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The Magnitude of Insecticide-Treated Net Utilization Gaps and Malaria Infection Determinants Among Febrile Patients in Osun State, Nigeria

***[1]Saheed Adeyinka Odediji, [2]Abdullah Olaleye Olawuyi, [3]Lateef Oluwatoyin Busari, [4]Kazeem Olarewaju Amoo, [5]Basirat Opemipo Amoo-Adeboye, [3]Yusirat Olarinre Yusuff, [3]Zarat Oyindamola Iwalewa, [3]Olabanji Ahmed Surakat and [3]Monsuru Adebayo Adeleke**

[1]Department of Medical Microbiology and Parasitology, Federal University of Health Science, Ila-Orangun, Nigeria.
[2]Department of Medical Laboratory Science, Federal University of Health Science, Ila-Orangun, Nigeria.
[3]Parasitology and Vector Biology Unit, Department of Animal and Environmental Biology, Osun State University, Osogbo, Nigeria.
[4]MRC Unit the Gambia, Banjul, Gambia.
[5]Department of Medical Microbiology and Parasitology, Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria.

*Corresponding authors' email: saheed.odediji@fuhsi.edu.ng Phone: +2348062273874

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ABSTRACT
The persistent disparity between insecticide-treated (ITN) net ownership and actual nightly utilization limits the effectiveness of malaria prevention strategies in Nigeria. This study assessed ITN coverage, the social determinants of its use, and its direct association with confirmed malaria infection among febrile patients in Osun State. A facility-based cross-sectional study enrolled 200 febrile patients across six Local Government Areas, serving as a focused sentinel investigation. Data regarding sociodemographics and net utilization were collected via a structured questionnaire. Malaria infection was confirmed using a nested polymerase chain reaction (PCR) reference standard. Data were analyzed using descriptive statistics and multivariate logistic regression, with multicollinearity assessed via Variance Inflation Factors (VIF). ITN ownership was 74.5%, while actual utilization was 52.0%, yielding a 22.5 percentage-point gap. Higher education (aOR=2.51), richest wealth quintile (aOR=3.02), and mass media exposure (aOR=1.89) independently predicted net use. PCR-confirmed malaria positivity was 23.5%. Net non-use (aOR=4.12) and open eaves (aOR=1.92) strongly predicted infection. Socioeconomic factors drive a significant utilization gap, resulting directly in higher malaria prevalence among non-users. Intervention strategies must pair distribution with targeted behavioral communication and structural improvements.

Keywords: Insecticide-Treated Nets, Utilization Gap, Malaria, Social Determinants, Febrile Patients

INTRODUCTION

Malaria continues to impose a substantial public health and socioeconomic burden across sub-Saharan Africa (SSA), with Nigeria bearing the highest burden globally and accounting for approximately 27 % of all cases worldwide (World Health Organization (WHO 2023; WHO 2024). National baseline data and indicator surveys emphasize the critical need to bridge coverage gaps across endemic states (National Population Commission [NPC], 2019; Omojuyigbe et al., 2023). In Osun State, located in southwestern Nigeria, perennial transmission remains intense, intensified by local vector challenges and insecticide susceptibility profiles of regional mosquito populations (Busari et al., 2023). Insecticide-treated nets (ITN) are highly cost-effective interventions that reduce all-cause child mortality by approximately 20 % (Lengeler, 2004; Bhatt et al., 2015).

The "ITN gap" defines the persistent disparity between the proportion of households that own at least one net and the proportion of individuals who actually sleep under them nightly (Koenker & Kilian, 2014). Prior investigations confirm that household wealth, maternal education, and mass media exposure influence utilization rates (Ankomah et al., 2012; Ankomah et al., 2014; Ismail et al., 2025). While local evaluations note suboptimal use among specific demographics (Sabo et al., 2025) and document the protective effects of net usage in regional communities (Salami et al., 2026), few evaluate utilization gaps alongside parasitologically confirmed infection rates among presenting patients utilizing sensitive molecular diagnostics (Awosolu et al., 2022; Osun et al., 2024; Rohkmad et al., 2025). Therefore, this study addresses this gap by assessing the specific drivers of net non-use and their direct association with PCR-confirmed malaria among febrile patients.

