

RESEARCH

Open Access



Assessing insecticide treated nets awareness at Njala University: case study of Njala and Towama Campuses, Sierra Leone

Samuel Maxwell Tom Williams^{1*}, Richard Wadsworth¹, Sahr Foday², Angella Magdalene George³, Ibrahim K. Foday¹, Esther Marie Williams⁴, George Mayeh Fefegula¹ and Mohamed S. P. Koker²

Abstract

Background Malaria is a significant health challenge in Sierra Leone, particularly affecting pregnant women and children under five years of age. Despite efforts to reduce malaria cases, its prevalence remains high. The Sierra Leone National Malaria Elimination Strategic Plan (NMESP) 2021–2025 aims to reduce the malaria burden significantly through universal access to Insecticide Treated Nets (ITNs).

Objective This study evaluates the knowledge and utilization of ITNs for malaria control in the Moyamba and Bo districts of Sierra Leone (at the Njala University's Main Campus in Moyamba District and Towama Location on Bo Campus in Bo District). It assesses awareness levels, factors associated with ITN use, and the effectiveness of current campaign strategies.

Methods A cross-sectional survey was conducted from July to September 2023, involving 742 participants from the Moyamba and Bo districts. Data were collected using a pretested interview guide covering ITN ownership, usage, and challenges. Descriptive statistics and Pearson's Chi-squared test were used for data analysis.

Results Of the respondents, 84.8% received training on ITN usage, primarily from health workers (46.1%). Most participants (94.7%) understood that ITNs provide protection against mosquitoes, and 84.5% believed in their effectiveness in preventing malaria. Sociodemographic factors like age, sex, education, marital status, and sources of information were significantly associated with ITN knowledge and utilization. Moreover, health workers' campaigns and interpersonal networks (community leaders, plus family and friends) play crucial roles in promoting ITN utilization, while mass media campaigns alone may not suffice. However, 48.2% of the participants found current ITN campaign strategies effective.

Conclusion While awareness and ownership of ITNs are high in the Moyamba and Bo districts, utilization is hindered by various factors, including availability and alternative uses. Enhanced campaign strategies and increased ITN distribution are necessary to improve usage and reduce malaria incidence.

Keywords Insecticide treated nets (ITNs), Malaria, Knowledge, Utilization, Sierra Leone

*Correspondence:

Samuel Maxwell Tom Williams
maxwell.williams@njala.edu.sl

¹Department of Biological Sciences, Njala University, Moyamba District, Sierra Leone

²Njala University Hospital, Njala University, Moyamba District, Sierra Leone

³Department of Public Health, Njala University, Bo City, Sierra Leone

⁴Ministry of Agriculture, Forestry and Food Security, Livestock Division, Freetown, Sierra Leone



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

Background

Malaria is one of the most prevalent diseases facing Sierra Leone, especially for pregnant women and children under the age of five [1]. The entire population of Sierra Leone is at risk of this disease and it is one of the leading causes of death and illness in Sierra Leone [2]. Even though Sierra Leone was committed to reducing new cases of the disease by 40% by the year 2020 [2], the prevalence is still high in the country [3]. It is estimated that about 2.2 million outpatient visits are caused by malaria every year, of which about one million patients are under five years old. Pregnant women and children under five years old make up 4.4% and 17.7% of the total population, respectively, and are the most vulnerable groups. *Plasmodium falciparum* is the predominant cause of malaria in Sierra Leone accounting for more than 90% of all malaria infections [4].

According to global estimates of the World Health Organization (WHO) in 2022, the global tally of malaria cases reached 249 million well above the estimated number of cases before the COVID-19 pandemic and an increase of five million over 2021 [5]. The WHO provides current guidance on vector control, including the use of Long Lasting Insecticidal Treated Nets (LLINs) [6]. Long-Lasting Insecticidal Treated Nets are a core prevention tool used widely by people at risk of malaria. Part of pillar 1 of the Global Technical Strategy for Malaria 2016–2030 (GTS) is to ensure universal coverage for all people at risk of malaria using effective vector control with either LLINs or the other core prevention tool, indoor residual spraying (IRS) [6].

The Sierra Leone National Malaria Elimination Strategic Plan (NMESP) 2021–2025 goal is to contribute significantly to the improvement of the well-being of the population by reducing the malaria burden [7]. The prevention interventions include the mass distribution of Insecticide Treated Nets (ITNs) and continuous distribution systems. Continuous distribution systems via routine health services maintain high coverage between campaigns as highlighted by Koenker et al. [8]. High population coverage of mosquito nets and effective treatment programs may reduce the mortality and morbidity of malaria and other mosquito-borne diseases by up to 50% in areas of intense perennial malaria transmission [9]. The use of insecticide-treated nets in areas of high malaria endemicity has resulted in a 50% reduction in new cases of uncomplicated malaria, compared to settings that did not use nets [10]. This has led to a mass distribution of Insecticide Treated Nets (ITNs) in Sierra Leone and more than half (60%) of households in Sierra Leone now own at least one ITN [11]. In Sierra Leone, ITNs are distributed through both public and private sectors. Public sector primarily targets vulnerable groups like pregnant women and children under five, with free

or subsidized ITNs provided through antenatal clinics and child health programs. They provide continuous distribution systems via routine health services maintain high coverage between campaigns, as highlighted by Koenker et al. [8]. The private sector enhances accessibility through pharmacies, drug stores, and retail outlets, while NGOs, funded by international donors, collaborate with private manufacturers for subsidized or free ITNs [12]. Social marketing organizations like Population Service International (PSI) use targeted strategies to distribute ITNs at reduced prices, and corporate partnerships and microfinance loans further support ITN distribution and affordability, complementing public health efforts for broader and sustained coverage [13].

The latest Demographic Health Survey (DHS) results from Sierra Leone provide an overall picture of malaria prevalence and key coverage indicators such as the ownership and use of Long-Lasting Insecticidal Nets (LLINs). According to the 2019 Sierra Leone Malaria Indicator Survey (MIS), 69% of households have at least one mosquito net, while 68% have at least one ITN. This implies that almost all mosquito nets owned by households in Sierra Leone are ITNs (12). Also, 47% of the *de facto* household population had access to an ITN, and 51% of the population slept under an ITN the night before the survey. A comparison of these two population-level indicators shows that there is only a slight difference between ITN access and use [1].

