West African Journal of Allied Health Sciences

Advancing Allied Health Research in West Africa

www.wajahs.org

eISSN: 3115-4581 pISSN: 3115-4573

Original Article Volume 2, Issue 1, April 2026

Knowledge of Malaria and Malaria Vaccines (RTS,S/R21) Among Caregivers of Under-Five Children in Plateau State, Nigeria: A Cross-Sectional Study

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Abstract

Background: Malaria remains a major public health challenge in Nigeria, particularly among children under five years. The introduction of malaria vaccines such as RTS,S and R21 represents a key milestone in malaria prevention. However, caregivers' knowledge is essential for successful uptake. This study assessed the knowledge of malaria and malaria vaccines among caregivers of under-five children in Plateau State, Nigeria.
Methods: A community-based cross-sectional study was conducted among caregivers in three selected Local Government Areas. A multistage sampling technique was used to select 412 participants, of whom 408 completed the questionnaire (response rate: 99.0%). Data were collected using a structured interviewer-administered questionnaire. Knowledge was assessed using composite scores and categorized as good or poor. Data were analyzed using descriptive statistics, chi-square tests, and binary logistic regression in SPSS version 25, with significance set at $p < 0.05$.
Results: All respondents demonstrated good knowledge of malaria transmission and prevention. However, only 10.5% had good knowledge of malaria vaccines. Although 69.1% had heard of malaria vaccines, only 1.0% knew how they work. Health workers (64.7%) and media (44.4%) were the main information sources. Knowledge was significantly associated with age, marital status, family type, and number of under-five children. Married caregivers (aOR = 3.76; 95% CI: 1.62–8.74) and those in polygamous families (aOR = 2.23; 95% CI: 1.11–4.47) were more likely to have good knowledge.
Conclusion: Despite high malaria awareness, knowledge of malaria vaccines was limited. Targeted health education and community engagement are needed to improve awareness and support vaccine uptake.

Keywords: Malaria; malaria vaccine; RTS,S; R21; caregivers; knowledge; Nigeria.

 DOI: 10.5281/zenodo.19907431
Received: March14, 2026 Revised: March 29, 2026 Accepted: March 31, 2026

Introduction

Malaria remains a major global public health challenge, particularly in low- and middle-income countries. In 2022, an estimated 249 million cases and 608,000 deaths were reported worldwide, with most occurring in sub-Saharan Africa World Health Organization, 2023. Children under five years account for nearly 80% of malaria-related deaths World Health Organization, 2022. Nigeria contributes approximately 25–27% of the global malaria burden, making it the highest contributor to malaria morbidity and mortality Adepoju, 2022; National Bureau of Statistics, 2023. Despite interventions such as long-lasting insecticidal nets, indoor residual spraying, and preventive treatments, malaria transmission remains high Malaria Consor-

tium, 2023.

Malaria vaccines represent a significant advancement in prevention. The RTS,S vaccine showed moderate effectiveness in pilot programmes, leading to WHO recommendation in 2021 World Health Organization, 2021. The R21 vaccine, with efficacy up to 77%, received endorsement in 2023 Datoo et al., 2021. Nigeria has approved R21 and is preparing for phased implementation Federal Ministry of Health, 2023. However, vaccine uptake depends on community awareness and acceptance. Caregivers play a critical role in immunization decisions, yet limited awareness, misconceptions, and poor knowledge of vaccination schedules may affect uptake Oduwole et al., 2021; Oladepo et al., 2011.

Plateau State continues to experience persistent malaria transmission despite ongoing interventions Plateau State Ministry of Health, 2022. Evidence on caregivers' knowledge of malaria vaccines in the state remains limited UNICEF Nigeria, 2023. This study therefore assessed caregivers' knowledge of malaria and malaria vaccines among caregivers of under-five children in Plateau State, Nigeria.

Methods

Study Design

A community-based cross-sectional study design was employed to assess the knowledge of malaria and malaria vaccines among caregivers of under-five children in selected Local Government Areas (LGAs) of Plateau State, Nigeria.

Study Area

The study was conducted in Plateau State, located in North-Central Nigeria. The state comprises 17 LGAs with a mix of urban, peri-urban, and rural settlements. Malaria transmission occurs year-round, with increased incidence during the rainy season when mosquito breeding conditions are optimal. Malaria remains a major public health problem in the state, contributing significantly to outpatient visits and childhood morbidity.

