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Nurses' knowledge and willingness to recommend malaria vaccination to caregivers of under-5 in Nigeria: a nationwide survey

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Abstract

Background   Malaria is a major public health problem in Nigeria. This study set out to ascertain Nigerian nurses' knowledge and willingness to recommend malaria vaccination to caregivers of under-5 children.

Methods   This was a cross-sectional study carried out among nurses from all six geopolitical zones of Nigeria. A pretested semi-structured questionnaire was used to collect data on participants' demographics, their knowledge of the RTS S/AS01 and R21 Matrix M malaria vaccines, how they obtain malaria vaccine-related information, and the factors that the nurses consider when recommending any malaria vaccine. Univariate association between each of the demographics characteristics and the key research variables: knowledge of the vaccine and willingness to recommend was used. This was examined using the Chi-Square test and multiple logistic regression.

Results   The study found that nearly two out of every three nurses had poor knowledge and perception of the vaccines ($p < 0.05$). Awareness of the malaria vaccine was the only factor that was found to be associated with their knowledge ($p < 0.05$). The odds of willingness to promote the vaccine were about 21 times higher among nurses with high perceptions of efficacy than their counterparts who have low perceptions.

Conclusions   The findings highlight major gaps in Nigerian nursing's knowledge and awareness of malaria vaccinations, as well as their willingness to recommend the vaccine to parents. Addressing these gaps will enable nurses to play a critical role in the successful implementation of malaria immunization campaigns, lowering the illness burden among vulnerable populations.

Keywords   Malaria vaccine, RTS, S/AS01, R21 Matrix-M, Nurses, Knowledge, Willingness, Vaccine recommendation

Background

Despite being treatable and avoidable, malaria nevertheless poses a significant threat to global health, particularly in sub-Saharan Africa [1]. In 2022 alone, there were 249 million cases of malaria in 85 endemic countries, which led to 608,000 fatalities [2].

With 31% of all malaria-related deaths worldwide and 27% of all projected malaria cases worldwide, Nigeria bears the largest share of the global malaria burden [2].

The female *Anopheles* mosquito, which spreads malaria parasites, is the bug that causes the greatest amount of death and suffering in human history [3].

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Many nations in the WHO African Region have started to implement the life-saving vaccines in response to the WHO's October 2021 and October 2023 recommendations for the use of RTS, S, and the R21/Matrix-M (R21) malaria vaccine, respectively, to prevent malaria in children living in malaria-endemic areas [4, 5].

It has been demonstrated that the WHO-recommended malaria vaccines dramatically lower the number of malaria cases and fatalities among young children from the deadly severe form of the disease [6]. A pooled review of the programme's implementation in Ghana, Kenya, and Malawi found that age-eligible children who received RTS, S/AS01 saw a 13% (95% CI 2–22%) drop in all-cause mortality (excluding injury-related deaths) [7]. The successful implementation of these malaria vaccines in the hardest-hit countries, such as Nigeria, will undoubtedly significantly reduce malaria-related deaths and safeguard the lives of vulnerable populations.

However, the long-term effects of these vaccines on the spread of malaria will be negligible if they are introduced but not adequately implemented. Furthermore, Nigeria has faced obstacles like myths surrounding the adoption of other vaccination programmes in the past, lack of confidence in the vaccine, fear of possible reactions, acceptability, and limited access to vaccines [8–10], all of which could compromise the country's capacity to successfully administer the malaria vaccination.

In particular, the Nigerian government should be cognizant of local politics as they impact healthcare delivery, especially public awareness campaigns regarding vaccination as essential steps in Nigeria's vaccine uptake, according to Jegede's critical review of the polio vaccine [10].

What is still unknown is the level of knowledge, acceptability, and preparedness of nurses—who are in charge of delivering vaccinations in the most affected and endemic nations, such as Nigeria—to convince parents of children under five to get them. This is especially significant since nurses comprise the largest group of health professionals and have been referred to as the foundation of any health system [11, 12].

Before the ultimate arrival and administration of this new intervention in Nigeria, a cross-section of nurses in Nigeria were sampled to assess their knowledge of the vaccine and their willingness to recommend the malaria vaccination to caregivers of children under the age of five, to provide a deeper understanding of the factors that must be addressed to ensure successful implementation of the malaria vaccination programme in Nigeria.

