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Prevalence and determinants of insecticide-treated net ownership among women of reproductive age in Nigeria: a mixed-effect insight from the 2021 malaria indicator survey

Oluwakemi Christie Ogidan[1], Chimezie Igwegbe Nzoputam[2,3], Amadou Barrow[4,5*] and Michael Ekholuenetale[6,7]

Abstract

Background Malaria continues to be a significant public health issue in Nigeria, which bears the highest burden of the disease globally. This study examined the prevalence and determinants of insecticide-treated net (ITN) ownership among women of reproductive age in Nigeria.

Methods The individual woman questionnaire data from the 2021 Nigeria Malaria Indicator Survey (NMIS) was used. In total, 14,476 women of reproductive age (15–49 years) made up the study's sample that was analysed. The outcome variable in the study was ITN ownership. Percentage and multivariable multilevel binary logistic regression model were estimated at $p < 0.05$.

Results The weighted prevalence of ITN ownership was 62.6% (95% CI 60.6–64.7%). Women aged 25–34 and 35–49 had 12% (aOR = 0.88; 95% CI 0.78–0.98) and 16% (aOR = 0.84; 95% CI 0.74–0.97) reduction in ITN ownership, when compared with women aged 15–24 years. Women who had 1–2 (aOR = 1.13; 95% CI 1.00–1.28), 3–4 (aOR = 1.28; 95% CI 1.11–1.46) and 5 and above living children (aOR = 1.35; 95% CI 1.15–1.58), had higher odds of ITN ownership when compared with those with no living child respectively. Women from non-poor households had higher odds of ITN ownership, when compared with their poor counterparts (aOR = 1.30; 95% CI 1.14–1.49). Women from North East (aOR = 4.52; 95% CI 3.08–6.63) and North West (aOR = 4.18; 95% CI 2.90–6.01) had higher odds of ITN ownership, while those from South East (aOR = 0.40; 95% CI 0.26–0.62) and South South (aOR = 0.59; 95% CI 0.41–0.85) had reductions in the odds of ITN ownership, when compared with women from North Central respectively.

Conclusion Approximately two-third of Nigerian women reported ITN ownership. This underscore the need for targeted interventions to address barriers and improve ITN access. While free ITN distribution programmes have been effective, socioeconomic and demographic factors have remained contributory to ITN access. Enhanced strategies should focus on equitable distribution and improved access to ITN among groups to achieve better malaria control outcomes in Nigeria.

*Correspondence:
Amadou Barrow
abarrow@utg.edu.gm
Full list of author information is available at the end of the article

Keywords Nigeria, ITN, Net, Women, Malaria

Background

Malaria remains a major public health challenge in Nigeria, being the country with highest burden of the disease worldwide [1]. According to World Health Organization (WHO), Nigeria accounts for 68 million malaria cases and 189,000 deaths in year 2022, causing 27% and 31% of the global malaria burden and deaths, respectively [2]. Malaria transmission is endemic and perennial in most parts of Nigeria, with seasonal variations influenced by rainfall patterns, relative humidity and minimum temperature [3, 4]. In response to this public health issue, the use of insecticide-treated nets (ITNs) has been identified as a critical preventive measure. Over the last decade, the Nigerian government and its partners have undertaken several malaria preventive programmes. ITN provide a physical barrier against mosquitoes, reducing human-vector contact, and are treated with insecticides that kill or repel mosquitoes. The use of ITNs has been shown to significantly reduce malaria incidence, morbidity, and mortality [5].

Regardless of insecticide treatment, bed nets create a physical barrier that reduces mosquito-human interaction and successful blood feeding. Insecticides give additional protection by killing or confusing mosquitoes, limiting their chances of entering a net and preventing them from biting persons who use nets [6]. This can provide communal protection in addition to personal effects. High insecticide-treated bed nets can also reduce adult mosquito density and alter the mosquito population's age distribution. Repeated exposure to insecticide-treated bed nets can limit transmission potential, and sublethal effects such as reduced feeding propensity and host-searching capacity may help to manage mosquitoes with lower fatality rates due to resistance [7].

Lately, however, the decrease in malaria morbidity and mortality has stalled [7, 8]. Some suggest that this inertia is due to increasing resistance in malaria vectors to the pyrethroid insecticides used for treating ITNs. However, there is currently insufficient evidence to draw conclusions about the cause of the reduction, thus there is need to using a broader approach to evaluate ITN performance in terms of net access. Understanding the prevalence and determinants of ITN ownership is crucial for the effective implementation of malaria control programmes.