Healthcare services in Plateau State are delivered through a three-tier system comprising primary, secondary, and tertiary health facilities. However, health system capacity varies considerably across LGAs. Rural communities such as Wase and Kanam often face greater challenges, including limited access to healthcare facilities, shortages of skilled health personnel, and weaker immunization service delivery compared with urban areas such as Jos North National Primary Health Care Development Agency, 2023; Plateau State Ministry of Health, 2022.

Study Population

The study population comprised caregivers of children aged 0–59 months residing in selected communities in Plateau State.

Eligible participants were caregivers who were the primary caregiver of at least one child aged 0–59 months, had resided in the selected community for at least six months, and provided informed consent to participate in the study. Caregivers who were seriously ill at the time of data collection or unable to communicate effectively during the interview were excluded.

Sample Size Determination

The sample size was calculated using the Cochran formula for prevalence studies, assuming a prevalence of 50% from a previous study Cochran, 1977. A 95% confidence level and a 5% margin of error were used in the calculation.

To account for the multistage sampling design, a design effect of 2 was applied. After adjusting for possible non-response, a final sample size of 412 caregivers was obtained.

Sampling Technique

A multistage sampling technique was used to select study participants.

In the first stage, three LGAs (Jos North, Wase, and Kanam) were purposively selected to represent urban, peri-urban, and rural settings National Primary Health Care Development Agency, 2023.

In the second stage, one ward was selected from each LGA using simple random sampling based on updated administrative ward lists UNICEF Nigeria, 2023.

In the third stage, settlements within each selected ward were selected using simple random sampling.

In the fourth stage, household listing was conducted within each selected settlement, after which

systematic sampling was used to select eligible households. The sampling interval was determined by dividing the total number of households by the required sample size for each settlement World Health Organization, 2022.

In the final stage, one eligible caregiver of an under-five child was recruited from each selected household. Where more than one eligible caregiver was present, simple balloting was used to select one participant.

Data Collection Instrument

Data were collected using a structured interviewer-administered questionnaire adapted from validated instruments used in previous studies assessing malaria vaccine knowledge and acceptance Adebayo et al., 2015; Adjei et al., 2021.

The questionnaire consisted of four sections: socio-demographic characteristics, knowledge of malaria transmission and prevention, knowledge of RTS,S and R21 malaria vaccines, and sources of malaria-related health information.

To enhance cultural relevance and comprehension, the questionnaire was translated into Hausa and back-translated into English to ensure conceptual equivalence UNICEF Nigeria, 2023. A pretest of the questionnaire was conducted among caregivers in a neighbouring LGA not included in the main study, and feedback was used to refine the instrument and improve clarity and reliability Faye et al., 2019.

Measurement of Knowledge

Knowledge was assessed using structured questions covering malaria transmission, symptoms, prevention, awareness of malaria vaccines, vaccination schedules, target age groups, and perceived effectiveness of RTS,S and R21 vaccines.

Each correct response was assigned a score of 1, while incorrect or "don't know" responses were scored 0. Individual knowledge scores were computed by summing responses across all items. The overall knowledge score was dichotomized using the mean score as the cut-off point: respondents scoring equal to or above the mean were categorized as having good knowledge, while those scoring below the mean were classified as having poor knowledge. This approach is consistent with methods used in similar knowledge-attitude-practice studies Yohanna et al., 2020.

Data Collection Procedure

Data collection was conducted by trained research assistants who administered the questionnaires during household visits. Interviews were conducted in private settings to ensure confidentiality and encourage honest responses.

Field supervisors reviewed completed questionnaires daily for completeness and consistency. As part of quality assurance, approximately 10% of completed questionnaires were randomly selected and cross-checked to verify data accuracy.

Data Analysis

Data were entered and analyzed using IBM Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize variables.

Bivariate analysis was conducted using the Chi-square test to assess associations between socio-demographic variables and knowledge of malaria vaccines. Variables that were statistically significant at the bivariate level were included in a binary logistic regression model to identify independent predictors of good knowledge. Statistical significance was set at $p < 0.05$.

Ethical Considerations

Ethical approval for the study was obtained from the Health Research Ethics Committee of the Plateau State Ministry of Health (Approval Number: MOH/MISC/202/VOL.I/XX).

Written informed consent was obtained from all participants prior to data collection. Participants were informed about the purpose of the study, their rights, and their freedom to decline participation or withdraw at any time without consequences. Confidentiality and anonymity were strictly maintained, and no personal identifiers were included in the dataset.

Results

A total of 412 questionnaires were distributed, of which 408 were completed and returned, yielding a response rate of 99.0%.

