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Original Article

Determinants of Malaria Insecticide-Treated Nets Use Among Women of Reproductive Age in Nigeria

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Abstract

Background: Malaria remains a major public health challenge in Nigeria, especially among women of reproductive age. Although insecticide-treated nets (ITNs) are effective, gaps between ownership and use persist. This study examined determinants of ITN use among women of reproductive age.

Methodology: Secondary data from the 2021 Nigeria Malaria Indicator Survey (NMIS), a nationally representative cross-sectional survey, were analysed. A weighted sample of 14,476 women aged 15–49 years was included. Logistic regression analyses were conducted using SPSS version 29, with significance level set at $p \leq 0.05$.

Results: Overall, 41.5% of women used an ITN despite 62.6% owning one. Education, age, region, wealth, religion, media exposure, and malaria-prevention knowledge significantly predicted use. Women with primary education had higher odds (AOR = 1.24; 95% CI: 1.11–1.40), while tertiary-educated women had lower odds (AOR = 0.80; 95% CI: 0.69–0.94) than those with no education. ITN use increased with age, highest among women aged 30–34 years (AOR = 1.54; 95% CI: 1.36–1.74). Average-wealth households had higher odds (AOR = 1.19; 95% CI: 1.07–1.32), whereas rich households had lower odds (AOR = 0.72; 95% CI: 0.64–0.82) compared with poor households. Regional disparities were marked: North-East (AOR = 3.20; 95% CI: 2.81–3.65) and North-West (AOR = 2.90; 95% CI: 2.58–3.26) showed higher odds, while southern regions had substantially lower odds. Muslim women had reduced odds (AOR = 0.74; 95% CI: 0.63–0.88). Media exposure (AOR = 1.27; 95% CI: 1.15–1.40) and malaria-prevention knowledge (AOR = 1.43; 95% CI: 1.30–1.57) increased the likelihood of use.

Conclusion: Despite moderate ownership, ITN use remains low. Interventions targeting wealthy and highly educated women, residents of southern regions, and those with limited malaria knowledge, combined with strengthened media outreach, are crucial to improve ITN utilisation.

Keywords: Women of Reproductive Age; Determinants; Insecticide-Treated Mosquito Bed Nets Use

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Introduction

Malaria is a leading cause of morbidity and mortality among reproductive-age women in Nigeria.[1–4] Despite global and national efforts to reduce the burden of malaria, Nigeria accounts for approximately 27% of global malaria cases and 31% of malaria deaths, with considerable consequences for maternal and child health.[2,5]The World Health Organisation (WHO) recommends the use of insecticide-treated nets (ITNs) as one of the most effective malaria prevention strategies, particularly for high-risk populations such as women of reproductive age.[6]The Nigerian government, through the National Malaria Elimination Programme (NMEP), has implemented several policies and strategies to increase ITN ownership and usage, including mass distribution campaigns, routine distribution through antenatal care services, and community-based interventions.[7] Although ITN ownership has improved over the years, actual utilisation among women of reproductive age remains suboptimal, with recent national data indicating inconsistencies between ITN possession and regular use.[3,8] Low ITN utilisation among women in this age group contributes to sustained malaria transmission, increased maternal morbidity, adverse pregnancy outcomes, and neonatal complications.[9] The 2021 Nigeria Malaria Indicator Survey found that 83% of participants knew the use of ITNs as a malaria prevention tool; however, this does not translate into their usage.[2,5] A multi-country study done in Nigeria, Democratic Republic of Congo, Mozambique and Uganda showed that higher educational status, higher wealth index and urban residence enable the use of ITNs among women than those with lower educational status, lower wealth index and rural residence.[10] However, some other studies done in Nigeria reported that educational status did not significantly predict the use of ITNs.[11,12]Barrow et al. found in their study that educational status, religion, wealth index, place of residence and region were significant predictors of ITNs' use.[13]

