urban residents of Jabi Tehnan District, northwest Ethiopia.

Materials and methods

Study design, period, and setting

A community-based cross-sectional study was conducted in March 2026 among residents of the three urban centers of Jabi Tehnan District (Finote Selam, Mankusa, and Jiga towns), West Gojjam Zone, Amhara National Regional State, northwest Ethiopia. Jabi Tehnan is a malaria-endemic district lies approximately between 10° 50' 0" N, 37° 10' 0" E (10.833333, 37.166667) and bordered by Dega Damot, Kuait, Sekela, Bure, and Dembecha districts (Fig. 1). According to the 2023 Ethiopian Statistical Service (ESS) population projection, the district has an estimated population of 230,992 (114,970 male and 116,022 female), and nearly 40% of the population are residents of the urban centers [26]. The district lies at an altitude ranging from 1,345 to 2,572 m above sea level, is predominantly characterized by the “*Woina Dega*” agro-ecological zone, receives an average annual rainfall of approximately 1,250 mm, and has mean annual temperatures ranging from 14°C to 32°C. Preliminary assessments indicate that the district contains various water sources, including rivers, dams, swampy areas, and ponds, which serve multiple purposes; however, many of these water bodies are poorly managed, creating potential breeding habitats for mosquito larvae and may contribute to residual malaria transmission. According to the Jabi Tehnan District Health Office, malaria accounted for 21.7% of outpatient visits during the 2023/24 reporting year (unpublished data). Malaria diagnosis and treatment are provided free of charge through public health facilities under Ethiopia’s National Malaria Elimination Programme. ITNs, particularly long-

lasting insecticidal nets (LLINs), are periodically distributed to at-risk populations, and additional malaria prevention, diagnosis, and treatment services are provided through private healthcare facilities and non-governmental organizations (NGOs).

Study site selection

The three urban centers of Jabi Tehnan District (Finote Selam, Mankusa, and Jiga towns) were purposively selected because they represent the district's urban population. They also possess ecological and epidemiological characteristics relevant to dry-season malaria transmission. The towns have potential *Anopheles* breeding habitats, including permanent and semi-permanent water bodies, a history of malaria transmission, and previous implementation of conventional malaria vector control interventions, including regular distribution of ITNs [25]. These characteristics make the sites suitable for assessing ITN ownership, utilization, and associated barriers among urban residents during the dry season.

Source and target population

The source population comprised all HHs residing in the selected urban communities of Jabi Tehnan District. The target population consisted of HH heads or adult representatives living in the selected study sites that met the study eligibility criteria.

Eligibility criteria

HH heads or adult representatives who had resided in the selected urban communities for at least six months before the survey and were present during the data collection period were eligible to participate. Individuals who declined to provide informed consent and were unable to participate in the interview were excluded from the study.

Sampling unit and study participant

The HH was the primary sampling unit. From each selected HH, one eligible head or adult representative was selected to participate in the interview and provide information on HH ITNs ownership, utilization status, and associated factors.

Sample size determination

The sample size was determined using the single population proportion formula based on an estimated ITNs utilization of 69.2% reported from Pawie District, Benishangul Gumuz, northwest Ethiopia [27]. The sample size was calculated using the formula: $n = \frac{(Z_{\alpha/2})^2 x p (1-p)}{d^2}$, where n is the required sample

size, p is the estimated proportion of ITN utilization (69.2%), Z is the standard normal value at a 95% confidence interval (1.96), and d is the margin of error (5%) [28]. The initial sample size was 328 HHs. After allowing for a 5% non-response rate, the sample size increased to 344 HHs. To account for the multistage sampling design, a design effect of 1.25 was applied, yielding a final required sample size of 430 HHs. Data were collected in March 2026. Of the 430 selected HHs, 25 were excluded because they did not meet the eligibility criteria nor had complete data. Consequently, 405 responses from HH heads or adult representatives were included in the final analysis.

Sampling procedure

A multistage sampling technique was employed to select study HHs and participants (Fig. 2). All three urban centers of Jabi Tehnan District (Finote Selam, Mankusa, and Jiga towns) were included in the study, and the final sample size of 430 HHs was proportionally allocated according to the estimated number of HHs in each town, resulting in 200 HHs from Finote Selam and 115 HHs each from Mankusa and Jiga. In the second stage, kebeles were selected using simple random sampling, whereby two of the four kebeles in Finote Selam and one of the two kebeles in each of Mankusa and Jiga were selected. HHs within the selected kebeles were then identified using systematic random sampling. Based on an estimated sampling frame of approximately 2,100 HHs, the sampling interval was calculated as ($k = N/n = 2,100/430 \approx 5$). After selecting a random starting HH in each kebele, every fifth HH was included until the required sample size was attained. In each selected HH, one eligible adult, preferably the head or another knowledgeable adult member, was interviewed using a structured questionnaire to obtain HH-level information. When the selected respondent was unavailable during the initial visit, a repeat visit was conducted, and if participation remained impossible after the revisit, the next eligible HH in the sampling sequence was included.

