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Factors Contributing to the Utilization of Long-Lasting Insecticidal Nets in Malaria Prevention among Households in Gasabo District, Rwanda

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Abstract: **Malaria remains a major public health challenge, particularly in sub-Saharan Africa, where it continues to contribute substantially to morbidity and mortality. Long-lasting insecticidal nets (LLINs) are among the most effective malaria prevention interventions; however, their utilization remains suboptimal in many high-risk settings. This study assessed the factors influencing the utilization of LLINs for malaria prevention among households in Gasabo District, Rwanda. A quantitative cross-sectional research design was employed, and data were collected using a structured questionnaire administered to 342 households selected from rural and peri-urban sectors. Data were analyzed using STATA 17.0 through descriptive statistics, binary logistic regression, and multivariable logistic regression to determine factors associated with LLIN utilization. The study was guided by the Health Belief Model (HBM) and the Social Ecological Model (SEM) to examine the influence of individual, household, and community-level factors on LLIN adoption and utilization. The findings revealed that the prevalence of LLIN utilization among households in Gasabo District was 55.8%. Awareness of LLINs was significantly associated with increased utilization (AOR = 3.5, 95% CI: 1.08–11.34, $p = 0.037$). Similarly, respondents who correctly identified mosquito bites as the mode of malaria transmission were significantly more likely to use LLINs appropriately (AOR = 2.7, 95% CI: 1.19–6.13, $p < 0.001$). Conversely, sleeping on foam mattresses (AOR = 0.62, 95% CI: 0.39–0.98, $p = 0.040$) and residing in houses with concrete walls (AOR = 0.61, 95% CI: 0.38–0.98, $p = 0.035$) were negatively associated with LLIN utilization. The findings indicate that although LLIN ownership is widespread, utilization remains inadequate and is influenced by both behavioral and structural factors. Strengthening community awareness, improving malaria education, and implementing context-specific interventions that address household environmental conditions could enhance LLIN utilization and contribute to reducing the malaria burden in Rwanda.**

Keywords: **Utilization, Insecticidal Nets, Malaria Prevention, Households, Gasabo District.**

1. INTRODUCTION

Malaria remains one of the world's most significant public health challenges, particularly in tropical and subtropical regions where climatic conditions favor mosquito breeding and disease transmission. According to the World Health Organization (WHO, 2024), an estimated 247 million malaria cases and 619,000 malaria-related deaths were reported globally, with the overwhelming majority occurring in sub-Saharan Africa. Although considerable progress has been achieved over the past two decades through strengthened prevention, diagnosis, and treatment strategies, malaria continues to impose substantial health, social, and economic burdens, especially among vulnerable populations such as children under five years of age and pregnant women (Kruk et al., 2018). Among the most effective malaria prevention interventions is the use of long-lasting insecticidal nets (LLINs), which reduce human-vector contact and have significantly contributed to declining malaria transmission in endemic countries (Nalinya et al., 2022a).

Sub-Saharan Africa continues to account for more than 90% of global malaria cases and deaths (WHO, 2024). The region's tropical climate, characterized by high temperatures, seasonal rainfall, and abundant mosquito breeding sites, sustains year-round malaria transmission in many settings. In response, governments and development partners have invested heavily in vector control interventions, particularly the large-scale distribution of LLINs. Since 2000, more than 1.6 billion LLINs have been distributed across Africa, contributing substantially to reductions in malaria morbidity and mortality (Aguma et al., 2023). Nevertheless, the public health benefits of LLINs largely depend not only on ownership but also on consistent and correct utilization. Evidence indicates that inadequate knowledge of proper net use, poor maintenance practices, physical deterioration of nets, cultural beliefs, and socioeconomic constraints continue to limit effective utilization in many African communities (Wubishet et al., 2021a; Ekusai-Sebatta et al., 2021; Rubuga et al., 2024).