Methods

Study design and population

This was a cross-sectional study of nurses from all six geopolitical zones of Nigeria: southwest, south-south, southeast, northwest, northeast, and northcentral. Nigeria is made up of 36 states and the Federal Capital Territory, all of which have been divided into six geopolitical zones to facilitate economic and political management. Nigeria's healthcare system is composed of primary, secondary, and tertiary facilities. In 2018, the estimated population of Nigeria was 195,606,286; however, there was a 26.55% nursing deficit among nurses [13].

Study tools and procedures

This online cross-sectional study was conducted between September and December 2023. A pre-tested semi-structured questionnaire was constructed using Google Forms (Google LLC, Mountain View, CA, USA; https://docs.google.com/forms/) was used to collect data on participants'demographics, antimalarial medications prescribed for uncomplicated and severe malaria, their knowledge of the two approved malaria vaccines, how they obtain malaria vaccine-related information, and the factors that the nurses consider when recommending any malaria vaccine. The questionnaire comprised closed-ended questions that required participants to select responses such as"yes", and"no", as well as open-ended questions in which individuals supplied comments based on their perception or otherwise.

To classify their knowledge as to whether good or poor, the correct response on items that assessed their knowledge was scored as 1 and the wrong response was scored as 0. The sum of the scores obtained by the nurses on knowledge items makes up their knowledge score and based on their knowledge score, each of the respondents was classified as having either poor or good knowledge. If the score obtained is less than 2, then it is classified as poor, otherwise, the respondents are classified as having good knowledge. The questionnaire was electronically distributed through nurses' social media sites, including WhatsApp and Telegram. The responses submitted by study participants were collected, coded, and exported to SPSS for analysis.

Sample size determination

Based on a population of 180,709 [14] registered nurses in Nigeria and an attrition rate of 10%, the sample size of 439 Nurses was estimated using Cochran's sample size formula as follows:

$$n = \frac{Z^2 pq}{d^2},$$

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where n is the sample size which is to be determined, p= is the proportion and for a more representative sample that accounts for maximum possible variability in the population, p was set to be 0.50, q= 1 − p= 1–0.50 =0.50 and d is the margin of error. The value of Z= 1.96 as obtained from the Z table at a 5% level of significance.

$$n = \frac{1.96^2 \times 0.50 \times 0.50}{0.05^2} = \frac{0.9604}{0.05^2} = 384.16.$$

The 10% attrition rate =38 and hence the sample size of 422 Nurses was estimated of this sample size, 418 filled the questionnaire in the study giving a response rate of 99.1%.

Statistical analyses

The data were coded after it was retrieved from the Google form sheet and was then imported into the Statistical Package for Social Sciences (SPSS version 27.0) environment. Data obtained were analysed descriptively using frequency and percentage for all relevant categorical variables while mean and standard deviation were computed for quantitative variables. The bivariate association between each of the demographic characteristics and the key research variables: knowledge of the vaccine and willingness to recommend use was examined using the Chi-Square test. Furthermore, multiple logistic regression was used to identify factors that were significantly associated with knowledge as well as their willingness to recommend the vaccine. Hence, odd ratios and their corresponding 95% confidence interval were estimated and p< 0.05 was considered to be significant.

Ethical considerations

Ethical approval was obtained from the National Health Research Ethics Committee (NHREC) of Nigeria with NHREC Approval Number NHREC/01/01/2007-12/11/2023. The questionnaire was anonymous, with no personal identifying information to maintain confidentiality.

Results

The participants'average age was 38.98 ± 11.09 years, and the majority of respondents (89.7%) were female. The 418 responders'ages were distributed as follows: 4.1% were younger than 20 years, 56.7% were between 20–40 years and 39.2% of the respondents were above 40 years. The majority of responders were Nursing Officer II (28.0%) and from Southwest (62.7%) (see Table 1).

Table 2 shows the results of the participants'level of knowledge on the RTS S/AS01 and R21 Matrix M malaria vaccines. Of the nurses, 64.1% had poor understanding of the vaccines, whereas only 35.9% had high knowledge. This suggests that most nurses don't know

Table 1 Demographics of the respondent

Demographic variables	No. of respondents (n =418)	Percentage (%)
Gender		
Male	43	10.3
Female	375	89.7
Age (years)		
Less than 20	17	4.1
20–40	237	56.7
Above 40	164	39.2
Geopolitical zone		
Northcentral	84	20.1
North East	14	3.3
Northwest	17	4.1
Southeast	13	3.1
South-south	28	6.7
Southwest	262	62.7
Cadre		
Assistant Chief Nursing Officer	34	8.1
Assistant Director of Nursing/ Head of Nursing Services	11	2.6
Chief Nursing Officer	71	17.0
Deputy Director of Nursing	13	3.1
Director of Nursing Services	6	1.4
Nursing Officer I	67	16.0
Nursing Officer II	117	28.0
Principal Nursing Officer	36	8.6
Senior Nursing Officer	63	15.1

