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Original Research Article

Predictors of Long-Lasting Insecticidal Net Ownership among Households in Gombe Metropolis, North-east Nigeria

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Abstract

Malaria continues to be a major public health concern worldwide, with sub-Saharan Africa carrying the highest burden of illness and death. Nigeria contributes a large share of global cases and fatalities, particularly among children under five years. Although long-lasting insecticidal nets (LLINs) are a proven and widely promoted preventive measure, their consistent use remains low in many communities. This study examined the factors influencing LLIN ownership among households in Gombe Metropolis, North-east Nigeria, to provide evidence for improving malaria prevention strategies. A community-based cross-sectional study was conducted among adult household members aged 18 years and above who had lived in Gombe Metropolis for at least six months. A sample size of 420 was determined using Fisher's formula, with a 10% added for non-response. A modified WHO 30-cluster sampling technique was used to select 30 settlements from 282 communities, followed by systematic household selection within clusters. Data were collected in June 2025 using a semi-structured questionnaire adapted from the Nigeria Malaria Indicator Survey and the Nigeria Demographic and Health Survey. The questionnaire captured socio-demographic characteristics, malaria knowledge, LLIN ownership and use, as well as barriers and facilitators to utilization. Data were collected electronically using KoboToolbox and analyzed using Microsoft Excel and Epi Info version 7.2. Chi-square tests and multivariate logistic regression were used to identify factors associated with LLIN ownership ($p < 0.05$). All 420 questionnaires were completed, giving a 100% response rate. The mean age of respondents was 26 ± 6.0 years, and most were married (88.8%), Muslim (96.2%), and Hausa (46.7%). Overall, 80.7% had good knowledge of malaria and LLINs, while awareness of malaria was almost universal (98.6%). Most households (86.7%) owned at least one

LLIN and ownership was significantly associated with antenatal care attendance, malaria knowledge, exposure to health worker and media messages, and community availability of nets ($p < 0.05$). Despite high awareness and relatively good ownership of LLINs, ownership remains below recommended levels in Gombe Metropolis. Both access-related factors and personal experiences especially comfort and perceptions play important roles in determining LLIN ownership. There are needs to strengthen LLIN distribution through antenatal care services and community platforms, improve targeted health education through health workers and media, and address behavioural barriers such as heat, discomfort, and perceived inconvenience. Community engagement and tailored interventions for vulnerable households are also essential to improve sustained LLIN ownership and reduce malaria transmission.

Introduction

Malaria remains one of the most pressing global health challenges of the 21st century, exerting a disproportionate toll on low- and middle-income countries. Despite decades of concerted control efforts, the disease continues to exact a heavy burden on vulnerable populations. Recent estimates indicate that in 2023 there were approximately 263 million new malaria cases globally, translating to an incidence rate of 60.4 cases per 1,000 population at risk, a concerning increase compared to the preceding year (World Health Organization [WHO], 2024). This reversal of earlier gains underscores the fragility of progress and highlights the persistent gaps in prevention, treatment, and vector control interventions but the burden of malaria is not equally distributed across the globe. Sub-Saharan Africa remains the epicenter of the epidemic, accounting for 94% of all cases and 95% of malaria-related deaths worldwide (WHO, 2024). Within this region, children under five and pregnant women continue to suffer the greatest consequences due to their heightened biological vulnerability. Alarmingly, an estimated 597,000 deaths were attributed to malaria in 2023 alone, of which 95% occurred in the WHO African Region (WHO, 2024). Just four countries, Nigeria, the Democratic Republic of the Congo, Niger, and the United Republic of Tanzania were responsible for more than half of these fatalities, underscoring the uneven distribution of disease burden and the urgent need for intensified country-specific strategies (WHO, 2024).

Malaria's persistence reflects not only the biological resilience of the parasite and its vectors but also the intersection of socioeconomic, environmental, and health system challenges. Climate variability, rapid urbanization, weak surveillance systems, and inequities in access to care collectively fuel ongoing transmission (WHO, 2024). Thus, while malaria is a preventable and curable disease, its continued high incidence and mortality emphasize the importance of renewed commitment to global and regional elimination goals (WHO, 2024).

Nigeria continues to carry one of the heaviest malaria burdens globally, a reality that has profound implications for its health system and overall development. In 2022, the country accounted for an estimated 27% of global malaria cases and 31% of malaria-related deaths, positioning it as the single largest contributor to the worldwide burden of the disease (WHO, 2024). This translated into an estimated 66.7 million malaria cases, a staggering figure that underscores both the scale and persistence of transmission within the country (WHO, 2024).