Within East Africa, countries have made remarkable progress in expanding malaria prevention interventions, including universal LLIN distribution campaigns. Rwanda has been recognized as one of the countries demonstrating significant commitment to malaria control through integrated strategies comprising LLIN distribution, indoor residual spraying, effective case management, and strengthened surveillance systems (Karema et al., 2020). National malaria control policies aim to ensure that households have adequate access to LLINs, typically targeting one net for every two household members. Despite these achievements, malaria transmission remains persistent in several districts, with periodic increases in reported cases suggesting that access to LLINs alone is insufficient to achieve sustained malaria control (MOH Rwanda, 2023; Nsekuye et al., 2024).

The continued occurrence of malaria in Rwanda has increasingly been attributed to challenges associated with the effective utilization rather than the availability of LLINs. Studies have shown that household knowledge, perceptions of malaria risk, sleeping arrangements, housing characteristics, socioeconomic conditions, and net maintenance practices significantly influence whether distributed LLINs are consistently used (Hakizimana et al., 2022; Akello et al., 2022a; García et al., 2024). Furthermore, physical degradation of LLINs resulting from frequent washing, prolonged exposure to sunlight, and improper handling reduces their protective effectiveness before scheduled replacement campaigns (Akello et al., 2022a; García et al., 2024). These challenges underscore the importance of complementing mass distribution campaigns with sustained behavioral change communication and community-based education to maximize the protective benefits of LLINs.

Gasabo District, one of Rwanda's malaria-endemic districts, presents a unique setting because it encompasses both urban and rural communities with differing levels of malaria risk and healthcare access. While urban populations generally benefit from improved health infrastructure and greater exposure to health education, many rural communities continue to experience environmental, socioeconomic, and behavioral conditions that favor malaria transmission (Ekusai-Sebatta et al., 2021). Agricultural activities, limited health education, inadequate housing conditions, and competing household priorities may reduce consistent LLIN utilization despite high ownership levels (Hakizimana et al., 2022; Liheluka et al., 2023). Consequently, malaria transmission persists in parts of the district despite sustained vector control interventions. Previous studies conducted in sub-Saharan Africa and Rwanda have primarily examined LLIN ownership, distribution coverage, or the effectiveness of malaria prevention programs at national or regional levels (Asingizwe et al., 2019; Karema et al., 2020; Nsekuye et al., 2024). Although these studies have identified several determinants of LLIN utilization, limited empirical evidence simultaneously examines individual knowledge, household characteristics, and structural factors influencing consistent LLIN use within households in Gasabo District. Moreover, changing malaria epidemiology, improvements in housing conditions, and evolving behavioral practices necessitate updated local evidence to guide context-specific malaria prevention strategies. Therefore, this study sought to assess the factors contributing to the utilization of long-lasting insecticidal nets among households in Gasabo District, Rwanda, with the aim of generating evidence to inform targeted interventions for improving LLIN utilization and strengthening malaria prevention efforts.

2. METHODOLOGY

2.1 Research Design

This research employed a cross-sectional design with a quantitative approach to assess the factors contributing to Long-Lasting Insecticidal Nets (LLINs) in malaria prevention.

2.2 Study Setting

This study was conducted in the Gasabo district, which is located in Kigali city of Rwanda country.

2.3 Study Population

The study population of this study was involved selected households of five (5) among fifteen (15) sectors of Gasabo district and its population size namely: Bumbogo (112,899), Gikomero (125,400), Nduba (95,164), Rutunga (75,611) and Jali (68,424) (NISR et al., 2021) The sample size of 423 was drawn across five rural sectors of the Gasabo district.

2.4 Sample Size Determination

The sample size was calculated using Cochran's formula (Nanjundeswaraswamy & Divakar, 2021), based on a 95% confidence level, a 5% margin of error, and Prevalence of utilization P which, according to A 2020 DHS survey indicated that around 66% of households in Rwanda own at least one LLIN, however as long as owning LLIN does not define utilization, it is yet to be determined so as, the prevalence P will be 50% while q=1-p. The formula will ensure an adequate sample size to detect statistically significant differences in defined variables.

$$N = \frac{Z^2\,pq}{e^2} = \frac{(1.96)^2 \text{ x } 0.5 \text{ x}(1-0.5)}{(0.05)^2} = 384.16$$

Where:

- **Z** = 1.96 (standard normal deviation corresponding to 95% confidence level)
- **p** = estimated proportion of LLINs utilization (0.5 or 50%)
- **e** = margin of error (0.05 or 5%)

To account for potential non-response or incomplete questionnaires, the sample size will be increased by 10%, bringing the total to approximately 423 participants.