MATERIALS AND METHODS

Study Design

This investigation employed a descriptive and analytical facility-based cross-sectional study design.

Study Setting

The study took place in Osun State, situated within the tropical rainforest belt of southwestern Nigeria. The state experiences a tropical climate featuring a long rainy season and a drier harmattan period, sustaining intense perennial malaria transmission.

Study Population

The study population comprised febrile individuals (axillary temperature >/=37.5^{0}C or documented history of fever within the preceding 48hrs) presenting with suspected malaria at selected sentinel health facilities across six Local Government Areas in the three senatorial district of Osun State.

Sample Size Determination and Sampling
A multistage, geographically stratified sampling strategy was utilized, beginning with the stratification of the state by senatorial district. Local Government Areas and sentinel facilities were selected within each stratum. The sample size was calculated using Cochran's single-proportion formula for prevalence studies (Cochran, 1977). Based on an expected febrile-infection prevalence of 0.25 and an absolute precision of 0.06, the required sample size was determined to be 200 patients. Eligible patients were enrolled consecutively on scheduled clinic days. Recognizing that a sample size of 200 yields a positive outcome subgroup of approximately 47 patients based on the observed 23.5 percent positivity rate.

Data Collection
A structured, interviewer-administered questionnaire collected data regarding sociodemographic characteristics, clinical history, net ownership, nightly utilization, and exposure to mass media malaria messaging. Household wealth quintiles were constructed via principal component analysis based on household assets. Housing structures were classified by the presence of open or closed eaves.

Operational Definitions
Net ownership
Household possession of at least one insecticide-treated net (ITN) confirmed during the interview
.
ITN Utilization
Self-reported nightly sleeping under a net during the preceding night.

ITN Utilization Gap
The mathematical difference between household net ownership percentage and actual nightly utilization percentage.

ITN Access
Household possession of sufficient ITNs to accommodate all members (ratio ≥ 1:2).

Open Versus Closed Eaves
characterized as housing structures featuring open roof-wall junctions permitting unimpeded mosquito entry versus structurally sealed or netted eaves.

Laboratory Analysis
Capillary blood via finger-prick and 2 mL of venous blood were collected into ethylenediaminetetraacetic acid (EDTA) micro-tubes under aseptic conditions. Blood samples were transported on ice to the molecular research laboratory and stored at −20∘C prior to molecular processing. A nested polymerase chain reaction targeting the 18S small-subunit ribosomal RNA gene served as the molecular reference standard to confirm *Plasmodium falciparum* infection.

Variables
The dependent variables comprised active nightly net utilization status and polymerase chain reaction-confirmed malaria infection status. The independent variables included sociodemographic characteristics, educational attainment, household wealth quintiles, mass media exposure, and housing structure eave design.

Statistical Analysis
Data were entered and analyzed using SPSS version 26. Prior to multivariate modeling, multicollinearity among independent variables was evaluated using Variance Inflation Factors, confirming that all values remained below the critical threshold of 5.0. Bivariate analysis was conducted using Fisher's exact tests. Variables with a p-value less than 0.20 in the bivariate analysis were incorporated into multivariate logistic regression models to identify independent predictors of net use and malaria positivity. All adjusted odds ratios are presented with 95 percent confidence intervals using a significance threshold of 0.05.

Ethical Consideration
The research was conducted in compliance with the Declaration of Helsinki (World Medical Association, 2013) and the National Code of Health Research Ethics of Nigeria. Ethical approval was granted by the Osun State Health Research Ethics Committee (OSHREC/PRS/569T/776). Written and witnessed informed consent was secured from all participants using bilingual English and Yoruba forms.

RESULTS AND DISCUSSION

Results
Participant Characteristics and Net Ownership
A total of 200 febrile patients participated in the study. Overall, 149 participants, representing 74.5 percent, reported owning at least one net. Ownership was significantly associated with secondary or tertiary education at 79.7 percent with a p-value of 0.008, and the richest wealth quintile at 80.0 percent with a p-value below 0.001 (Table 1).