By 2023, malaria remained firmly entrenched as the leading cause of morbidity and mortality in Nigeria, responsible for more hospital admissions and outpatient consultations than any other disease (Malaria Consortium, 2025). The human cost is most evident among children under five years of age, who are at greatest risk of severe illness and death due to their still-developing immunity (Ogunwale et al., 2024). These children often endure repeated episodes of malaria each year,

contributing significantly to the nation's high under-five mortality rates. The ongoing heavy toll among this vulnerable age group highlights the urgency of strengthening prevention and control interventions, while also addressing the broader socioeconomic and environmental determinants that sustain transmission (Ogunwale et al., 2024).

Vector control remains the cornerstone of malaria prevention, with long-lasting insecticidal nets (LLINs) recognized as one of the most cost-effective and scalable interventions. Endorsed by the World Health Organization (WHO), LLINs are central to global initiatives such as Roll Back Malaria and the Global Technical Strategy for Malaria 2016–2030 (WHO, 2015; WHO, 2014).

In Nigeria, large-scale mass distribution campaigns have significantly expanded household ownership of LLINs, delivering millions of nets nationwide and contributing to notable improvements in coverage indicators. Yet, a persistent gap remains between LLIN ownership and consistent utilization, reflecting the complex interplay of behavioural, socio-economic, and systemic barriers (WHO, 2014; Nwachukwu et al., 2022). These challenges underscore the reality that increasing physical access to LLINs, while critical, is insufficient on its own to guarantee effective protection. Closing this gap will require integrated strategies that address community perceptions, user preferences, and structural limitations within the health system (Nwachukwu et al., 2022).

Gombe State in north-east Nigeria exemplifies this paradox, where household ownership of LLINs is relatively high, yet actual usage remains critically low. This disconnect is not unique to Gombe; similar trends have been consistently observed across several parts of sub-Saharan Africa, highlighting the persistent challenge that possession of a net does not automatically ensure its use (Okova et al., 2024; Abubakar et al., 2020). The reasons for this gap are multifaceted, encompassing behavioural preferences, cultural practices, and socio-economic constraints, as well as issues related to comfort and perceptions of risk (Abubakar et al., 2020). Understanding these determinants, particularly the behavioural and socio-cultural factors that influence decision-making at the household level is essential for tailoring interventions that go beyond distribution to foster consistent and effective utilization.

This study therefore, seeks to address this critical gap by examining the barriers and facilitators that influence LLIN ownership among households in Gombe Metropolis. By systematically identifying the behavioural, socio-cultural, and structural determinants of ownership, the research aims to generate context-specific evidence that can inform more effective malaria control strategies. The findings will provide valuable insights for policymakers, programme managers, and implementing partners, ensuring that the considerable investments made in LLIN procurement and distribution translate into measurable improvements in coverage, consistent ownership, and ultimately, reductions in malaria-related morbidity and mortality (Ankomah et al., 2012; MacroTrends, 2025).

Methodology

Study Area

The study was carried out in Gombe Metropolis, located in north-east Nigeria. The area represents a multi-ethnic and socio-culturally diverse setting, comprising urban, peri-urban, and rural communities within a landmass of approximately 82 km² and an estimated population of 620,000 in 2025, projected from the 2006 national census (MacroTrends, 2025). The metropolis lies within the Sahel–savannah ecological zone, characterized by annual rainfall reaching 976 mm and vegetation conducive to malaria transmission (Nigerian Meteorological Agency [NiMET], 2024). Several rivers and streams intersect the area; however, inadequate drainage systems contribute to extensive mosquito breeding sites, particularly in peri-urban and rural neighborhoods (Gombe State Environmental Protection Agency [GSEPA], 2023).

Health service provision in Gombe is relatively robust, with 69 functional health facilities across 13 wards, including a Federal Teaching Hospital, a Specialist Hospital, Women and Children's Hospital, two Comprehensive Health Centres, 32 private clinics, and 34 primary healthcare facilities. Collectively, these institutions provide antenatal

care (ANC) to an estimated 32,216 pregnant women annually (Gombe State Ministry of Health [GSMoH], 2025). As part of malaria control interventions, free malaria treatment and LLINs are routinely distributed through ANC services as well as through periodic mass community campaigns targeting pregnant women and children under five years of age (Gombe State Malaria Elimination Programme [GSMEP], 2024).

Study Design

A descriptive, community-based cross-sectional design was employed.