Numerous studies have been conducted, providing valuable insights into the factors influencing ITN utilization and its impact on malaria control. Previous studies in several African countries identified factors such as small household size (equal to or less than four members), education (more educated people), urban residence, improved housing, wealthier households, and proximity to retail stores as predictors of ITN utilization [14, 15]. Also, another study by Ameyaw [16] and Olapeju et al. [15] demonstrated that access to ITNs is a major driver of ITN use, followed by individual-level factors like age and gender. Additionally, a systematic review by Eisele et al. [17] and Lengeler [10] showed that ITNs significantly reduces *Plasmodium falciparum* prevalence among children under 5 years old by 13% and also reduce post-neonatal (1–59 months) all-cause mortality by 18% in areas of stable malaria transmission in Africa. Moreover, subsidy programs have been implemented to make ITNs affordable for low-income households. Previous studies have demonstrated that even small incentives can significantly increase the uptake of health services. For instance, Banerjee et al. [18] found that modest incentives greatly improved immunization rates in resource-poor settings, proving to be more cost-effective than merely increasing the availability of services. This concept applies similarly to the use of insecticide-treated

nets (ITNs), where incentives could potentially boost their utilization by providing additional motivation for individuals to adopt and consistently use ITNs.

The Southern Region of Sierra Leone comprising the Moyamba and Bo districts, has been a focal point for numerous health interventions due to its high malaria burden. The proximity of Njala University provides a unique setting for this study, as the university communities and its surrounding areas are likely to have varying degrees of exposure to health education initiatives and resources. This study focuses on the effectiveness of ITN campaign strategies among people living near the Njala University campuses in the Southern Region of Sierra Leone, specifically the Mokonde community, Njala Campus and the Towama community, Bo Campus. The primary goal is to evaluate the knowledge and utilization of ITNs among these communities. This includes assessing the awareness levels regarding ITNs, identifying factors that influence their use, and examining the current campaign strategies used to educate and sensitize the population about ITN benefits.

Methodology

Study area

The study was carried out in the southern province of Sierra Leone, a case study of Njala University-Main Campus in Moyamba District and Towama Location on Bo Campus in Bo District.

Njala University - The Main Campus (Mokonde) - Moyamba District

Njala University-Main Campus is located in the Mokonde community, in Moyamba District, and is one of the sixteen districts of Sierra Leone, lying within the Southern Province. This predominantly rural district relies heavily on agriculture and experiences a humid tropical climate with distinct wet and dry seasons, contributing to the high prevalence of malaria. The Main Campus is a key educational and research hub, attracting students, faculty, and staff nationwide. This academic institution creates a unique blend of rural and semi-urban characteristics in the surrounding community, with varying access to health information and resources. The campus hosts a health center open 24/7, providing continuous service. Most communities are within 3 to 4 km of these facilities due to a well-maintained road network, though some suburban villages face longer travel distances and potential accessibility issues.

Njala University - Bo Campus, Towama Location - Bo District

The Towama Location of Njala University Campus is situated in Bo District, part of the Southern Province. Bo District is the most populous district, and is more

urbanized than Moyamba, with better access to health-care facilities and educational institutions. The Towama Campus, situated on the outskirts of Bo Town, shares the diverse socio-economic landscape of the district. The campus community includes students, faculty, staff, and a significant number of local residents. This urban and semi-urban mix contrasts with Moyamba District, enabling a comparative analysis of ITN campaign effectiveness in different settings. Bo and Moyamba Districts are major economic areas in the region, collectively comprising over 60% of the regional population (Bo: 39.9%, Moyamba: 22.1%).

The Bo campus and its surrounding areas are served by several health centers and posts open 24/7 and also have access to a district and referral hospital. Most communities are within 3 to 4 km of these facilities, but some suburban villages may experience longer travel distances and potential accessibility issues.

Study design

The study employs quantitative research methods. We used a cross-sectional survey design to collect data from a representative sample of households in Njala – Mokonde and Towama Sierra Leone between July to September 2023. A pretested interview guide was initially used to explore responses on pre-identified themes such as; sources of ITNs, reasons for not using ITNs, and the situation or conditions under which the ITNs were distributed. The survey consisted of closed-ended questions that covered topics such as knowledge about malaria prevention, ITN ownership, usage, and challenges with the use of ITNs. The questionnaire used in this study was developed for this study.

Sample size

We used a simple random sampling technique to sample 42 participants, with equal numbers from both locations (371 from each campus). The study participants were individuals ranging from adolescents to adults (within the age group of 15 and above). The sociodemographic data collected from the participants were; age, sex, level of education, marital status, and time that the participant reclined to sleep.

Data management and statistical analysis

The survey data were analyzed using descriptive statistics such as frequencies, and percentages, to determine the socio-demographic characteristics of the respondents using Microsoft Excel 2019 software. For univariate analysis, frequencies and proportions were calculated for household ownership and utilization of ITNs and cross-tabulated with the background demographic characteristics of the households. Pearson's Chi-squared test was

used to determine the association with a P -value of <0.05 accepted as significant.

Ethical considerations

The study made use of exclusive primary data that was collected from the residents of Njala University campuses. Before the data were collected, we informed the participants about the nature and purpose of the research. Written informed consent was signed by all participants and by parents or guardians for participants under 18 years of age before conducting the interview. An ethical clearance was provided by the Directorate of Research and Development of Njala University.

Result

The study assessed the knowledge and usage of insecticide-treated nets in the Southern provinces of Sierra Leone. The study surveyed 742 respondents with 371 respondents from each district.

Socio-demographic characteristics of the respondents

In our study, we delve into the socio-demographic profiles of the respondents, shedding light on key aspects that shape their perspectives. Table 1 presents a comprehensive overview of these characteristics. Notably, nearly half (45.4%) of the participants fell within the 21–30 age years age bracket, followed closely by the 31–40 age group (26.8%). A smaller proportion (14.0%) comprised individuals aged 20 or younger, while those above 40 years constituted the smallest segment (13.7%). Furthermore, our findings reveal a gender distribution, with female respondents (52.6%) outnumbering their male counterparts (47.4%). The study revealed that the

majority of respondents have tertiary education (56.2%), followed by secondary education (18.3%) and primary education (5.9%). Additionally, 19.5% of the respondents are either illiterate or have not had formal education. Most respondents (55.3%) are single, while 37.5% are married or cohabiting. Additionally, 7.3% of the study population have previously been married, including divorcees and widows. The study revealed that at least most (46.2%) of the respondents do go to bed early (8:00 pm to 9:00 pm) 18.6% go to bed at around 10:00 to 11:00 pm, and 32.5% around 12:00am and or later.

Knowledge assessment and effective use of ITNs among respondents

In our investigation, we delve into the understanding and practical utilization of ITNs among our study cohort. Table 2 provides a succinct overview of these critical aspects. Remarkably, a substantial proportion (84.8%) of the study population has undergone training in the correct usage of ITNs. Health workers are the primary educators, accounting for 46.1% of the training, with mass media outlets such as radio, television, and social platforms like Facebook contributing 27.9%. Additionally, 6.1% gained knowledge through family and friends, while 4.7% were informed by community leaders. The remaining 15.2% who have not been trained on ITN usage did not identify any particular sources of information.