Table 2 Knowledge of nurses in Nigeria of the RTSS/AS01 malaria vaccine

Variables	Frequency	Percentage (%)
Knowledge of RTSS/AS01 malaria vaccine		
Poor	268	64.1
Good	150	35.9
Heard about the vaccine		
Yes	233	55.5
No	187	44.5
What age is recommended for its use		
5 years	188	44.8
5–10 years	109	26.0
10 years	45	10.7
No idea	78	18.6
Recommended dose regimen		
2	110	26.2
4	145	34.5
5	69	16.4
No response	96	22.9

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much about the R21 Matrix M and RRTS S/AS01 malaria vaccines. Only 55.5% of the nurses who took part in the survey knew about the vaccine, according to the results of the analysis of the specific knowledge items.

As also shown in Table 2, the results also reveal that only 34.5% of respondents correctly indicated the appropriate vaccination regimen, and only 44.8% of nurses were able to determine the appropriate age at which the vaccine should be administered.

For factors associated with their level of knowledge of the vaccines, the result shows that gender ($p = 0.487$, $p > 0.05$), geopolitical zone ($p = 0.425$, $p > 0.05$), age ($p = 0.786$, $p > 0.05$) and cadre were found not to be significantly associated with the knowledge of the RTS S/AS01 and R21 Matrix M malaria vaccines ($p > 0.05$). Awareness of the vaccination was the only factor that was found to be associated with their knowledge of the vaccines ($p = 0.000$, $p < 0.05$) (Table 3). The result of logistic regression presented in Table 4 also shows that gender, geopolitical zone, age, and cadre were not significantly associated with knowledge of the vaccines ($p < 0.05$). Awareness was found to be significantly associated with knowledge as the odd of good knowledge of the vaccine was more than 35 times higher among those that were aware of the vaccine than those that were not aware of the vaccine (OR = 35.260, CI = 18.488–67.250, $p = 0.000$, $p < 0.05$). This implies better awareness will bring about a significant improvement in knowledge of the vaccine.

From this Fig. 1, it is obvious that the majority of the respondent secured 10 on their willingness to recommend (24.2%) malaria vaccines. A sizeable number of respondents 18.4% scored 5 which is like the boundary score.

Moreover, possible factors that could be associated with their willingness to recommend the vaccine were analysed and the result of the bivariate analysis reveals

**Table 3** Factors associated with the knowledge of the vaccines

Factors	Knowledge of the vaccines			χ^2-calc.	P-value
	Poor (n = 268)	Good (n = 150)	Total (n = 418)		
Gender					
Male	25 (58.1)	18 (41.9)	43 (10.3)	0.482	0.487
Female	243 (64.8)	132 (35.2)	375 (89.7)		
Age(years)					
Less than 20	8 (47.1)	9 (52.9)	17 (4.1)	0.481	0.786
20–40	132 (55.7)	105 (44.3)	237 (56.7)		
Above 40	90 (54.9)	74 (45.1)	164 (39.2)		
Geopolitical Zone					
Northcentral	51 (60.7)	33 (39.3)	84 (20.1)	4.926	0.425
North East	7 (50.0)	7 (50.0)	14 (3.3)		
Northwest	14 (82.4)	3 (17.6)	17 (4.1)		
Southeast	7 (53.8)	6 (46.2)	13 (3.1)		
South-south	19 (67.9)	9 (32.1)	28 (6.7)		
Southwest	170 (64.9)	92 (35.1)	262 (62.7)		
Cadre					
Assistant Chief Nursing Officer	17 (50.0)	17 (50.0)	34 (8.1)	7.267	0.508
Assistant Director of Nursing/Head of Nursing Services	7 (63.6)	4 (36.4)	11 (6.7)		
Chief Nursing Officer	49 (69.0)	22 (31.0)	71 (17.0)		
Deputy Director of Nursing	10 (76.9)	3 (23.1)	13 (3.1)		
Director of Nursing Services	2 (33.3)	4 (66.7)	6 (1.4)		
Nursing Officer I	44 (65.7)	23 (34.3)	67 (16.0)		
Nursing Officer II	75 (64.1)	42 (35.9)	117 (28.0)		
Principal Nursing Officer	24 (66.7)	12 (33.3)	36 (8.6)		
Senior Nursing Officer	40 (63.5)	23 (36.5)	63 (15.1)		
Awareness of the vaccine					
Aware	60 (25.8)	173 (74.2)	233 (55.7)	179.625	0.000**
Not aware	170 (91.9)	18 (8.1)	185 (44.3)		