Study Population

All household members aged 18 years and above who had resided in Gombe Metropolis for at least six months prior to the survey were included. Temporary visitors, household members in transit or on vacation within the study area, and individuals with communication impairments such as speech or cognitive difficulties that could hinder effective participation in the study were excluded.

Sample Size Determination

The sample size was determined using the Fisher's formula (Lwanga & Lemeshow, 1991):

$n = Z^2pq / d^2$

Where: Z = Standard normal deviate corresponding to 95% confidence interval was 1.96, p = 0.56 (56%) Proportion of children below the age of 5 years using LLIN in the North-east Nigeria (WHO, 2018), q = Complement probability = (1 – p) = 0.44 (44%), d = level of precision was set at 0.05 ($n = (1.96)^2 \times 0.56 (1 – 0.56) / (0.05)^2$; n = 378)

Making a provision for an anticipated maximum non-response rate (nr) of 10%:

Nr = n × 1 / (1 – nr) assuming nr of 10%; = 378 × 1 / (1 – 0.1); = 378 × 1.11; = 420

Sampling Method

The study employed a modified WHO 30-cluster sampling approach (WHO, 1991). From a list of 282 settlements (provided by the Gombe LGA PHC Immunization Office), 30 clusters were systematically selected using a sampling interval of nine and a random starting point. Within each selected settlement, households were chosen via settlement-based systematic sampling. Maps and guidance from traditional leaders enabled field teams to identify central starting points. Thereafter, a standardized upward clockwise path was adhered to, with research team turning right at every opportunity, and systematically sampling households until the ward-specific quota was achieved.

Data Collection

Data collection employed a semi-structured questionnaire adapted from national templates, including the Nigeria Malaria Indicator Survey (NMIS) (National Malaria Elimination Programme [NMEP] et al., 2016) and the Nigeria Demographic and Health Survey (NDHS) (National Population Commission [NPC] & ICF International, 2014). The questionnaire comprised five sections: Socio-Demographics characteristics of the respondents, Malaria knowledge among respondents, LLIN ownership and usage among respondents, facilitators of LLIN use among respondents, and barriers to effective LLIN use among respondents.

The questionnaire was translated into Hausa and back-translated into English to ensure conceptual equivalence. A pre-test was conducted among 42 households (10% of intended sample) in a non-study ward, with subsequent refinements implemented based on the feedback obtained during the pre-test.

Data were collected over a 21-day period in June 2025 using KoboToolbox via the Open Data Kit (ODK, v1.24.0), minimizing entry errors and improving efficiency. Twelve research assistants—including midwives, nurses, CHEWs, and VCMs—were recruited based on their previous experience in data collection and trained over three days on the study protocol, participant engagement, ODK navigation, role-playing interviews, and pre-test procedures. Daily debriefings were held to ensure data completeness, with revisit efforts initiated the following day for missing, incomplete, or inconsistent responses.

Data Analysis

Survey data were securely stored on the KoboToolbox server, and then exported in CSV format for cleaning and analysis using Microsoft

Excel 2016 and Epi Info version 7.2.0.1. Dependent variables consisted of LLIN ownership; independent variables included socio-demographic factors (age, marital status, education, occupation, income), residence type, parity, ANC attendance, household size, and spouse's educational level. A malaria/LLIN knowledge score based on 12 items was computed and classified into good, fair or poor knowledge. Respondents with a mean score of 75% or more were classified as having good knowledge, while mean scores from 50-74 were classified as fair, whereas respondents with scores below the mean score of 50% were classified as having poor knowledge (Soleimani-ahmadi et al., 2014).

Data were summarized using descriptive statistics such as means and standard deviation for quantitative variables such as age. Frequencies and proportions were calculated for qualitative variables such as level of education, ownership of LLIN. Bivariate analysis was conducted to test for significance of association between the dependent and independent variables with level of significance set at 5%. Significant factors were then subjected to multivariate analysis to identify the intrinsic determinants of LLIN ownership among respondents.

Ethical Considerations

Ethical approval was sought for and obtained from the Gombe State Ministry of Health Ethical Review Committee. Written informed consent (signature or thumbprint) was obtained from all participants after providing them with clear information on the study's objectives, procedures, and their rights, including confidentiality, anonymity, voluntary participation, and the option to withdraw at any stage without penalty. All identifying information was anonymized, and data were stored securely and were accessed only by individuals engaged in the study.