Table 1: Sociodemographic Characteristics of Febrile Patients Stratified by Net Ownership Status

Characteristic	Total (N=200)	Net Owners (n=149)	Non-Owners (n=51)	p-value
Age Group (Years)				0.421
< 20	38 (19.0%)	27 (18.1%)	11 (21.6%)	
20 – 40	112 (56.0%)	85 (57.0%)	27 (52.9%)	
> 40	50 (25.0%)	37 (24.8%)	13 (25.5%)	
Educational Attainment				0.008
Primary or None	72 (36.0%)	48 (32.2%)	24 (47.1%)	
Secondary or Tertiary	128 (64.0%)	101 (67.8%)	27 (52.9%)	
Wealth Quintile				Less than 0.001
Poorest or Poorer	80 (40.0%)	52 (34.9%)	28 (54.9%)	
Middle	40 (20.0%)	30 (20.1%)	10 (19.6%)	
Richer or Richest	80 (40.0%)	67 (45.0%)	13 (25.5%)	

The Net Ownership and Utilization Gap

In Figure 1, the actual utilization among all participants was 52.0 percent, creating a 22.5 percentage point gap between household ownership and nightly use. The disparity varied markedly across socioeconomic strata, narrowing significantly as wealth increased (Figure 1).

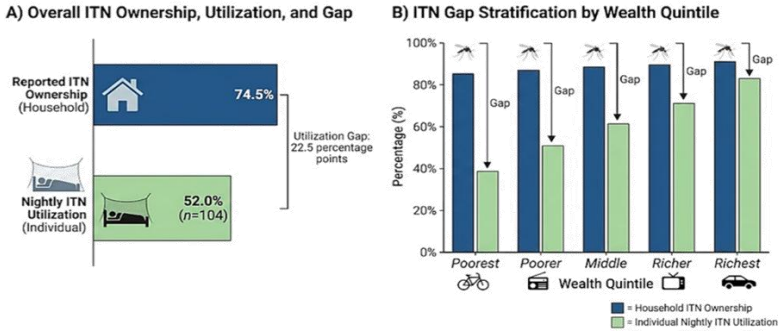

Figure 1: ITN Ownership vs Nightly Utilization Gap Among Febrile Patients in Osun State Nigeria

Determinants of Net Utilization

Multivariate logistic regression analyses identified key independent predictors of active net utilization among the study cohort (Figure 2, Table 2).

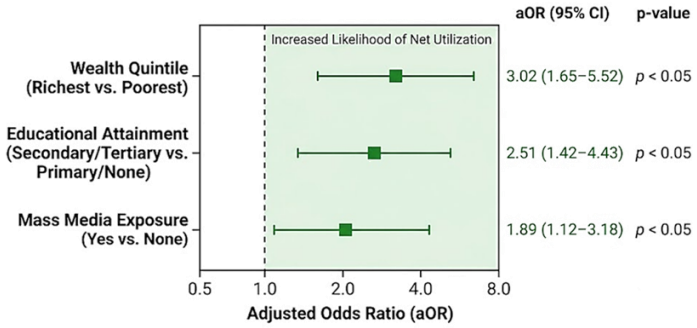

Figure 2: Independent Determinants of Net Utilization

Table 2: Multivariate Logistic Regression Analysis of Independent Determinants of Net Utilization

Variable	Adjusted Odds Ratio	95% Confidence Interval	p-value
Educational Attainment (Ref: Primary or None)	2.51	1.42 – 4.43	0.002
Wealth Quintile (Ref: Poorest)	3.02	1.65 – 5.52	Less than 0.001
Mass Media Exposure (Ref: None)	1.89	1.12 – 3.18	0.016

Association Between Net Use, Housing Structure, and Confirmed Malaria Infection

Nested polymerase chain reaction testing confirmed a malaria positivity rate of 23.5 percent, representing 47 positive cases among the screened febrile cohort. Multivariate models evaluating infection risk demonstrated that non-use of a net and residing in housing with open eaves were strong independent predictors of confirmed infection (Table 3).