Methods of data collection

A structured questionnaire was administered through face-to-face interviews with selected adult HH members to collect HH-level data. The questionnaire covered sociodemographic characteristics, housing conditions, ITN ownership and utilization during the dry season, reasons for non-utilization, and exposure to malaria prevention education and information. Information on HH sleeping arrangements and other factors relevant to ITNs utilization was also collected. Each interview lasted approximately 20 minutes.

Data quality assurance

Several measures were implemented to ensure the quality and consistency of the data. The questionnaire was initially developed in English, translated into Amharic (the local language), and back-translated into English to ensure conceptual equivalence. Prior to the main data collection engagement, the questionnaire was pretested on 5% of the target population in a non-study area to assess its clarity, content validity, and reliability. Internal consistency was evaluated using Cronbach's alpha, which yielded

a coefficient of 0.83, indicating good reliability. Before data collection, all data collectors received half a day of training on the study objectives, interview techniques, ethical considerations, and standardized data collection procedures. Throughout the data collection period, completed questionnaires were reviewed daily by the principal investigator to ensure completeness, accuracy, and consistency, and any identified errors or omissions were addressed promptly through feedback to the data collection team.

Statistical analysis

Data were checked for completeness, accuracy, and consistency before being entered into Microsoft Excel and exported to SPSS Statistics version 23 (IBM Corp., Armonk, NY, USA) for analysis. Descriptive statistics were used to summarize participants' sociodemographic and HH characteristics, ITNs ownership and utilization, and reported barriers to ITNs use. Bivariable logistic regression was performed to assess associations between explanatory variables and ITNs utilization, and crude odds ratios (CORs) with 95% CIs were calculated. Variables with $p < 0.25$ in the bivariable analysis were considered potential candidates for multivariable analysis. Because of the limited number of non-utilization events and sparse observations in some predictor categories, conventional multivariable logistic regression was susceptible to complete or quasi-complete separation and unstable estimates. Therefore, Firth's penalized logistic regression was used to obtain bias-reduced adjusted estimates. A parsimonious multivariable model was fitted based on candidate predictors, considering the number of outcome events, sparse cells, and model stability. The final model included residence, sleeping space, and number of ITNs per HH and was restricted to participants with complete observations for these variables ($n = 340$). Adjusted odds ratios (AORs) with 95% CIs were reported, and $p < 0.05$ was considered statistically significant.

Results

Sociodemographic characteristics

A total of 405 urban residents were included in this study, with a response rate of 94.2% (405/430). Finote Selam accounted for 45.4% ($n = 184$) of participants, followed by Mankusa (27.9%, $n = 113$) and Jiga (26.7%, $n = 108$). Female participants comprised 62.5% ($n = 253$), while more than half were aged between 30 and 45 years (53.6%, $n = 217$). The majority were married (54.6%, $n = 221$), and self-employment was the leading occupation (24.0%, $n = 97$). Regarding educational achievement, 25.2% ($n = 102$) had no formal education, while 52.6% ($n = 213$) had completed secondary or higher education. HHs with 4 to 6 members constituted 58.5% ($n = 237$); 53.6% ($n = 217$) reported a monthly HH income of less than 5,000 Ethiopian Birr, and 28.4% ($n = 115$) of participants slept on the floor (Table 1).

Table 1
Sociodemographic and housing characteristics of study participants among urban residents of Jabi Tehnan District, northwest Ethiopia, March 2026.

Variables	Category	Frequency (n)	Percentage (%)
Residence	Finote Selam	184	45.4
	Jiga	108	26.7
	Mankusa	113	27.9
Gender	Male	152	37.5
	Female	253	62.5
Age (year)	18–29	99	24.4
	30–45	217	53.6
	46–60	71	17.5
	> 60	18	4.4
Marital status	Single	70	17.3
	Married	221	54.6
	Widowed	39	9.6
	Divorced	75	18.5
Occupation	Student	10	2.5
	Job seeker	6	1.5
	Self-employee	97	24.0
	Daily-labor	75	18.5
	Farmer	54	13.3
	Safety-net user	15	3.7
	Govt's employee	81	20.0
	House-wife	67	16.5
Educational status	No formal education	102	25.2
	Primary school	90	22.2
	Secondary school	112	27.7
	Higher education	101	24.9
Family size	1–3	156	38.5

Variables	Category	Frequency (n)	Percentage (%)
	4–6	237	58.5
	> 6	12	3.0
Sleeping space	Floor	115	28.4
	Bed	290	71.6
Monthly income/Eth birr	No income	6	1.5
	< 5000	217	53.6
	5,000–10,000	127	31.4
	10,000–20,000	53	13.1
	> 20,000	2	0.5