Participants were informed that the study entailed no physical or legal risks beyond the time commitment required to complete the questionnaire. They were further advised that, although no financial remuneration would be provided, their participation would contribute to the generation of evidence intended to inform and strengthen healthcare policy and practice, with potential long-term benefits for health system performance and population well-being.

Results

A total of 420 questionnaires were administered and analysed, yielding a response rate of 100%.

Socio-demographic Profile

Table 1 presents the socio-demographic characteristics of respondents. The mean age of respondents was 26 ± 6.0 years, with the largest proportion [160 (38.1%)] aged 25–29 years. The majority were married [373 (88.8%)], Muslims [404 (96.2%)], and of Hausa ethnicity [196 (46.7%)]. Most respondents [294 (70.0%)] resided in urban areas. Household heads were predominantly petty traders and artisans [145 (34.5%)]. More than two-thirds [318 (75.7%)] had at least secondary school education. All respondents were employed, with 141 (33.6%) earning less than ₦18,000 (minimum wage) monthly. Only 56 (13.3%) of the households had members currently pregnant. Respondents have an average family size of 6.7, with the majority [276 (64.5%)] having fewer than nine members. Among respondents with a history of pregnancy in their households, 278 (66.2%) reported ANC visits of four or more times. A small proportion of respondents' spouses [36 (8.6%)] had no formal education, while most [354 (84.3%)] earned less than ₦18,000 monthly.

Knowledge of Malaria and LLIN

As shown in Figure 1, overall, 339 (80.7%) of respondents demonstrated good knowledge of malaria and LLIN, while 22 (5.2%) had poor knowledge.

Table 2 presents the detailed knowledge of respondents regarding malaria and LLINs. Almost all respondents [414 (98.6%)] had heard of malaria. Fever (95.0%) and chills (59.1%) were the most frequently cited symptoms, while fewer mentioned vomiting (11.7%). Mosquito bites were widely recognized as the main mode of transmission (94.8%), though 2.1% reported not knowing how malaria is transmitted.

Table 1: Socio-demographic Profile of Respondents with Relevant Family and Spousal History

Variables	Freq	Pert. (%)
Age group (in years)		
18-19	21	5.0
20-24	43	10.2
25-29	160	38.1
30-34	91	21.7
35-39	51	12.1
40-44	17	4.1
≥45	37	8.8
Marital status		
Married	373	88.8
Divorcee	26	6.2
Widow	21	5.0
Religion		
Christianity	16	3.8
Islam	404	96.2
Position within the household		
Household head	49	11.7
Spouse	363	86.4
Others	8	1.9
Ethnicity		
Hausa	196	46.7
Fulani	149	35.5
Terawa	22	5.2
Tangale/Waja	18	4.3
Kanuri	13	3.1
Others	22	5.2
Settlement type		
Rural	126	30.0
Urban	294	70.0
Occupation of household head		
Farmer	97	23.1
Petty trading/Artisans	145	34.5
Public/Private Service	178	42.4
Educational status of household head		
No formal education	34	8.1
Primary	68	16.2
Secondary	143	34.0
Tertiary	175	41.7
Average monthly income		
<₦18,000	141	33.6
≥₦18,000	279	66.4
Pregnant Status of respondent's spouse		
Pregnant	56	13.3
Not Pregnant	364	86.7
Frequency of ANC visits during index pregnancy		
< 4 times	142	33.8
≥4 times	278	66.2
Family size (Mean = 6.7)		
1 – 4	127	30.2
5 – 9	149	35.5
10 – 14	83	19.8
15 and above	61	14.5
Educational level of Spouse		
No formal Education	36	8.6
Primary	79	18.8
Secondary	231	55.0
Tertiary	74	17.6
Occupation of Spouse		
Housewife	134	31.9
Petty trading / Artisan	215	51.2
Public / Private service	71	16.9
Average monthly income of Spouse		
<₦18,000	354	84.3
≥₦18,000	66	15.7