Many studies have identified multiple determinants of ITN use among Women of reproductive age in Nigeria. These determinants include educational status, age, place of residence, household wealth index, religion, geopolitical zone, exposure to mass media, knowledge of malaria prevention, and household ITN ownership.[9–14]Studies from other countries have also identified these determinants of ITN use.[15–19]Figure 1 shows the conceptual framework for this study,which is built on the premise that insecticide-treated net (ITN) use among reproductive-age women is shaped by a combination of socio-demographic determinants, knowledge-related factors, and enabling conditions within the household and community. Socio-demographic factorssuch as age, educational level, household wealth, place of residence, religion, and geopolitical zoneform the foundational background characteristics that influence women's exposure to health information, perceived vulnerability to malaria, and capacity to adopt preventive behaviours. These background characteristics affect women's knowledge of malaria prevention methods, awareness of the benefits of ITNs, and the likelihood that their households possess mosquito nets. In turn, knowledge and the availability of ITNs act as intermediate factors that directly influence behavioural outcomes, such as whether the woman slept under an ITN the night before the survey. The framework, therefore, illustrates a pathway in which structural and socio-demographic factors shape enabling conditions and knowledge, ultimately determining ITN use among reproductive-age women in Nigeria.Given the persistent malaria burden and the vital role of ITN utilisation in malaria control, there is a need to examine the determinants influencing ITN use among women of reproductive age in Nigeria. Understanding how these socio-demographic, economic, and cultural factors affect ITN use is crucial for designing targeted interventions to improve coverage and reduce malaria-related health burdens.This study aimed to identify socio-demographic, economic, and knowledge-related determinants of Insecticide-treated net use among Nigerian women of reproductive age using data from the 2021 Nigeria Malaria Indicator Survey. This will provide evidence to inform policies and programmes aimed at improving malaria prevention among Nigerian women.

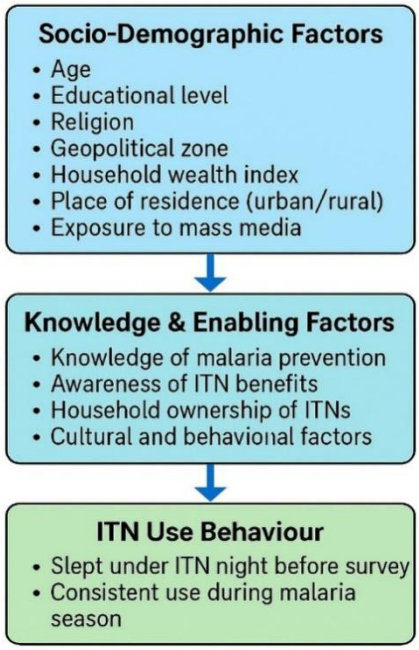

Figure 1. Insecticide-Treated Net Conceptual Framework. This shows the interaction between socio-demographic factors and knowledge and enabling factors that facilitate ITN use.

Materials and Methods

Data Source

The 2021 Nigeria Malaria Indicator Survey (NMIS) dataset of women of reproductive age was used for this study. This is a nationally representative cross-sectional designsurvey thatprovidesindicators for the country, the six geopolitical zones and urban and rural areas.Fourteen thousand, four hundred and seventy-six (14,476) women of reproductive ageparticipated in the survey.A two-stage sampling method was used to select the study participants, and variables of interest were collected using the women's questionnaire. The fullmethodology details of this survey have been described elsewhere.[2]

Variables Measures

"Respondent slept under the mosquito bed net" is the dependent variable for this study. Itwas one of the questions asked in the 2021 Nigeria Malaria Indicator Survey.If the respondentdid not sleep under a mosquito bed net, it was coded as 0; if the respondent slept under a mosquito bed net, it was coded as 1. Thedeterminants of insecticide-treated net use, including sociodemographic variables which had data in the primary survey and were identified in the literature as affecting women's use of ITNs,were used in this study as independent or explanatory variables.Exposure to Mass Media variable was created by combining the frequency of reading newspaper or magazine, listening to radio and watching television. No Exposure to Mass Media was coded as 0 if the respondent is not exposed to any of these mentioned media, and as 1if the participant is exposed to at least one of these media.In Nigeria, mass media, including newspapers, magazines, radio, and television, provide information on malaria prevention methods, such as the use of ITNs.The dichotomisation of this variable is due to the study's aim to investigate the impact of exposure to and non-exposure to mass media on the use of insecticide-treated nets. Also, knowledge of malaria prevention methods was dichotomised to enhance comparability with

previous studies, as several malaria prevention and health behaviour studies also classify knowledge levels as “good” or “poor” based on a cutoff point. Religionwas coded as (Catholic = 1, Other Christian = 2, Islam = 3). Traditionalist and Other Religion categories were omitted from the data analysis because their sample sizes were small. This is to improve model stability andreduce unreliable estimates.These variables were measured on the nominal scale, and the detailed codingis shown in the appendix.