Women are particularly vulnerable to malaria. ITN ownership among women is critical for reducing malaria transmission, especially in regions with high malaria prevalence. ITNs are one of the most effective tools for preventing malaria by protecting individuals from mosquito bites. Despite efforts to distribute ITNs, disparities in ownership persist, influenced by socioeconomic factors, geographic location, education, and access to healthcare. Rural women, those with lower education, and poorer households are less likely to own ITNs [9]. Promoting ITN distribution, raising awareness, and addressing barriers to access are essential to increase ITN ownership among women of reproductive age in Nigeria. Women are key in malaria prevention programmes due to their susceptibility to malaria-related complications during pregnancy, which can lead to adverse outcomes for both mothers and their babies. This study explores the prevalence and factors associated with ITN ownership among women in Nigeria.

Methods

Data source

The individual woman questionnaire data from the 2021 Nigeria Malaria Indicator Survey (NMIS) was used. In total, 14,476 women of reproductive age (15–49 years) made up the study's sample that was analysed. The data collection took place from 12 October to 4 December 2021. The 2021 NMIS sample included indicators for rural and urban areas across each of the six geopolitical zones in Nigeria, comprising 36 states and the Federal Capital Territory (FCT). Nigeria's geopolitical zones where the data was collected are as follows:

North Central: Benue, Kogi, Kwara, Nasarawa, Niger, Plateau, and FCT.

North East: Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe.

North West: Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto, and Zamfara.

South East: Abia, Anambra, Ebonyi, Enugu, and Imo.

South South: Akwa Ibom, Bayelsa, Cross River, Delta, Edo, and Rivers.

South West: Ekiti, Lagos, Ogun, Osun, Ondo, and Oyo.

Sample design

The sample frame for the Federal Republic of Nigeria's projected 2023 Population and Housing Census (PHC) was utilized in the 2021 NMIS. Nigeria is separated into states administratively. Local government areas (LGAs) are the lowest level of governance in each state. Within LGAs are wards, and within wards are localities. Census enumeration areas (EAs), which are handy areas, are further subdivided into localities. Based on the EAs for the projected 2023 PHC, the primary sampling unit (PSU), also known as a cluster unit for the 2021 NMIS, was defined. For the NMIS of 2021, a two-phase sampling approach was chosen. A probability proportional to the EA size was used to choose 568 EAs in the first stage.

The number of households inside an EA determines its size. The sample was chosen in a way that made it representative of every state. As a consequence, there were 568 clusters nationwide—195 of which were in urban areas and 373 of which were in rural areas. Between August 26, 2021, and September 18, 2021, all of the households in these clusters were listed in full. The lists of homes that were produced were used as the sample frame to choose the households for the second stage. In the 2021 NMIS sample, GPS dongles were utilized to record coordinates during the households listing process [10]. By using equal probability systematic sampling, 25 households from each cluster were chosen for the second step of the selection procedure. The datasets are available in the public domain via https://dhsprogram.com/data/dataset/Nigeria_MIS_2021.cfm?flag=1.

Selection and measurements of variables

Outcome variables

The outcome variable in the study was ITN ownership. It was derived from the question variable "*V459—Have mosquito bed net for sleeping*". This yielded a binary response, with 'yes' coded as "1" indicating that the respondent had ITN, and 'no' coded as "0" indicating otherwise. This follows the operational definition of ITN ownership as used by NMIS [10]. The MIS 2021 provides current and comprehensive data on malaria-related indicators, including ITN ownership.

Explanatory variables

The selection of explanatory variables was guided by a thorough review of existing literature on factors associated with ITN ownership [9, 11–14]. These studies provided empirical evidence on individual, household, and community-level factors that influence ITN ownership and other malaria-related outcomes. The following variables were included in the study: Age (in years): 15–24, 25–34, 35–49; Education: No education/primary, Secondary/higher; religion: Christianity, Islam, Others; exposed to malaria messages: no, yes; number of living children: 0, 1–2, 3–4, 5 + ; wealth: poor, non-poor; sex of household head: male, female; region: North Central, North East, North West, South East, South South, South West; place of residence: urban, rural; community-level ethnic: mono-ethnic, multi-ethnic; community-level poverty: low, medium, high; community-level education: low, medium, high; community-level exposure to malaria messages: low, medium, high.

Analytical approach

Stata software version 17.0 (Stata Corporation, College Station, Texas, USA) was used for data analysis. Since the study included the multi-stage stratified cluster sample design, the survey module's ('svy') function to account for sampling design (weighting, clustering, and stratification) was employed. Percentage was employed in the univariable analysis. The fixed and random effects of ITN ownership were investigated using the multilevel multivariable binary logistic regression. In order to assess multicollinearity, which is known to raise serious issues with the logit model, the variance inflation factor was employed [15].