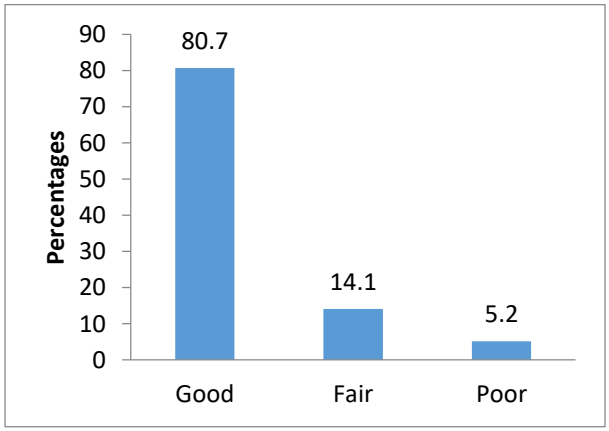

Figure 1: Respondents Knowledge of Malaria and LLIN among Respondents

LLIN use (92.1%) and insecticide sprays (82.4%) were the most frequently cited preventive measures. For malaria in pregnancy, respondents highlighted LLIN (90.7%) as the most effective preventive measure, followed by Sulphadoxine-Pyrimethamine (55.5%), insecticide sprays (46.9%), and mosquito coils (7.9%). Children (60.0%) and pregnant women (31.2%) were perceived as most at risk of malaria. More than two-thirds (67.9%) identified artemisinin-based combination therapy

(ACT) as the preferred treatment, while 4.1% did not know the recommended drug. The majority [391 (93.1%)] had heard of long-lasting insecticidal nets (LLIN). Most identified malaria prevention (81.2%) and protection from mosquito bites (67.9%) as key benefits of LLIN use. A large proportion [85.2%] considered children and pregnant women as priority groups for LLIN use.

Table 2: Respondents Knowledge of Components of Malaria and LLIN

Variables	Freq (n=420)	Percent (%)
Ever heard of malaria		
Ever heard	414	98.6
Never heard	6	1.4
Symptoms*		
Fever	399	95.0
Cold	248	59.1
Headache	231	55.0
Joint pain	119	28.3
Loss of appetite	64	15.2
Vomiting	49	11.7
Jaundice	37	8.8
Altered Consciousness	6	1.4
Modes of malaria transmission*		
Mosquito bite	398	94.8
Stagnant water	175	41.7
Dirty environment	63	15.0
Contact with infected person	24	5.7
Don't know	9	2.1
People at higher risk of malaria infection		
Children	218	51.9
Pregnant women	156	37.1
Everybody	39	9.3
Adults	7	1.7
Respondents' knowledge on drug treatment of malaria		
ACT	286	68.1
Chloroquine	57	13.6
Sulfadoxime-pyrimethamine	39	9.3
Paracetamol	24	5.7
Herbal remedy	9	2.1
Don't know	5	1.2
Measures of malaria prevention*		
Use of LLINs	387	92.1
Use of Insecticide sprays	346	82.4
Environmental sanitation	128	30.5
Closing doors and windows	106	25.2
Use of Mosquito coils	49	11.7
Use of Repellants	15	3.6
Measures for preventing malaria in pregnancy*		
Use of LLINs	381	90.7
Use of Sulfadoxine-pyrimethamine	233	55.5
Use of insecticide sprays	197	46.9
Closing windows and doors	106	25.2
Use of mosquito coils	33	7.9
Use of Repellants	25	6.0
Aware about LLIN		
Ever heard of LLIN	391	93.1
Never heard of LLIN	29	6.9
Usefulness of LLIN*		
Prevention of malaria	341	81.2
Prevention of mosquito bite	285	67.9
Killing of mosquito	59	14.1
Prevention of typhoid fever	7	1.7
Who needs LLINs most in the house		
Children and pregnant women	358	85.2
Children under 5	29	6.9
Pregnant women	21	5.0
Children	9	2.1
Adults	3	0.7

*Multiple responses allowed

Ownership of LLIN

Table 3 presents the ownership patterns of LLIN among respondents. Most households 373 (88.8%) confirmed availability of LLIN within their communities, and [364 (86.7%)] owned at least one LLIN. Majority of the respondents [339 (93.0%)] obtained LLINs free of charge through community distribution, ANC clinic visits, or vaccination

campaigns. Others purchased LLINs (5.0%) or received them through medical and religious outreaches (1.0%).