2.5 Data Collection Instruments

Data were collected using a structured questionnaire adapted from previous studies and aligned with the study objectives. The questionnaire comprised four sections: sociodemographic characteristics (age, sex, marital status, education level, household size, and occupation), socioeconomic characteristics (income, house ownership, access to electricity, mobile phone ownership, health-related expenditures, and financial assistance), health-related factors (malaria awareness, knowledge of malaria prevention, previous malaria experience, and healthcare recommendations), and LLIN-related factors (ownership, condition, and utilization of long-lasting insecticidal nets). The questionnaire was administered in either Kinyarwanda or English and required approximately 15 minutes, including obtaining informed consent and completing the interview.

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics of Respondents

The results of the study reveal the most common demographic and socioeconomic characteristics among the respondents. The most prevalent age group was 26–35 years, accounting for 122 (28.8%) of the participants. In terms of gender, females slightly outnumbered males, with 224 (53%) of the respondents identifying as female. Married individuals made up the largest proportion of the sample, with 219 (51.8%) reporting their marital status as married. Regarding educational background, the majority of participants had completed primary school, with 179 (42.3%) indicating this as their highest level of education. Most households consisted of 3–5 members, as reported by 245 (57.9%) of respondents. In terms of occupation, farming was the most common, with 116 (27.4%) of participants engaged in agricultural activities. The highest reported household monthly income range was 50,000–150,000 RWF, noted by 175 (41.4%) of respondents. A significant majority, 290 (68.6%), owned their homes, and mobile phone ownership was also widespread, with 357 (84.4%) indicating that they owned a mobile device.

Table 1: Social-demographic characteristics of respondents

Variable	Category	Frequency (n)	Percent (%)
Age group	18–25	86	20.3
	26–35	122	28.8
	36–45	105	24.8
	46–60	65	15.4
	60 and above	45	10.6
Gender	Female	224	53
	Male	199	47
Marital Status	Divorced	38	9
	Married	219	51.8
	Single	145	34.3
	Widowed	21	5
Highest Level of Education	No formal education	29	6.9
	Primary school	179	42.3
	Secondary school	170	40.2
	Tertiary/University	45	10.6
Household Size	1–2	83	19.6
	3–5	245	57.9
	Above 5	95	22.5
Occupation	Business	91	21.5
	Farmer	116	27.4
	Public servant	62	14.7
	Student	95	22.5
	Unemployed	59	13.9
Household Monthly Income	150,001–300,000 RWF	84	19.9
	50,000–150,000 RWF	175	41.4
	Less than 50,000 RWF	125	29.6
	More than 300,000 RWF	39	9.2
Own a House	No	133	31.4
	Yes	290	68.6
Own a Mobile Phone	No	66	15.6
	Yes	357	84.4

Source: Primary data, 2024

3.2 Presentation of Findings

3.2.1 Prevalence of Utilization of LLINs

Figure 1 below, indicates the prevalence of utilization of long-lasting insecticidal nets among households in Gasabo district.

