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Utilization of Malaria Control Interventions and Associated Factors among Women of Reproductive Age in Lira City, Northern Uganda

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ABSTRACT

Malaria remains a major public health concern in Uganda, with prevalence in Lira City rising sharply in recent years despite ongoing interventions. Women of reproductive age are particularly vulnerable, yet little is known about their use of available preventive measures. This study assessed knowledge, attitudes, perceptions, and utilization of malaria control interventions, and examined factors influencing their uptake.

A cross-sectional study was conducted with 629 randomly selected women of reproductive age in Lira City. Quantitative data were collected using semi structured questionnaires, while qualitative insights were obtained through focus group discussions. Descriptive statistics were used to summarize knowledge, attitudes, perceptions, and use of insecticide-treated nets (ITNs), intermittent preventive treatment (IPT), and indoor residual spraying (IRS). Chi-square tests were used to examine associations, and multivariate logistic regression was applied to identify predictors of utilization. Qualitative data were analyzed thematically to explore barriers to uptake, and findings were triangulated with quantitative results for validation and deeper interpretation.

ITN utilization was high (84.1%), IPT uptake moderate (68%), and IRS coverage low (32.8%). Almost all participants (96.8%) were knowledgeable about ITNs, mainly gained through health workers, and expressed positive attitudes toward malaria prevention (mean score: 4.34, SD = 0.67). While most (91.9%) perceived IRS as effective, concerns included bad odor and discomfort (51.7%), doubt about safety (21.9%), and effectiveness (17.3%). Age, type of house, challenges faced with nets, marital status, and exposure to health education were significant predictors of utilization.

Despite widespread ITN use, IRS uptake remains limited due to persistent concerns and misconceptions. Strengthening targeted health education, addressing community fears, and improving access to interventions are critical for enhancing malaria control in high-transmission settings like Lira City.

Keywords: Utilization, malaria controls, women of reproductive age, Lira city

INTRODUCTION

Malaria is a life-threatening disease caused by *Plasmodium* parasites and transmitted through the bites of infected female *Anopheles* mosquitoes[1][2][3]. Despite being preventable and treatable, malaria continues to heavily impact health and livelihoods globally, particularly in tropical and subtropical regions [1][4]. Pregnant women are especially vulnerable, with infections linked to adverse outcomes such as low birth weight and increased infant mortality [5]. In 2023, an estimated 36 million pregnancies occurred across 33 moderate to high transmission countries in the WHO African Region. Of these, 12.4 million (34%) were infected with malaria, contributing to approximately 763,000 cases of low birth weight, a modest decline from 822,000 cases in 2020, yet still reflecting a substantial burden that demands strengthened antenatal malaria prevention and care[6][7].

In 2023, approximately 263 million people contracted malaria globally, resulting in 597,000 deaths across 83 countries, marking an increase of 11 million cases from the previous year[6]. The African Region accounted for 94% of all cases and 95% of deaths, with children under five comprising nearly 80% of fatalities. The three countries with the highest estimated case burdens were Nigeria (26%), the Democratic Republic of Congo (13%), and Uganda (5%)[6].

The high burden in Africa is driven by factors such as limited access to healthcare, inadequate preventive resources, and favorable environmental conditions for mosquito breeding [8]. To mitigate transmission, sub-Saharan Africa has scaled up interventions such as intermittent preventive treatment (IPT), indoor residual spraying (IRS), and insecticide-treated nets (ITNs), particularly targeting pregnant women and children under five years of age[9][10].

Uganda ranks third globally in malaria cases and eighth in malaria-related deaths, contributing 5.1% and 2.9% of the global totals, respectively. The country bears the highest malaria burden in East and Southern Africa, with 23% of regional cases[11]. Although the entire population is at various levels of risk of malaria, children under five years and pregnant women bears the highest risk[12][13]. While Uganda has made progress in implementing interventions such as ITNs, IRS, artemisinin-based combination therapies, and IPTp, the burden remains high in certain regions. Northern Uganda, in particular, experiences intense transmission, with incidence rates exceeding 450 cases per 1,000 people [14]. Uptake of three or more doses of Intermittent Preventive Treatment in pregnancy (IPTp3) is especially low, with only 14.7% of pregnant women receiving the recommended three doses [4].

The Lango sub-region, which includes Lira city, is classified as a moderate malaria transmission setting, with incidence ranging between 251 and 450 cases per 1,000 people [15] In Lira, 4.4% of women were recently found to have placental malaria at delivery, with varying degrees of parasitaemia [16]. Alarmingly, malaria prevalence in the area rose following the last IRS campaign in May 2022, this resurgence reflects broader patterns observed across Northern Uganda[17].

This sharp increase raises concerns about the effectiveness and uptake of malaria control interventions in the area. Despite the availability of proven preventive strategies, utilization remains suboptimal; for example, only 47.05% of pregnant women in East Africa reported using ITNs well below the WHO target of 90%[18]. In Lira City, the post-IRS surge in prevalence suggests that low coverage and inconsistent use of interventions may be sustaining high transmission. This study examined the use of malaria control interventions among women of reproductive age in Lira City, focusing on knowledge, attitudes, practices, and barriers, to guide strategies for improved coverage and reduced malaria burden.

MATERIALS AND METHODS

Study Area

The study was conducted in Lira City, Northern Uganda (Figure 1), a rapidly developing urban center with a population of about 249,900[19]. The city's economy is mainly based on agriculture and trade. Administratively, the city is divided into Lira City East (4 wards, 23 parishes, 153 villages) and Lira City West (3 wards, 22 parishes, 83 villages). Lira has a tropical savanna climate with warm temperatures throughout the year and a bimodal rainfall pattern (April–May and August–October), receiving 1,000–1,400 mm annually. The climate is further influenced by atmospheric circulation, topography, and nearby water bodies.

Lira City lies on a predominantly flat landscape with undulating plains, intersected by streams flowing into Lake Kyoga. It comprises both urban and peri-urban areas, with uneven population distribution and some densely populated divisions. Located in the Lango Sub-region, Lira city is classified as a moderate malaria transmission area, recording 251–450 cases per 1,000 population, similar to Karamoja, Teso, Bukedi, and Busoga regions [20]. Studies indicate that malaria remains endemic in Lira city, with variations in transmission influenced by factors such as seasonal rainfall, vector density, and intervention coverage [21]

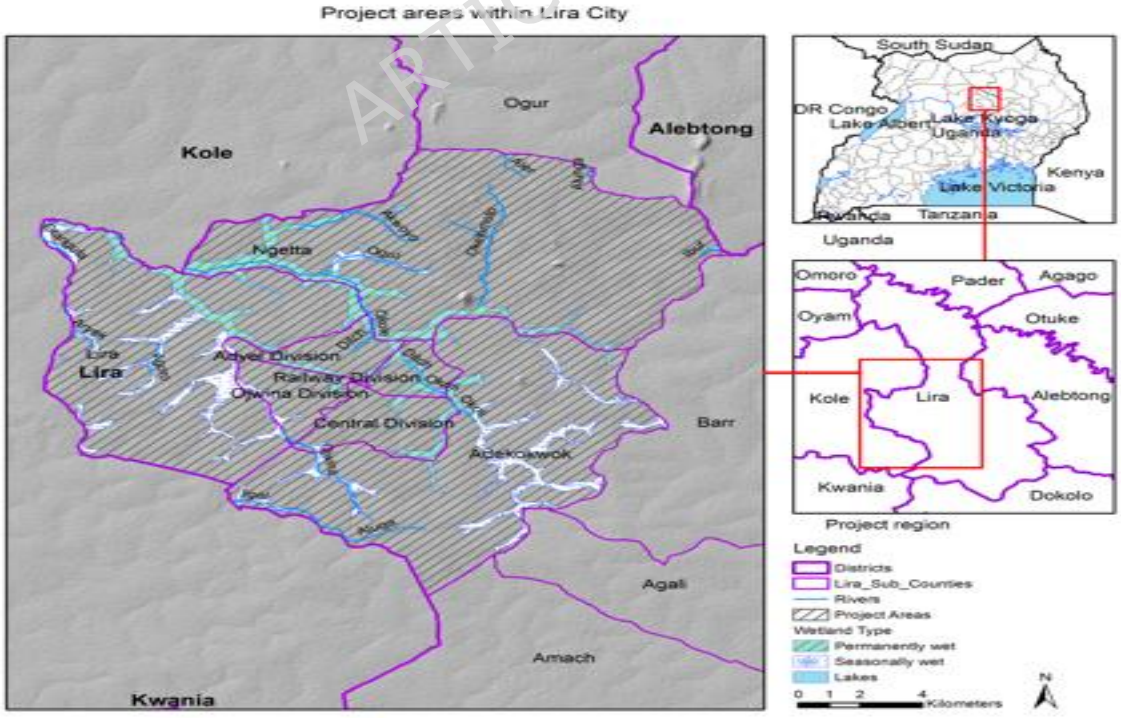

Figure 1: Location of the study areas within Lira City. The main map on the left illustrates the administrative boundaries of Lira district. Map drawn by the author using ArcGIS.