** Significant at 1% ($p < 0.01$), *Significant at 5% ($p < 0.05$)

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Table 4 Logistic regression results showing factors associated with the knowledge of the vaccines (odd ratios and 95% confidence interval)

Factors	Coefficient (β)	SE	OR [95% CI]	P-value
Gender				
Male	0.348	0.454	1.416 [0.582–3.443]	0.443
Female	1.00 (reference)			
Age	0.008	0.018	1.008 [0.974–1.044]	0.632
Geopolitical zone				
Northcentral	0.563	0.360	1.756 [0.867–3.557]	0.289
Northeast	1.777	1.020	5.910 [0.801–43.604]	0.118
Northwest	0.035	0.660	1.036 [0.284–3.774]	0.081
Southeast	0.877	0.811	2.405 [0.491–11.781]	0.957
South-south	0.553	0.566	1.739 [0.573–5.275]	0.279
Southwest	1.00 (reference)	–	–	–
Cadre				
Senior Nursing Officer	− 0.108	0.461	0.898 [0.363–2.218]	0.815
Chief Nursing Officer	− 0.271	0.518	0.762 [0.276–2.103]	0.600
Deputy Director of Nursing	0.398	0.889	1.490 [0.261–8.514]	0.654
Nursing Officer II	0.094	0.431	1.099 [0.472–2.557]	0.827
Principal Nursing Officer	0.186	0.587	1.204 [0.381–3.800]	0.752
Assistant Chief Nursing Officer	− 0.212	0.582	0.809 [0.259–2.529]	0.715
Director of Nursing Services	1.888	1.241	6.608 [0.581–75.215]	0.128
Assistant Director of Nursing/Head of Nursing Services	1.00 (reference)	–	–	–
Awareness of the vaccine				
Aware	3.563	0.329	35.260 [18.488–67.250]	0.000**
Not aware	1.00 (reference)	–	–	–

** Significant at 1% (p < 0.01), *Significant at 5% (p < 0.05)
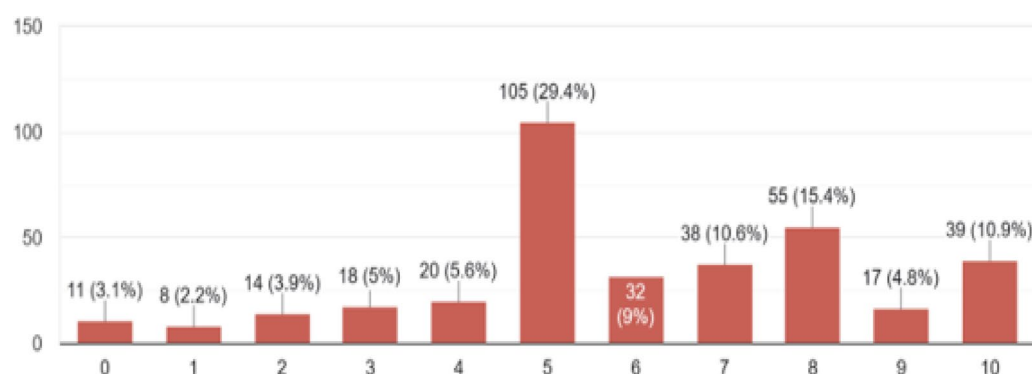
Fig. 1 Willingness to recommend malaria vaccination to caregivers of under-5

that only knowledge (p = 0.000, p < 0.05) and perception of the efficacy of the vaccines (p = 0.000, p < 0.05) were found to be significantly associated with their willingness to recommend the vaccine (Table 5). The result of logistic regression shows that among the factors considered only perception of the efficacy of the vaccine has a significant association with willingness to recommend the vaccine (p < 0.05) as shown in Table 6.

The odds of willingness to recommend the vaccine among Nurses was about 21 times higher among nurses with a high perception of the efficacy than their counterparts that had low perception of the efficacy of the vaccine (OR = 20.768, CI = 11.479–37.573, p = 0.000, p < 0.05). This means that the perception of the efficacy of the vaccine was significantly associated with willingness to recommend.