Data Management and Analysis

Secondary Data analysis of the 2021 Nigeria Malaria Indicator Survey was done using Version 29 of the Statistical Package for Social Sciences (SPSS). Fourteen thousand, four hundred and seventy-six (14,476) women of reproductive age were included in the data analysis. There was no missing data.The sampleweight for women of reproductive age, provided by the survey implementers, was used to weight the data to ensure its representativeness.[2]Bivariate logistic regression analyses were conducted to identify the determinants of insecticide-treated bed net useamong women of reproductive age. The level of significance was set at Alpha = 0.05, and the independent orexplanatory variables not significant at this level were removed from the multivariable regression analysis model.The crude and adjusted odds ratios, along with their 95% confidence intervals, were reported for the different determinant categories relative to their respective reference categories. Weighted frequencies of the study variables were obtained by cross-tabulation between the independent and the dependent variables. The independent variables with a *p*-value of ≤0.05 in the multivariable regression analysis were considered statistically significant predictors or determinants of insecticide-treated nets among women of reproductive age in Nigeria. There was no multicollinearity among the independent variables as the variance inflation factor was less than five for all the variables.[15]

Ethical Procedures

The authors requested permission to use the dataset, which the DHS Programme granted to us to download the data for the study from https://dhsprogram.com/data/dataset/Nigeria_MIS_2021.cfm?flag=1. The procedure approved by the Institutional Review Board for DHS public-use datasets does not allow respondents, households, or sample communities to be identified. The data files do not contain personal identifiers of individuals or households.

Results

Table 1 showsthe socio-demographic characteristics of the study participants. A total weighted sample of 14,476 women of reproductive age, 15–49 years, was analysed. The educational status showed that 35.6% of respondents had no education, 14.4% had primary education, 37.1% had secondary education, and 12.9% had tertiary education.The age distribution showed that women in the 15-19 age category were highest in the sample (19.3%), followed by those in the 25-29 age category (18.4%), and those in the 45-49 age category were the least in the sample (5.6%). Most of the respondents lived in rural areas (67.9%) rather than urban areas (32.1%). Concerning the household wealth index, 43.5% belonged to rich households, 19.3% to average households, and 37.2% to poor households. Regarding religion, 58.7% were Muslims, 33.9% were other Christians, and 7.3% belonged to the Catholic religion. Regional distribution showed that North-West had the highest number of respondents (33.4%), followed by the North-East (16.6%), North-Central (16.4%), South-West (14.0%), South-South (12.0%), and South-East (7.7%). More respondents reported exposure to the mass media (56.7%) and knowledge of malaria prevention methods (80.2%). Ownership of mosquito bed nets by the respondents was 62.6%, while only 41.5% reported sleeping under it the night preceding the survey.

Table 1. Weighted distribution of socio-demographic, household, and malaria-related predictors of insecticide-treated net use among reproductive-age women in Nigeria.

Predictors	Weighted Frequency (n)	Weighted Per cent (%)
Educational Level		
No Education	5156	35.6
Primary Education	2089	14.4
Secondary	5364	37.1
Tertiary	1867	12.9
Age Categories (Years)		
15-19	2793	19.3
20 – 24	2464	17.0
25 – 29	2660	18.4
30 – 34	2362	16.3
35 – 39	1964	13.6
40 – 44	1419	9.8
45 - 49	814	5.6
Place of Residence		
Urban	4641	32.1
Rural	9835	67.9
Household Wealth Index		
Poor Household Wealth Index	5382	37.2
Average Household Wealth Index	2799	19.3
Rich Household Wealth Index	6295	43.5
Religion		
Catholic	1057	7.3
Other Christian	4893	33.9
Islam	8469	58.7
Geopolitical Zone		
North-Central	2377	16.4
North-East	2399	16.6
North-West	4832	33.4