Table 3: Ownership of LLIN among Respondents

Variables	Freq (n=420)	Percent (%)
Availability of LLIN in the community		
LLIN available	373	88.8
LLIN not available	47	11.2
Ownership of at least 1 LLIN		
Yes	364	86.7
No	56	13.3
Source of obtaining LLINs		
Free	339	93.0
Bought	18	5.0
Others	7	1.0
Ownership and use of LLINs		
Observed hanged	267	63.6
Observed not hanged	58	13.8
Not sighted	39	9.3
Do not have LLIN	56	13.3

Bivariate Analysis of Factors Influencing LLIN Ownership

Table 4 presents the bivariate analysis of factors associated with LLIN ownership. Ownership of LLIN was significantly associated with ANC attendance of four or more visits [$\chi^2 = 115.7$, $p < 0.001$], community availability of LLIN [$\chi^2 = 109.5$, $p < 0.001$], and good knowledge of malaria [$\chi^2 = 97.8$, $p < 0.001$]. Other significant factors included family size [$\chi^2 = 20.7$, $p < 0.001$], level of education [$\chi^2 = 18.3$, $p < 0.001$], media as source of information [$\chi^2 = 108.6$, $p < 0.001$], occupation [$\chi^2 = 9.13$, $p = 0.01$], and spouse's monthly income [$\chi^2 = 14.8$, $p < 0.001$]. No statistically significant association was found between respondents' income and LLIN ownership. On the contrary, households with spouses earning ₦18,000 or more were more likely to own LLIN.

Multivariate Analysis of Factors Influencing LLIN Ownership

Table 5 presents the multivariate logistic regression analysis of factors influencing LLIN ownership. Key independent predictors of LLIN ownership after adjustment were family size, ANC attendance, education, knowledge, media exposure, community availability, and spouse's income. Occupation lost significance, suggesting its effect is mediated by other socioeconomic factors.

Discussion

This study revealed a high level of awareness of malaria among respondents, with 98.6% familiar with the disease and 94.8% correctly attributing its transmission to mosquito bites. Similar findings were reported by the NetMark survey in Nigeria, where the majority of respondents in Kano (94.7%) and Maiduguri (97.7%) recognized mosquitoes as the cause of malaria, compared with lower proportions in Lagos (84.3%), Nsukka (77.7%), and Ibadan (73.9%) (NetMark, 2004). The consistent attribution of malaria to mosquitoes may reflect the close association of local terminologies for malaria with mosquitoes in many Nigerian communities. In contrast, studies outside Nigeria have reported alternative views. For instance, in Ethiopia, a substantial proportion attributed malaria to poor hygiene and rubbish disposal (Adera, 2003).

Respondents in this study demonstrated good knowledge of the signs and symptoms of malaria, with fever (95.0%) and headache (55.2%) being the most frequently identified symptoms. These findings are consistent with NMIS 2015 (NMEP et al., 2016) and Akaba et al. (2013), where fever and headache were the predominant symptoms mentioned. By contrast, studies in Ethiopia reported much higher recognition of symptoms such as chills, joint pain, and loss of appetite (Tilaye & Deressa, 2007). Such variations may be due to differences in community exposure, cultural beliefs, and the intensity of health education interventions provided at community level.

Awareness of preventive measures was also high in this study. Nearly all respondents (92.1%) identified LLINs as an effective prevention method, followed by insecticide spraying (90.5%) and environmental sanitation (30.5%). The high level of LLIN awareness (98.3%) is comparable to findings from Nigerian studies (Adebayo et al., 2013; Nnebue et al., 2013; Nwokolo, 2014) and across sub-Saharan Africa (Kimbi et al., 2014).

Table 4: Bivariate Analysis of Factors Influencing Ownership of LLIN among Respondents

Variables	Owns LLIN	Did not Own LLIN	Total	χ^2	p-value	Cramer's V	Strength of Association
Settlement type							
Urban	256	38	294	0.13	0.71	0.018	None
Rural	108	18	126				
Family size							
≤5	99	28	127	20.7	<0.001*	0.22	Weak to Moderate
>5	164	129	293				
Age group (years)							
18–19	16	5	21	10.4	0.11	0.11	Weak to Moderate
20–24	34	9	43				
25–29	143	17	160				
30–34	88	3	91				
35–39	47	4	51				
40–44	14	3	17				
≥45	22	15	37				
Occupation of Respondents							
Petty trading /artisans	189	26	215	9.13	0.01*	0.15	Weak to Moderate
Housewife	105	29	134				
Public/private service	70	1	71				
ANC attendance							
≥4 times	271	7	278	115.7	<0.001*	0.53	Moderate to Strong
<4 times	93	49	142				
Level of Education							
Post-primary	279	26	305	18.3	<0.001*	0.21	Weak to Moderate
Primary	85	30	115				
Knowledge							
Good	316	23	339	97.8	<0.001*	0.48	Strong
Poor	48	33	81				
Media as source of information							
Media	251	13	264	108.6	<0.001*	0.51	Moderate
Others	113	43	156				
Community availability of LLIN							
Available	346	27	373	109.5	<0.001*	0.51	Strong
Not available	18	29	47				
Respondent's Monthly Income							
<₦18,000	302	52	354	1.12	0.29	0.052	None
≥ ₦18,000	62	4	66				
Spouse's monthly income							
< ₦18,000	136	5	141	14.8	<0.001*	0.188	Weak to Moderate
≥ ₦18,000	228	51	279				