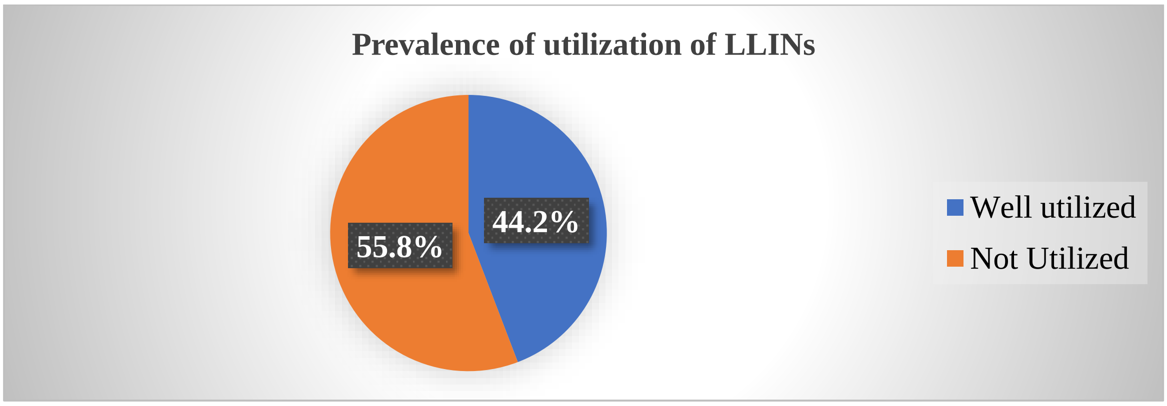

Figure 1: Prevalence of utilization of long-lasting insecticidal nets among households in Gasabo district.

Source: Primary data

To assess the prevalence of long-lasting insecticidal net (LLIN) utilization among households in Gasabo District, the study analyzed whether respondents reported using LLINs during the study period. As shown in the findings, 44.2% of households reported that they had well utilized LLINs, while 55.8% had not utilized them. This indicates that the majority of households in Gasabo District were not using LLINs, with the prevalence of utilization standing at 44.2% during the study period.

3.2.2 Factors contributing to the utilization of LLINs among households in Gasabo District, Rwanda

Several factors were associated with the utilization of Long-Lasting Insecticidal Nets (LLINs) among households in Gasabo District, Rwanda, including socio-demographic characteristics, socio-economic and health related factors.

a) Socio-demographic factors associated with the utilization of LLINs among households in Gasabo District, Rwanda?

The distribution of utilization varied across groups. Individuals aged 36–45 showed the highest proportion of well utilization at 52.4%, while those aged 46–60 showed the lowest at 36.9%. Despite these variations, the statistical test revealed a p = 0.236, indicating that the observed differences in utilization by age group were not statistically significant.

Gender differences were also assessed, with n = 224 females and n = 199 males participating. Among females, 41.1% utilized the service well, compared to 47.7% of males. While males showed slightly higher utilization, the p-value was 0.168, suggesting that the difference was not statistically significant. In terms of marital status, singles demonstrated the highest rate of utilization (51.7%), while married individuals showed lower rates (39.7%). However, with p = 0.143, these differences were again not statistically significant. The highest level of education attained by respondents was also considered. Interestingly, utilization rates were fairly consistent across all education levels, ranging from 43% to 48.3%. Individuals with no formal education had a utilization rate of 48.3%, while those with tertiary education reported 44.4%. The resulting p= 0.957. Lastly, the study examined household size. Respondents in households of 3–5 people had the highest utilization rate at 46.1%, while those in households with more than five people showed lower rates (38.9%). Despite these differences, the p-value was 0.488, again showing no statistically significant association between household size and LLINs utilization.

Table 2: Bivariate analysis of Socio-demographic factors associated with the utilization of LLINs among households in Gasabo District, Rwanda

		LLINs Utilization				
Variables n=423	**Category**	**Well utilized**		**Not well utilized**		**P-Value**
		n	%	n	%	
Age	18-25	33	38.4	53	61.6	0.236
	26-35	54	44.3	68	55.7	
	36-45	55	52.4	50	47.6	
	46-60	24	36.9	41	63.1	
	60 and above	21	46.7	24	53.3	
Gender	Female	92	41.1	132	58.9	0.168
	Male	95	47.7	104	52.3	
Marital Status	Divorced	17	44.7	21	55.3	0.143
	Married	87	39.7	132	60.3	
	Single	75	51.7	70	48.3	
	Widowed	8	38.1	13	61.9	
Highest Level of Education	No formal education	14	48.3	15	51.7	0.957
	Primary school	77	43	102	57	
	Secondary school	76	44.7	94	55.3	
	Tertiary/University	20	44.4	25	55.6	
Household Size	1-2	37	44.6	46	55.4	0.488
	3-5	113	46.1	132	53.9	
	Above 5	37	38.9	58	61.1	

b) Socio-economicic factors associated with the utilization of LLINs among households in Gasabo District, Rwanda?