Study Design and Sampling

The study targeted women of reproductive age (15–49 years) in Lira City, given their heightened vulnerability to malaria, especially during pregnancy, and their influence on family and community health. It employed a cross-sectional analytical design, using both quantitative and qualitative methods to assess the utilization of malaria control interventions and associated factors. The sample size was determined using the Cochran formula for cross-sectional studies, defined as follows:

$$n = \frac{Z^2 \times p \times (1-p)}{d^2}$$

Where: *n* is the sample size, Z is the Z-value corresponding to 95% confidence level (Z= 1.96), *p* is the estimated prevalence of malaria control intervention utilization (an estimate of 50% was used for maximum sample size), *d* is the desired level of precision 5%, the sample size was adjusted for the design effect for multistage sampling by multiplying by 1.5 and considering a 10% non-response rate: thus, the final sample size was 634 participants. To obtain the required number of participants, the study employed a multistage sampling technique. Six city wards were randomly selected, from which four parishes were chosen per ward, and at least three villages per parish. In each village, households were sampled systematically at five household intervals, starting with a randomly selected household. From each household, one eligible woman of reproductive age was randomly chosen for an interview. If there was more than one eligible woman in a household, one was randomly selected to participate.

Inclusion and Exclusion Criteria

Women of reproductive age (15–49 years) residing in Lira City, who were pregnant, postpartum, or not pregnant, and who willingly consented to participate, were included in the study. For the IPT utilization, only women who were currently pregnant or had ever experienced pregnancy were considered. Women aged 15–49 years who did not reside in

Lira City, had serious health conditions preventing participation, or were still under the care of their parents were excluded from the study.

Data Collection Methods

Quantitative data were collected using semi-structured questionnaires and qualitative data through focus group discussions (FGDs). The quantitative questionnaire was developed after an extensive review of relevant literature on malaria prevention and utilization of malaria interventions, including insecticide-treated nets (ITNs), intermittent preventive treatment (IPT), and indoor residual spraying (IRS). The tool was further informed by national malaria control guidelines and similar population-based studies conducted in comparable settings. The questionnaire comprised closed-ended items covering socio-demographic characteristics, knowledge, access, and utilization of malaria intervention. The FGD guide was developed alongside the questionnaire to explore, in greater depth, community perceptions, experiences, and contextual factors influencing the utilization of malaria interventions. Open-ended questions and probing prompts were designed to encourage discussion and allow participants to freely express their views.

The questionnaires for data collection, translated into Luo or English, were uploaded to the Kobo Collect Android app installed on mobile phones [22] and administered by trained research assistants. The tools were pretested in Apii village, Ayer Sub County, Kole District, to ensure reliability. To complement the questionnaire findings, three FGDs (one in Lira City West and two in City East) were conducted, each with 10 women of reproductive age drawn from different parishes and villages to ensure broad representation and deeper insights into the utilization of malaria interventions (ITNs, IPTs, IRS). All FGDs were conducted in Luo, recorded with participants' consent, and supplemented by detailed field notes to capture non-verbal cues and contextual factors. A thematic framework was developed inductively from the data. Codes were generated through repeated readings of the transcripts by three different coders, and the process was strengthened through triangulation with field notes and peer debriefing.

Data Management and Analysis

Before data collection, the questionnaire was piloted in Apii village, Kole district. Restricted questions were used to minimize missing data, and all responses were processed through

sorting and tabulation to check for errors. Ethical standards were strictly followed, with anonymization and informed consent ensured. Data were analyzed in STATA v18 at three levels: univariate, bivariate, and multivariate. Descriptive statistics summarized knowledge, attitudes, perceptions, and utilization of ITNs, IPTs, and IRS. For the outcome variable, utilization was defined as the use of at least two of the three malaria prevention methods (ITNs, IPTs, and IRS). Respondents who reported using two or more methods were categorized as "Yes," while those who reported fewer than two were categorized as "No." Chi-square tests identified factors associated with utilization, and variables with $p < 0.2$ were included in multivariate logistic regression, with $p < 0.05$ considered significant. Qualitative data from FGDs were coded, categorized into themes, and triangulated with quantitative findings for comprehensive analysis.

RESULTS

Socio-demographic Characteristics

The study achieved a response rate of 99.2%, with 629 participants. Table 1 summarizes their demographic and socio-economic characteristics. Most respondents were aged 21–30 years (42.4%, *n*=267) or 31–40 years (36.1%, *n*=227). Nearly half (49%, *n*=308) reported a monthly household income below 100,000 UGX (27.8USD), and 52.8% (*n*=332) had fewer than five household members. A majority (65.7%, *n*=413) had two or fewer children. In terms of education, 45.8% (*n*=288) had secondary education, 29.7% (*n*=187) had only primary education, and 5.7% (*n*=36) had no formal education. Most participants were married (75.2%, *n*=473). Self-employment was the most common occupation (49.9%, *n*=314), followed by farming (36.7%, *n*=231). Most lived in permanent housing (64.9%, *n*=408) and resided in urban areas (64.2%, *n*=404). The dominant religious affiliations were Protestant (42.4%, *n*=267) and Catholic (36.9%, *n*=232).

Table 1: **Socio-demographic Characteristics of Study Participants (N = 629)**

Variables	Number	Percent
Age in years		
<=20	59	9.4
21-30	267	42.4
31-40	227	36.1

Above 40	76	12.1
Average household income per month (UGX)		
<=100000 (27.8USD)	308	49.0
100001-200000 (27.8USD-55.6USD)	149	23.7
Above 200000 (55.6USD)	172	27.3
Household size		
<5	332	52.8
5+	297	47.2
Number of children		
<=2	413	65.7
above2	216	34.3
Education level		
None	36	5.7
Primary	187	29.7
Secondary	288	45.8
Tertiary	118	18.8
Marital status		
Divorced	81	12.9
Married	473	75.2
Single	55	8.7
Widowed	20	3.2
Occupation		
Civil Servant	55	8.7
Farming	231	36.7
Others Specify	16	2.5
Self-Employment	314	49.9
Student	13	2.1
Type of housing		
Permanent	408	64.9
Semi-permanent	168	26.7
Temporary	53	8.4
Current place of residence		

Peri urban	225	35.8
Urban	404	64.2
Religious affiliation		
Catholics	232	36.9
Muslim	19	3.0
Seventh Day Adventist (SDA)	22	3.5
Pentecostals	89	14.1
Protestants	267	42.4

FGD Participant's Profile

Participants in the first focus group discussion were labeled R1 to R10. For the second focus group, participants were labeled R21 to R210, and in the third focus group, participants were labeled R31 to R310. All participants were female in the age of 15-49 and were resident of Lira City. Three focus group discussions (FGDs) were conducted with each group comprised of ten participants, giving a total of thirty women. The majority were married (70%, n=21) and had more than two children (77%, n=23). Most participants had primary education (47%, n=14), while smaller proportions had informal (23%, n=7), secondary (17%, n=5), or tertiary education (13%, n=4). The majority of participants were engaged in informal employment (87%, n=26), while 13% (n=4) had formal jobs

Level of Utilization of ITNs, IPTs and IRS

Utilization of malaria prevention methods was analyzed as a composite outcome variable, defined as the use of at least two of the three interventions (ITNs, IPTs and IRS). Figure 2 presents the utilization of ITNs, IPTs and IRS among women of reproductive age in Lira City. The results indicate high utilization of Insecticide-Treated Nets (ITNs), with 529 (84.1%) of respondents reporting use, suggesting that ITNs remain the most widely adopted malaria prevention method among the population. In contrast, the uptake of Intermittent Preventive Treatment in pregnancy (IPT) was moderate, with 428 (68.0%) reporting utilization, while Indoor Residual Spraying (IRS) was the least used, with only 206 (32.8%) of respondents indicating that their households had received spraying. The overall trend points to a preference for individual or household-controlled prevention methods like ITNs over community-based interventions like IRS.