*Statistically significant values

Table 5: Multivariate (Logistic Regression) Analysis of Factors Influencing Ownership of LLIN among Respondents

Variable (exposure)	Crude-OR (95% CI)	p-value	Adjusted-OR (95% CI)	p-value
Family size (≤5 vs >5)	2.78 (1.72 – 4.50)	<0.001*	2.05 (1.20 – 3.49)	0.008*
Occupation (Petty trading vs Housewife)	2.01 (1.13 – 3.59)	0.019*	1.45 (0.92 – 2.27)	0.110
ANC attendance (≥4 vs <4)	20.40 (8.93 – 46.56)	<0.001*	5.20 (2.45 – 11.05)	<0.001*
Level of education (Post-primary vs Primary)	3.79 (2.12 – 6.75)	<0.001*	1.88 (1.02 – 3.46)	0.042*
Knowledge (Good vs Poor)	9.45 (5.13 – 17.44)	<0.001*	4.90 (2.75 – 8.72)	<0.001*
Media as main source (Media vs Others)	7.35 (3.79 – 14.24)	<0.001*	2.85 (1.55 – 5.23)	<0.001*
Community availability (Available vs Not available)	20.65 (10.20 – 41.96)	<0.001*	10.25 (4.68 – 22.47)	<0.001*
Spouse's monthly income (≥₦18,000 vs <₦18,000)	0.16 (0.06 – 0.42)	<0.001*	1.70 (1.05 – 2.75)	0.031*

*Statistically significant values

Respondents also recognized the vulnerability of children and pregnant women, aligning with NetMark's earlier survey (NetMark, 2004) and WHO reports emphasizing these groups as most at risk. Nonetheless, misconceptions persisted, with some respondents attributing malaria to stagnant water or dirty environments, echoing earlier findings in Nigeria (Ibidapo, 2005) and Ethiopia (Adera, 2003).

Regarding malaria prevention during pregnancy, 55.5% identified sulphadoxine-pyrimethamine (SP) as the most effective strategy, while 81.9% recognized LLIN use as critical. These results are consistent with NMIS (NMEP et al., 2016) but higher than those reported in Malawi, where only 8% mentioned SP and 29% LLINs (Mathanga et al., 2006). The discrepancy may be explained by differences in health education campaigns and the scale of preventive interventions in different settings.

Knowledge of treatment was moderate. Although 63.7% mentioned artemisinin-based combination therapy (ACT) as the appropriate treatment, some respondents still reported obsolete drugs such as chloroquine and Fansidar. This is comparable to findings in Aleiro, Northern Nigeria, where chloroquine remained a common response despite its withdrawal from national guidelines (Abdullahi et al., 2013). Similarly, NMIS (NMEP et al., 2016) showed lower awareness of ACT (26%), highlighting the persistence of outdated treatment perceptions.

Ownership of LLINs was relatively high in this study (86.7%), higher than that reported in NDHS 2013 (NPC & ICF International, 2014) but comparable to findings from Imo State (Nnebue et al., 2013) and Sierra Leone (Steketee et al., 2008). However, ownership rates vary across Nigeria, with lower figures reported in Enugu (Nwokolo, 2014) and the Federal Capital Territory (42.6%) (Federal Ministry of Health [FMoH], 2014). The high ownership observed here may reflect the impact of free mass distribution campaigns, as many respondents reported obtaining nets through ANC visits (43.7%) and community distribution (43.3%), consistent with NMIS 2015 (NMEP et al., 2016).

Despite relatively high ownership, barriers to LLIN utilization were common. Respondents cited discomfort from heat (38%), skin irritation (29.9%), and perceived suffocation (27.7%), findings similar to those from Imo and Enugu (Nnebue et al., 2013; Nwokolo, 2014). Studies in Ethiopia also highlighted behavioural challenges, such as saving nets for future use and low perceived risk (Sena et al., 2013). Preferences regarding net shape and colour, also reported in this study, further influenced acceptance, echoing earlier findings from NetMark (NetMark, 2004). These challenges emphasize the importance of behavioral change

interventions that are culturally sensitive and address user comfort.