Malaria-related awareness, ITNs ownership and utilization practices

Almost all participants had awareness about malaria (98.0%, n = 397), with health workers being the main source of information (78.1%, n = 310). More than half (58.2%, n = 236) of the participants had adequate knowledge of at least two malaria prevention methods. Awareness of ITN utilization was high (97.3%, n = 394), and 84.0% (n = 340) of the HHs reported owning at least one ITN. Among ITN-owning HHs, 48.2% (n = 164) possessed two nets, while 38.5% (n = 131) had only one. Overall, 96.8% (n = 329) of ITN-owning HHs reported utilizing their nets. However, daily utilization was reported by only 44.4% (n = 146) of the HHs, while 34.0% (n = 112) utilized ITNs when mosquitoes were heard and 21.6% (n = 71) reported seasonal use. Regarding the number of individuals sleeping under an ITN, 51.1% (n = 168) of the HHs reported that two individuals slept under a net, while 41.6% (n = 137) reported that three individuals slept per net. In addition, among ITN-owning HHs, 35.0% (n = 119) reported having old ITNs, and 15.0% (n = 51) reported that their nets had holes. Washing of ITNs was reported by 38.2% (n = 130) of the HHs (Table 2). Seventy-six (19.0%) HHs reported not utilizing ITNs, with lack of access (85.0%, n = 65) being the most commonly mentioned reason (Fig. 3).

Table 2

Malaria-related awareness, ITN ownership and utilization practices among urban residents of Jabi Tehnan District, northwest Ethiopia, March 2026.

Variables	Category	Frequency (n)	Percentage (%)
Awareness about malaria	Yes	397	98.0
	No	8	2.0
Information sources about malaria (n = 397)	Family	3	0.8
	Friends	4	1.0
	Health workers	310	78.1
	Media	80	20.1
Knowledge of malaria prevention	No idea	17	4.2
	Using ITNs	89	22.0
	IRS	10	2.5
	Water drainage	15	3.7
	Smoking	38	9.4
	Two or more methods	236	58.2
Awareness of ITN use	Yes	394	97.3
	No idea	11	2.7
Information sources for ITN use (n = 394)	Friends	3	0.8
	Health workers	330	83.8
	Media	61	15.4
Ownership of ITNs	Yes	340	84.0
	No	65	16.0
Number of ITNs in a HH (n = 340)	One	131	38.5
	Two	164	48.2
	Three	42	12.4
	More than three	3	0.9
Awareness of the importance of ITNS use	No idea	8	2.0
	Kill mosquito	80	19.8
	Prevent mosquito bite	211	52.1

Variables	Category	Frequency (n)	Percentage (%)
	Protect from malaria	61	15.1
	Two or more importance	45	11.1
ITNs utilization status (n = 340)	Yes	329	96.8
	No	11	3.2
Number of individuals per ITNs (n = 329)	One	19	5.8
	Two	168	51.1
	Three	137	41.6
	More than three	5	1.5
Who used ITNs more in the family (n = 329)	Whole family	156	47.4
	Children	62	18.8
	Mother and children	82	24.9
	Parents only	29	8.9
Frequency of ITN utilization (n = 329)	Mosquito sound	112	34.0
	Summer season	71	21.6
	Every day	146	44.4
Functional status of ITNs (n = 340)	Old	119	35.0
	Medium	93	27.4
	New	128	37.6
How old ITNs in the HH (n = 340)	One month	82	24.1
	Six months	88	25.9
	One year	31	9.1
	Two years	56	16.5
	More than two years	83	24.4
Shape of ITNs in the HH (n = 340)	Circle	45	13.2
	Rectangle	295	86.8
Color of ITNs (n = 340)	White	50	14.7
	Blue	290	85.3

Variables	Category	Frequency (n)	Percentage (%)
Washing experience of ITNs (n = 340)	Yes	130	38.2
	No	210	61.8
Frequency of washing ITNs (n = 130)	Once	41	31.5
	Twice	49	37.7
	More than twice	40	30.8
Hole status of HH ITNs (n = 340)	Yes	51	15.0
	No	289	85.0
How big is the hole in ITNs (n = 51)	Small	22	43.1
	Medium	20	39.2
	Large	9	17.7
Sleep under ITNs causes problems (n = 405)	Yes	89	22.0
	No	316	78.0

Factors associated with ITNs utilization

In the bivariable analysis, residence, age, marital status, occupation, sleeping space, and number of ITNs per HH were associated with ITNs utilization (Table 3). Participants residing in Mankusa had lower odds of ITN utilization than those residing in Finote Selam (COR = 0.474, 95% CI: 0.268–0.837; $p = 0.012$). Participants aged 46–60 years had higher odds of utilization than those aged > 60 years (COR = 6.600, 95% CI: 1.734–25.124; $p = 0.008$). Lower odds of utilization were observed among single and divorced participants compared with married participants, and among students, housewives, and safety-net users compared with government employees. Participants who slept on the floor had lower odds of utilization than those who slept on a bed (COR = 0.464, 95% CI: 0.276–0.779; $p = 0.005$). HHs with two ITNs had higher odds of utilization when compared with the reference category (COR = 1.244, 95% CI: 1.881–14.267; $p = 0.011$).

Table 3

Bivariable logistic regression analysis of factors associated with ITN utilization among urban residents of Jabi Tehnan District, northwest Ethiopia, during the dry season.