A two-level model was designed for binary response reporting ITN ownership, with level 1 representing individual women's factors nested within communities and level 2 for community/EA-level factors. Four models were built. First, the community-level variance was computed in the empty or unconditional model, which included no explanatory factors. The null model served as a benchmark to assess the extent to which community characteristics accounted for the observed changes. The results justified the use of a multilevel statistical model. Since the variance was statistically significant, the use of multilevel regression was established. The second model included individual-level factors, and the third model included community-level factors. Finally, the fourth model (full model) adjusted for the individual and community-level factors. The level of significance was determined at $p < 0.05$. To choose the best model from the four models, the Bayesian and Akaike Information Criteria were used. A lower Akaike or Bayesian Information Criterion value denotes a better model fit [16].

Fixed and random effects

Adjusted odds ratios (aORs) along with their 95% confidence interval (CI) were used to report the outcomes of fixed effects (measures of association) of the factors associated with ITN ownership. The Intra-class Correlation (ICC) and Median Odds Ratio (MOR) were used to quantify the likely contextual effects [17]. The ICC was used to assess the similarity between respondents living in the same community. The ICC is a measure of the clustering of odds of ITN ownership in the same community. It shows the percentage of the total variance in the likelihood of ITN ownership that is connected to the community-level factors. The MOR estimates the probability of ITN ownership that can be assigned to the community by measuring the second-level (community) variance as odds ratios. Furthermore, when the MOR is one, there is no variance in communities.

Conversely, the higher the MOR, the more important are the contextual effects for understanding the probability of ITN ownership. The linear threshold was utilized to compute ICC using the Snijders and Bosker formula [18], MOR, on the other hand, measures the heterogeneity of unexplained clusters.

Ethical consideration

The de-identified public secondary dataset was used for this study. The respondents' informed consent was collected by NMIS in accordance with standard ethical protocol. The authors were granted permission to use the data, therefore no further participants' agreement or consent was required. The details of DHS ethical guidelines can be found here: http://goo.gl/ny8T6X.

Results

The weighted prevalence of ITN ownership was 62.6% (95% CI 60.6–64.7%). Figure 1 showed that two-third of Nigerian women reported ITN ownership.

Table 1 presents the prevalence of ITN ownership among Nigerian women across various demographic, socioeconomic, and community-level characteristics. Significant differences in ITN ownership prevalence were observed for several variables, as indicated by their p-values. Young women aged 15–24 years had the highest prevalence of ITN ownership (64.7%; 95% CI 62.2–67.1) compared to those aged 25–34 (62.3%; 95% CI 60.0–64.5) and 35–49 years (60.5%; 95% CI 57.9–63.0), with a significant p-value of 0.002. Women with no formal education or only primary education had significantly higher ITN ownership (68.6%; 95% CI 65.7–59.1) compared to those with secondary or higher education (56.7%; 95% CI 54.2–59.1) ($p < 0.001$). Religion was also significantly associated with ITN ownership ($p < 0.001$). Muslim women reported the highest ITN ownership (70.3%; 95% CI 67.4–73.1), compared to Christian women (51.8%; 95% CI 49.0–54.5). Additionally, households headed by males had a significantly higher prevalence of ITN ownership (64.4%; 95% CI 62.3–66.5) compared to female-headed households (50.8%; 95% CI 46.7–54.9) ($p < 0.001$).

Significant regional disparities in ITN ownership were observed ($p < 0.001$). Women from the North East (77.9%; 95% CI 73.9–81.4) and North West (77.0%; 95% CI 73.0–80.5) regions had the highest prevalence of ITN ownership, while women from the South East (42.1%; 95% CI 37.4–46.9) and South South (42.5%; 95% CI 38.1–47.0) regions had the lowest prevalence. Rural dwellers had significantly higher ITN ownership (64.0%; 95% CI 61.3–66.6) compared to urban dwellers (59.9%; 95% CI 56.8–62.9) ($p = 0.046$). Community-level characteristics also showed significant associations with ITN ownership. Women from mono-ethnic communities reported higher ITN ownership (68.6%; 95% CI 64.1–72.8) compared to those from multi-ethnic communities (60.8%; 95% CI 58.3–63.2) ($p = 0.006$). Community-level poverty and education showed significant trends, with low poverty (71.6%; 95% CI 67.7–75.2) and low education (72.1%; 95% CI 68.0–75.8) being associated with higher ITN ownership (both $p < 0.001$). See Table 1 for the details.