The study also found ANC attendance, education, knowledge, media exposure, community availability, family size, and spouse's income to be significant predictors of LLIN ownership, with ANC attendance and community availability being the strongest. These results align with Augustine et al. (2020) and NMIS 2015 (NMEP et al., 2016), which highlighted ANC and community supply as key distribution channels. Education also predicted ownership, consistent with findings that better-educated women are more likely to adopt preventive practices (Fagbamigbe & Adebayo, 2015; Afoakwah et al., 2015). Smaller family size was associated with higher ownership, supporting reports that larger households face resource competition (Akinleye et al., 2013).

Contrasting findings exist. Some Nigerian studies reported household wealth, rather than spouse's income, as the main economic driver (Ezeama et al., 2019), while Ethiopian studies found settlement type predictive even after adjustment (Sena et al., 2013). Such differences may reflect distribution models: in ANC-driven contexts, settlement type may be less relevant, whereas in universal campaigns urban–rural disparities persist. Public health implications are clear. Strengthening ANC distribution, ensuring continuous community supply, and tailoring approaches for low-education groups and larger households will enhance equitable ownership.

A notable observation was that prior negative experiences (e.g., discomfort, heat) reduced use, echoing behavioural studies showing that perceptions of inconvenience can undermine adherence (Pulford et al., 2011; Koenker et al., 2018). In contrast, some studies emphasized cultural practices and sleeping arrangements as stronger barriers (Pulford et al., 2011), while others found wealth and settlement type more influential (Ezeama et al., 2019). Such differences highlight context-specific determinants shaped by cultural norms and distribution strategies.

Programmatically, malaria control should prioritize ANC attendance, continuous community-level distribution, and effective communication through media and health workers. Addressing concerns about net comfort and usability will be vital for sustained use.

Limitations

This study is not without limitations. First, reliance on self-reported information may have introduced recall and social desirability bias. Second, the cross-sectional design limits the ability to establish causal relationships between identified factors and LLIN ownership. Third, because the study was confined to Gombe Metropolis, the findings may not be generalizable to rural or socio-economically diverse populations. Finally, although research assistants received extensive training to minimize interviewer-related errors, the possibility of interviewer bias cannot be completely excluded.

Conclusion

This study demonstrates that while awareness of malaria and its prevention is high in Gombe Metropolis, consistent ownership of long-lasting insecticidal nets (LLINs) remains below recommended targets. Key determinants of ownership included ANC attendance, education, knowledge, media exposure, community availability, family size, and spouse's income, with ANC attendance and community distribution emerging as the strongest predictors. Ownership was shaped by similar factors, particularly ANC attendance, knowledge, media exposure, and health worker counselling, though negative experiences such as heat, discomfort, and perceptions of harmful chemicals significantly reduced adherence.

Recommendations

Based on the findings of this study, several programmatic recommendations can be made to improve malaria prevention through enhanced LLIN ownership in Gombe Metropolis and similar contexts. Efforts should focus on strengthening ANC and community-based distribution of LLINs, since attendance at ANC and the availability of nets within communities emerged as the strongest predictors of ownership. Ensuring continuous and equitable distribution through health facilities,

ANC clinics, and community-level campaigns, beyond one-off mass distributions, will be critical to sustaining access.

Second, the role of health workers and the media as facilitators of LLIN use underscores the importance of health education and communication. Consistent and context-specific information should be delivered during ANC visits, vaccination campaigns, and through electronic and print media to encourage correct and sustained ownership of nets.

Thirdly, community engagement remains vital. Actively involving community leaders, religious authorities, and other influential stakeholders in planning and implementing malaria control programmes will help strengthen ownership, increase acceptability, and promote consistent use of LLINs across households.

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Author Contribution

Lawal SM. – Conceptualization, study design, protocol development, data collection supervision, data analysis, and manuscript writing. Jibrin MB. – Literature review, questionnaire adaptation, data collection, and manuscript revision. Usman A. – Statistical analysis, interpretation of results, and manuscript revision. Ibrahim SA. – Data collection coordination, field logistics, and manuscript review. Abubakar M. – Ethical approval processing, community engagement, and manuscript editing. Haruna RM. – Data quality assurance, training of research assistants, and manuscript finalization. All authors contributed equally to the conception and design of the study, acquisition of data, analysis and interpretation of data, drafting and revising the manuscript critically for important intellectual content, and final approval of the version to be published. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest

The authors declare that they have no competing interests. No financial or personal relationships with other people or organizations that could inappropriately influence (bias) this work exist.

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