Variables	Total respondent n (%)	ITN utilization n (%)	COR (95% CI)	p-value
Residence				
Mankusa	113(27.9)	81(71.7)	0.474 (0.268–0.837)	0.012
Jiga	108(26.7)	93(86.1)	1.160 (0.591–2.277)	0.736
Finote Selam	184(45.4)	155(84.2)	1	-
Gender				
Male	152(37.5)	130(85.5)	1.603 (0.932–2.759)	0.090
Female	253(62.5)	199(78.7)	1	-
Age (years)				
18–29	99(24.4)	72(72.7)	1.333 (0.455–3.907)	0.580
30–45	217(53.6)	179(82.5)	2.355 (0.832–6.668)	0.116
46–60	71(17.6)	66(93.0)	6.600 (1.734–25.124)	0.008
> 60	18(4.4)	12(66.7)	1	-
Marital Status				
Single	70(17.3)	52(74.3)	0.297 (0.116–0.765)	0.014
Widowed	221(54.6)	180(81.4)	0.452 (0.193–1.056)	0.070
Divorced	39(9.6)	29(74.4)	0.299 (0.104–0.861)	0.028
Married	75(18.5)	68(90.7)	1	-
Occupation				
Student	16(4.0)	6(37.5)	0.057 (0.016–0.203)	0.001
Self-employee	97(24.0)	85(87.6)	0.670 (0.251–1.790)	0.473
Daily laborer	75(18.5)	63(84.0)	0.497 (0.184–1.338)	0.221
Farmer	54(13.3)	43(79.6)	0.370 (0.133–1.025)	0.070
House-wife	67(16.5)	50(74.6)	0.278 (0.108–0.720)	0.007
Note: NE: Not estimable				

Variables	Total respondent n (%)	ITN utilization n (%)	COR (95% CI)	p-value
Residence				
Safety-net user	15(3.7)	8(53.3)	0.108 (0.030–0.388)	0.001
Gov.'s employee	81(20.0)	74(91.4)	1	-
Educational level				
No formal	102(25.2)	77(75.5)	0.537 (0.264–1.093)	0.112
Primary	90(22.2)	70(77.8)	0.610 (0.291–1.280)	0.197
Secondary	112(27.7)	96(85.7)	1.047 (0.488–2.243)	0.999
Higher	101(24.9)	86(85.1)	1	-
Monthly income				
No income	6(1.5)	0(0.0)	NE	
< 5000	217(53.5)	170(78.8)	0.443 (0.179–1.097)	0.086
5000-10,000	127(31.4)	110(86.6)	0.792 (0.294–2.132)	0.809
> 10,000	55(13.6)	49(89.1)	1	-
Sleeping space				
Floor	115(28.4)	83(72.2)	0.464 (0.276–0.779)	0.005
Bed	290(71.6)	246(84.8)	1	-
Family size				
> 6	12(3.0)	12(100.0)	NE	-
4–6	237(58.5)	195(82.3)	1.294 (0.780–2.145)	0.361
1–3	156(38.5)	122(78.2)	1	-
Knowledge of malaria prevention				
No idea	17(4.2)	0(0.0)	NE	-
Using net	89(22.0)	81(91.0)	1.943 (0.869–4.347)	0.111
IRS	10(2.5)	6(60.0)	0.288 (0.078–1.069)	0.071
Drainage	15(3.6)	11(73.3)	0.528 (0.160–1.745)	0.288
Note: NE: Not estimable				

Variables	Total respondent n (%)	ITN utilization n (%)	COR (95% CI)	p-value
Residence				
Sanitation	38(9.4)	33(86.8)	1.267 (0.465–3.452)	0.812
Two or more methods	236(58.3)	198(83.9)	1	-
Number of ITNs per HH (n = 340)				
One	131(38.5)	119(90.8)	0.967 (0.109–8.534)	0.999
Two	164(48.2)	163(99.4)	1.900 (1.881–14.267)	0.011
≥ Three	45(13.3)	41 (91.1)	1	-
Knowledge of the importance of ITNs				
No idea	8(2.0)	0(0.0)	NE	-
Kill mosquito	80(19.8)	61(76.3)	0.803 (0.328–1.962)	0.663
Prevent mosquito bite	211(52.1)	183(86.7)	1.634 (0.711–3.754)	0.248
Protection from malaria	61(15.1)	49(80.3)	1.021 (0.389–2.681)	0.999
Two or more importance	45(11.1)	36(80.0)	1	-
Functional status of ITNs in the HH (n = 340)				
Old	119 (35.0)	117(98.3)	3.384 (0.689–16.628)	0.174
Medium	93(27.4)	91(97.8)	2.632 (0.534–12.971)	0.309
New	128(37.6)	121(94.5)	1	-
Note: NE: Not estimable				

Given the limited number of non-utilization events and sparse observations in some categories, Firth's penalized logistic regression was used for the final multivariable analysis (Table 4). In the parsimonious model, residence and number of ITNs per HH remained independently associated with ITN utilization. Participants residing in Mankusa had lower odds of utilization (AOR = 0.128, 95% CI: 0.032–0.519; p = 0.004). Compared with HHs possessing three or more ITNs, HHs with one ITN had lower odds of utilization (AOR = 0.297, 95% CI: 0.098–0.901; p = 0.032), whereas those with two ITNs had higher odds of utilization (AOR = 2.244, 95% CI: 3.145–15.311; p = 0.002). However, sleeping space was not found to

be independently associated with ITN utilization after adjustment (AOR = 1.813, 95% CI: 0.531–6.192; p = 0.343).