Table 3: Association Between Net Use, Structural Housing Factors, and Polymerase Chain Reaction-Confirmed Malaria Infection

Risk Factor	Positive (n=47)	Negative (n=153)	Adjusted Odds Ratio	95% CI	p-value
Net Utilization Status					Less than 0.001
Non-User	38 (80.9%)	58 (37.9%)	4.12	2.38 – 7.14	
Regular User	9 (19.1%)	95 (62.1%)	Reference	—	
Housing Structure Eaves					0.022
Open Eaves	34 (72.3%)	78 (51.0%)	1.92	1.10 – 3.35	
Closed Eaves	13 (27.7%)	75 (49.0%)	Reference	—	

Discussion

In this cohort of febrile patients in Osun State, household insecticide-treated net (ITN) ownership was 74.5%, whereas actual nightly utilization was 52.0%, revealing a 22.5 percentage point utilization gap. This finding aligns closely with recent national survey evaluations tracking ownership versus sustained utilization across Nigerian populations (NPC, 2019; Omojuyigbe et al., 2023; Rohkmad et al., 2025). This disparity illustrates the operational divide between bed net access and sustained utilization formally conceptualized by Koenker and Kilian (2014). Relying solely on household ownership as a benchmark overestimates effective population

coverage, a structural limitation documented across regional evaluations in sub-Saharan Africa (Haileselassie et al., 2023; Barrow et al., 2025; Nzelu et al., 2026).

Multivariate logistic regression identified socioeconomic standing and educational attainment as primary independent determinants of net utilization. Participants in the highest wealth quintile (aOR = 3.02) and those with secondary or tertiary education (aOR = 2.51) demonstrated significantly higher odds of nightly net compliance. These findings directly align with epidemiological surveys in Nigeria indicating that economic resources and formal education govern health-seeking behaviors (Ladi-Akinyemi et al., 2019; Ismail et al., 2025). Higher educational attainment enhances health literacy and risk perception, whereas household capital facilitates net maintenance, replacement, and access to living quarters suitable for net installation (Oresanya et al., 2008; Ndjinga & Minakawa, 2010; Omole & Ndukwe, 2023). Onwujekwe et al. (2004) observed that lower wealth strata exhibit reduced purchasing power and lower willingness to pay for vector control tools, reinforcing the equity barriers inherent in non-universal distribution models.

Beyond systemic socioeconomic indicators, micro-level behavioral and environmental barriers within households directly impede compliance. Reported reasons for net non-use include physical net deterioration, insufficient hanging infrastructure, elevated ambient indoor temperatures, and low perceived mosquito density (Baume & Marin, 2007). In a systematic review, Pulford et al. (2011) identified thermal discomfort and seasonal fluctuations in vector density as primary drivers of non-compliance, observations corroborated by field evaluations of domestic bed net practices in tropical regions (Krezanoski et al., 2014; Oladimeji et al., 2019), alongside vector susceptibility studies in Osogbo (Busari et al., 2023). Conversely, exposure to mass media malaria messaging independently predicted regular net utilization (aOR = 1.89). This observation reinforces findings from Kano State by Dawaki et al. (2016) and national program evaluations establishing that targeted public health communication drives the adoption of preventive vector control practices (Oguonu et al., 2005; Udonwa et al., 2010; Ankomah et al., 2014).

The failure to translate net ownership into consistent usage carries clinical consequences. Patients who did not sleep under an ITN had over four-fold increased odds of nested polymerase chain reaction (PCR)-confirmed Plasmodium falciparum infection (aOR = 4.12, 95% CI: 2.38-7.14). This finding demonstrates that community-level protection depends upon active, individual adherence (Salami et al., 2026). Furthermore, precise molecular diagnostic evaluation underscores the necessity of sensitive detection methods like nested PCR in identifying low-density parasitemia across endemic cohorts (Awosolu et al., 2022; Osun et al., 2024; Rohkmad et al., 2025). Large-scale trials and meta-analyses confirm that sustained nightly ITN usage produces substantial reductions in parasite transmission, clinical febrile illness, and child mortality across endemic settings (Eisele et al., 2012; Bhatt et al., 2015).

In addition to individual behavioral factors, housing construction represented a significant environmental determinant of malaria positivity. Residing in dwellings with open roof eaves was associated with nearly double the odds of PCR-confirmed malaria (aOR 1.92, 95 CI: 1.10-3.35). Unsealed eaves serve as the primary entry point for endophilic vector species such as *Anopheles gambiae s.s.*, as demonstrated in entomological studies across southwestern Nigeria (Awolola et al., 2002). Structural house screening, including closed eaves and window netting, limits indoor vector density and complements bed net coverage (Adeleke et al., 2008; Oladepo et al., 2010). Integrating housing modifications with social and behavior change communication remains essential to bridge the utilization gap and suppress transmission in Osun State.