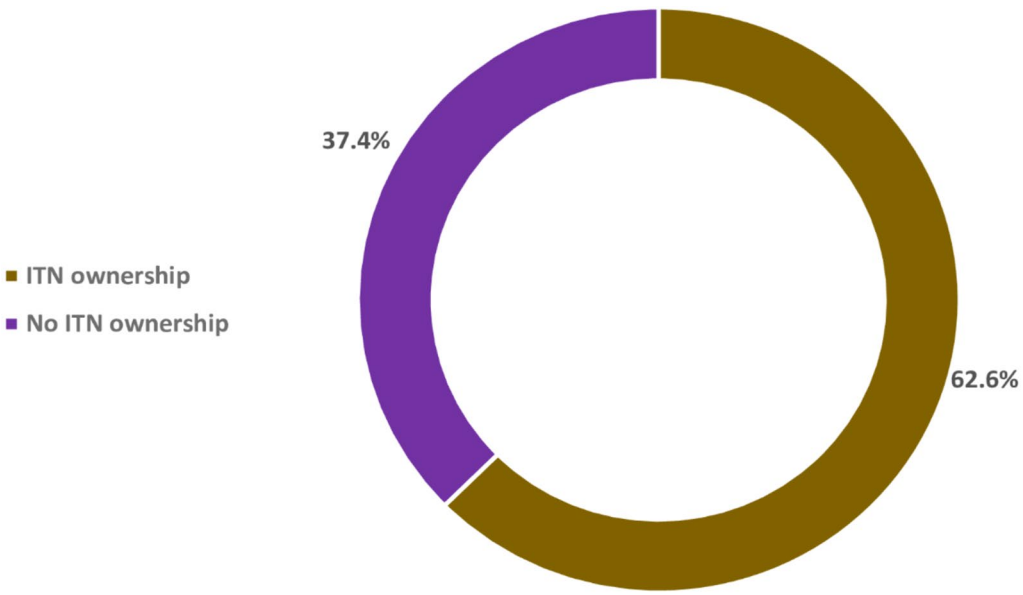

Fig. 1 Prevalence of ITN ownership among Nigerian women

Table 1 Prevalence of ITN ownership among Nigerian women (n = 14,476)

Variable	n (%)	Prevalence of ITN ownership, % (95% CI)	P-value
Age (in years)			0.002
15–24	5129 (35.4)	64.7 (62.2–67.1)	
25–34	5027 (34.7)	62.3 (60.0–64.5)	
35–49	4320 (29.8)	60.5 (57.9–63.0)	
Education			< 0.001
No education/ primary	6769 (46.8)	68.6 (65.7–59.1)	
Secondary/higher	7707 (53.2)	56.7 (54.2–59.1)	
Religion			< 0.001
Christianity	7058 (48.8)	51.8 (49.0–54.5)	
Islam	7344 (50.7)	70.3 (67.4–73.1)	
Others	74 (0.5)	57.3 (38.1–74.5)	
Exposed to malaria messages			0.225
No	7720 (53.3)	61.8 (59.2–64.4)	
Yes	6756 (46.7)	63.6 (61.2–65.9)	
Number of living children			< 0.001
0	4250 (29.4)	59.2 (56.4–62.0)	
1–2	3662 (25.3)	61.2 (58.6–63.7)	
3–4	3479 (24.0)	63.1 (60.7–65.5)	
5 +	3085 (21.3)	68.1 (65.1–71.0)	
Wealth			< 0.001
Poor	5052 (34.9)	70.0 (66.2–73.1)	
Non-poor	9424 (65.1)	58.3 (55.7–60.7)	
Sex of household head			< 0.001
Male	12339 (85.2)	64.4 (62.3–66.5)	
Female	2137 (14.8)	50.8 (46.7–54.9)	
Region			< 0.001
North Central	2674 (18.5)	54.4 (49.6–59.1)	
North East	2523 (17.4)	77.9 (73.9–81.4)	
North West	3635 (25.1)	77.0 (73.0–80.5)	
South East	1523 (10.5)	42.1 (37.4–46.9)	
South South	2148 (14.8)	42.5 (38.1–47.0)	
South West	1973 (13.6)	48.5 (43.7–53.3)	
Place of residence			0.046
Urban	4930 (34.1)	59.9 (56.8–62.9)	
Rural	9546 (65.9)	64.0 (61.3–66.6)	
Community-level ethnic			0.006
Mono-ethnic	3568 (24.7)	68.6 (64.1–72.8)	
Multi-ethnic	10908 (75.3)	60.8 (58.3–63.2)	
Community-level poverty			< 0.001
Low	4934 (34.1)	71.6 (67.7–75.2)	
Medium	4779 (33.0)	65.6 (61.4–69.6)	
High	4763 (32.9)	48.5 (44.7–52.3)	
Community-level education			< 0.001
Low	4857 (33.6)	72.1 (68.0–75.8)	
Medium	4839 (33.4)	62.6 (58.6–66.4)	
High	4780 (33.0)	50.3 (46.3–54.3)	
Community-level exposure to malaria messages			0.307
Low	4850 (33.5)	64.5 (60.3–68.6)	
Medium	4815 (33.3)	63.3 (59.5–67.0)	
High	4811 (33.2)	59.9 (55.4–64.7)	