South-East	1111	7.7
South-South	1734	12.0
South-West	2023	14.0
Exposure to Mass Media		
No Exposure to Mass Media	6270	43.3
Exposed to Mass Media	8206	56.7
Knowledge of Malaria Prevention Methods		
No Knowledge	2862	19.8
Have Knowledge	11614	80.2
Have Mosquito bed net for sleeping		
No	5409	37.4
Yes	9067	62.6
Respondent slept under a Mosquito bed net		
No	8469	58.5
Yes	6007	41.5

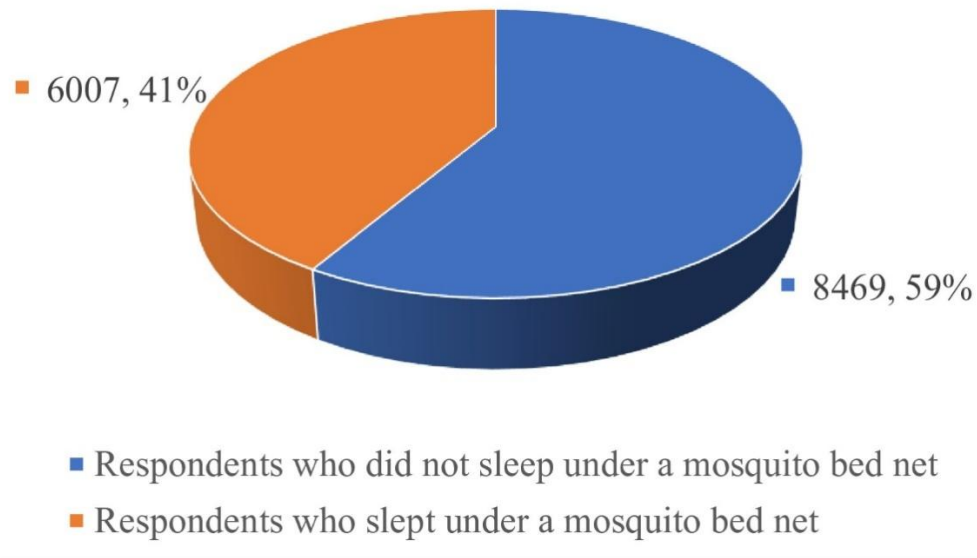

Figure 2. Frequency distribution of determinants of malaria insecticide-treated net use among women of reproductive age. Most of the women of reproductive age did not sleep under a malaria insecticide-treated net.

Table 2. Bivariate and multivariable logistic regression analysis of predictors of insecticide-treated net use among reproductive-age women in Nigeria.

Predictors	**COR (95% C.I.), *p*-value**	**AOR (95% C.I.), *p*-value**
Educational Level	*p*< .001	*p < .001*
No Education	*Ref*	*Ref*
Primary Education	.85 (.77, .94); *p* = .001	1.24 (1.11,1.40);*p* < .001
Secondary	.52 (.48, .57); *p* < .001	1.05(.93,1.18); *p* = .44
Tertiary	.37 (.33, .42); *p* < .001	.80(.69,.94); *p* = .005
Age Categories (Years)	*p*< .001	*p < .001*
15-19	Ref	Ref
20 – 24	1.31 (1.17, 1.46); *p* <.001	1.42(1.26,1.60);p < .001
25 – 29	1.14 (1.02, 1.27); *p* = .02	1.40(1.24,1.58);*p < .001*
30 – 34	1.28 (1.14, 1.43); *p* <.001	1.54(1.36,1.74); *p < .001*
35 – 39	1.05 (.94, 1.19); *p* = .39	1.44(1.26,1.64); p < .001
40 – 44	1.16 (1.02, 1.32); *p* =.03	1.41 (1.22,1.63); p< .001
45 - 49	1.11 (.94, 1.30);*p* = .22	1.39 (1.17,1.66); p < .001
Place of Residence		
Urban	Ref	Ref
Rural	1.35 (1.26, 1.45); *p*< .001	1.07 (.98,1.17); *p* = .13
Household Wealth Index	*p*< .001	
Poor Household Wealth Index	Ref	Ref0.05
Average Household Wealth Index	.87 (.79, .95); *p* = .003	1.19(1.07,1.32);*p*= .001
Rich Household Wealth Index	.41 (.38, .44); *p*< .001	.72(.64,.82);*p*< .001
Geopolitical Zone	*p*< .001	
North-Central	Ref	*Ref*
North-East	2.79 (2.48,3.14); *p*< .001	3.20(2.81,3.65);*p* < .001
North-West	2.58 (2.33, 2.86); *p* < .001	2.90(2.58, 3.26); *p*< .001
South-East	.53 (.45, .62); *p*< .001	.44(.37,.53); *p*< .001
South-South	.50 (.43, .58);*p*< .001	.46(.40,.54); *p*< .001
South-West	.61 (.53, .70); *p* < .001	.65(.57,.75); *p*< .001
Religion	*p < .001*	*p < .001*
Catholic	Ref	Ref