In terms of the level of utilization, a significant proportion 280 (44.52%) of respondents reported using two prevention methods, while 153 (24.32%) had used one method, and 150 (23.85%) had used three methods. Only a small percentage 46 (7.31%) reported never using any of the three malaria prevention measures.

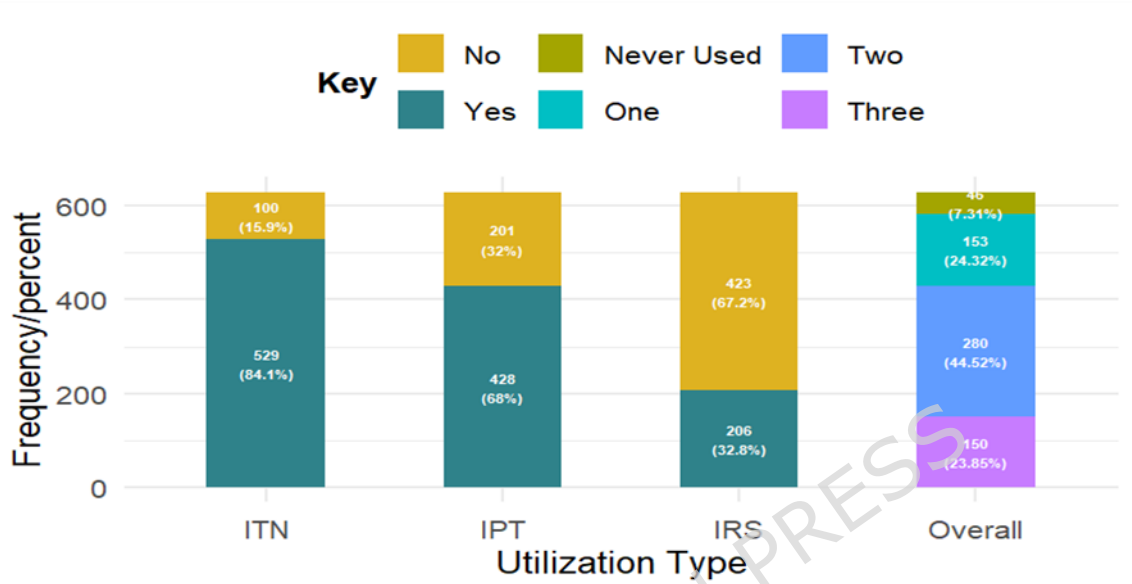

Figure 2: Utilization of ITNs, IPTs and IRS among Women of Reproductive Age in Lira City

Participants Knowledge Towards Utilization of ITNS, IPTS and IRS

Table 2 summarizes participants' knowledge and use of malaria prevention methods. The most frequently mentioned methods were indoor residual spraying (IRS) (32.8%, *n*=590) and use of insecticide-treated nets (ITNs) (32.3%, *n*=582), followed by intermittent preventive treatment in pregnancy (IPTp) (19.3%, *n*=347) and clearing stagnant water (14.5%, *n*=261). Only 0.3% (*n*=5) reported no knowledge of malaria prevention methods. The majority (90.9%, *n*=572) learned about these methods from health workers, while smaller proportions cited the media (5.6%, *n*=35) or community sources such as meetings, friends, or family (1.4%, *n*=9 each). Most participants (85.2%, *n*=536) reported having received education on the importance of IPT.

Regarding treatment-seeking behavior, 88.1% (*n*=554) said they would seek care at a health facility, 11.4% (*n*=72) at a pharmacy, and only 0.5% (*n*=3) considered traditional healers. Overall, the findings indicate substantial awareness of malaria prevention and

treatment methods, with IRS and ITNs being the most recognized strategies and health workers serving as the primary source of information.

Table 2: Knowledge and Utilization of Malaria Prevention and Treatment Methods Among Women of Reproductive Age in Lira City

Variable	Number	Percent
Methods to prevent malaria (Multiple response)		
IRS	590	32.78
Taking IPT	347	19.28
Clearing stagnant water	261	14.50
Bed nets	582	32.33
Don't know	5	0.28
Others	15	0.83
Where you first learnt about these methods		
Community meetings	9	1.4
Friends/Family	9	1.4
Health workers	572	90.9
Media (TV, Radio, Newspaper)	35	5.6
Other	0.6	0.6
Think ITNs help prevent malaria		
No	20	3.2
Yes	609	96.8
IPTs reduces malaria risk in pregnant women		
No	29	4.6
Yes	600	95.4
Ever been educated on the importance of IPT		
No	93	14.8
Yes	536	85.2
What do you do if you suspect that you or someone else has malaria		
Buy over-the-counter medication	69	11.0

Go to a health facility	547	87.0
Other (specify)	1	0.2
Take traditional medicine	12	1.9
Know where to seek treatment if you or family member gets sick		
Health facility	554	88.1
Pharmacy	72	11.4
Traditional healer	3	0.5

The qualitative findings revealed varying levels of knowledge and awareness of malaria control interventions among participants, with ITNs emerging as the most commonly recognized preventive method. However, very few have a deep understanding of IPT's purpose beyond Antenatal care visit (ANC).

A significant number of respondents demonstrated a basic understanding of the role ITNs play in malaria prevention, particularly in protecting against mosquito bites. However, some expressed doubts about malaria control citing concerns that they still get sick despite using nets and taking hospital prescribed medications.

"Without net we wouldn't sleep. Our place has a lot of mosquitoes and I use it because I know its benefit." (R31)

"Nets have saved our children from mosquito bites and how I wish they would be distributed frequently." (R32)

"Nets are very good and I used to sleep with a lot of peace before my net was torn, but now mosquitoes still bite me because it has holes." (R37)

"I don't have any problem sleeping under a net. The only problem is laziness to tie it, especially after washing. You find that I can take three to four days before hanging it again after washing." (R34)

"I don't use a net because it makes me experience difficulties in breathing." (R7)

Persistent misconceptions about malaria causation coexisted with biomedical knowledge, with respondents connecting malaria to food, dirty water, witchcraft, or demonic forces,

indicating that the illness was perceived not only as a medical condition but also as a social and spiritual experience. Reported beliefs included: *"Malaria is also caused by eating mangoes in the morning"* (R3); *"Malaria is caused by dirty water around homes as it keeps mosquitoes"* (R21);

"To me, I think sometimes it's caused by witchcraft. Like for my case, in the last pregnancy, each and every time I would be sick with malaria, but when I gave birth, it stopped and I strongly believe it was my co-wife working on me." (R39) and *"Sometimes malaria appears to be demonic when you have little money, everyone at home may fall sick"* (R3).

Several respondents voiced concerns about the practicality and perceived effectiveness of ITNs, particularly when nets were damaged or during the hot season when sleeping under a net became uncomfortable. Behavioral and environmental factors were reported to affect compliance, reducing the overall effectiveness of ITN use in real-world settings.

Notably, the theme also uncovered significant gaps in knowledge and widespread misconceptions surrounding Intermittent Preventive (IPT). Despite being a cornerstone of malaria prevention in pregnancy, IPT was poorly understood by many respondents. This qualitative finding supports the study's quantitative results, which revealed that knowledge about IPT was significantly associated with greater utilization. While some women were aware that they received Fansidar (Sulfadoxine-Pyrimethamine) during antenatal visits, they lacked a clear understanding of its purpose as testified by the following narratives.

"I thought Fansidar was just for treating malaria, not prevention, but even after taking it, I still got sick when I was pregnant." (R9)

"They always give us red and white drug to help the baby make blood. I'm not sure whether that same drug also controls malaria. Sometimes they give us drugs without telling us the use, but they only tell you this is to help the baby and this is for you and how to take." (R25)

"I don't know any drug used for malaria control." (R33)

"I guess Fansidar (IPTs) could be in the drug shops, but since I don't have much knowledge about its role in malaria control, I have never bothered to ask." (R39)

"I don't know whether there is any drug to prevent malaria apart from the one they give us during ANC." (R24).