p-values reported in this table are based on chi-square test results

Measures of variations (random effects) and model fit statistics

In Table 2, Model IV (full model) was selected as the most suitable due to the least AIC value (16148.63). The variations in the odds of ITN ownership across communities ($\sigma^2 = 1.25$) was estimated. Results from Median Odds Ratio became evidence of community contextual factors shaping ITN ownership. It was estimated that if a woman moved to another community with a higher probability of ITN ownership, the median increase in their odds of ITN ownership would be 2.91 with ICC of 27.6%. MOR equal to unity, would indicate no community variance given ICC at 0.0%. At community level, the explained variance was 39.9%. This implied that a good amount of variance in ITN ownership has been explained by community-level factors. PCV helped in understanding the contribution of added covariates to reducing unexplained variance. A higher PCV indicates that the predictors in the model explain a good proportion of the variance at the community level.

Measures of associations (fixed effects)

Results from Table 3 showed that women aged 25–34 and 35–49 had 12% (aOR = 0.88; 95% CI 0.78–0.98) and 16% (aOR = 0.84; 95% CI 0.74–0.97) reduction in ITN ownership, when compared with women aged 15–24 years. Women who had 1–2 (aOR = 1.13; 95% CI 1.00–1.28), 3–4 (aOR = 1.28; 95% CI 1.11–1.46) and 5 + (aOR = 1.35; 95% CI 1.15–1.58) living children, had higher odds of ITN ownership when compared with those with no living child respectively. Women from non-poor households had higher odds of ITN ownership, when compared with their poor counterparts (aOR = 1.30; 95% CI 1.14–1.49). Women from North East (aOR = 4.52; 95% CI 3.08–6.63) and North West (aOR = 4.18; 95% CI 2.90–6.01) had higher odds of ITN

Table 2 Random effect estimates of individual- and community-level factors associated with ITN ownership

Random-effect	Model I	Model II	Model III	Model IV
Community-level				
Variance (95% CI)	2.08 (1.79–2.41)*	1.87 (1.60–2.19)*	1.25 (1.07–1.46)*	1.25 (1.07–1.47)*
Explained variance (PCV)	Reference	10.1%	39.9%	39.9%
MOR	3.95	3.69	2.90	2.91
ICC	38.7% (35.2–42.2%)	36.3% (32.7–40.0%)	27.5% (24.4–30.8%)	27.6% (24.6–30.9%)
Model fit statistics				
AIC	16384.56	16349.18	16170.30	16148.63
BIC	16399.72	16440.14	16268.84	16322.98
Log-likelihood	− 8190.22	− 8162.59	− 8072.15	− 8051.32
Sample size				
Community	567	567	567	567

Model I—baseline model with no explanatory variables, or empty null model (unconditional model)

Model II—solely taking into account individual-level factors

Model III—solely taking into account community-level factors

Model IV—full model adjusted for characteristics at the individual, and community levels

AIC Akaike's Information Criterion, *BIC* Bayesian Information Criterion, *PCV* Proportional Change in Variance, *ICC* Intra-class correlation

* Significant at $p < 0.05$

ownership, while those from South East (aOR = 0.40; 95% CI 0.26–0.62) and South South (aOR = 0.59; 95% CI 0.41–0.85) had reductions in the odds of ITN ownership, when compared with women from North Central, respectively.

Discussion

The study examined the prevalence and factors associated with ITN ownership among women of reproductive age in Nigeria. The study found that 62.6% of Nigerian women of reproductive age own an ITN, with a 95% Confidence Interval (CI) of 60.6–64.7%. This is short of the 80% Roll Back Malaria (RBM) targeted since 10-years ago and short of 2013 target of National Malaria Control Programme which says that at least 80% of households with two or more ITN/LLIN (one net to two people) by 2010 and sustained at this level until 2013 [19]. Our study's prevalence of ownership is similar to a community study in the south-western part of Nigeria [20]. The 62.6% ownership of an ITN among women of reproductive age could be attributed to free distribution of ITNs, as most ITNs are obtained for free. However, there is need to improve malaria prevention coverage especially in areas with lower ITN coverage and addressing barriers to access ITN.