Other Christian	.98 (.85, 1.13);*p* = .74	.99(.84,1.16); *p* = .85
Islam	2.18 (1.90, 2.50);*p*< .001	.74(.63,.88); *p* < .001
Exposure to Mass Media		
No Exposure to Mass Media	Ref	Ref
Exposed to Mass Media	.61 (.57, .65);*p*< .001	1.27(1.15,1.40); *p*< .001
Knowledge of Malaria Prevention Methods		
No Knowledge	Ref	Ref
Have Knowledge	1.32 (1.21, 1.43);*p*< .001	1.43(1.30,1.57); *p*< .001
Have Mosquito bed net for sleeping		
No	Ref	
Yes	3171019516.2(.000, -); *p* = .97	-

Table 2 shows the results of the logistic regression analysis. Significant predictors of mosquito bed net use were identified after adjusting for potential confounders.Women with primary education were 24% more likely to use bed nets than those with no education (AOR = 1.24; 95% CI: 1.11–1.40; p < .001), while those with tertiary education were 20% less likely to use it(AOR = 0.80; 95% CI: 0.69–0.94; p = .01) than those with no education. There was no difference in the mosquito insecticide-treated net use between women of reproductive age with secondary education and those with no education (AOR = 1.05; 95% CI:.93-1.18; p = .44). Women aged 20–24, 25–29, 30–34, 35–39, 40–44, and 45–49 years all had significantly higher odds of bed net use compared to those aged 15–19 years, with the highest odds observed among women aged 30–34 years (AOR = 1.54; 95% CI: 1.36–1.74; p < .001). There was no statistically significant difference in the mosquito insecticide-treated net use between rural and urban participants (AOR = 1.07;95% CI: .98-1.17; p = .13), although rural residence was associated with higher odds in bivariate analysis (COR = 1.35;95% CI:1.26-1.45;p < .001). Households wealth index showed a mixed pattern. Women from average-wealth households were 19% more likely to use bed nets than those from poor households(AOR = 1.19; 95% CI: 1.07–1.32; p = .001), whereas those from rich households were 28% less likely to use them(AOR = 0.72; 95% CI: 0.64–0.82; p < .001). Regional differences in mosquito bed net usage among the women were significant (p < .001). In comparison to the North-Central region, women from the North-East (AOR = 3.20; 95% CI: 2.81–3.65; p < .001) and North-West (AOR = 2.90; 95% CI: 2.58–3.26; p < .001) were three times more likely to use bed nets. Women from South-East (AOR = 0.44; 95% CI: 0.37–0.53; p < .001), South-South (AOR = 0.46; 95% CI: 0.40–0.54; p < .001), and South-West (AOR = 0.65; 95% CI: 0.57–0.75; p < .001) were 56%, 54%, and 35% less likely to use insecticide treated bed net respectively. Muslim women were 26% less likely to use bed nets (AOR = 0.74; 95% CI: 0.63–0.88; p < .001) compared to Catholics, while no significant difference in bed net utilisation was observed between Other Christians and Catholics (AOR = 0.99; 95% CI: .84-1.16); p = .85). Women who had mass media exposure were 27% more likely to use the bed nets than those with no mass media exposure (AOR = 1.27; 95% CI: 1.15–1.40; p < .001).Women with knowledge of malaria prevention methodswere 43% more likely to use mosquito bed nets than those without knowledge (AOR = 1.43; 95% CI: 1.30–1.57; p < .001).The relationship between bed net ownership and usage was insignificant, with a very high odds ratio in the bivariate regression analysis. This may be due to complete or perfect separation, where bed net ownership by the women completely predicted their use. Therefore,

it was excluded from the multivariable regression model.The Hosmer–Lemeshow goodness-of-fit test indicated poor fit of the logistic regression model ($\chi^2 = 16.79$, df = 8, p = 0.032), suggesting that the model's predicted probabilities did not fully match the observed outcomes.