In relation to Indoor Residual Spraying (IRS), participants acknowledged its effectiveness in killing mosquitoes and other nuisance insects; however, its acceptance was not uniform. A strong dislike for the odor of the spray, coupled with concerns about potential side effects (including unusual culturally rooted fears such as perceived effects on "manhood"), highlights a significant communication gap regarding the safety and benefits of IRS. These knowledge and attitude gaps not only hinder the acceptance of IRS but also illustrate the need for community engagement to clarify the benefits and dispel myths. This narrative is supported by participants' quotations below.

"IRS, prevents and kills the mosquitoes but me I don't like the smell of the drug and last time I only sprayed the Kitchen because LC1 told us if you don't spray your house you will be arrested" (R8).

"If possible, the drug used for IRS should be odorless, because some of us did not spray our houses as the smell was irritating" (R7).

The sensory discomfort and distrust towards individuals tasked with spraying often based on personal reputation or suspected motives, creates fear and resistance to public health interventions. This mistrust reduces community compliance, even among those who understand the protective benefits of IRS.

"I did not spray my house last time because I did not trust the person who was spraying people's houses. She has a bad heart, and I thought she might overspray my house and the drug could kill me. They should always select good people to do the work" (R25).

"Some people use the insecticides for spraying for the wrong purpose of killing humans. They pretend to have sprayed their houses, yet they conspire with the sprayers and keep the drug for another purpose" (R3).

Attitude Towards Utilization of ITNS, IPTS and IRS among Women of Reproductive Age in Lira City

Table 3 presents the attitudes of women of reproductive age in Lira City towards the use of insecticide-treated nets (ITNs), intermittent preventive treatment (IPT), and indoor residual spraying (IRS). Overall, participants showed positive attitudes, with mean scores ranging

from 4.27 to 4.41, indicating strong agreement regarding the effectiveness and safety of these methods. A majority of women agreed or strongly agreed that IRS is a good practice for malaria prevention (85.6%, *n*=538), and 98.1% (*n*=617) believed ITNs are effective. Similarly, 94.0% (*n*=591) agreed that taking IPTp during pregnancy is necessary, and 94.2% (*n*=592) believed IPTp is safe for pregnant women. Most participants (97.8%, *n*=615) felt comfortable sleeping under ITNs nightly, and 98.4% (*n*=619) believed ITNs reduce mosquito bites. Additionally, 91.9% (*n*=578) were comfortable with IRS in their homes, and 99.3% (*n*=624) would recommend ITNs to others. The overall mean attitude score was 4.34 (SD = 0.67), reflecting a strong positive perception of malaria prevention practices.

Table 3. Attitude Towards Utilization of ITNS, IPTS and IRS

Items	SA		A		NS		D		SD		Mean	SD
	n	%	*n*	%	*n*	%	*n*	%	*n*	%		
I feel that the IRS is a good practice for preventing malaria in my home	376	59.8	162	25.8	29	4.6	39	6.2	23	3.7	4.32	1.06
Using insecticide-treated nets (ITNs) is an effective way to prevent malaria in my household."	270	42.9	347	55.2	11	3	0.5	2	0.3		4.40	0.57
I think taking IPT during pregnancy is necessary to prevent malaria	242	38.5	349	55.5	31	4.9	6	0.9	1	0.2	4.31	0.62
I believe IPTs are safe for pregnant women	250	39.8	342	54.4	34	5.4	2	0.3	1	0.2	4.33	0.61
I feel comfortable sleeping under an ITN every night	252	40.1	363	57.7	2	0.3	9	1.4	3	0.5	4.35	0.62
I think ITNs are effective in reducing mosquitoes bites	243	38.6	376	59.8	7	1.1	3	0.5	0	0.0	4.37	0.53
I am comfortable with my house being sprayed with IRS for malaria prevention	266	42.3	312	49.6	16	2.5	22	3.5	13	2.1	4.27	0.84
I would you recommend others to use ITNs for malaria prevention	262	41.7	362	57.6	4	0.6	1	0.2	0	0.0	4.41	0.51
Average											**4.34**	**0.67**

Perception Towards Utilization of ITNS, IPTS and IRS

Table 4 presents the respondents' perception toward the utilization of ITNs, IPTs, and IRS for malaria prevention. A majority of women (61.5%, n=387) believed that IRS is safe for their households, and most (91.9%, n=578) agreed that indoor spraying with insecticides helps reduce malaria transmission. Regarding concerns about IRS, the most frequently reported issue was the unpleasant odor or discomfort caused by the insecticide (51.7%, n=325), followed by concerns about safety (21.9%, n=138) and effectiveness (17.3%, n=109). When using ITNs, almost all women (98.4%, n=619) reported a reduction in mosquito bites, and 96.8%, (n=609) believed that ITNs help prevent malaria. Additionally, 95.4% (n=600) believed that IPT effectively reduces malaria risk in pregnant women. The main concerns regarding ITN use were safety (45.3%, *n* = 285), accessibility (31.5%, *n* = 198), and comfort (17.2%, *n* = 108). These findings indicate a generally positive perception of ITNs and IRS, although concerns related to comfort, accessibility, and safety persist.

Table 3: Perception Towards Utilization of ITNS, IPTS and IRS among participants

Variable	Number	Percent
Main concerns about using ITNs		
Accessibility	198	31.5
Comfort	108	17.2
Cost	27	4.3
Other	11	1.7
Safety	285	45.3
Believe IRS is safe for your household		
No	242	38.5
Yes	387	61.5
Believe IRS reduce malaria transmission		
No	51	8.1
Yes	578	91.9
Main concerns about the IRS		
Cost	44	7.0
Effectiveness	109	17.3
Other	13	2.1
Safety	138	21.9
Smell/Discomfort	325	51.7
Noticed any reduction in mosquito bites or malaria cases when using ITN		
No	10	1.6
Yes	619	98.4
IPTs effectively reduce malaria risk in pregnant women		
No	29	4.6
Yes	600	95.4

Although the quantitative data indicates strong reported belief in the effectiveness and safety of ITNs, IPT, and IRS, the qualitative findings uncover deeper perceptions of discomfort, mistrust, and limited understanding that challenge consistent utilization.

Many respondents expressed appreciation for ITNs and perceived it as good, but their continued use was challenged by perceived discomfort and reduced effectiveness. One participant shared:

"Without net we wouldn't sleep. Our place has a lot of mosquitoes and I use it because I know its benefit." (R31). Another respondent said;

"Nets have saved our children from mosquito bites and how I wish they would be distributed frequently." (R32)

"Net is good, it prevents mosquito bites, but the challenge comes when weather changes, especially during dry season. It can be too hot, so in most cases we are forced to remove it." (R4)

Notably, the qualitative finding uncovered significant gaps in knowledge and widespread misconceptions surrounding Intermittent Preventive Treatment (IPT) which affects perception. For example, R4 shared,

"The white drugs they give us during antenatal care visit have a very strong smell. I don't like it and I remembered taking it once and it made me unwell, so I stopped taking it much as they emphasize you should take it for the good of the baby." Similarly,

Perceptions of IPT also revealed significant gaps in understanding. Although Fansidar (Sulfadoxine-Pyrimethamine) is routinely administered during antenatal care, many women lacked clarity about its preventive role.

R25 noted, *"IPTs (Fansidar) is generally not known for control of malaria but we use it during pregnancy because they give it to you from the hospital,"* highlighting passive acceptance without informed consent.

Others expressed outright unfamiliarity: *"I do not know any drug pregnant women use to control malaria" (R24), "I've never heard of IPTs before. I don't know if I've used them" (R7), and "I thought Fansidar was just for treating malaria, not control" (R9).* These statements underscore a widespread perception that IPT is either ineffective or misunderstood, which may hinder adherence.