Table 4
Firth's penalized logistic regression analysis of factors associated with ITN utilization among urban residents of Jabi Tehnan District, northwest Ethiopia, during the dry season.

Variables	Total respondent n (%)	ITN utilization n (%)	AOR (95% CI)	p-value
Residence				
Mankusa	113(27.9)	81(71.7)	0.128 (0.032–0.519)	0.004
Jiga	108(26.7)	93(86.1)	0.366 (0.078–1.711)	0.201
Finote Selam	184(45.4)	155(84.2)	1	-
Sleeping space				
Floor	115(28.4)	83(72.2)	1.813 (0.531–6.192)	0.343
Bed	290(71.6)	246(84.8)	1	-
Number of ITNs per HH (n = 340)				
One	131(38.5)	119(90.8)	0.297 (0.098–0.901)	0.032
Two	164(48.2)	163(99.4)	2.244 (3.145–15.311)	0.002
≥ Three	45(13.3)	41 (91.1)	1	-

Discussion

Ethiopia has set an ambitious goal of achieving malaria elimination by 2030 [29]. Vector control remains a cornerstone of these efforts, with ITNs playing a central role in reducing malaria transmission among populations at risk. Although widespread ITN use has contributed to reductions in malaria morbidity and mortality, their effectiveness depends on adequate access and consistent and appropriate use [30, 31]. Understanding ITNs ownership, utilization, and the factors influencing their use is therefore essential for strengthening malaria prevention and advancing the national malaria elimination agenda. The present study therefore assessed ITN ownership, utilization, and associated factors among urban residents of Jabi Tehnan District, northwest Ethiopia, during the dry season.

In this study, 84.0% of HHs owned at least one ITN. The finding was comparable with reports from Kersa District, southwest Ethiopia (89.0%) [32], Boricha and Bilate Zuria districts of Sidama Regional State (85.3%) [33], and report from six zones of the Southwest Ethiopia People's Regional State (89.0%) [17]. In contrast, lower ownership levels have been reported from southern Ethiopia (48.7%) [20] and Tigray region (58.1%) [34]. The ownership observed in the present study was also higher than the national estimate of LLIN ownership (71.5%) reported by a nationwide post-LLIN distribution survey conducted in

2024–2025 [13]. Nevertheless, higher ownership was reported in Benishangul-Gumuz (90.0%), Afar (94.3%), and Gambela (95.0%) regions in the same national survey [13].

Regarding its utilization, the present study found a high level of reported utilization, with 96.8% of HHs owning ITNs reporting their use. This finding was similarly high compared with the 91.9% reported from Kola Diba town, northwest Ethiopia [35]. However, lower utilization levels were reported from Kersa District, southwest Ethiopia (83.5%) [32], Pawie District, northwest Ethiopia (69.2%) [27], and Bibugn District, northwest Ethiopia (71.3%) [19]. In addition, only 61.6% of HHs owning at least one ITN reported utilization in Tigray region [34].

The relatively high levels of ITN ownership and utilization observed in the present study suggest good HH access to ITNs during the study period. However, ownership and utilization vary across settings, potentially underlining differences in socioeconomic characteristics, malaria-related knowledge and perceptions, transmission intensity, and net availability and condition. For example, a study in Bibugn District, northwest Ethiopia, reported lower ITN utilization among women, HHs with lower monthly income, and participants who were unable to read and write [19]. In Mirab Abaya District, southern Ethiopia, knowledge that LLINs prevent malaria, proper net hanging, and HH sleeping arrangements were important determinants of proper utilization, while more than 30% of owned nets were no longer in use [21]. More importantly, the extent of ITN utilization cannot be fully captured by HH use alone; the frequency with which ITNs are used is also relevant to the consistency of protection. In the present study, although 96.8% of HHs owning ITNs reported their use, only 44.4% reported daily use. This highlights that high reported utilization may not necessarily mean consistent nightly use.

In the present study, 19.0% of respondents reported not utilizing ITNs. The main reason was the absence of an ITN in the HH (85.0%), followed by irritation and suffocation (12.0%). Similar previous studies have also identified poor net condition, inadequate hanging space, and heat or suffocation as important barriers to ITNs use [19]. Beyond these practical barriers, perception of malaria risk may also influence patterns of ITNs use. An earlier study in Jabi Tehnan District found that 69.7% of ITN non-users attributed this to perception of the absence of malaria transmission [36]. Consistent with this pattern, in the present study, 34.0% of respondents reported using ITNs when mosquitos were heard, while 21.6% used only during the malaria season. These findings suggest that some HHs adjust their ITNs according to perceived transmission risk, which is relevant during the dry season when malaria risk may be perceived as lower despite ongoing transmission [37].