The vast majority (94.7%) of participants are aware that ITNs serve as a protection against mosquitoes. Additionally, 84.5% confirm the effectiveness of ITNs in reducing the spread of malaria. The research also observed that 46.6% consider the threat of malaria as the primary motivator for ITN usage, with the accessibility and expense of ITNs (29.8%), and the comfort provided by ITNs (13.7%) following suit. A small portion (9.8%) were uncertain about the reasons influencing ITN usage. Beyond their intended purpose, ITNs are repurposed by 59.6% of respondents as cleaning tools, 18.3% as fencing for gardens and poultry enclosures, 8.6% are sold, 6.6% are used for fishing, 2.3% as makeshift goalposts, and some even use them to cover mattresses. Despite the varied applications of ITNs, 56.1% have encountered difficulties in obtaining them, and a significant proportion (96.4%) believe that the government or other entities should increase the distribution of ITNs.

Factors that influence ITN utilization

In our rigorous examination, we delve into associated factors of ITN utilization. Table 3 unveils the chi-square (X^2) values and corresponding p -values associated with these factors. Notably, the chi-square statistics reveal no significant association between the two geographical locations ($X^2 = 2.999$, $p = 0.084$). However, age emerges as a highly significant predictor ($X^2 = 32.458$, $p < 0.001$), with older

Table 1 Sociodemographic characteristics (N = 742)

Labels	Variable	Frequency	Percent
Districts	Bo	371	50.0
	Moyamba	371	50.0
Age	20 or less	104	14.0
	21–30	337	45.4
	31–40	199	26.8
	41 or more	102	13.7
Sex	Male	352	47.4
	Female	390	52.6
Education level	No education	145	19.5
	Primary	44	5.9
	Secondary	136	18.3
	Tertiary	417	56.2
Marital status	Never in union	410	55.3
	Married/cohabiting	278	37.5
	Previously married	54	7.3
Time to bed	8–9:00 pm	343	46.2
	10–11:00 pm	138	18.6
	12:00 am and later	261	35.2

Table 2 Knowledge assessment and effective uses of ITNs

Labels	Variable	Frequency	Percent
Have you ever received training on ITN usage	Yes	629	84.8
	No	113	15.2
Source of information	Community leaders	35	4.7
	Family and friends	45	6.1
	Health workers	342	46.1
	Mass media	207	27.9
	None	113	15.2
How ITNs work	Protective barrier	703	94.7
	Don't know	39	5.3
Are ITNs effective in preventing malaria transmission	Yes	627	84.5
	No	115	15.5
Challenges that influence ITN use	Availability and cost	221	29.8
	Comfort	102	13.7
	Malaria risk	346	46.6
	Not sure	73	9.8
What other uses do you use ITNs for?	Washing sponges	368	59.6
	Fence for garden and chicken coop	136	18.3
	Sell	64	8.6
	Fishing	49	6.6
	Use as a goal net	17	2.3
	Used to wrap mattress	7	0.9
	Nothing else	101	13.6
Challenges in acquiring ITNs	Yes	416	56.1
	No	326	43.9
The government or other organizations should provide more ITNs	Yes	712	96
	No	30	4

(n = 742)

individuals demonstrating a greater propensity for ITN usage. Remarkably, in our sample, 13.7% of respondents aged over 40 years consistently use mosquito nets.

Also, women are much more likely to use ITNs than men ($X^2 = 16.650, p < 0.001$). Surprisingly while education is statistically significant those with or undertaking tertiary education were less likely to use ITN ($X^2 = 15.077, p = 0.002$). Marital status is a significant factor with married couples more likely to use a net than never married, while the divorced and widowed are 100% net users ($X^2 = 13.904, p = 0.001$). Going to bed early was associated with higher use of ITN ($X^2 = 27.267, p < 0.001$).

Finally, understanding how ITNs work, is significantly associated with ITN use ($X^2 = 173.475, p < 0.001$). Also, challenges influencing ITN use, such as malaria risk, availability and cost, and comfort, show significant associations with ITN utilization ($X^2 = 141.62, p < 0.001$).

Factors that influence the utilization of insecticide treated nets by the community

In our comprehensive analysis, we delve into the intricate relationship between knowledge sources and the adoption of ITNs. As revealed in Table 4, various channels play a pivotal role in promoting ITN usage. The study findings indicate that ITN campaigns led by health

workers, coupled with support from community leaders, family, and friends, significantly promote ITN usage. Notably, the impact of health workers' campaigns is greater than the combined influence of community leaders and social connections. The ITN campaigns conducted by health workers were structured and systematic, involving direct community engagement and education. Health workers visited households, provided detailed information about the importance and correct usage of ITNs, and distributed nets directly to the population. These campaigns also included follow-up visits to ensure proper usage and address any concerns. The success of these campaigns can be attributed to the health workers' professional training, which equipped them with the skills to effectively communicate health messages and build trust within the community. Their ability to maintain confidentiality and leverage their prior interactions with the population further enhanced the credibility and acceptance of the campaigns, leading to a higher impact compared to efforts led by community leaders and social connections.

Interestingly, contrary to common assumptions, mass media campaigns do not significantly affect ITN utilization. Despite approximately half of the population of the country having access to social media, television, and

Table 3 Chi-square analysis to determine factors associated with ITN utilization

Label	Variable	Do you use ITN (n = 742)		X2	p-value
		Frequency	%		
Location	Bo	336	45.3	2.99	0.084
	Moyamba	321	43.3		
Age categories	< 20	78	10.5	32.458	< 0.001
	20_30	302	40.7		
	31_40	175	23.6		
	> 40	102	13.7		
Sex	Female	363	48.9	16.65	< 0.001
	Male	294	39.6		
Education	Illiterate	135	18.2	15.077	0.002
	Primary	44	5.9		
	Secondary	124	16.7		
	Tertiary	354	47.7		
Marital status	Never in union	349	47.0	13.904	0.001
	Married	244	32.9		
	Previously married	54	7.3		
Time to bed	8–9:00 pm	309	41.6	27.267	< 0.001
	10–11:00 pm	105	14.2		
	12:00 am and later	243	32.7		
Knowledge about ITN	No	59	8.0	173.475	< 0.001
	Yes	598	80.6		
Source of information	Community leaders	34	4.6	45.263	< 0.001
	Family & friends	45	6.1		
	Health & workers	343	46.2		
	Mass media	203	27.4		
How ITNs works	None	32	4.3	265.289	< 0.001
	don't know	3	0.4		
Challenges in using ITNs	physical barrier	654	88.1	141.62	< 0.001
	availability and cost	210	28.3		
	Comfort	92	12.4		
	malaria risk	321	43.3		
	not sure/don't know	34	4.6		

Table 4 Chi-Square analysis to determine the effect of source knowledge on ITN utilization

Source of information	ITN use	Observed	Expected	P-Value	Meaning
Mass Media	Never	42	35.2	0.448884	NOT significant
	Sometimes	62	65.3		
	Always	103	106.6		
Health Workers	Never	22	58.1	0.000001	Extremely significant
	Sometimes	119	107.9		
	Always	201	176.1		
Community Leaders, Family & Friends	Never	4	13.5	0.01584	significant at $p < 0.05$
	Sometimes	27	25.2		
	Always	49	41.2		

radio, these channels do not substantially impact ITN campaign effectiveness. Perhaps other factors, such as direct interpersonal communication and trust in health workers, play a more critical role in encouraging ITN use.