Negative experiences with IPT shaped women's perceptions and uptake. Several respondents reported that the drugs provided during antenatal care caused discomfort, which undermined their trust in the intervention. One woman explained:

"The white drugs they give us during antenatal care visits have a very strong smell. I don't like it, and I remembered taking it once and it made me unwell, so I stopped taking it much as they emphasize you should take it for the good of the baby." (R4)

This account illustrates how embodied side effects outweighed biomedical advice, leading to discontinuation despite awareness of the drug's intended benefits. Similarly, another respondent noted:

"The drugs made me feel sick, all the time you feel nausea and because of this I avoided taking it again." (R11)

Such experiences created negative associations with IPT, reinforcing avoidance behavior and shaping perceptions of risk. In contrast, some women expressed preference for familiar treatments, highlighting the role of trust and recognition in drug uptake. For example:

"*I only know Cartem for malaria, not this IPT drug you're talking about." (R3)*

"I have never known about drugs that are used to control of malaria apart from Cartem." (R2) These quotations demonstrate how familiarity with known medications such as Coartem (artemether/lumefantrine) influenced decision-making, with IPT perceived as unfamiliar and therefore less trustworthy.

Community responses to IRS revealed a complex interplay between acknowledged benefits and deeply rooted concerns. Narratives highlighted widespread discomfort with the odor of the insecticide, apprehensions about health risks, and culturally embedded fears particularly regarding male reproductive health. Additionally, rumors linking IRS to unintended consequences, such as bedbug infestations and soil degradation, further undermined trust. As illustrated by the following narratives

"Spraying house reduces mosquitoes but only for a short while compared to how nets protect, but also spraying has more risk because the drug used is not good for our health and our animals. A reason they told us last time that after mopping the house we have to pour the water in the toilet." (R32)

"The drug can even affect the soil by killing small organisms in it resulting in poor crop yield." (R310)

"I didn't spray because I feared it would harm my husband who is asthmatic." (R16)
"The drug they use for spraying is not safe at all, that's why in the last exercise I didn't spray my house." (R29)

Some people's views about IRS were shaped by rumors and fears. One woman said she refused spraying because she feared it would harm her sons:

I'm not okay with spraying my house because we have heard that the drug makes men powerless and that means in future they will not be able to produce, and for me I have only boys children so I couldn't carry out the exercise in the previous IRS." (R39)

This statement illustrates how reproductive concerns and gendered expectations shaped resistance to IRS. The fear of "male powerlessness" was not only a biomedical misconception but also a reflection of the social value placed on male fertility and lineage continuity. Such beliefs reveal how health interventions can be interpreted through cultural lenses that prioritize family survival and masculinity.

Similarly, perceptions of IRS as a cause of bedbug infestations were widespread and carried significant weight in household decision-making. One respondent recounted:

"Spraying the house caused bedbugs, I witnessed in the last IRS exercise in my house and I was not the only one who experienced it, others were complaining too." (R24)

Another participant refused IRS altogether, stating:

"I heard IRS brought bed bugs and because of this I feared to spray my house in the last exercise". (R27)

These quotes show how rumors became stronger when people thought they saw proof in their own homes. Even if the link between IRS and bedbugs is not proven, the shared stories made people believe it and avoid spraying.

Factors Associated with Utilization of ITNs, IPTs and IRS

Table 5 presents the bivariate analysis of factors influencing the use of insecticide-treated nets (ITNs), intermittent preventive treatment (IPT), and indoor residual spraying (IRS) among women of reproductive age in Lira City. The analysis shows that several sociodemographic and contextual factors significantly affect utilization.

Age was a significant factor, with women aged 21–30 and 31–40 more likely to use these interventions than those aged ≤20 or >40 years (χ^2=22.83, df =3, p<0.001). Marital status also played a role—married women showed higher utilization than single, divorced, or widowed women (χ^2=25.82, df=3, p<0.001). Similarly, women living in permanent housing had higher utilization rates compared to those in semi-permanent or temporary structures (χ^2=9.78, df= 1, p=0.008).

The presence of community myths about malaria significantly influenced uptake; women in communities without such myths were more likely to utilize interventions (χ^2=11.36, df=1, p<0.001).

Preferred treatment location was also important those who sought care at hospitals or clinics had higher utilization (χ^2=19.12, df=2, p<0.001).

Women who received encouragement from community leaders were more likely to use these interventions (χ^2=3.96, df=1 p=0.047), as were those living within 1–5 km of a health facility (χ^2=6.47, df=2 p=0.039). Notably, women who did not report challenges using bed nets had significantly higher utilization rates (χ^2=20.77, p<0.001).

Moreover, women who had been educated about the importance of IPTp during pregnancy (χ^2=24.70, df=1, p<0.001) and those who believed that IRS reduces malaria transmission (χ^2=7.75, df=1, p=0.005) were significantly more likely to use these malaria prevention methods

Table 4: Bivariate Analysis of Factors Associated with the Utilization of ITNs, IPT, and IRS among Women of Reproductive Age in Lira City

	Utilization			
Variable	**No (%)**	**Yes (%)**	**χ^2(df)**	**p-value**
Sociodemographic factors				
Age in years				
<=20	20 (10.1)	39 (9.1)	22.83(3)	<0.001*
21-30	82 (41.2)	185 (43.0)		
31-40	56 (28.1)	171 (39.8)		
above 40	41 (20.6)	35 (8.1)		

Average household Income				
<=100000 (27.8USD)	90 (45.2)	218 (50.7)	1.96(2)	0.374
100001-200000 (27.8USD -55.6USD)	53 (26.6)	96 (22.3)		
above 200000 (55.6USD)	56 (28.1)	116 (27.0)		
Household size				
<5	102 (51.3)	230 (53.5)	0.272(1)	0.602
5+	97 (48.7)	200 (46.5)		
Number of children				
<=2	123 (61.8)	290 (67.4)	1.91(1)	0.166
Above2	76 (38.2)	140 (32.6)		
Education level				
None	15 (7.5)	21 (4.9)	5.81(3)	0.121
Primary	65 (32.7)	122 (28.4)		
Secondary	78 (39.2)	210 (48.8)		
Tertiary	41 (20.6)	77 (17.9)		
Marital status				
Divorced	29 (14.6)	52 (12.1)	25.82(3)	<0.001*
Married	128 (64.3)	345 (80.2)		
Single	31 (15.6)	24 (5.6)		
Widowed	11 (5.5)	9 (2.1)		
Occupation				
Civil Servant	15 (7.5)	40 (9.3)	7.02(4)	0.135
Farming	68 (34.2)	163 (37.9)		
Others Specify	4 (2.0)	12 (2.8%)		
Self-Employment	104 (52.3)	210 (48.8%)		
Student	8 (4.0)	5 (1.2)		
Type of housing do you live in				
Permanent	116 (58.3)	292 (67.9)	9.78(2)	0.008*
Semi-permanent	57 (28.6)	111 (25.8)		
Temporary	26 (13.1)	27 (6.3)		
Place of residence				
Peri urban	75 (37.7)	150 (34.9)	0.466(1)	0.495
Urban	124 (62.3)	280 (65.1)		
Religious affiliation				
Catholics	71 (35.7)	161 (37.4)	3.55(4)	0.470
Muslim	9 (4.5)	10 (2.3)		
SDA	5 (2.5)	17 (4.0)		
Pentecostals	26 (13.1)	63 (14.7)		
Protestants	88 (44.2)	179 (41.6)		
Community factors				
Myths about malaria in your community				
No	138(69.3)	350(81.4)	11.36(1)	<0.001
Yes	61 (30.7)	80 (18.6)		
Women have the autonomy to make decisions regarding malaria				

No	22 (11.1)	66 (15.3)	2.08(1)	0.149
Yes	177(88.9)	364(84.7)		
Place of preference to seek treatment				
Both	20 (10.1)	10 (2.3)	19.12(2)	<0.001*
Hospital /clinic	171(85.9)	391(90.9)		
Traditional medicine	8 (4.0)	29 (6.7)		
Leaders encourage or provide guidance				
No	21 (10.6)	26 (6.1)	3.96(1)	0.047*
Yes	178(89.4)	403(93.9)		
Attended a malaria education session				
No	69 (34.7)	162(37.8)	0.56(1)	0.455
Yes	130(65.3)	267(62.2)		
Community health workers visit your household to provide information on malaria				
No	45 (22.6)	79 (18.5)	1.48(1)	0.224
Yes	154(77.4)	349(81.5)		
Distance to nearest health facility that provides malaria prevention tools				
1-5km	95 (47.7)	232(54.0)	6.47(2)	0.039*
<1km	82 (41.2)	134(31.2)		
>5km	22 (11.1)	64 (14.9)		
Do you face challenges in using insecticide-treated bed nets				
No	130(65.3)	352(81.9)	20.77(1)	<0.001*
Yes	69 (34.7)	78 (18.1)		
Personal factors				
Think ITNs help prevent malaria				
No	9 (4.5)	11 (2.6)	1.71(1)	0.192
Yes	190 (95.5)	419 (97.4)		
Ever been educated on IPT importance				
No	50 (25.1)	43 (10.0)	24.70(1)	<0.001*
Yes	149 (74.9)	387 (90.0)		
Believe the IRS is safe for household use				
No	71 (35.7)	171 (39.8)	0.96(1)	0.327
Yes	128 (64.3)	259 (60.2)		
Believe IRS helps reduce malaria transmission				
No	25 (12.6)	26 (6.0)	7.75(1)	0.005*
Yes	174 (87.4)	404 (94.0)		

χ^2=Chi square Statistics; * Significant Variable at 0.05

Multivariate Analysis of Factors Associated with Utilization

The logistic regression analysis in Table 6 identified several factors significantly associated with utilization of malaria control interventions among women of reproductive age in Lira City. These quantitative findings are supplemented by qualitative testimonies.