The findings revealed that only occupation had a statistically significant association with LLIN utilization (p = 0.041), indicating a meaningful difference in utilization levels among different occupational groups. For instance, students had the highest rate of LLIN utilization at 53.7%, followed by public servants (46.8%) and business people (46.2%), while the unemployed had the lowest at 32.2%.

In contrast, other variables examined in the study did not show statistically significant associations with LLIN utilization. Household monthly income (p = 0.390) showed utilization rates ranging from 48.8% for those earning 150,001–300,000 RWF to 38.5% for those earning more than 300,000 RWF. Home ownership (p = 0.966) showed nearly identical utilization rates between those who owned homes (44.1%) and those who did not (44.4%). Similarly, mobile phone ownership (p = 0.623) showed a utilization rate of 47.0% among those without phones and 43.7% among phone owners.

Table 3: Bivariate analyses of Socio-economic factors associated with the utilization of LLINs among households in Gasabo District, Rwanda

		LLINs Utilization				
Variables n=423	**Category**	**Well utilized**		**Not well utilized**		**P-Value**
		n	%	n	%	
Occupation	Business	42	46.2	49	53.8	**0.041**
	Farmer	46	39.7	70	60.3	
	Public servant	29	46.8	33	53.2	
	Student	51	53.7	44	46.3	
	Unemployed	19	32.2	40	67.8	
Household Monthly Income	150,001 - 300,000 RWF	41	48.8	43	51.2	0.39
	50,000 - 150,000 RWF	82	46.9	93	53.1	
	Less than 50,000 RWF	49	39.2	76	60.8	
	More than 300,000 RWF	15	38.5	24	61.5	
Own a House	No	59	44.4	74	55.6	0.966
	Yes	128	44.1	162	55.9	
Own a Mobile Phone	No	31	47	35	53	0.623
	Yes	156	43.7	201	56.3	

Source: Primary data, 2024

c) Association between health-related factors and utilization of LLINs among households in Gasabo District, Rwanda?

The findings revealed that several factors had statistically significant associations with the utilization of Long-Lasting Insecticidal Nets (LLINs) among the study participants (n = 423).

Awareness of LLINs was significantly associated with utilization (p = 0.037). Among those who were aware of LLINs, 45.2% reported using them well, compared to only 18.8% among those who were not aware. The type of sleeping place also showed a significant association with LLIN utilization (p = 0.040). Utilization was higher among those who slept on grass mattresses (49.0%) than among those who slept on foam mattresses (40.2%). The condition of the walls in the sleeping area was also significantly associated with utilization (p = 0.035). Participants living in houses with mud and wood frame walls had a higher utilization rate (48.7%) than those living in houses with concrete walls (38.5%). Other variables, including having an LLIN (p = 0.217), frequency of LLIN use (p = 0.202), household malaria cases in the past year (p = 0.781), perception of LLIN effectiveness (p = 0.788), and malaria prevention priority (p = 0.747), did not show statistically significant associations with LLIN utilization.

These results suggest that awareness of LLINs (p = 0.037), type of sleeping place (p = 0.040), and wall condition of the room (p = 0.035) are significantly associated with how well LLINs are utilized.