Sociodemographic Characteristics

The mean age of respondents was 29 ± 5.75 years. The majority of caregivers were aged 25–34 years (46.8%), followed by 19–24 years (38.0%). Most respondents were female (76.7%). Slightly more than half were Muslim (52.9%), while 47.1% were Christians.

In terms of education, nearly half of the respondents had secondary education (48.5%). The majority were employed or engaged in income-generating activities, with business-related activities being the most common (40.2%). Most caregivers earned between ₦30,000 and ₦70,000 monthly (65.7%).

Most respondents were married (91.9%), and more than half lived in polygamous households (55.6%). Regarding household composition, 72.1% had two or fewer under-five children (Table 1).

Knowledge of Malaria and Malaria Vaccines

All respondents (100%) had heard of malaria and correctly identified mosquito bites as the primary mode of transmission. Awareness of malaria prevention methods such as insecticide-treated nets, indoor residual spraying, and malaria prophylaxis was also high.

However, knowledge of malaria vaccines was limited. Approximately 69.1% of respondents had heard of a malaria vaccine. Among these, only 1.0% knew how the vaccine works, while 99.0% lacked such knowledge.

Health workers were the main source of information (64.7%), followed by media/social media (44.4%). The majority (85.8%) had not received formal health education on malaria vaccines.

Knowledge Scores

All caregivers demonstrated good knowledge of malaria. However, only 10.5% had good knowledge of malaria vaccines.

Factors Associated with Knowledge of Malaria Vaccines

Bivariate analysis showed that age, marital status, family type, and number of under-five children were significantly associated with knowledge of malaria vaccines ($p < 0.05$).

Caregivers aged ≤ 29 years were less likely to have good knowledge compared with those aged > 29 years ($\chi^2 = 18.213$; $p < 0.001$). Similarly, marital status ($\chi^2 = 10.663$; $p = 0.001$), family type ($\chi^2 = 5.273$; $p = 0.022$), and number of under-five children ($\chi^2 = 6.353$; $p = 0.012$) were significant. No significant associations were observed with gender, religion, education, occupation, ethnicity, or income (Table 2).

Table 1: Sociodemographic Characteristics of Respondents ($n = 408$)

Variables	Frequency (n)	Percentage (%)
Age (years)		
≤ 29	179	43.9
> 29	229	56.1
Gender		
Female	313	76.7
Male	95	23.3
Religion		
Islam	216	52.9
Christianity	192	47.1
Education		
Formal	364	89.2
Non-formal	44	10.8
Employment Status		
Employed	230	56.4
Unemployed	178	43.6
Monthly Income		
≤ ₦70,000	228	55.9
> ₦70,000	180	44.1
Marital Status		
Married	375	92.0
Not married	33	8.0
Family Type		
Monogamous	181	44.4
Polygamous	227	55.6
Under-five Children		
≤ 2	294	72.1
> 2	114	27.9

Percentages may not sum to 100 due to rounding.

Predictors of Knowledge of Malaria Vaccines

Multivariate logistic regression identified age, marital status, family type, and number of under-five children as independent predictors of malaria vaccine knowledge.

Caregivers aged ≤ 29 years were less likely to have good knowledge (aOR = 0.23; 95% CI: 0.11–

0.47; $p < 0.001$). Married caregivers were more likely to have good knowledge (aOR = 3.76; 95% CI: 1.62–8.74; $p = 0.002$).

Caregivers from polygamous families (aOR = 2.23; 95% CI: 1.11–4.47; $p = 0.024$) and those with more than two under-five children (reference category) also showed significant associations (Table 3).

Discussion

This study demonstrated a high level of awareness of malaria among caregivers of under-five children in Plateau State, Nigeria, but revealed substantial gaps in knowledge regarding malaria vaccines. While nearly all respondents were familiar with malaria transmission and prevention, only a small proportion had adequate knowledge of malaria vaccines, and an even smaller fraction understood how the vaccines work. These findings are consistent with emerging evidence from malaria-endemic settings following the introduction of RTS,S and R21 vaccines, where awareness often precedes comprehensive understanding Datoo et al., 2021; World Health Organization, 2022.

The high level of malaria awareness observed in this study likely reflects the impact of sustained national malaria control efforts, including widespread health education campaigns and community-based interventions National Malaria Elimination Programme, 2021. However, the limited knowledge of malaria vaccines suggests that vaccine-specific communication has not yet achieved similar reach or effectiveness. Comparable studies in Ghana and Kenya have reported similar gaps between general malaria knowledge and vaccine-specific understanding Adjei et al., 2021; Otieno et al., 2022.