Individuals who had ever received any form of education or had specifically been educated on intermittent preventive treatment (IPT) were significantly more likely to utilize malaria control services (AOR = 2.05, 95% CI: 1.24–3.38, p = 0.005). Participant narratives emphasizing the role of information access reinforced this. One respondent noted,

"I got some information during pregnancy, but there's no regular program in our village to teach us about malaria. It's only the LC1 that comes around sometimes to inform us when nets are being distributed" (R2). Another added,

"The village health teams are there and they mainly identify pregnant mothers and direct them to attend antenatal care. They also participate in net distribution" (R32). However, gaps in understanding were evident:

"No one has ever explained to me what Fansidar or other malaria drugs are used for. I just take what I'm given at the hospital" (R4), and *"I thought Fansidar was just for treating malaria, not prevention" (R9)*. Health education was reported to improve uptake, while the quality and clarity of health messaging influenced acceptance.

Living in temporary housing was associated with lower odds of service utilization (AOR = 0.38, 95% CI: 0.19–0.75, p = 0.005). Qualitative data highlights structural challenges:

"Our house is made of mahbati (iron sheets), and there is nowhere to hang the net properly" (R6), and maintenance issues: *"Our nets are in bad condition because it was last distributed by government in 2023. The torn ones are being used by children because they are very weak"* (R32). These statements explain why women in temporary or poorly structured homes may struggle to use ITNs consistently.

Participants' narratives reveal that environmental discomfort and behavioral factors hinder utilization. For instance, *"During the dry season like this, it's too hot under the net and I stopped using it for over a month…new nets irritate a lot"* (R9), and *"I feel suffocated when I sleep under the net. It makes breathing difficult"* (R7). Laziness in net reinstallation also affected use: *"The only problem is laziness to tie especially after washing. You find that I can*

take three to four days before hanging it again" (R34). These testimonies align with the logistic regression result that difficulties in using ITNs reduced odds of utilization (AOR = 0.44, 95% CI: 0.29–0.68, p < 0.001).

Laziness in net reinstallation also affected use: *"The only problem is laziness to tie especially after washing. You find that I can take three to four days before hanging it again"* (R34).

Additionally, logistical issues such as poor net condition and lack of replacements were common;

"Our nets are in bad condition, the torn ones are being used by children because they are very weak. We received few nets because it wasn't enough for everyone, and I can't afford to buy because it's very expensive" (R32).

Respondents aged above 40 years and single individuals were less likely to utilize malaria control services (AOR = 0.45, 95% CI: 0.26–0.79, p = 0.005 and AOR = 0.31, 95% CI: 0.16–0.59, p < 0.001, respectively). Qualitative testimonies hint at possible sociocultural influences, including mistrust and household roles; *"I didn't spray my house last time because I didn't trust the person who was spraying people's houses, they should always select good people"* (R25), and

"I've never sprayed my house because it's very hard to collect things out of the house. I rely on nets instead" (R4). These accounts illustrate that older and single women may face practical, social, or trust-related barriers that reduce participation in malaria prevention.

Table 5: Logistic Regression of Factors Associated with Utilization

Variable	COR (95%CI)	p-value	AOR (95%CI)	p-value
Type of house				
Permanent	1.00		1.00	
Semi-permanent	0.77(0.52-1.14)	0.191	0.67(0.44-1.03)	0.069
Temporary	0.41(0.23-0.74)	0.003*	0.38(0.19-0.75)	0.005*
Age in years				
<=30	1.00		1.00	
31-40	1.56(0.84-2.90)	0.155	1.34(0.88-2.05)	0.171
40+	0.44(0.22-0.88)	0.021*	0.45(0.26-0.79)	0.005*
Face challenges with nets				
No	1.00		1.00	

Yes	0.42(0.29-0.61)	<0.001*	0.44(0.29-0.68)	<0.001*
Ever been educated on IPT importance				
No	1.00		1.00	
Yes	3.02(1.92-4.73)	<0.001*	2.05(1.24-3.38)	0.005*
Distance to the nearest facility				
<5km	1.00		1.00	
>=5km	1.19(0.69-2.04)	0.525	0.76(0.51-1.12)	0.171
Occupation				
Farming	1.00		1.00	
Self employed	0.76(0.40-1.43)	0.393	0.76(0.52-1.12)	0.165
Student	0.23(0.07-0.83)	0.025*	0.29(0.08-1.09)	0.066
Marital status				
Married	1.00		1.00	
Single	0.43(0.21-0.38)	0.019*	0.31(0.16-0.59)	<0.001*
Believe ITN helps prevent malaria				
No	1.00		1.00	
Yes	1.80(0.73-4.42)	0.197	2.10(0.80-5.52)	0.132
Believe IRS helps prevent malaria				
No	1.00		1.00	
Yes	2.23(1.2-3.98)	0.006*	1.78(0.94-3.37)	0.076
Community myths and conception				
No	1.00		1.00	
Yes	0.51(0.36-0.76)	0.001*	0.69(0.45-1.09)	0.114

*1.00=Reference; COR=Crude Odds Ratio, AOR=Adjusted Odds Ratio, *significant variable at 0.05*

Additional factors from FGDs

Although not all systemic factors were statistically significant, qualitative data revealed their substantial impact. Participants described irregular distribution and unreliable access to malaria control intervention:

"I participated in the last net distribution and net was not enough for everyone" (R7), and

"The government health Centre is less costly but it's far, and sometimes when you get there, there are no drugs" (R8)

"The hospital is very far, and if you go you don't find drugs, so I normally buy drugs from a drug shop" (R3), and economic constraints:

"Nets are readily available but they are expensive and we mostly rely on the ones given by government" (R36). These factors reduce timely and consistent use of malaria prevention tools.

Financial constraints emerged as a critical barrier to malaria prevention and treatment, not simply in terms of access but in how households navigated daily survival priorities. One respondent explained:

"Nets are readily available in supermarkets, but they are expensive and we mostly rely on the ones given by government." (R36)

This illustrates that while physical availability of nets was not the issue, affordability determined uptake. Reliance on government distribution reflects broader economic vulnerability, where preventive health commodities are deprioritized in favor of immediate household needs. Another participant described adaptive strategies to cope with these constraints:

"I normally buy drugs for malaria from a drug shop near home, and sometimes they allow us to pay in instalments." (R3)

The practice of paying in instalments shows that families struggle financially, and local drug shops help by being flexible and supportive. Therefore, getting malaria treatment depended not just on money, but also on trust and the informal credit systems in the community. This shows how poverty and social conditions affect the way people seek healthcare.

Further IPT uptake is complicated by negative experiences and mistrust in the medication which emerged as a common deterrent to consistent IPT adherence reported by many respondents. For example,

"The drugs made me feel sick, I avoided taking it again" (R11), and *"The white drugs they give during antenatal care visits have a very strong smell. I remembered taking it once and it made me unwell" (R4).*

Participants also highlighted poor communication from health providers, which often discouraged pregnant women from seeking antenatal care (ANC). Respondents described negative experiences at health facilities, including rude treatment and limited explanations about prescribed medications. Such encounters created fear and reluctance to attend ANC, particularly in government facilities. One woman explained:

"Sometimes they give us drugs without telling us the use, but they only say this is to help the baby and this is for you" (R25), and another stated;

"In most cases, we take the medication without adequate understanding, as nurses can be tired and rude, which makes us afraid to ask questions" (R26).