Table 3: Bivariate analysis of other health-related factors and utilization of LLINs among households in Gasabo District, Rwanda

		LLINs Utilization				
Variables n=423	**Category**	**Well utilized**		**Not well utilized**		**P-Value**
		n	**%**	**n**	**%**	
Aware of LLINs	No	3	18.8	13	81.3	**0.037**
	Yes	184	45.2	223	54.8	
Have an LLIN	No	12	34.3	23	65.7	0.217
	Yes	175	45.1	213	54.9	
Frequency of LLIN Use	Every night	120	46.7	137	53.3	0.202
	Never	23	47.9	25	52.1	
	Occasionally	44	37.3	74	62.7	
Household Malaria Cases (Past Year)	No	115	44.7	142	55.3	0.781
	Yes	72	43.4	94	56.6	
LLIN Effectiveness Perception	I don't know	15	38.5	24	61.5	0.788
	Not effective	26	44.8	32	55.2	
	Somewhat effective	59	47.2	66	52.8	
	Very effective	87	43.3	114	56.7	
Malaria Prevention Priority	No	38	45.8	45	54.2	0.747
	Yes	149	43.8	191	56.2	
Heard about malaria	No	0	0	1	100	0.373
	Yes	187	44.3	235	55.7	
Malaria transmission mode	Mosquito bite	176	43.3	230	56.7	**<0.001**
	Other modes	11	64.7	6	35.3	
Preventive measure	Drainage stagnant water	3	75	1	25	0.308
	IRS	3	30	7	70	
	LLINs	181	44.3	228	55.7	
Mosquito biting time	All the time	32	48.5	34	51.5	0.628
	At night time	148	43.8	190	56.2	
	Day time	7	36.8	12	63.2	
Educational message on LLINs	No	1	20	4	80	0.273
	Yes	186	44.5	232	55.5	
Source of information	HEW	159	46	187	54	0.303
	Media	25	36.8	43	63.2	
	Others	3	33.3	6	66.7	
Reason for not using LLINs	Attract other insects	14	35.9	25	64.1	0.514
	For other purpose	39	42.9	52	57.1	
	No malaria now	92	47.7	101	52.3	
	Too hot	42	42	58	58	
Priority to sleep under LLIN	All family	146	43.5	190	56.5	0.335
	Pregnant women	21	55.3	17	44.7	
	Under five children	20	40.8	29	59.2	
Periods to use LLINs	All the year	53	44.9	65	55.1	0.912
	Dry season	16	47.1	18	52.9	
	Rainy season	118	43.5	153	56.5	
Sleeping place	Foam mattress	92	40.2	137	59.8	**0.040**
	Grass mattress	95	49	99	51	
Where LLINs found	Discarded	36	46.8	41	53.2	0.879
	Inside	110	43.5	143	56.5	
	Outside	41	44.1	52	55.9	
Walls of the room status	Concrete	72	38.5	115	61.5	**0.035**
	Mud with wood frame	115	48.7	121	51.3	

Source: Primary data, 2024

d) Multivariate Analysis of factors contributing to the utilization of LLINs among households in Gasabo District, Rwanda?

According to table 5. The study reveals several important factors that influence the utilization of Long-Lasting Insecticidal Nets (LLINs). Individuals who are aware of LLINs are 2.4 times more likely to use them properly compared to those who are unaware ($p = 0.037$), emphasizing the role of awareness in promoting effective usage. However, ownership of an LLIN does not significantly impact utilization, with no notable difference between owners and non-owners ($p = 0.217$). The frequency of use also does not affect proper usage, as indicated by the p-value of 0.202. Interestingly, people who believe in transmission modes other than mosquito bites are 2.6 times more likely to use LLINs effectively ($p < 0.001$), suggesting that misconceptions about malaria transmission could ironically lead to better net utilization. Additionally, those who sleep on foam mattresses are 1.5 times less likely to use LLINs properly compared to those on grass mattresses ($p = 0.04$), highlighting how comfort and sleeping conditions can influence usage. Furthermore, individuals in households with mud and wood-frame walls are 1.5 times more likely to use LLINs well compared to those with concrete walls ($p = 0.035$), indicating that environmental factors, like housing structure, play a role in LLIN utilization. Other factors, such as household malaria cases, perceptions of LLIN effectiveness, and malaria prevention priorities, did not show significant associations with proper usage, suggesting that while these elements are important, they do not have as strong an impact as awareness, misconceptions, and environmental factors.