Because of sparse data and the low number of non-utilization events in the present study, Firth penalized logistic regression was used to obtain more stable estimates. Three variables were retained in the adjusted model as potential predictors of ITN utilization, of which residence and number of ITNs owned remained independently associated with utilization.

Households owning one ITN had significantly lower odds of ITN utilization than HHs owning ≥ 3 ITNs (AOR = 0.297, 95% CI: 0.098–0.901; $p = 0.032$), corresponding to approximately 70.3% lower odds of utilization. This finding is consistent with evidence from Itang, Gambella, where HHs having two or more

ITNs had higher odds of utilization compared with only one ITN in the HH [38]. Similarly, Tassew et al. (2017) in Mirab Abaya District, southern Ethiopia, also identified the number of sleeping spaces and availability of hanging ITNs as important determinants of utilization [21]. The lower odds among HHs owning one ITN may suggest insufficient net availability relative to HH sleeping needs, whereas multiple ITNs may facilitate allocation to different HH members and sleeping spaces.

Residence was independently associated with ITN utilization. HHs in Mankusa town had approximately 87.2% lower odds of utilization than those in Finote Selam (AOR = 0.128, 95% CI: 0.032–0.519; $p = 0.004$). This difference may partly reflect the semi-urban setting of Mankusa compared with the urban settings of Finote Selam and Jiga. Similar contextual differences have been reported in the southwest Ethiopia People's Regional State, where urban residents had higher odds of ITN utilization than rural residents [17]. However, the direction of this association has not been consistent across studies. A systematic review among pregnant women reported higher ITNs utilization among rural than urban residents [39], while a study in East Belessa District, northwest Ethiopia, also found higher odds of utilization among rural residents than their urban counterparts [40]. These contrasting findings suggest that the relationship between residence and ITNs utilization would be context-specific and influenced by differences in housing conditions, malaria exposure, perceived risk, and access to prevention information and services.

Although sleeping space was not independently associated with ITNs utilization in the Firth model, respondents who slept on the floor had lower odds of ITNs use in the present study. A study examining the physical integrity and utilization of LLINs in four regions of Ethiopia similarly found that individuals who slept on the floor were less likely to use LLINs [41]. Comparable findings have been reported among HHs in malaria elimination districts of Arsi Zone, Oromia Regional State, where sleeping arrangements were associated with ITNs utilization [22]. Qualitative evidence from villages around Lake Tana, northwest Ethiopia, has also identified inadequate sleeping space and the discomfort of stretching nets over the floor as barriers to ITNs use [42]. These findings suggest that sleeping arrangements may constitute a practical barrier to the proper and consistent use of ITNs. One possible explanation is that floors, particularly those outside designated bedrooms, may serve multiple purposes and provide limited opportunities for securely hanging ITNs, thereby making regular use more difficult.

Conclusion

This study found relatively high ITN ownership and reported utilization among urban HHs in Jabi Tehnan District during the dry season. However, utilization was independently associated with residence and the number of ITNs owned, with lower odds of utilization among HHs in Mankusa town and those owning one ITN. In addition, ITN unavailability, suffocation, and irritation were identified as reasons for non-utilization. These findings highlight the importance of ensuring adequate ITN availability and addressing context-specific barriers to consistent utilization.

Abbreviations

AORs
Adjusted odd ratios
APHI
Amhara Public Health Institute
CIs
Confidence intervals
COR
Crude odd ratios
ESS
Ethiopian Statistical Services
HH
Household
IRERC
Institutional Research Ethical Review Committee
IRS
Indoor residual spray
ITNs
Insecticidal-treated nets
LLINs
Long-lasting insecticidal nets
NGOs
Non-governmental organizations
SPSS
Statistical package for social sciences
WHO
World Health Organizations

Declarations

Ethical approval and consent to participate

Before data collection started, ethical approval was obtained from the Institutional Research Ethical Review Committee (IRERC) of the College of Science, Bahir Dar University (Reference number: IRERC08/2026). A letter of permission was also obtained from the Amhara Public Health Institute (APHI), which facilitated authorization from the relevant governmental and public institutions to conduct the study.

Consent to participate

The study objectives, procedures, potential risks, and benefits were explained to Jabi Tehnan District health officials, relevant stakeholders, and all study participants before data collection. Informed consent

was obtained from each selected participant before participation. Confidentiality and anonymity were maintained throughout the study by ensuring that personal identifiers were not collected or disclosed. All study procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki [43].

Competing interests

The authors declared that they have no competing interests.

Consent to publication

All authors have approved the submission of the final copy for publication.

Disclaimer

During the preparation of this manuscript, the authors used OpenAI's ChatGPT and Grammarly tools solely to improve the English language, grammar, clarity, and readability of the manuscript.

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Author Contribution

SY, EN, and GA conceived and designed the study. SY and FAK performed the statistical analyses. All authors contributed to data interpretation and critically revised the manuscript for important intellectual content.