Factors associated with knowledge about insecticide treated nets

In this rigorous investigation, we delve into the intricate interplay between various factors and the awareness of ITNs. Table 5 meticulously outlines the results of the Pearson chi-square test. The chi-square test indicates a significant correlation between knowledge of ITNs and variables such as age, sex, educational status, marital

Table 5 Chi-Square analysis to determine factors associated with knowledge about ITNs

Labels	Variables	Knowledge about how ITN works		X ²	p-value
		Yes (n)	%		
Age range	20 or less yrs.	67	9.0	40.0	< 0.005
	21–30 yrs.,	297	40.0		
	31–40 yrs.	172	23.2		
	> 40 yrs.	93	12.5		
Sex level	Male	277	37.3	19.2	< 0.005
	Female	352	47.4		
Education status	No education	120	16.2	8.7	0.034
	Primary	44	5.9		
	Secondary	113	15.2		
	Tertiary	352	47.4		
Marital status	Never in union	342	46.1	10.5	0.005
	Married	233	31.4		
	Previously married	54	7.3		
How does ITN work	Protective barrier	619	83.4	111.5	< 0.005
	Don't know	10	1.3		
Are ITNs effective in preventing malaria transmission	Yes	543	73.2	10.5	0.001
	No	86	11.6		
Challenges in using ITNs	Availability and cost	194	26.1	51.4	< 0.005
	Comfort	89	12.0		
	Malaria risk	305	41.1		
	Not sure	41	5.5		

status, source of information about ITNs, understanding of ITN functionality, perceived effectiveness of ITNs in malaria prevention, and factors for ITN usage, all with Pearson chi-square *p*-values less than 0.005. Conversely, the challenges in obtaining ITNs do not seem to be linked to the level of knowledge about ITNs.

Furthermore, younger people (20 years or less, and 21–30 years) have higher knowledge levels about ITNs compared to older age groups (31–40 years, > 40 years), ($X^2 = 40.0$, $p < 0.05$). There is a significant difference in knowledge about ITNs between males and females, with females (352) having more knowledge than males (277), ($X^2 = 19.2$, $p < 0.05$). The survey revealed a significant association between education status and knowledge about ITNs. Participants with tertiary education demonstrated the highest levels of knowledge ($n = 352$), followed by those with secondary, primary, and no education ($X^2 = 8.7$, $p < 0.034$). This finding suggests an association but does not imply causation.

Marital status is significantly associated with ITN knowledge, with individuals who have never been in a union (342) having the highest knowledge, followed by married and previously married individuals, ($X^2 = 10.5$, $p < 0.05$).

Marital status is significantly associated with ITN knowledge, with individuals who have never been in a union (342) having the highest knowledge, followed by married and previously married individuals, ($X^2 = 10.5$, $p < 0.05$).

Understanding how ITNs work is significantly associated with knowledge about them, with most respondents who know ITNs work as a protective barrier (619) having higher knowledge ($X^2 = 111.5$, $p < 0.05$). Belief in the effectiveness of ITNs is significantly associated with knowledge, with the majority of knowledgeable respondents (543) believing ITNs are effective, with a Chi-Square value of 10.5 and *p*-value 0.001. Finally, challenges influencing ITN use, such as availability and cost (194), comfort (89), and perceived malaria risk (305), are significantly associated with knowledge about ITNs, with a Chi-Square value of 51.4 and *p*-value < 0.05.

Assessing the opinion of the participants about the success of ITN campaign strategies

From Table 6, the research utilized binary questions to evaluate the success of the strategies implemented by non-governmental organizations and the Sierra Leone government in encouraging the use of ITNs. The findings indicated that 61.1% of participants are open to joining future ITN initiatives. Furthermore, 67.0% acknowledged that their understanding of ITNs was enhanced by past campaigns, although 51.3% reported no increase in ITN availability following these campaigns. 57.7% of the participants verified an increase in ITN utilization due to previous efforts, yet a mere 7.0% have been receiving incentives for their ITN usage. Also, 54.0% of those surveyed think that incentives could boost ITN adoption.

Table 6 Assessing the campaign strategies for promoting ITN use (*n* = 742)

Questions	Yes (%)	No (%)
Can you participate in ITN campaign usage?	61.1	38.9
Previous ITN campaigns increase your knowledge about ITNs	67.0	33.0
Does the previous ITN campaign increase ITN supply?	48.7	51.3
Previous ITN campaigns increase ITN use	57.7	42.3
Received any incentives for using ITNs	7.0	93.0
Can incentives promote the use of ITNs?	54.0	46.0
current strategies for the ITN campaign are effective?	48.2	51.8

Lastly, only 48.2% confirmed that these past and current strategies are effective in ITN promotion.

Discussion

Malaria is an endemic disease and the efforts by WHO and NMCP have reduced the incidence by supporting the provision/implementation of quality malaria-preventative interventions, through universal access to ITNs through a mass campaign [7]. The first mass distribution of ITNs in Sierra Leone took place in 2006 in Bo and Pujehun districts [19]. Mass distribution of ITNs has subsequently been conducted ever since. These mass campaigns, together with other distribution channels, have helped increase the ownership of ITN in Sierra Leone. The success of ITN campaigns in Sierra Leone can be attributed to thorough planning, strong community engagement, effective distribution strategies, and continuous monitoring and education efforts. Despite facing logistical and resistance challenges, the introduction of advanced ITNs like PBO and dual insecticide nets, coupled with robust community involvement, helped ensure the campaigns’ overall success in reducing malaria incidence.

The distribution of dual active ingredient (AI) LLINs in Sierra Leone primarily includes ITNs impregnated with a pyrethroid and the synergist piperonyl-butoxide (PBO) and Permethrin [20, 21]. Piperonyl-butoxide acts as a synergist, enhancing the efficacy of permethrin by inhibiting the detoxification enzymes in mosquitoes that confer resistance to pyrethroids [22, 23]. This combination has been particularly effective in areas where resistance to traditional insecticides has been observed [24, 25]. The selection of the type of LLINs used is informed by entomological monitoring data, which guides where and how these nets are deployed to combat resistance [20, 24]. In terms of distribution, these advanced LLINs are primarily distributed in regions where insecticide resistance has been documented, ensuring that the most affected areas receive the most effective intervention [25, 26]. The dual active ingredients and PBO-treated LLINs are also integrated into both mass distribution campaigns and

continuous distribution channels, such as antenatal clinics and immunization centers, to ensure widespread coverage [26, 27]. This strategic approach allows for ongoing protection against malaria, particularly in high-risk and resistant areas, while maintaining the flexibility to adapt to emerging resistance trends across the country.