Perceived inequities in intervention delivery were highlighted*; "Why is it that the spraying is only done in Northern Uganda and more frequent in Lango sub-region?" (R38)*, suggesting that regional disparities may erode trust and reduce participation.

DISCUSSION

Knowledge, Attitude and Perception Towards Utilization of ITNs, IPTs and IRS

The study revealed that most women possessed substantial knowledge of malaria prevention methods, particularly Insecticide-Treated Nets (ITNs) and Indoor Residual Spraying (IRS). Health workers were the main source of information, and formal health facilities were the preferred place for treatment. This finding aligns with a study conducted in Nigeria, which reported that 90% of pregnant women had substantial knowledge of ITNs, with radio and television serving as the primary channels for malaria-related information [23]. Furthermore, these results support previous research highlighting the importance of health education in enhancing malaria awareness and promoting preventive behaviors [24][25] The high levels of malaria knowledge can be attributed to structured antenatal care programs, where malaria prevention is integrated into maternal healthcare services. Studies in Ethiopia and Mozambique indicate that women attending antenatal care regularly are exposed to repeated malaria prevention messaging, reinforcing their understanding[26]. Additionally, government-led malaria campaigns often distributed through radio, community outreach, and health worker engagement have played a significant role in increasing knowledge levels[27].

The high mean attitude score (4.34, SD = 0.67) reflects a generally positive outlook and willingness to use malaria prevention methods. This matches findings from Ghana, where mothers displayed strong support for malaria control strategies[28]. The positive attitudes towards malaria prevention may be influenced by personal experiences with malaria and the cost associated with malaria treatment that drains the family resources. Women, particularly those with children, tend to perceive malaria prevention as necessary due to the experience their children had in past infection[28]. Additionally, Education plays a pivotal role in shaping attitudes toward health interventions. Women who have received any form of education on

malaria prevention strategies are more likely to trust and adopt medical interventions. For instance, the findings revealed that women with knowledge of Intermittent Preventive Treatment (IPT) exhibited higher utilization rates compared to their counterparts who had never received any form of education. Furthermore, insights from Focus Group Discussions (FGDs) indicated that women with higher levels of education demonstrated a deeper understanding of malaria preventive measures, including the rationale behind IPT and the importance of consistent adherence. These observations underscore the transformative impact of education in enhancing health literacy and promoting proactive health-seeking behaviors among women. However, attitude alone does not guarantee utilization. Studies in Uganda and Nigeria show that logistical challenges, affordability, and inconvenience impact adherence, even when attitudes are positive [29][30]. For instance, some women understand IRS is effective but reject it due to discomfort or fear of chemical exposure. This suggests that addressing environmental and logistical barriers is just as important as improving attitudes.

Despite high knowledge and positive attitudes, there remains a mixed perception as many women expressed concerns about comfort and safety, particularly with ITNs and IRS, which affected their consistent use. Similar findings have been documented across sub-Saharan Africa, where behavioral and environmental barriers affect intervention uptake[31]. The discomfort associated with ITNs in hot climates is a well-documented challenge with many households reporting heat retention and perceived side effects as key reasons for inconsistent ITN use[32]. Similarly, the perception of IRS as toxic often stems from inadequate communication leading to mistrust[33] which undermines consistent utilization. In Southwestern Uganda, many people recognized the importance of ITNs, consistent use remained low due to discomfort, perceived side effects, and family disagreements[30][2]. Similarly, a study in Nigeria confirmed that while IRS was widely accepted as effective, comfort and logistical issues could affect community acceptance[29]. Additionally, in Southeast Asia systematic review conducted emphasized the need to understand behavioral and environmental barriers to improve ITN and IRS utilization in malaria-endemic regions[31] .

Overall, the findings from Lira City are encouraging and suggest that women of reproductive age are well informed and generally supportive of malaria prevention strategies. However,

as seen in other regions such as Ethiopia[33][34] and Mozambique[26], knowledge and positive attitudes do not always lead to proper practice. To bridge this gap, targeted health education and behavior change campaigns should address the specific concerns and misconceptions that hinder consistent use. Engaging trusted community health workers and integrating malaria prevention into maternal health services could further strengthen uptake. Sustained efforts that combine accurate information with practical support and culturally sensitive messaging are essential to enhance the overall effectiveness of malaria control strategies[27][35][36].

Level of utilization of ITNs, IPTs and IRS among Women

The results from both qualitative and quantitative findings show that utilization of the three malaria prevention methods vary with ITNs being widely utilized most followed by IPTs and IRS. Particularly, the findings reveal a notably high utilization of Insecticide-Treated Nets (ITNs) among women of reproductive age in Lira City, with 84.1% reporting to use, a figure that surpasses national averages according to the Uganda Malaria Indicator Survey (UMIS) of 2018-2019. This high uptake is consistent with a study done across multiple regions in Uganda where 78.2% of women surveyed used insecticide-treated nets (ITNs) [37]. In Ethiopia, household ITN utilization also remains strong, with 83.5% reporting consistent use [38]. Similarly, in Kenya, 98.1% of household who own LLIN used them and the high utilization is attributed to mass distribution campaigns[39]. However, in contrast to these encouraging results, regional studies have reported lower ITN utilization, for example, 59.4% in Ethiopia [24], 52% in Sierra Leone[40], and 66.1% consistent use in Uganda despite 84% ownership [30]. These disparities suggest that while ownership may be widespread, actual utilization probably hinges on other factors such as education, cultural attitudes, and the effectiveness of community sensitization. The exceptional uptake in Lira City may therefore be attributed to their affordability, ease of use compared to other methods and targeted interventions efforts by government such as mass net distribution campaigns by the Ugandan Ministry of Health and partners such as the Global Fund and USAID in 2023, and the integration of ITN distribution into routine antenatal care and immunization services.

Intermittent Preventive Treatment also shows significant usage at 68%**,** indicating strong awareness and implementation of this malaria prevention strategy among women of

reproductive age in Lira City. Since IPT is administered as medication during antenatal care visits, its uptake may reflect the effectiveness of health systems in encouraging preventive measures during pregnancy. The moderate adoption of IPT (68%) during pregnancy is consistent with findings from elsewhere in sub-Saharan Africa, where IPT utilization is influenced by antenatal care services and healthcare access [24]. While IPT uptake is generally improving, national data from Uganda **(**UMIS 2018-2019**)** indicates that utilization remains below the strategic targets, suggesting room for increased awareness and service expansion.

Indoor Residual Spraying (IRS) has a notably lower adoption rate at 32.8%, with a majority (67.2%**)** of women not using it. This is far below the WHO recommendation for implementation of IRS in areas with high malaria transmission of at least 80% household coverage to achieve effective vector control[41]. This finding aligns with a study conducted in Northern Uganda, which found that only one in three households preferred IRS over insecticide-treated nets (ITNs), indicating a similarly low adoption rate [42]. However, it contrasts sharply with findings from Zambia, where the acceptance level for IRS was high (87%), attributed to favorable timing and perceived effectiveness of the intervention [43]. Similarly, a study from Tororo, Uganda, reported that 79.9% of respondents expressed willingness to undergo repeat of IRS, suggesting regional variability in acceptance [8]. A systematic review and meta-analysis affirmed the efficacy of IRS in reducing malaria incidence but emphasized that its impact is most pronounced when household coverage exceeds 80% [44]. This demonstrates that while IRS has the potential to significantly curb malaria transmission, its effectiveness is heavily dependent on sufficient coverage.

Several factors may contribute to the low uptake of IRS among women of reproductive age in Lira City. Misconceptions about the safety and effectiveness of IRS, along with concerns about chemical exposure, are common deterrents. Additionally, a lack of information and awareness may lead to hesitancy, especially among women who may not have full autonomy over household health decisions. This limitation, coupled with low trust in spraying programs, can hinder broader acceptance as illustrated by narratives. These findings highlight that knowledge and positive attitudes alone are not always enough to ensure consistent use of malaria prevention methods. Addressing barriers related to

comfort, perception, and accessibility is essential to improving the effectiveness of these interventions.