Women's age (older women had reduction in the odds of insecticide treated net ownership, when compared with women aged 15–24 years) significantly associate with ITN ownership. This highlights potential gaps in malaria prevention efforts and health equity. A previous finding from a study conducted in Ghana documented that age has no significant association with ITN ownership in the multivariate analysis [21]. The difference in the findings reflect various underlying factors, including health education, policy implementation on ITN distribution, cultural attitudes, and socioeconomic conditions. Addressing these factors through targeted and context-specific interventions could help bridge the gap in ITN ownership across different age groups. might be due The higher ownership of ITNs among younger reproductive age women (Most prominent group for pregnancy and delivery) might be due to free distribution of ITNs to pregnant women at their first clinic antenatal care (ANC), and mothers attending infant welfare clinics [12]. Ensuring that all age groups have equitable access to ITNs is crucial for effective malaria control and improving overall public health outcomes.

Number of living children for Women (women who had children had higher odds of insecticide treated net ownership. This may be because of ITN distribution programs that often focus on households with under five children due to the heightened risk of malaria for this age group. The presence of young children could also heighten the concern of mothers about malaria and thus increase the likelihood of obtaining and using ITNs. Similar findings were documented in an analysis of the 2018 Demographic and Health Survey of Guinea [22]. Public health initiatives can be better designed to reduce malaria risk and improve health outcomes across different population groups.

Wealth (non-poor/rich women had higher odds of insecticide treated net ownership, when compared with poor women). Studies have documented similar findings

Table 3 Fixed effect of individual and community-level factors associated with ITN ownership

Variable	Odds ratio (95% CI)			
	Model I	Model II	Model III	Model IV
Age (in years)				
15–24		1.00		1.00
25–34		0.85 (0.76–0.95)*		0.88 (0.78–0.98)*
35–49		0.79 (0.69–0.90)*		0.84 (0.74–0.97)*
Education				
No education/primary		1.00		1.00
Secondary/higher		1.00 (0.89–1.12)		1.12 (0.99–1.25)
Religion				
Christianity		1.00		1.00
Islam		1.42 (1.21–1.65)*		0.94 (0.80–1.10)
Others		1.33 (0.68–2.63)		1.28 (0.66–2.47)
Number of living children				
0		1.00		1.00
1–2		1.13 (1.00–1.27)*		1.13 (1.00–1.28)*
3–4		1.28 (1.12–1.47)*		1.28 (1.11–1.46)*
5 +		1.38 (1.18–1.61)*		1.35 (1.15–1.58)*
Wealth				
Poor		1.00		1.00
Non-poor		1.10 (0.97–1.25)		1.30 (1.14–1.49)*
Sex of household head				
Male		1.00		1.00
Female		0.85 (0.76–0.96)*		0.90 (0.780–1.01)
Region				
North Central			1.00	1.00
North East			4.40 (3.01–6.43)*	4.52 (3.08–6.63)*
North West			4.13 (2.89–5.90)*	4.18 (2.90–6.01)*
South East			0.42 (0.28–0.64)*	0.40 (0.26–0.62)*
South South			0.60 (0.42–0.86)*	0.59 (0.41–0.85)*
South West			0.77 (0.54–1.11)	0.76 (0.52–1.10)
Place of residence				
Urban			1.00	1.00
Rural			1.25 (0.96–1.61)	1.25 (0.94–1.58)
Community-level ethnic				
Mono-ethnic			1.00	1.00
Multi-ethnic			0.84 (0.64–1.09)	0.83 (0.63–1.08)
Community-level poverty				
Low			1.00	1.00
Medium			1.34 (0.97–1.85)	1.16 (0.83–1.62)
High			0.86 (0.58–1.27)	0.71 (0.48–1.08)
Community-level education				
Low			1.00	1.00
Medium			1.38 (0.96–1.97)	1.31 (0.91–1.88)
High			1.37 (0.86–2.16)	1.28 (0.80–2.05)

Model I—baseline model with no explanatory variables, or empty null model (unconditional model)

Model II—solely taking into account individual-level factors

Model III—solely taking into account community-level factors

Model IV—full model adjusted for characteristics at the individual, and community levels

* Significant at $p < 0.05$

across African Countries [21, 23], which indicates the need to address the specific barriers that prevent low-income households from obtaining ITNs. This might include improving distribution channels, providing ITNs at no cost or subsidized rates, and ensuring that health education reaches all socioeconomic groups. Effective and regular provision of ITNs at no cost across all group may serve as panacea to malaria, an endemic across African Countries including Nigeria.