Although a majority of caregivers had heard of malaria vaccines, the depth of knowledge was inadequate, particularly regarding vaccine mechanisms, eligibility, and schedules. This disconnect between awareness and understanding has important implications for vaccine uptake, as informed decision-making is strongly influenced by the quality of information available to caregivers. Evidence suggests that information delivered through trusted sources, particularly healthcare workers, plays a critical role in shaping vaccine acceptance and uptake Oladepo et al., 2011.

Sociodemographic factors were significantly associated with knowledge of malaria vaccines. Younger caregivers were less likely to demonstrate good knowledge, which may reflect limited exposure to health education messages or reduced engagement with healthcare services. In contrast, married caregivers and those from polygamous households were more likely to have good knowledge, possibly due to increased opportunities for information sharing and collective decision-making within households. Similar patterns have been observed in studies examining maternal health decision-making in Northern Nigeria Yohanna et al., 2020.

Additionally, caregivers with a higher number of under-five children were more likely to have better knowledge, likely due to repeated interactions with immunization services and healthcare providers. This finding aligns with previous studies indicating that increased contact with health services enhances exposure to health information and improves knowledge and practices Bello et al., 2019.

Interestingly, no significant associations were observed between knowledge of malaria vaccines and factors such as education, occupation, or income. This suggests that access to malaria vaccine information may not yet be sufficiently widespread or equitably distributed across different socioeconomic groups. It also highlights potential gaps in current communication strategies, which may not be effectively reaching all segments of the population. Addressing these gaps will be essential to ensure equitable access to information and to support successful vaccine implementation.

Conclusion

This study highlights a critical gap between high awareness of malaria and limited knowledge of malaria vaccines among caregivers of under-five children in Plateau State. While general malaria knowledge is widespread, understanding of malaria vaccines remains insufficient, and awareness does not necessarily translate into informed knowledge.

Key sociodemographic factors, including age, marital status, family structure, and number of under-five children, were identified as significant

Table 2: Factors Associated with Knowledge of Malaria Vaccine among Caregivers of Under-Five Children in Plateau State ($n = 408$)

		Knowledge of Malaria Vaccine				
Variable	**Category**	**Good n (%)**	**Poor n (%)**	**Total n (%)**	χ^2	p-value
Age (years)	≤ 29	32 (7.8)	147 (36.1)	179 (43.9)	18.213	< 0.001*
	> 29	11 (2.7)	218 (53.4)	229 (56.1)		
Gender	Female	37 (9.1)	276 (67.6)	313 (76.7)	2.343	0.126
	Male	6 (1.4)	89 (21.8)	95 (23.3)		
Religion	Islam	26 (6.4)	190 (46.6)	216 (52.9)	1.092	0.296
	Christianity	17 (4.1)	175 (42.9)	192 (47.1)		
Occupation	Employed	25 (6.1)	205 (50.3)	230 (56.4)	0.061	0.805
	Unemployed	18 (4.4)	160 (39.2)	178 (43.6)		
Education	Educated	38 (9.3)	326 (79.9)	364 (89.2)	0.360	0.850
	Not educated	5 (1.2)	39 (9.6)	44 (10.8)		
Tribe	Hausa/Fulani	24 (5.9)	149 (36.6)	173 (42.4)	3.540	0.060
	Others	19 (4.6)	216 (52.9)	235 (57.6)		
Monthly income (₦)	≤70,000	25 (6.1)	203 (49.8)	228 (55.9)	0.099	0.753
	>70,000	18 (4.4)	162 (39.7)	180 (44.1)		
Marital Status	Married	34 (8.3)	341 (83.6)	375 (92.0)	10.663	0.001*
	Not married	9 (2.2)	24 (5.9)	33 (8.0)		
Family Type	Monogamous	12 (2.9)	169 (41.4)	181 (44.4)	5.273	0.022*
	Polygamous	31 (7.6)	196 (48.1)	227 (55.6)		
Number of under-five children	≤ 2	38 (9.3)	256 (62.8)	294 (72.1)	6.353	0.012*
	> 2	5 (1.2)	109 (26.7)	114 (27.9)		

Note: χ^2 = Chi-square test; *Statistically significant at $p < 0.05$.