Knowledge/awareness of insecticide treated nets (ITNs)

This study shows a high level of awareness of ITNs as a malaria preventive tool by the study population. This study revealed a high level of knowledge about how ITN works which is in agreement with Nyavor et al. [28], who reported a high level (98.7%) of awareness in Ghana, and Animut et al. [29] with a 91.1% awareness of ITN in Ethiopia. Also, a series of surveys conducted in 2000, 2004, and 2006 in Nigeria, Senegal, Uganda, and Zambia indicated that awareness of ITNs was nearly universal in all of the countries except Nigeria. Uganda had 23%, Zambia had 51%, Senegal had 70% and Nigeria had 7% who have heard of insecticide-treated nets [30]. The methodologies used in the studies conducted by Baume and Marin [30] might have varied across countries. Differences in sampling techniques, data collection methods, and timeframes can significantly influence the results. The prevalence and intensity of malaria transmission differ among these countries, which can influence public awareness and prioritization of malaria prevention measures. Countries with higher malaria burdens might have more extensive public health campaigns focused on ITN usage.

In the study, nearly all of the respondents who use ITN consider it effective as they believe it prevents mosquito bites. The high level of awareness of ITNs in this study is attributed to the intensification of health education and ITN campaigns by health workers through mass media. A similar study in a rural community in Southern Nigeria identified radio/Television and hospitals as the main sources of information about ITN use for malaria prevention which aligns with the findings of this present study [31].

Associated factors that influenced ITN use

The study conducted in the Njala University campuses of Moyamba and Bo districts of Sierra Leone aimed to identify factors influencing the utilization of long-lasting insecticidal nets (ITNs). Interestingly, the findings indicate that geographic location within these districts does not significantly impact ITN usage. This suggests that other factors, rather than the specific geographic location, play a more crucial role in determining whether individuals use ITNs in these areas.

Age emerges as a strong determinant of ITN utilization. The study finds a highly significant association between age and ITN usage. Specifically, individuals aged 20–30 years are more likely to use ITNs compared to other

age groups. This age group may have higher awareness or better access to ITNs, possibly due to greater health awareness or economic stability. This finding is consistent with Scott et al. [32] and [33]. In many malaria-endemic countries, studies have consistently shown that mothers with children under five are the most likely to use ITNs/ITNs compared to other age groups. This is largely due to targeted distribution efforts and educational campaigns focusing on the protection of young children who are highly vulnerable to malaria. According to Baume and Marin [30], campaigns often distribute ITNs through antenatal care visits and child health clinics, ensuring that pregnant women and mothers with young children receive and use the nets. Additionally, Eisele et al. [34] found that ITN use among children under five increased significantly in sub-Saharan Africa, highlighting the emphasis on protecting this age group due to their higher risk of severe malaria and mortality.

Gender also shows a significant association with ITN utilization, with females more likely to use ITNs than males. This could be attributed to the role of women in family health care and child protection, motivating higher ITN usage. A study conducted in Nigeria found that females were more likely to use ITNs compared to males [35]. Literacy, particularly tertiary education, significantly influences ITN use. Individuals with higher education levels are more likely to use ITNs. Educated individuals may have a better understanding and awareness of the benefits of ITNs in preventing malaria. A study conducted in Ethiopia found that higher education status was an independent predictor of ITN utilization among pregnant women [36]. Improving women's understanding of ITNs through education can enhance their use. However, this finding is inconsistent with research conducted by [37] that identified that less educated respondents were five times more likely to use ITN (95% CI=1.24–21.28).

Marital status is another significant factor, showing an association with ITN use. Married individuals might be more inclined to use ITNs, possibly due to a greater responsibility towards family health. A study conducted in Guinea found that marital status was associated with ITN use. Married individuals had higher odds of using ITNs [33]. The time participants go to bed significantly impacts ITN utilization. Those who go to bed earlier may be more diligent in using ITNs, possibly due to routine and the desire to prevent mosquito bites during peak mosquito activity times.

ITN campaigns conducted by health workers significantly influence ITN utilization. Their professional approach, confidentiality, and prior interactions with the population contribute to the acceptance of ITNs. A study by Obol et al. [38], found that health worker-led campaigns were effective in promoting ITN use in

Uganda. This difference could be attributed to the professional demeanor of health workers, their ability to maintain confidentiality, and their prior interactions with the population. The combined factor of community leaders, family, and friends also plays a role in encouraging ITN usage. The lack of impact from mass media campaigns on ITN use could be due to various factors, such as the quality of messaging, audience segmentation, or the need for more personalized approaches. This result is also contrary to Ankomah et al. [39] who revealed that pregnant women who listened to mass media campaigns were more likely to adopt strategies to protect themselves from malaria.

Mass campaigns primarily target vulnerable groups, providing free or subsidized ITNs through antenatal clinics and child health programs. Continuous distribution via routine health services maintains high coverage between campaigns [8]. The private sector enhances accessibility through pharmacies, drug stores, and retail outlets, while NGOs, funded by international donors, collaborate with private manufacturers to distribute subsidized or free ITNs [12]. The study identified factors such as perceived malaria risk, availability, cost, and comfort as significantly associated with ITN utilization ($p < 0.01$), consistent with Theuri et al. [40], which found that perceived malaria risk and prevention, socioeconomic status, accessibility, cost, and individual beliefs were identified as critical determinants of ITN ownership and utilization. Interestingly, challenges in acquiring ITNs do not show a significant association with ITN utilization ($p > 0.05$). This suggests that once individuals are aware of and value ITNs, they are likely to find ways to obtain them despite potential obstacles.

Factors that influenced ITN knowledge

The knowledge of ITNs is influenced by a complex interplay of demographic, socio-economic, and practical factors. The study revealed that demographic factors such as age and sex, along with socio-economic variables like educational status and marital status, play a significant role in shaping one's awareness of ITNs. Moreover, the source of information from which individuals learn about ITNs, their comprehension of ITN functions, and their personal beliefs about the efficacy of ITNs in malaria prevention are intricately linked to their awareness and understanding of ITNs.

Younger age groups (20 or less, 21–30 years) demonstrated significantly higher knowledge about ITNs compared to older age groups (31–40 years, >40 years). This finding aligns with previous research indicating that younger populations are more likely to be targeted by educational campaigns and are more receptive to new information technologies [41].

A significant gender difference was observed, with females (352) showing greater knowledge about ITNs compared to males (277). This disparity may be due to women often being the primary caregivers and thus more engaged in health-related information [42]. Educational status significantly influences ITN knowledge. Also, participants who have never been in a marriage (single) possessed the highest knowledge about ITNs, followed by married and previously married individuals. This may reflect the independent decision-making and engagement in health-seeking behaviors typically associated with single individuals [43].