CONCLUSION

Socioeconomic deprivation and low educational attainment drive a substantial net utilization gap in Osun State, and this disparity translates directly into elevated rates of confirmed malaria infection among non-users; however, the cross-sectional, facility-based design and limited sample of 200 febrile patients preclude causal inference and generalization to asymptomatic community members. Sustaining high ownership through mass distribution is necessary but insufficient, and closing the utilization gap requires targeted behavioral interventions and structural housing improvements.

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CONSENT FOR PUBLICATION

Not applicable. This manuscript does not contain any individual person's data in any form (including individual details, images, or videos).

CONFLICT OF INTEREST STATEMENT

The authors declare no competing interests.

DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

Adeleke, M. A., Mafiana, C. F., Idowu, A. B., Adekunle, M. F., & Sam-Wobo, S. O. (2008). Mosquito larval habitats and public health implications in Abeokuta, Ogun State, Nigeria. Tanzania Journal of Health Research, 10(2), 103–107. https://doi.org/10.4314/thrb.v10i2.14353

Ankomah, A., Adebayo, S. B., Arogundade, E. D., Anyanti, J., Nwokolo, E., Inyang, U., Ipadeola, O. B., & Meremiku, M. (2014). The effect of mass media campaign on the use of insecticide-treated bed nets among pregnant women in Nigeria. Malaria Research and Treatment, 2014, 694863. https://doi.org/10.1155/2014/694863

Ankomah, A., Adebayo, S. B., Arogundade, E. D., Anyanti, J., Nwokolo, E., Ladipo, O., & Meremikwu, M. M. (2012). Determinants of insecticide-treated net ownership and utilization among pregnant women in Nigeria. BMC Public Health, 12(1), 105. https://doi.org/10.1186/1471-2458-12-105

Awolola, T. S., Okwa, O., Hunt, R. H., Ogunrinade, A. F., & Coetzee, M. (2002). Dynamics of the malaria-vector populations in coastal Lagos, south-western Nigeria. Annals of Tropical Medicine & Parasitology, 96(1), 75–82. https://doi.org/10.1179/000349802125000484

Awosolu, O. B., Yahaya, Z. S., Farah Haziqah, M. T., & Olusi, T. A. (2022). Performance evaluation of nested polymerase chain reaction (Nested PCR), light microscopy, and Plasmodium falciparum histidine-rich protein 2 rapid diagnostic test (PfHRP2 RDT) in the detection of falciparum malaria in a high-transmission setting in Southwestern Nigeria. Pathogens, 11(11), 1312. https://doi.org/10.3390/pathogens11111312

Barrow, A., Ogidan, O. C., Nzoputam, C. I., & Ekholuenetale, M. (2025). Coverage and contextual factors associated with insecticide-treated net use among women of reproductive age in Nigeria: Evidence from the 2021 malaria indicator survey data. PLOS Global Public Health, 5(2), e0004207. https://doi.org/10.1371/journal.pgph.0004207

Baume, C. A., & Marin, M. C. (2007). Intra-household mosquito net use in Ethiopia, Ghana, Mali, Nigeria, Senegal, and Zambia: Are nets being used? Who in the household uses them? The American Journal of Tropical Medicine and Hygiene, 77(5), 963–971. https://doi.org/10.4269/ajtmh.2007.77.963

Bhatt, S., Weiss, D. J., Cameron, E., Bisanzio, D., Mappin, B., Dalrymple, U., Battle, K. E., Moyes, C. L., Henry, A., Eckhoff, P. A., Wenger, E. A., Briët, O., Penny, M. A., Smith, T. A., Bennett, A., Yukich, J., Eisele, T. P., Griffin, J. T., Fergus, C. A., ... Hay, S. I. (2015). The effect of malaria control on Plasmodium falciparum in Africa between 2000 and 2015. Nature, 526(7572), 207–211. https://doi.org/10.1038/nature15535

Busari, L. O., Raheem, H. O., Iwalewa, Z. O., Fasasi, K. A., & Adeleke, M. A. (2023). Investigating insecticide susceptibility status of adult mosquitoes against some class of insecticides in Osogbo metropolis, Osun State, Nigeria. PLoS ONE, 18(5), e0285605. https://doi.org/10.1371/journal.pone.0285605

Cochran, W. G. (1977). Sampling techniques (3rd ed.). John Wiley & Sons.