Table 3: Predictors of Knowledge of Malaria Vaccine among Caregivers of Under-Five Children in Plateau State ($n = 408$)

		Knowledge of Malaria Vaccine				
Variable	**Category**	**Good n (%)**	**Poor n (%)**	**aOR**	**95% CI**	p-value
Age (years)	≤ 29	32 (7.8)	147 (36.1)	0.232	0.113–0.474	< 0.001*
	> 29 (Reference)	11 (2.7)	218 (53.4)	1.00	–	
Marital Status	Married	34 (8.3)	341 (83.6)	3.761	1.618–8.741	0.002*
	Not married (Reference)	9 (2.2)	24 (5.9)	1.00	–	
Family Type	Monogamous (Reference)	12 (2.9)	169 (41.4)	1.00	–	
	Polygamous	31 (7.6)	196 (48.1)	2.227	1.109–4.474	0.024*
Number of under-five children	≤ 2	38 (9.3)	256 (62.8)	0.309	0.118–0.806	0.016*
	> 2 (Reference)	5 (1.2)	109 (26.7)	1.00	–	

Note: aOR = Adjusted odds ratio; CI = Confidence interval. Reference categories are indicated with aOR = 1.00. *Statistically significant at $p < 0.05$.

determinants of knowledge. These findings underscore the need for targeted and context-specific interventions to improve malaria vaccine knowledge, particularly in anticipation of large-scale vaccine rollout in Nigeria.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Strengthen community-based health education initiatives focusing specifically on malaria vaccines, including their benefits, safety, and schedule.
2. Integrate malaria vaccine communication into routine healthcare services, particularly antenatal care, immunization clinics, and child health visits.
3. Utilize multiple communication channels, including mass media, social media, and community leaders, to disseminate accurate and culturally appropriate information.
4. Develop targeted interventions aimed at younger caregivers and underserved populations to bridge identified knowledge gaps and promote equitable access to information.

Implications for Practice and Policy

The findings of this study have important implications for both public health practice and policy in Nigeria. The low level of knowledge regarding malaria vaccines, despite high awareness of malaria, indicates a critical gap in health communication strategies. From a practice perspective, healthcare workers who were identified as the primary source of information should be further empowered through targeted training to deliver accurate and comprehensive information on malaria vaccines. Integrating malaria vaccine education into routine maternal and child health services, including antenatal care and immunization clinics, will enhance caregiver exposure to relevant information. From a policy standpoint, there is a need for the Federal Ministry of Health and National Primary Health Care Development Agency to develop structured communication frameworks specifically for malaria vaccine introduction. Policies should emphasize community engagement, culturally sensitive messaging, and the use of multiple communication platforms to ensure equitable information dissemination across different population groups. These efforts will be critical for improving vaccine acceptance and ensuring successful nationwide rollout.

What is Known About This Topic

Malaria remains a leading cause of morbidity and mortality among children under five in sub-Saharan Africa, particularly in Nigeria. Malaria vaccines such as RTS,S and R21 have been developed and recommended to complement existing malaria control strategies. Caregiver knowledge and perception play a crucial role in the uptake of childhood vaccines. Previous studies in African settings have shown that awareness of malaria vaccines is increasing, but detailed knowledge about their function, schedule, and benefits remains limited.

Authors' Contributions

Abbas Sani Muhammad conceptualized and designed the study, supervised data collection, performed data analysis, and drafted the manuscript. Hadiza Musa Abdullahi and Aminatu Ayaba Kwaku contributed to study design, methodology development, and critical revision of the manuscript. Ibrahim Shehu Aliyu and Adamu Alhaji supported data analysis and interpretation of findings. Mamuda Alhaji Sabo, Isa Sadeeq Abubakar, and Hassan Yusuf Ahmad contributed to data collection, literature review, and manuscript editing. All authors read and approved the final version of the manuscript.

Funding

This research received no external funding. The study was self-funded by the authors.

Conflict of Interest

The authors declares no conflict of interest.

Limitations

This study has some limitations that should be considered when interpreting the findings. First, the cross-sectional design limits the ability to establish causal relationships between variables. Second, the study relied on self-reported data, which may be subject to recall bias or social desirability bias. Ad-

ditionally, the study was conducted in selected Local Government Areas of Plateau State, which may limit the generalizability of the findings to other regions. Finally, the assessment of knowledge using a structured questionnaire may not fully capture the depth of participants' understanding of malaria vaccines.

Acknowledgement

The authors sincerely acknowledge the support of the Plateau State Ministry of Health for facilitating this study. We are also grateful to the community leaders in the selected Local Government Areas for their cooperation and assistance during data collection.

We appreciate the dedication of the research assistants whose efforts contributed significantly to the successful implementation of this study. Finally, we extend our heartfelt gratitude to all the caregivers who participated in the study for their time, willingness, and valuable contributions.

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