Respondents with tertiary education exhibited the highest knowledge levels (352), followed by those with secondary, primary, and no education. This supports findings by Jones et al. [44], that higher education levels correlate with better health literacy and information retention. The source of information is crucial, with health workers, mass media, family and friends (45), and community leaders being significant influencers. These findings resonate with communication theories emphasizing the role of trusted sources in health information dissemination [45–47].

Understanding how ITNs work (as a protective barrier) significantly enhances knowledge that supports the health belief model which assumes that understanding health measures can increase engagement [48]. Also, the individual perspective about ITN effectiveness is significantly linked to knowledge, which is consistent with studies that indicate perceived benefits strongly predict health behavior adoption [49].

Finally, perceived malaria risk, comfort, availability, and cost are significantly associated with ITN knowledge. This reinforces the notion that practical concerns and perceived vulnerability influence health intervention uptake [50]. Conversely, no significant association was found between challenges in obtaining ITNs and knowledge about them, indicated by a chi-square value of 3.0 and *p*-value of 0.086. This suggests that knowledge levels may be resilient to access barriers, emphasizing the importance of information dissemination regardless of physical access [51].

Campaign strategies

The results of the study provide a nuanced understanding (complex and interesting) of the effective strategies implemented by non-governmental organizations (NGOs) and the Sierra Leone government to promote the use of ITNs for malaria control.

The fact that 67.0% of participants reported an enhanced understanding of ITNs due to past campaigns highlights the effectiveness of educational efforts. Awareness and knowledge are crucial components of public health interventions, as they lay the groundwork for

behavioral change [52]. Enhanced understanding likely contributes to informed decision-making regarding ITN use, which is essential for sustained malaria prevention.

Despite increased knowledge, 51.3% of respondents reported no increase in ITN availability. This disconnect suggests that while educational campaigns have been successful, they are not sufficiently supported by the distribution logistics necessary to ensure widespread ITN availability. Studies have shown that the effectiveness of ITNs in malaria prevention is contingent not only on awareness but also on accessibility and proper usage [30]. Therefore, improving the supply chain and distribution mechanisms must be a priority for future initiatives. Also, the finding that 57.7% of participants noticed an increase in ITN utilization due to previous efforts is encouraging. It demonstrates that when ITNs are available, educational campaigns can effectively drive their use. However, the disparity between increased utilization and the reported availability issues underscores the need for a more integrated approach that combines education with improved distribution strategies.

The fact that only 7.0% of participants have received incentives for ITN usage is a critical insight. Introducing incentives, such as subsidies, rewards, or conditional cash transfers, could significantly enhance the impact of ITN distribution programs. Incentives have been shown to enhance participation in public health programs by providing tangible benefits that encourage desired behaviors [18]. For example, Banerjee et al. [18] demonstrated that small incentives had a large positive impact on the uptake of immunization services in resource-poor areas and were more cost-effective than purely improving the supply of services. This finding suggests that the low percentage of incentive recipients might be a missed opportunity to increase ITN usage in the study area. It found that small incentives had a large positive impact on the uptake of immunization services in resource-poor areas and were more cost-effective than purely improving the supply of services. Also, the survey indicates that 54.0% of respondents believe incentives could boost ITN adoption, suggesting a potentially effective strategy to increase utilization rates.

Finally, only 48.2% of respondents affirmed the effectiveness of past and current strategies in promoting ITNs. This modest level of confidence signals the need for a reassessment of current approaches. While educational campaigns have had some success, their impact is limited without concurrent improvements in ITN availability and utilization incentives. However, 61.1% of participants expressed willingness to join future ITN initiatives, indicating a generally positive attitude towards ITNs and providing a solid foundation for future campaigns [30, 53].

Conclusion

The study conducted in Sierra Leone aimed to evaluate the knowledge and utilization of ITNs as a preventive measure against malaria. The research highlighted that awareness of ITNs is significantly high, with health workers and mass media being the primary sources of information. Despite the high awareness, there are considerable challenges in the availability and distribution of ITNs. Although 57.7% of participants reported increased ITN usage due to educational campaigns, only 7.0% received incentives for their use, and 54.0% believed that incentives could boost adoption rates. The study also identified key factors influencing ITN knowledge, including age, sex, educational status, marital status, and sources of information. It was found that a significant portion of the population has not received formal training on ITN usage, and there is a noticeable gap between increased awareness and the actual availability of ITNs. This suggests a need for improved distribution logistics and potentially the introduction of incentives to enhance ITN usage further.

The research underscores the importance of targeted public health strategies and educational campaigns in improving ITN awareness and usage in Sierra Leone. Despite the successes of previous initiatives, significant gaps remain, particularly in ITN availability and the provision of incentives for usage. Future programs should adopt a more holistic approach that integrates education with improved distribution mechanisms and the introduction of incentives such as subsidies or conditional cash transfers. Addressing these gaps is crucial for achieving higher ITN utilization rates and sustained malaria prevention in Sierra Leone.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-024-21007-5>.

Supplementary Material 1

Acknowledgements

We extend our gratitude to the research assistants, Christopher Moiwa Allieu, Josephine Johnny, and Mohamed Tambi, students from Njala University pursuing a BSc. Honors in Biological Sciences. Their assistance in conducting the survey was invaluable and played a crucial role in achieving these results.

Author contributions

SMTW, RW, and SF contributed to the study design and conceptualization. SMTW and RW performed the analysis. SMTW, RW, and SF also participated in the interpretation of results and critically revised the manuscript for intellectual content. SMTW, RW, SF, AMG, IKF, EMW, GMF, and MSPK developed the initial draft. All the authors critically reviewed the manuscript for its intellectual content. All authors read and amended drafts of the paper and approved the final version. SMTW had the final responsibility to submit for publication.

Funding

The study received no funding.

Data availability

The data that support the findings of this study are available on request from the corresponding author (SMTW).

Declarations

Ethics approval and consent to participate

This study was conducted following the Declaration of Helsinki. A written consent was read to all participants about the nature and purpose of the research survey. We sought ethical approval from the Directorate of Research and Development of Njala University.

Competing interests

The authors declare no competing interests.