Dawaki, S., Al-Mekhlafi, H. M., Ithoi, I., Ibrahim, J., Atroosh, W. M., Abdulsalam, A. M., Sady, H., Elyana, F. N., Adamu, A. U., Yelwa, S. I., Ahmed, A., Al-Areeqi, M. A., & Lau, Y. L. (2016). Is Nigeria winning the battle against malaria? Prevalence, risk factors and KAP assessment among Hausa communities in Kano State. Malaria Journal, 15, 351. https://doi.org/10.1186/s12936-016-1394-3

Eisele, T. P., Larsen, D. A., Anglewicz, P. A., Keating, J., Yukich, J., Bennett, A., Hutchinson, P., & Steketee, R. W. (2012). Malaria prevention in pregnancy, birthweight, and neonatal mortality: A meta-analysis of 32 national cross-sectional datasets in Africa. The Lancet Infectious Diseases, 12(12), 942–949. https://doi.org/10.1016/S1473-3099(12)70222-0

Haileselassie, W., Adam, R., Habtemichael, M., David, R. E., Solomon, N., Workineh, S., Haider, J., Belachew, A., Deressa, W., Yan, G., & Kassaw, N. A. (2023). Socio-demographic and economic inequity in the use of insecticide-treated bed nets during pregnancy: A survey-based case study of four sub-Saharan African countries with a high burden of malaria. Archives of Public Health, 81(1), 64. https://doi.org/10.1186/s13690-023-01080-9

Ismail, M., Mukhtar, A., Odetokun, I. A., Ibrahim, M. A., Salman, A. A., Bawa-Sani, H. G., Nass, S. S., Goni, B. W., Nuhu, A., Zhang, X., Usman, A., & Isah, M. B. (2025). Performance of rapid diagnostic tests for malaria diagnosis in Nigeria: A systematic review and meta-analysis. Malaria Journal, 25(1), 17. https://doi.org/10.1186/s12936-025-05680-4

Koenker, H., & Kilian, A. (2014). Recalculating the net use gap: A multi-country comparison of ITN use versus ITN access. PLoS ONE, 9(5), e97496. https://doi.org/10.1371/journal.pone.0097496

Krezanoski, P. J., Tsai, A. C., Hamer, D. H., Comfort, A. B., & Bangsberg, D. R. (2014). Household malaria knowledge and its association with bednet ownership in settings without large-scale distribution programs: Evidence from rural Madagascar. Journal of Global Health, 4(1), 010401. https://doi.org/10.7189/jogh.04.010401

Ladi-Akinyemi, B. O., Ogunyemi, A. O., & Oluwole, F. A. (2019). A rural-urban comparison of ownership and utilization of Long-Lasting Insecticide Treated Nets among pregnant women in Ogun State Nigeria. Annals of Health Research, 5(1), 36–50.

Lengeler, C. (2004). Insecticide-treated bed nets and curtains for preventing malaria. Cochrane Database of Systematic Reviews, (2), CD000363. https://doi.org/10.1002/14651858.CD000363.pub2

National Population Commission. (2019). Nigeria demographic and health survey 2018. NPC and ICF.

Ndjinga, J. K., & Minakawa, N. (2010). The importance of education to increase the use of bed nets in villages outside of Kinshasa, Democratic Republic of the Congo. Malaria Journal, 9, 279. https://doi.org/10.1186/1475-2875-9-279

Nzelu, C. E., Nzelu, U. M., Ugwunze, A. R., & Azodoh, N. (2026). Determinants of malaria insecticide-treated nets use among women of reproductive age in Nigeria. Nigerian Medical Journal, 66(5), 1823–1834.