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Data availability

All data analyzed during this study are included in this manuscript.

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Figures

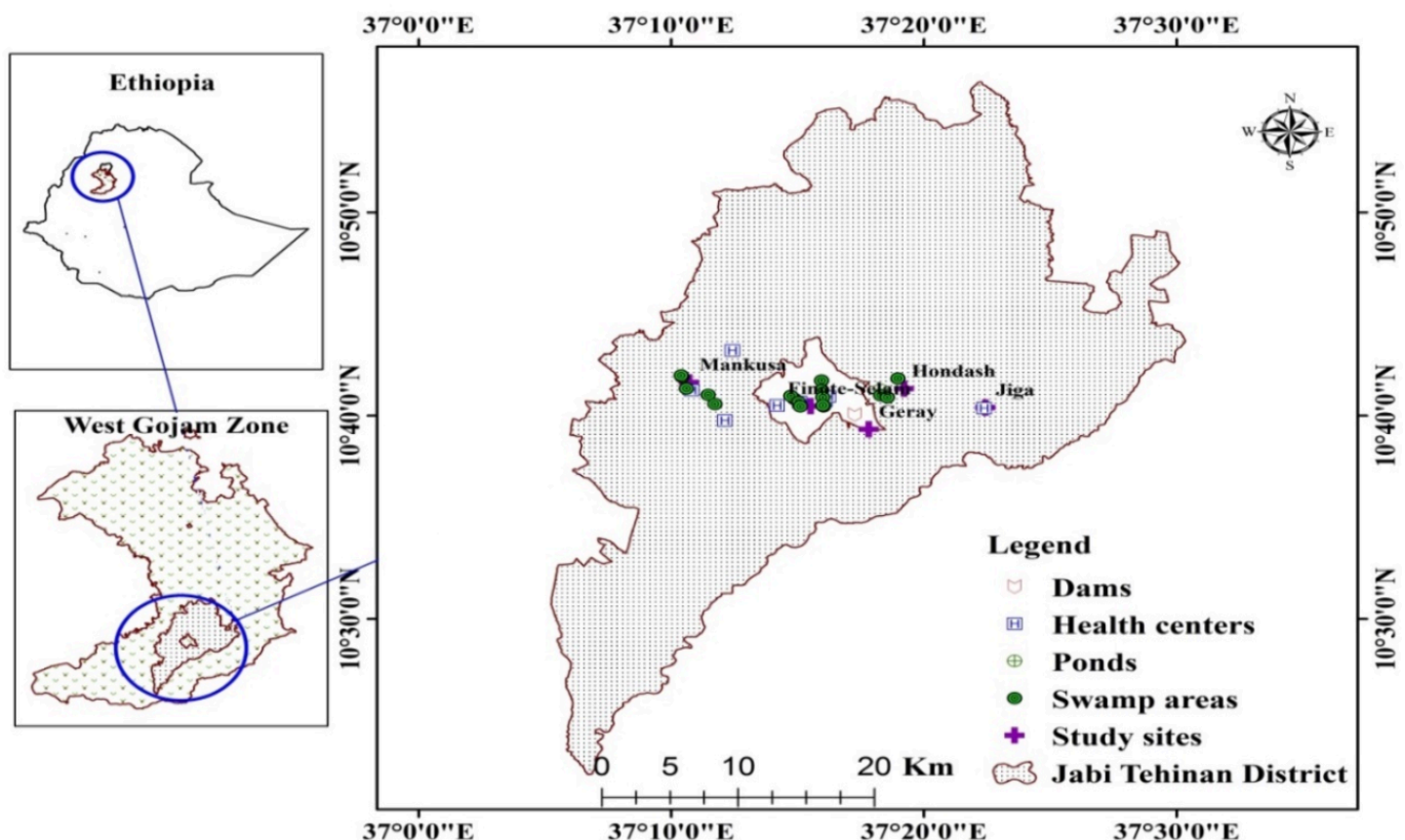


Figure 1

Geographical location of the study areas