Received: 17 June 2024 / Accepted: 6 December 2024

Published online: 10 February 2025

References

1. Statistics Sierra Leone and ICF. Sierra Leone Demographic and Health Survey 2019, Freetown, Sierra Leone, and Rockville, Maryland, USA: Stats SL and ICF, 2020. [Online]. Available: https://www.statistics.sl/images/StatisticsSL/Documents/DHS2018/SIERRA_LEONE_2019_DHS_REPORT.pdf
2. WHO. Tackling malaria in Sierra Leone, WHO | Regional Office for Africa., Accessed: Feb. 11, 2023. [Online]. Available: <https://www.afro.who.int/news/tackling-malaria-sierra-leone>
3. George AM, Kargbou A, Wadsworth R, Kangbai JB. Trends and Seasonal variations for confirmed malaria cases for Sierra Leone for 2012–2020. *SM J Public Health Epidemiol*. 2023. <https://www.jsmcentral.org/sm-public-health/smjph/e344186.pdf>.
4. Sierra. Leone | LINK malaria. Accessed: Feb. 14, 2023. [Online]. Available: <https://web.archive.ishtm.ac.uk/www.linkmalaria.org/country-profiles/sierra-leone.html>
5. WHO. World malaria report 2023. Accessed: Jul. 24, 2024. [Online]. Available: <https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2023>
6. WHO. Achieving and maintaining universal coverage with long lasting insecticidal nets for malaria control. Accessed: Jul. 30, 2024. [Online]. Available: <https://www.who.int/publications/i/item/WHO-HTM-GMP-2017.20>
7. USPMI, Sierra Leone malaria operational plans (MOPs), PMI, Accessed: Feb. 11, 2023. [Online]. Available: <https://www.pmi.gov/where-we-work/sierra-leone/>
8. Koenker H, Keating J, Allio M, Acosta A, Lynch M, Nafo-Traore F. Strategic roles for behaviour change communication in a changing malaria landscape. *Malar J*. 2014;13(1):1. <https://doi.org/10.1186/1475-2875-13-1>.
9. WHO. Insecticide-Treated Mosquito Nets: A WHO Position Statement., Geneva World Health Organ. 2007. [Online]. Available: <https://files.givewell.org/files/DWDA%202009/Interventions/Nets/itnspospaperfinal.pdf>
10. Lengeler C. Insecticide-treated bed nets and curtains for preventing malaria. *Cochrane Database Syst*. 2004.
11. Sierra Leone Malaria Indicator Survey 2016, NMCP, SSL, USL, CRS, and National Malaria Control Programme - NMCP/Sierra Leone, Statistics Sierra Leone - SSL, University of Sierra Leone - USL, Catholic Relief Services - CRS, and ICF, Freetown ICF. Sierra Leone, 2016. [Online]. Available: <http://dhsprogram.com/pubs/pdf/MIS25/MIS25.pdf>
12. Hanson K, et al. Vouchers for scaling up insecticide-treated nets in Tanzania: methods for monitoring and evaluation of a national health system intervention. *BMC Public Health*. 2008;8(1):205. <https://doi.org/10.1186/1471-2458-8-205>.
13. Malaria - PSI. Accessed: Jul. 24, 2024. [Online]. Available: <https://www.psi.org/practice-area/malaria/>, <https://www.psi.org/practice-area/malaria/>
14. Kim H, Miller FD, Hernandez A, Tanser F, Mogeni P, Cuadros DF. Spatiotemporal analysis of insecticide-treated net use for children under 5 in relation to socioeconomic gradients in Central and East Africa. *Malar J*. 2020;19(1):163. <https://doi.org/10.1186/s12936-020-03236-2>.
15. Olapeju B, et al. Age and gender trends in insecticide-treated net use in sub-Saharan Africa: a multi-country analysis. *Malar J*. 2018;17(1):423. <https://doi.org/10.1186/s12936-018-2575-z>.
16. Ameyaw EK. Individual, community and societal correlates of insecticide treated net use among pregnant women in sub-Saharan Africa: a multi-level