Table 4: Multivariable analysis of factors contributing to the utilization of LLINs among households in Gasabo District, Rwanda

Variables	Well utilized n(%)	Not well utilized n(%)	AOR	95% C.I	P-value
Walls of the room status					
Concrete(ref)	72(38.5)	115(61.5)		1	
Mud with wood frame	115(48.7)	121(51.3)	1.61	(1.07-2.4)	**0.021**
Sleeping place					
Grass mattress	95(49.0)	99(51.0)	1.46	(0.98-2.18)	0.063
Foam mattress(ref)	92(40.2)	137(59.8)		1	
Malaria transmission mode					
Mosquito bite	176(43.3)	230(56.7)	2.39	(0.14-4.11)	**0.032**
Other modes(ref)	11(64.7)	6(35.3)		1	
Aware of LLINs					
Yes(ref)	184(45.2)	223(54.8)		1	
No	3(18.8)	13(81.3)	3.82	(1.03-14.22)	**0.040**
Occupation					
Farmer	46(39.7)	70(60.3)	1.80	(0.45-2.11)	**0.026**
Public servant	29(46.8)	33(53.2)	1.09	(0.56-2.12)	0.796
Student	51(53.7)	44(46.3)	1.40	(0.78-2.53)	0.259
Unemployed	19(32.2)	40(67.8)	0.54	(0.27-1.09)	0.087
Business(ref)	42(46.2)	49(53.8)		1	

Source: Primary data 2024, AOR: Adjusted Odds ratio, Ref: reference category**, Bold***: significant at p value <0.05,

3.2.3 Model Building Strategy

Multicollinearity Assessment

To ensure the validity and interpretability of the logistic regression model, a multicollinearity assessment was performed using the Variance Inflation Factor (VIF) test. Multicollinearity occurs when two or more independent variables in a regression model are highly correlated, which can inflate the variance of coefficient estimates and make the model unstable or difficult to interpret. The VIF test results showed a mean VIF of 1.00, and all individual VIF values were either exactly 1.00 or very close to it. In addition, the 1/VIF values were also 1.00, which further confirms the absence of linear relationships among the independent variables. These values are well below the commonly accepted threshold (VIF > 5 or 10), beyond which multicollinearity may become a concern. Based on these findings, it was concluded that there is no evidence of multicollinearity among the predictor variables in the model. This indicates that the independent variables are statistically independent, and the estimated regression coefficients can be considered reliable, stable, and interpretable. Consequently, no variables were excluded or transformed due to multicollinearity, allowing the model to retain its original structure for further analysis.

4. DISCUSSION

This study reveals that 44.2% of households in Gasabo District, Rwanda, effectively utilize long-lasting insecticidal nets (LLINs), which is similar to a study done in Kazo District, Uganda, where 54.4% of households used ITNs despite 60% owning them (Kwiringira et al., 2022). Both studies highlight that ownership alone does not ensure utilization. Furthermore, as seen in research from southern Rwanda, where 84.1% of pregnant women owned LLINs but only 87.6% used them, barriers such as cultural beliefs, lack of awareness, and access issues were identified as common factors hindering full utilization (Habimana et al., 2020).

The study found that individuals who were aware of LLINs were 3.82 times more likely to use them effectively compared to those who were unaware (AOR = 3.82, p = 0.040). This result aligns with numerous studies, such as (Wubishet et al., 2021a), which demonstrated that awareness significantly boosts LLIN usage.

This may be because people who understand the importance of LLINs are more likely to adopt and use them correctly. Education about malaria and the protective benefits of LLINs tends to foster better practices. However, in some studies, despite high levels of awareness, proper utilization remained low. The study done by (Anikwe et al., 2020) noted that even though individuals were aware of LLINs, socio-cultural factors, limited access, or perceived discomfort with the nets still hindered proper use. This may be due to external barriers, such as limited availability or cultural perceptions of LLINs, that education alone may not overcome.