Overall, the low IRS utilization compared to ITNs suggests barriers to IRS implementation, similar to trends observed in other regions. Studies indicate that IRS acceptance depends heavily on cultural perceptions, accessibility, and trust in spraying programs[26][43]. Additionally, IRS is most effective when mosquitoes rest indoors, meaning its impact can be limited where housing structures do not support residual spraying[41]. A study conducted in Tanzania demonstrated that combining IRS with ITNs significantly reduced malaria transmission, indicating that integrated promotion of both interventions could enhance protection[45].

Factors associated with utilization of ITNs, IPTs and IRS among women

Individuals who had received any form of education related to IPT were significantly more likely to utilize services. Qualitative findings further revealed that women with formal education demonstrated a deeper understanding of IPT although formal education did not emerge as a statistically significant factor in the quantitative analysis. These results align with previous research emphasizing the critical role of awareness and health education in promoting the adoption of preventive health measures[46][47] . For instance, a study conducted in Burundi found that education was a significant predictor of IPT utilization and was strongly associated with receiving the optimal dose among pregnant women [48]. Similarly, research from Nigeria indicated that pregnant women with secondary or tertiary education were 8.3 times more likely to use IPT compared to those without formal education [49]. Furthermore, education was found to play a critical role in improving IPT uptake [50]. These findings highlight the importance of health education programs in increasing IPT coverage and reducing malaria-related complications. Educated individuals are more likely to understand the benefits of ITNs, IPT, and IRS, leading to higher compliance with malaria prevention strategies. This corresponds with other studies, which emphasize that knowledge gaps, misconceptions, and lack of education are major barriers to ITN and IRS utilization[51][38]. Increasing community awareness and behavioral change communication strategies may further improve adoption of these interventions [36].

Age was another influential factor, with individuals over 40 years being less likely to utilize malaria prevention services compared to those aged 30 years or younger (AOR = 0.45, p =

0.005). This finding supports the Mozambique study, which found that older age groups were more resistant to ITN adoption, possibly due to habitual attitudes or a lower perceived risk of malaria [36]**.** Additionally, younger mothers are more consistent in ITN use[23], reinforcing the trend of lower malaria prevention uptake among older populations. This could be due to younger individuals being more receptive to public health campaigns and also surrounded by fear of malaria as being a young mother. Older individuals may perceive malaria as less of a threat due to lifelong exposure and personal coping mechanisms. Also, barriers related to mobility or accessibility may affect older populations.

Challenges faced while using bed nets was significantly associated with lower utilization (AOR=0.44, $p<0.001$). This highlights the practical difficulties individuals experience in consistently using ITNs, such as discomfort, damage to the nets, or misconceptions about their effectiveness. This result align with other studies that identified barriers to ITN use such as poor ventilation, unpleasant odor, undesirable color, and discomfort while sleeping[52][36][53][25]. Addressing these issues through community engagement, improved net designs, and education could enhance ITN adoption.

Single individuals were significantly less likely to utilize malaria prevention services compared to married ones. This could be due to household responsibility where married individuals, especially those with children, might prioritize malaria prevention for their families. It could also be due to social support where married women may receive encouragement from spouses, family, or antenatal care programs, leading to higher uptake of control interventions This finding conforms with studies that support the notion that married women or those living with partners are more likely to use ITNs due to family responsibilities and awareness from antenatal care services[23][32].

Individuals living in temporary housing were less likely to utilize malaria prevention services. This suggests that those in less stable living conditions may face challenges such as limited access to health programs, difficulty maintaining ITNs properly, and consequently, greater exposure to mosquito breeding sites. Evidence from Uganda supports this observation, where studies have shown that housing characteristics are strongly associated with malaria burden. Poorly constructed or temporary housing increased vulnerability to mosquito entry and reduced the effectiveness of ITNs and IRS, while improved housing structures (such as closed eaves and screened windows) were linked to lower malaria transmission. Together,

these findings indicate that housing stability plays a critical role in shaping the utilization and effectiveness of malaria prevention interventions[54]. Similarly, higher income levels have been shown to facilitate ITN acquisition and utilization, reinforcing the idea that financial constraints limit access to preventive interventions[32]. Moreover, the effectiveness of indoor residual spraying (IRS) depends on mosquitoes resting indoors; hence, the structural instability of temporary housing may reduce IRS impact and discourage its adoption. In Lira City, malaria transmission is primarily driven by *Anopheles gambiae* and *Anopheles funestus*, with *Anopheles arabiensis* contributing significantly through outdoor biting [55]. Importantly, outdoor biting sustains residual transmission despite IRS and ITN coverage, underscoring the limitations of interventions that target only indoor vectors [55].

LIMITATIONS

The study relied on participants' recollection of malaria prevention practices during pregnancy, which may have introduced recall bias. Women might have under- or over-reported IPT doses, ITN use, or IRS exposure due to memory lapses or social desirability. Although research assistants were trained to ask questions neutrally and use probing techniques to minimize this bias, the possibility of inaccurate recall remains and could affect the validity of reported coverage rates. Also some participants may have provided incomplete or socially desirable answers despite assurances of confidentiality. This could lead to underestimation of barriers or misrepresentation of true utilization patterns.

The study exclusively targeted women of reproductive age. While this focus is justified given women's central role in pregnancy and household malaria prevention, it limits generalizability to male or mixed-gender populations. Male household members often influence health-seeking behavior and resource allocation. Excluding them may overlook important dynamics in malaria control at the household level.

The research concentrated on three interventions ITNs, IRS, and IPT prioritized and supported by the national malaria control program while excluding other potentially relevant strategies such as larval source management, environmental management or seasonal malaria chemoprevention. This narrow scope may underestimate the broader landscape of malaria prevention and the interplay between multiple interventions. IRS is a government-administered intervention delivered according to scheduled spraying

campaigns. As such, household-level responses may not reflect regular usage or individual decision-making. This limits the ability to assess household agency in IRS uptake and may bias results toward programmatic availability rather than personal utilization.

Data collection did not fully account for seasonal fluctuations in malaria transmission, which can affect both exposure risk and preventive behaviors. For instance, ITN use may be higher during peak transmission seasons, while IRS campaigns are often scheduled around anticipated outbreaks. Without controlling for seasonality, findings may not represent year-round practices.

CONCLUSION AND RECOMMENDATIONS

Women demonstrated substantial knowledge of malaria prevention, with ITNs being the most commonly used method. However, gaps remain in understanding the role of IPT despite its high acceptance. Education level, age, marital status, and housing type were key factors influencing uptake. While many respondents engage in prevention, full adoption of ITNs, IRS, and IPT is still limited.

To improve uptake, stakeholders should strengthen behavior change communication, ensure consistent supply of ITNs and IRS, and maintain the ongoing integration of malaria education into antenatal care services. Building trust between healthcare providers and women, training community leaders, and empowering VHTs to reach vulnerable groups are essential for enhancing adherence and impact.

Abbreviations

IRS: Indoor Residual Spraying

ITN: Insecticides Treated Nets

LLINs: Long-Lasting Insecticidal Nets

MOH: Ministry of Health

WHO: World Health Organization

IPTp: Intermittent Preventive Treatment during Pregnancy.

IPT: Intermittent Preventive Treatment

NMCP: National Malaria Control Program

UMIS: Uganda Malaria Indicator Survey

UBOS: Uganda Bureau of Statistic

VHTs: Village Health Teams

ANC: Antenatal care

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Uganda National Guidelines for Research Involving Humans as Research Participants. The study adhered to the ethical principles of the Helsinki Declaration (2002 version), which sets ethical standards for medical research involving humans, and was approved by the Gulu University Research Ethics Committee (GUREC-2024-989). Permission to collect data within the community was obtained from City clerk of Lira City. Prior to participation, written informed consent was sought from all the participants, and for participants under the age of 16 (minors), consent to participate was obtained from their parents or legal guardians. In the case of illiterate participants, verbal informed consent was obtained, which was documented in the presence of a witness or legally authorized representative. Participation in the study was entirely voluntary. The collected data was exclusively utilized for this study, and participants were informed about the potential publication of the study results. To ensure clarity, the data collection tool (questionnaire) was translated into the native language, 'leb langо,' and then back into English before the commencement of data collection.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors have no declared conflicts of interest.

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