- analysis | BMC Public Health | Full Text. Accessed: Jul. 30, 2024. [Online]. Available: <https://bmcpubhealth.biomedcentral.com/articles/https://doi.org/10.1186/s12889-021-11635-6>
17. Eisele TP, Larsen D, Steketee RW. Protective efficacy of interventions for preventing malaria mortality in children in *Plasmodium falciparum* endemic areas, in Database of Abstracts of Reviews of Effects (DARE): Quality-assessed Reviews, Centre for Reviews and Dissemination (UK), 2010. Accessed: Jul. 30, 2024. [Online]. Available: <https://www.ncbi.nlm.nih.gov/books/NBK78633/>
 18. Banerjee AV, Duflo E, Glennerster R, Kothari D. Improving immunisation coverage in rural India: clustered randomised controlled evaluation of immunisation campaigns with and without incentives. *BMJ*. 2010;340:c2220. <https://doi.org/10.1136/bmj.c2220>.
 19. USPMI TUSPMIVP: Sierra Leone – The U.S. President’s Malaria Initiative Vector-Link Project. Accessed: May 12, 2024. [Online]. Available: <https://pmivectorlink.org/where-we-work/sierra-leone/>
 20. USPMI. Sierra Leone – The U.S. President’s Malaria Initiative VectorLink Project. Accessed: Sep. 03, 2024. [Online]. Available: <https://pmivectorlink.org/where-we-work/sierra-leone/>
 21. CDC, CDC in Sierra Leone., Global Health. Accessed: Sep. 03, 2024. [Online]. Available: <https://www.cdc.gov/global-health/countries/sierra-leone.html>
 22. Lukole E, et al. Protective efficacy of holed and aging PBO-pyrethroid synergist-treated nets on malaria infection prevalence in north-western Tanzania. *PLOS Glob Public Health*. 2022;2(10):e0000453. <https://doi.org/10.1371/journal.pgph.0000453>.
 23. Martin JL, et al. Personal protection with PBO-pyrethroid synergist-treated nets after 2 years of household use against pyrethroid-resistant *Anopheles* in Tanzania. *Parasit Vectors*. 2021;14(1):150. <https://doi.org/10.1186/s13071-021-04641-5>.
 24. Leone WHOS. Nationwide Rollout of the Insecticide Treated Nets (ITNs) Mass Distribution Campaign in Sierra Leone, WHO | Regional Office for Africa. Accessed: Sep. 03, 2024. [Online]. Available: <https://www.afro.who.int/countries/sierra-leone/news/nationwide-rollout-insecticide-treated-nets-itns-mass-distribution-campaign-sierra-leone>
 25. Leone WHOS. Sierra Leone tackling malaria amidst COVID-19 outbreak response, WHO | Regional Office for Africa. Accessed: Sep. 03, 2024. [Online]. Available: <https://www.afro.who.int/news/sierra-leone-tackling-malaria-amidst-covid-19-outbreak-response>
 26. Reliefweb. Sierra Leone tackling malaria amidst COVID-19 outbreak response - Sierra Leone | ReliefWeb. Accessed: Sep. 03, 2024. [Online]. Available: <https://reliefweb.int/report/sierra-leone/sierra-leone-tackling-malaria-amidst-covid-19-outbreak-response>
 27. Leone UNICEFS. Mass distribution of long-lasting insecticide treated bed nets to households in Sierra Leone | UNICEF Sierra Leone. Accessed: Sep. 03, 2024. [Online]. Available: <https://www.unicef.org/sierraleone/stories/mass-distribution-on-long-lasting-insecticide-treated-bed-nets-households-sierra-leone>
 28. Nyavor KD, et al. Assessing the ownership, usage and knowledge of insecticide treated nets (ITNs) in Malaria Prevention in the Hohoe Municipality, Ghana. *Pan Afr Med J*. 2017;28:67. <https://doi.org/10.11604/pamj.2017.28.67.934>.
 29. Animut A, Gebre-Michael T, Medhin G, Balkew M, Bashaye S, Seyoum A. Assessment of Distribution, Knowledge and Utilization of Insecticide Treated Nets in Selected Malaria Prone Areas of Ethiopia, *Ethiop. J. Health Dev.*, 22(3):Art. no. 3, 2008, Accessed: May 20, 2024. [Online]. Available: <https://www.ejhd.org/index.php/ejhd/article/view/511>
 30. Baume CA, Marin MC. Gains in awareness, ownership and use of insecticide-treated nets in Nigeria, Senegal, Uganda and Zambia. *Malar J*. 2008;7:153. <https://doi.org/10.1186/1475-2875-7-153>.
 31. Johnson O, et al. Awareness, Ownership and Utilization of Insecticide Treated Nets among households in a Rural Community in Southern Nigeria. *Sch J App Med Sci*. 2015;3:608–13.
 32. Scott J, Kanyangara M, Nhama A, Macete E, Moss WJ, Saute F. Factors associated with use of insecticide-treated net for malaria prevention in Manica District, Mozambique: a community-based cross-sectional survey. *Malar J*. 2021;20(1):200. <https://doi.org/10.1186/s12936-021-03738-7>.
 33. Diallo OO, Ozodiegwu ID, Camara A, Galatas B, Gerardin J. Factors associated with the ownership and use of insecticide-treated nets in Guinea: an analysis of the 2018 demographic and Health Survey. *Malar J*. 2023;22(1):29. <https://doi.org/10.1186/s12936-023-04463-z>.
 34. Eisele TP, Keating J, Littrell M, Larsen D, Macintyre K. Assessment of insecticide-treated bednet use among children and pregnant women across 15 countries using standardized national surveys. *Am J Trop Med Hyg*. 2009;80(2):209–14.
 35. Garley AE, Ivanovich E, Eckert E, Negroustoueva S, Ye Y. Gender differences in the use of insecticide-treated nets after a universal free distribution campaign in Kano State, Nigeria: post-campaign survey results. *Malar J*. 2013;12(1):119. <https://doi.org/10.1186/1475-2875-12-119>.
 36. Kassie GA, et al. Insecticide-treated bed net utilization and associated factors among pregnant women in Ethiopia: a systematic review and meta-analysis. *Malar J*. 2023;22(1):223. <https://doi.org/10.1186/s12936-023-04655-7>.
 37. Adebayo AM, Akinyemi OO, Cadmus EO. Ownership and utilisation of insecticide-treated mosquito nets among caregivers of under-five children and pregnant women in a rural community in Southwest Nigeria, *J. Prev. Med. Hyg.*, 2014;55(2):58–64.
 38. Obol J, Ononge S, Orach C. Utilisation of insecticide treated nets among pregnant women in Gulu: a post conflict district in northern Uganda, *Afr. Health Sci*. 2013;13(4):962–969. <https://doi.org/10.4314/ahs.v13i4.15>
 39. Ankomah A, et al. The Effect of Mass Media Campaign on the use of insecticide-treated Bed nets among pregnant women in Nigeria. *Malar Res Treat*. 2014;2014:p694863. <https://doi.org/10.1155/2014/694863>.
 40. Theuri C, Serem G, Mwenda K. Determinants of utilization of Malaria Preventive interventions in Kenya: a systematic literature review. *Int J Sci Res Publ*. 2023;13(7). <https://doi.org/10.29322/IJSRP.13.07.2023.p13940>.
 41. Gust D, Woodruff R, Kennedy A, Brown C, Sheedy K, Hibbs B. Parental perceptions surrounding risks and benefits of immunization, *Semin. Pediatr. Infect. Dis.*, 2003;14:207–12. [https://doi.org/10.1016/S1045-1870\(03\)00035-9](https://doi.org/10.1016/S1045-1870(03)00035-9)
 42. Smith N, Leiserowitz A. The role of emotion in global warming policy support and opposition. *Risk Anal off Publ Soc Risk Anal*. 2014;34(5):937–48. <https://doi.org/10.1111/risa.12140>.
 43. Williams DR, Jackson PB. Social sources of racial disparities in health. *Health Aff Proj Hope*. 2005;24(2):325–34. <https://doi.org/10.1377/hlthaff.24.2.325>.
 44. Jones CL, Jensen JD, Scherr CL, Brown NR, Christy K, Weaver J. The Health Belief Model as an explanatory framework in communication research: exploring parallel, serial, and moderated mediation. *Health Commun*. 2015;30(6):566–76. <https://doi.org/10.1080/10410236.2013.873363>.
 45. Detweiler-Bedell B, Detweiler-Bedell J. Emerging trends in Health Communication: the powerful role of subjectivism in moderating the Effectiveness of Persuasive Health Appeals: emerging trends in Health Communication. *Soc Personal Psychol Compass*. 2016;10:484–502. <https://doi.org/10.1111/spc3.12264>.
 46. Hu Y. Health communication research in the digital age: a systematic review. *J Commun Healthc*. 2015;8. <https://doi.org/10.1080/17538068.2015.1107308>.
 47. Noar S, Head K. Trends in the Research and Practice of Health Communication Campaigns. *Sociol Compass*. 2011;5. <https://doi.org/10.1111/j.1751-9020.2011.00379.x>.
 48. Irwin M, Rosenstock, Historical Origins of the Health Belief Model -, Rosenstock IM. 1974. Accessed: May 29, 2024. [Online]. Available: <https://journals.sagepub.com/doi/10.1177/109019817400200403>
 49. Champion VL, Skinner CS. The health belief model. in *Health behavior and health education: theory, research, and practice*. 4th ed. San Francisco, CA, US: Jossey-Bass; 2008. pp. 45–65.
 50. Fishbein M, Ajzen I. Predicting and Changing Behavior: The Reasoned Action Approach | Request PDF. Accessed: Jun. 18, 2024. [Online]. Available: https://www.researchgate.net/publication/263227940_Predicting_and_Changing_Behavior_The_Reasoned_Action_Approach
 51. Bandura A. Health promotion by social cognitive means, *Health Educ. Behav. Off. Publ. Soc. Public Health Educ*. 2004;31(2):143–164 <https://doi.org/10.1177/1090198104263660>
 52. Bélanger-Gravel A, et al. Examining public health practitioners’ perceptions and use of behavioural sciences to design health promotion interventions. *BMC Health Serv Res*. 2023;23:493. <https://doi.org/10.1186/s12913-023-09455-y>.
 53. Kaombe TM, Hamuza GA. Impact of ignoring sampling design in the prediction of binary health outcomes through logistic regression: evidence from Malawi demographic and health survey under-five mortality data; 2000–2016. *BMC Public Health*. 2023;23(1):1674. <https://doi.org/10.1186/s12889-023-16544-4>.

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.