Discussion

This study assessed the determinants of insecticide-treated bed net (ITN) use among women of reproductive age, and findings showed that sociodemographic, economic, regional, religious, and knowledge-related factors significantly predicted the use of ITN among the women.Educational status of the women showed acomplex relationship with the use of bed nets. Women with primary education were more likely to use ITNs compared to those with noeducation, supporting previous studies done in sub-Saharan African countries that highlighted the positive impact of highereducation on malaria prevention behaviours.[10,16] Interestingly, tertiary education was associated with reduced odds of ITN use. This was supported by a similar study done in Sierra Leone.[17] Higher educational status is supposed to facilitate knowledge of the benefits of ITN use, thereby increasing its usage. However, those with higher educational status may belong to higher wealth index households with access to better housing conditions and alternative malaria preventive methods other than ITNs, therebyseeing no need for ITN use.[3,18]Age was a significant predictor, with older women, particularly those aged 30–34 years, showing the highest likelihood of ITN use. This finding is consistent with evidence that older women tend to have more experience with childbearing and may prioritise malaria prevention, especially during pregnancy and child-rearing periods.[19]

Contrary to expectation, rural-urban residence did not significantly influence ITN use after adjusting for confounders, despite a higher crude likelihood among rural women. Other studies have reported mixed findings, with greater odds of using ITNs among the women reported in either rural or urban areas.[12,20]A non-linear association between women of reproductive age's household wealth index and ITN use was found in this study. Women from average wealth households were more likely to use bed nets compared to those from poor households, while women from rich households had reduced odds of ITN use. This inverse association among the wealthy has been reported in previous studies, potentially suggesting complacency due to improved living standards or greater reliance on alternative malaria prevention strategies.[3,18]

Regional disparities were evident, with significantly higher ITN use in the North-East and North-West compared to the North-Central region. These findings are consistent with the known higher malaria burden and targeted interventions in Northern Nigeria, including mass ITN distribution campaigns.[21,22] Conversely, women from the Southern regions had lower odds of ITN use, underscoring the need for region-specific strategies to improve coverage and usage.[21,23]Religious affiliation influenced ITN utilisation, with Muslim women less likely to use bed nets than Catholics. This is supported by similar studies done in other African countries.[24–26] While religion itself may not directly affect health behaviours, it often intersects with cultural norms, socioeconomic status, and geographic location, all of which can shape malaria prevention practices (13).

Exposure to mass media and malaria prevention knowledge were strong positive predictors of ITN use, corroborating previous studies that emphasisethe role of health education and awareness campaigns in promoting preventive behaviours.[26–30] Mass media have been shown to increase knowledge and change attitudes towards malaria prevention, particularly in resource-limited settings.[30]Finally, although the relationship between bed net ownership and use could not be reliably estimated due to perfect prediction or complete separation, prior evidence underscores that ownership is a fundamental prerequisite for usage, though gaps often remain between ownership and effective utilisation.[30,32]

Strengths and Limitations

A key strength of this study is its large, nationally representative sample, which allows for robust estimates across various subgroups. However, limitations include reliance on self-reported data, which may be prone to recall or social desirability bias. Additionally, a cross-sectional design precludes causal inferences. The inability to assess the effect of bed net ownership on utilisation due to complete separation in the regression model limits the interpretation of this important determinant. Lastly, the effect of unmeasured factors or confounders may impact the findings of this study.The model showed evidence of poor fit according to the Hosmer–Lemeshow test. This may be due to omitted variables, non-linear relationships, or influential outliers. Therefore, the results should be interpreted cautiously. Nonetheless, the model demonstrated moderate discriminative ability (AUC = 0.71). Future studies could explore additional predictors or transformations to improve model calibration.

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