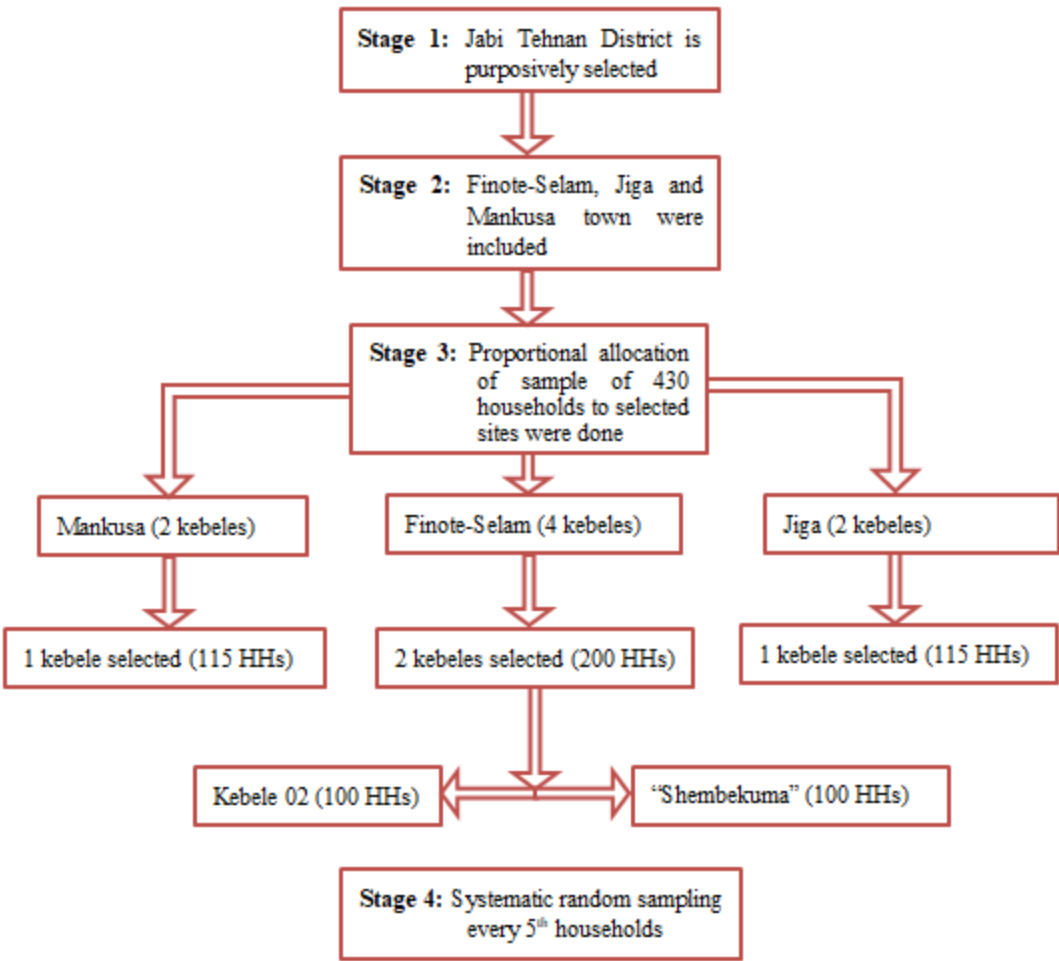


Figure 2

Graphical presentation of sampling technique

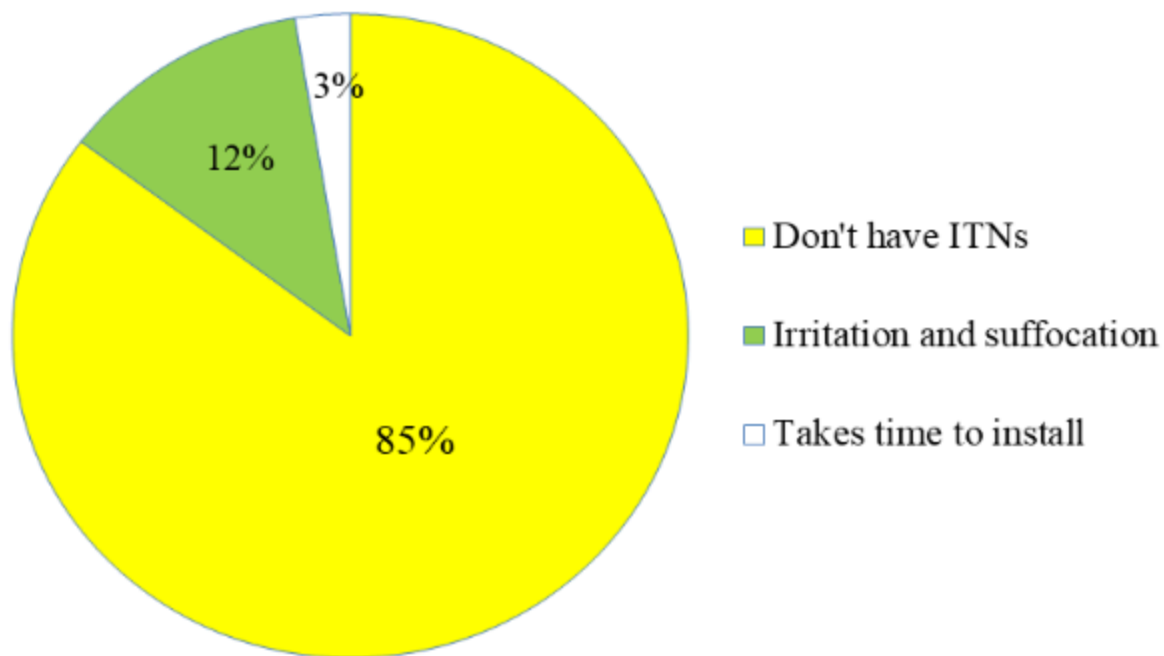


Figure 3

Reasons for non-utilization of ITNs among urban residents of Jabi Tehnan District, northwest Ethiopia during the dry season (n=76).