Women from North East and North West provinces of Nigeria had higher odds of insecticide treated net ownership, when compared with North Central women. Also, women from South East and South South provinces of Nigeria had reduction in the odds of net ownership when compared with their North Central counterparts. This finding provides valuable insights into regional disparities in malaria prevention strategies, it suggests a higher uptake or better distribution of malaria prevention resources in the northern part compared to the southern part regions of Nigeria. Data from the 2018 Nigeria Demographic and Health Survey (NDHS) revealed that prevalence of malaria ranges from 16% in the South and South East Zones to 34% in the North West Zone [24]. Another report documented that the crisis in the northern part of Nigeria causing many Internally Displaced Persons (IDPs) has complicated the burden of malaria and other health conditions that prompted governments and nongovernmental organizations to provide number of intervention programmes including free distribution of ITNs [25]. These might account for higher odds of insecticide treated net ownership in the northern regions when compared with the southern region of Nigeria. Addressing these disparities through targeted interventions and resource allocation can contribute to more effective malaria prevention and control across Nigeria.

Conclusion

The ITN ownership among Nigerian women of reproductive age own falls short of the target set by Roll Back Malaria initiative and National Malaria Control Programme, which aims for every household member to sleep under an ITN. The ownership rates vary by region, with higher prevalence in the North East and North West provinces compared to the North Central and southern regions. Factors such as age, number of children, and socioeconomic status significantly influence ITN ownership, highlighting ITN ownership disparities among different groups. To bridge these gaps, targeted and context-specific interventions are essential to enhance ITN coverage and improve malaria prevention efforts across different demographic and geographic groups in Nigeria.

Abbreviations

ANC	Antenatal care
CI	Confidence interval
FCT	Federal capital territory
ICC	Intra-class correlation
IDPs	Internally displaced persons
ITNs	Insecticide-treated net
LGAs	Local government areas
LLIN	Long-lasting insecticide net
MOR	Median odds ratio
NDHS	Nigeria demographic and health survey
NMIS	Nigeria malaria indicator survey
PHC	Population and housing census
PSU	Primary sampling unit
WHO	World Health Organization

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Author contributions

ME conceptualized the study and conducted data curation and analysis and wrote the results. OCO, CIN, AB, ME reviewed the literature, drafted the initial manuscript, designed the study, interpreted the results and discussed the findings. All the authors certified the content of the paper and approved the final manuscript for submission.

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Availability of data and materials

Secondary data analyzed could be accessed online at https://dhsprogram.com/data/dataset/Nigeria_MIS_2021.cfm?flag=1.

Declarations

Ethics approval and consent to participate

The authors hereby confirm that all methods and procedures were performed in accordance with the relevant guidelines. The 2021 NMIS protocol was reviewed and approved by the ICF Institutional Review Board. The protocol was also approved in Nigeria by the National Health Research Ethics Committee of Nigeria (NHREC). Written and verbal consent were obtained from participants prior to the interview. A formal request to analyse the NMIS datasets was made by the authors and authorization was granted by MEASURE DHS, the custodian of the datasets. All analyses were performed in anonymized forms. The datasets are available in the public domain via https://dhsprogram.com/data/dataset/Nigeria_MIS_2021.cfm?flag=1.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Nursing Science, College of Medicine, Ekiti State University, Ado Ekiti, Ekiti State, Nigeria. [2]Department of Medical Biochemistry and Molecular Biology, School of Basic Medical Sciences, University of Benin, Benin City, Nigeria. [3]Department of Public Health, Center of Excellence in Reproductive Health Innovation, College of Medical Sciences, University of Benin, Benin City, Nigeria. [4]Department of Public & Environmental Health, School of Medicine & Allied Health Sciences, University of the Gambia, Kanifing, The Gambia. [5]Department of Epidemiology, College of Public Health & Health Professions, University of Florida, Gainesville, FL, USA. [6]Department of Epidemiology and Medical Statistics, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria. [7]Faculty of Science and Health, School of Health and Care Professions, University of Portsmouth, Hampshire PO1 2UP, UK.