Oguonu, T., Okafor, H. U., & Obu, H. A. (2005). Caregivers' knowledge, attitude and practice on childhood malaria and treatment in urban and rural communities in Enugu, south-east Nigeria. Public Health, 119(5), 409–414. https://doi.org/10.1016/j.puhe.2004.05.013

Oladepo, O., Tona, G. O., Oshiname, F. O., & Titiloye, M. A. (2010). Malaria knowledge and agricultural practices that promote mosquito breeding in two rural farming communities in Oyo State, Nigeria. Malaria Journal, 9, 91. https://doi.org/10.1186/1475-2875-9-91

Oladimeji, K. E., Tsoka-Gwegweni, J. M., Ojewole, E., & Yunga, S. T. (2019). Knowledge of malaria prevention among pregnant women and non-pregnant mothers of children aged under 5 years in Ibadan, South West Nigeria. Malaria Journal, 18, 92. https://doi.org/10.1186/s12936-019-2962-x

Omojuyigbe, J. O., Owolade, A. J., Sokunbi, T. O., Bakenne, H. A., Ogungbe, B. A., Oladipo, H. J., & Agughalam, P. I. (2023). Malaria eradication in Nigeria: State of the nation and priorities for action. Journal of Medicine, Surgery, and Public

Health, 1, 100024. https://doi.org/10.1016/j.glmedi.2023.100024

Omole, E. B., & Ndukwe, O. S. (2023). Assessment of socio-demographic factors associated with the utilization of Insecticide-Treated Nets (ITNs) among children under-5 years old and pregnant women in Nigeria: A secondary analysis of NMIS data. medRxiv. https://doi.org/10.1101/2023.11.30.23299225

Onwujekwe, O., Hanson, K., & Fox-Rushby, J. (2004). Inequalities in purchase of mosquito nets and willingness to pay for insecticide-treated nets in Nigeria: Challenges for malaria control interventions. Malaria Journal, 3, 6. https://doi.org/10.1186/1475-2875-3-6

Oresanya, O. B., Hoshen, M., & Sofola, O. T. (2008). Utilization of insecticide-treated nets by under-five children in Nigeria: Assessing progress towards the Abuja targets. Malaria Journal, 7, 145. https://doi.org/10.1186/1475-2875-7-145

Osun, O. G., Ahmed, A. S., Suliman, S. A., Olorunfemi, A. B., Thomas, B. N., & Ojurongbe, O. (2024). Comparative evaluation of microscopy, rapid diagnostic tests, and polymerase chain reaction (PCR) for malaria diagnosis in Nigerian children. Cureus, 16(11), e73739. https://doi.org/10.7759/cureus.73739

Pulford, J., Hetzel, M. W., Bryant, M., Siba, P. M., & Mueller, I. (2011). Reported reasons for not using a mosquito net when one is available: A review of the published literature. Malaria Journal, 10, 83. https://doi.org/10.1186/1475-2875-10-83

Rohkmad, M. F., Sandy, S., Widiyanti, M., Adiningsih, S., Kesuma, A. P., Maladan, Y., Anggraeni, Y. M., Ramadhani, T., Ipa, M., Hidajat, M. C., & Kawulur, H. (2025). Performance comparison of rapid diagnostic test, microscopy, and polymerase chain reaction for malaria detection in high-transmission area, Keerom Regency, Papua Province, Indonesia. Acta Tropica, 107935. https://doi.org/10.1016/j.actatropica.2025.107935

Sabo, M., Abdulrasheed, D., Muhammad, A. Q., Olanrewaju, O. D., Aujara, I. L., & Adeola, A. M. (2025). Distribution, ownership and utilization of insecticide treated mosquito net in relation to malaria prevention among pregnant women in Irepodun Local Government Area, Osun State, Nigeria. Sahel Journal of Life Sciences FUDMA, 3(3), 272–276.

Salami, T. A., Animasaun, T. T., & Daramola, C. F. (2026). Insecticides treated nets (ITNs) usage intensity and self-reported malaria prevalence among rural households in Osun State, Nigeria. FUDMA Journal of Agriculture and Agricultural Technology, 12(2), 57–70.

Udonwa, N. E., Gyuse, A. N., & Etokidem, A. J. (2010). Malaria: Knowledge and prevention practices among school adolescents in a coastal community in Calabar, Nigeria. African Journal of Primary Health Care & Family Medicine, 2(1), 103. https://doi.org/10.4102/phcfm.v2i1.103

World Health Organization. (2023). World malaria report 2023. World Health Organization.

World Health Organization. (2024). World malaria report 2024. World Health Organization.

World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA, 310(20), 2191–2194. https://doi.org/10.1001/jama.2013.281053