The study found that individuals living in houses with mud and wood-frame walls were 1.61 times more likely to use LLINs properly compared to those living in homes with concrete walls (AOR = 1.61, p = 0.021). This may be due to environmental factors, such as the ventilation in homes with mud walls, which could make them more comfortable to sleep in with an LLIN. This contrasts with other studies, which reported that concrete houses were associated with better malaria prevention practices because they are less permeable to mosquitoes (Nawa et al., 2024). The difference may also be due to local contextual factors, such as the physical space or room layout, which can influence how easily LLINs are used in different types of homes.

The study also found a marginally significant result regarding sleeping place, where individuals using grass mattresses were slightly more likely to use LLINs correctly compared to those with foam mattresses (AOR = 1.46, p = 0.063).

In contrast, foam mattresses are often found in more urban settings, where people may sleep on elevated beds, creating a barrier to the proper use of LLINs (Nuwamanya et al., 2018). The difference here may be due to cultural norms and living conditions, with rural households being more integrated into traditional practices that prioritize malaria prevention also it may be due to the fact that grass mattresses are more common in rural areas, where people may be more accustomed to sleeping on the floor, a practice that might facilitate easier use of LLINs.

In this study, individuals who believed that malaria is transmitted by mosquito bites were 2.39 times more likely to use LLINs effectively compared to those who believed in other transmission modes (AOR = 2.39, p = 0.032).

This finding is consistent with other study done in Uganda, where understanding malaria transmission was linked to higher LLIN usage (Cote et al., 2021). However, some studies, such as (Adeneye et al., 2020), have found that knowledge alone does not always lead to behavior change, which may be due to economic constraints or physical access to LLINs, which can limit the ability to act on that knowledge and may be due to when people correctly understand that mosquitoes are the primary vector for malaria, they are more likely to take action to protect themselves.

The study found that farmers were 1.80 times more likely to use LLINs properly compared to business owners (AOR = 1.80, p = 0.026). This finding aligns with other study done which found that rural workers were more likely to adopt malaria prevention practices. In contrast, public servants and students in this study did not show significant differences in LLIN utilization (Asingizwe et al., 2019). This may be due to lower perceived risk in urban settings or occupations that involve less exposure to malaria, thus reducing the perceived need for LLIN use.

The study also revealed that unemployed individuals were 0.54 times less likely to use LLINs effectively (AOR = 0.54, p = 0.087).. This finding is consistent with (Yirsaw et al., 2024) which indicated that individuals from lower-income backgrounds were less likely to use LLINs due to the cost or limited access to the nets. The lack of consistent income or employment might lead to fewer resources for purchasing or replacing LLINs. This may be due to socioeconomic factors, where unemployed individuals may face financial barriers that limit their access to LLINs or make it difficult for them to maintain their use.

5. CONCLUSION

This study assessed the level of long-lasting insecticidal net (LLIN) utilization and identified the factors influencing their use among households in Gasabo District, Rwanda. The findings indicate that LLIN utilization remains suboptimal despite ongoing malaria prevention efforts. Awareness of LLINs and accurate knowledge of mosquito bites as the mode of malaria transmission were significant positive predictors of LLIN utilization, whereas sleeping on foam mattresses and residing in houses with concrete walls were negatively associated with consistent LLIN use. These findings demonstrate that both behavioral and household structural factors influence the effective utilization of LLINs.

The study underscores the need for malaria control interventions that extend beyond increasing LLIN ownership to promoting their consistent and correct use. Strengthening community health education, improving awareness of malaria transmission and prevention, and implementing context-specific behavioral change interventions are essential for enhancing LLIN utilization. In addition, malaria control programs should consider household environmental and structural characteristics when designing intervention strategies. Addressing these factors will contribute to improving the effectiveness of LLIN-based malaria prevention and support Rwanda's efforts toward reducing malaria transmission and achieving sustained malaria control.

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