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References

1. Shekarau E, Uzoanya M, Ogbulafor N, Ntadom G, Ijezie SN, Uzoanya MI, et al. Severe malaria intervention status in Nigeria: workshop meeting report. Malar J. 2024;23:177.
2. The VP. WHO World malaria report. Lancet Microbe. 2023;2024(5):e214.
3. Ibrahim OR, Lugga AS, Ibrahim N, Aladesua O, Ibrahim LM, Suleiman BA, et al. Impact of climatic variables on childhood severe malaria in a tertiary health facility in northern Nigeria. Sudan J Paediatr. 2021;21:173–81.
4. Makinde OS, Abiodun GJ, Ojo OT. Modelling of malaria incidence in Akure, Nigeria: negative binomial approach. GeoJournal. 2021;86:1327–36. https://doi.org/10.1007/s10708-019-10134-x.
5. Tizifa TA, Kabaghe AN, McCann RS, van den Berg H, Van Vugt M, Phiri KS. Prevention efforts for malaria. Curr Trop Med Rep. 2018;5:41–50.
6. Musoke D, Atusingwize E, Namata C, Ndejjo R, Wanyenze RK, Kamya MR. Integrated malaria prevention in low- and middle-income countries: a systematic review. Malar J. 2023;22:79.
7. Lindsay SW, Thomas MB, Kleinschmidt I. Threats to the effectiveness of insecticide-treated bednets for malaria control: thinking beyond insecticide resistance. Lancet Glob Health. 2021;9:e1325–31.
8. Douglas NM, Burkot TR, Price RN. Malaria eradication revisited. Int J Epidemiol. 2022;51:382–92.
9. Ankomah A, Adebayo SB, Arogundade ED, Anyanti J, Nwokolo E, Ladipo O, et al. Determinants of insecticide-treated net ownership and utilization among pregnant women in Nigeria. BMC Public Health. 2012;12:105.
10. National Malaria Elimination Programme (NMEP) [Nigeria], National Population Commission (NPC) [Nigeria], and ICF. 2022. Nigeria Malaria Indicator Survey 2021 Final Report. Abuja, Nigeria, and Rockville, Maryland, USA: NMEP, NPC, and ICF. NMIS. 2022 [cited 16 Sep 2024]. Available: https://www.dhsprogram.com/publications/publication-MIS41-MIS-Final-Reports.cfm
11. Konlan KD, Kossi Vivor N, Gegefe I, Hayford L. Factors associated with ownership and utilization of insecticide treated nets among children under five years in sub-Saharan Africa. BMC Public Health. 2022;22:940.
12. 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;55:58–64.
13. Oyeyemi AO, Alawode A-G, Sogunro R. Ownership and utilization of LLIN after LLIN distribution campaign in a South Western state of Nigeria. Malar J. 2010;9:P34.
14. Andrada A, Herrera S, Inyang U, Mohammed AB, Uhomoibhi P, Yé Y. A subnational profiling analysis reveals regional differences as the main predictor of ITN ownership and use in Nigeria. Malar J. 2019;18:185.
15. Midi H, Sarkar SK, Rana S. Collinearity diagnostics of binary logistic regression model. J Interdiscip Math. 2010;13:253–67.
16. Spiegelhalter DJ, Best NG, Carlin BP, van der Linde A. Bayesian measures of model complexity and fit. J R Stat Soc Ser B Stat Methodol. 2002;64:583–639.
17. Larsen K, Merlo J. Appropriate assessment of neighborhood effects on individual health: integrating random and fixed effects in multilevel logistic regression. Am J Epidemiol. 2005;161:81–8.
18. Stawski RS. Multilevel analysis: an introduction to basic and advanced multilevel modeling (2nd Edition). Struct Equ Model Multidiscip J. 2013;20:541–50. https://doi.org/10.1080/10705511.2013.797841.
19. Tesfazghi K, Hill J, Jones C, Ranson H, Worrall E. National malaria vector control policy: an analysis of the decision to scale-up larviciding in Nigeria. Health Policy Plan. 2016;31:91–101.
20. Adeneye A, Adeogun A, Aina O, Ajibaye O, Orok A. Dynamics of household ownership, usage and washing pattern of long lasting insecticidal nets in three rural communities in Ikorodu, Lagos State, Nigeria. Ann Infect Dis Epidemiol. 2021;6:1065.
21. Kanmiki EW, Awoonor-Williams JK, Phillips JF, Kachur SP, Achana SF, Akazili J, et al. Socio-economic and demographic disparities in ownership and use of insecticide-treated bed nets for preventing malaria among rural reproductive-aged women in northern Ghana. PLoS ONE. 2019;14:e0211365.
22. 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;22:29.
23. Forty J, Keetile M. Patterns and correlates of ownership and utilization of insecticide-treated bed-nets for malaria control among women of reproductive age (15–49 years) in Malawi. J Biosoc Sci. 2022;54:269–78.
24. U.S. President's Malaria Initiative: Nigeria Malaria Operational Plan FY 2023. 2023.
25. Ambe JP, Balogun ST, Waziri MB, Nglass IN, Saddiq A. Impacts of seasonal malaria chemoprevention on malaria burden among under five-year-old children in Borno State, Nigeria. J Trop Med. 2020;2020:9372457.

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