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Table 5 Chi-square result summary showing factors associated with willingness to recommend the vaccine

Factors	Willingness to recommend the vaccines			χ^2-calc.	P-value
	Not willing (n = 121)	Willing (n = 297)	Total (n = 418)		
Gender					
Male	10 (23.3)	33 (76.7)	43 (10.3)	0.478	0.489
Female	111 (29.6)	264 (70.4)	375 (89.7)		
Age (years)					
Less than 20	5 (29.4)	12 (70.6)	17 (4.1)	0.018	0.991
20–40	68 (28.7)	169 (71.3)	237 (56.7)		
Above 40	48 (29.3)	116 (70.7)	164 (39.2)		
Geopolitical Zone					
Northcentral	51 (60.7)	33 (39.3)	84 (20.1)	4.926	0.425
North East	7 (50.0)	7 (50.0)	14 (3.3)		
Northwest	14 (82.4)	3 (17.6)	17 (4.1)		
Southeast	7 (53.8)	6 (46.2)	13 (3.1)		
South–south	19 (67.9)	9 (32.1)	28 (6.7)		
Southwest	170 (64.9)	92 (35.1)	262 (62.7)		
Cadre					
Senior Nursing Officer	16 (25.4)	47 (74.6)	63 (15.1)	2.246	0.945
Chief Nursing Officer	22 (31.0)	49 (69.0)	71 (17.0)		
Deputy Director of Nursing	3 (23.1)	10 (76.9)	13 (3.1)		
Nursing Officer II	37 (31.6)	80 (68.4)	117 (28.0)		
Principal Nursing Officer	11 (30.6)	25 (69.4)	36 (8.6)		
Assistant Chief Officer	11 (32.4)	23 (67.6)	24 (8.1)		
Director of Nursing Service	2 (33.3)	4 (66.7)	6 (1.4)		
Assistant Director of Nursing	19 (24.4)	59 (75.6)	78 (18.7)		
Awareness of the vaccine					
Aware	78 (42.2)	107 (57.8)	185 (43.3)	27.038	0.000**
Not aware	43 (18.5)	190 (81.5)	233 (55.7)		
Perception of the efficacy of the vaccine					
Low	93 (70.5)	39 (29.5)	132 (31.6)	158.66	0.000**
High	28 (9.8)	258 (90.2)	286 (68.4)		

** Significant at 1% ($p < 0.01$), *Significant at 5% ($p < 0.05$)

Discussion

This study, which adds to the body of knowledge on healthcare workers'responsibilities in vaccine uptake, is the first that we are aware of in Nigeria to evaluate nurses'knowledge and willingness to recommend the RTS, S/AS01, and R21 Matrix M malaria vaccines. With a female-to-male ratio of 9 to 1, women made up the bulk of respondents in this cross-sectional survey. In southwest Nigeria, Fadare et al. [15] discovered a comparable 9:1 female-to-male ratio among nurses. This study population's high percentage of female nurses aligns with the gender distribution of the nursing profession as a whole.

Almost two out of three Nigerian nurses, according to this current study, knew very little about the RTS S/AS01 and R21 Matrix M malaria vaccinations. Most

participants in the study had never heard of the RTS S/AS01 and R21 Matrix M malaria vaccines. On a scale of 0 to 10, we found that several of our respondents reported being willing to promote malaria immunizations with a score of 5, which is comparable to the border level. The study found that the only factor substantially correlated with knowledge of malaria vaccines was vaccination awareness.

More significantly, nurses'knowledge of the vaccines and their opinion of their effectiveness were found to be strongly correlated with their willingness to advise parents to get vaccinated against malaria. For Nigeria's malaria vaccination program to be implemented successfully, these findings have significant implications.

Interestingly, it was found out that most of the nurses in this present study knew very little about the RTS S/AS01 and R21 Matrix M malaria vaccinations and had

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Table 6 Logistic regression results showing factors associated with the willingness to recommend the vaccines (odd ratios and 95% confidence interval)

Factors	Coefficient (β)	SE	OR[95% CI]	P-value
Gender				
Male	− 0.221	0.489	0.801 [0.307–2.091]	0.651
Female	1.00 (reference)			
Age	0.013	0.020	1.013 [0.975–1.053]	0.498
Geopolitical zone				0.882
Northcentral	0.202	0.371	1.224 [0.592–2.533]	0.585
North East	1.788	1.260	5.980 [0.506–70.78]	0.156
Northwest	0.726	0.768	2.068 [0.459–9.321]	0.344
Southeast	0.454	0.757	1.575 [0.357–6.942]	0.548
South–south	0.164	0.559	1.178 [0.394–3.526]	0.770
Southwest	1.00 (reference)	–	–	–
Cadre				0.949
Senior Nursing Officer	0.185	0.499	1.204 [0.453–3.198]	0.710
Chief Nursing Officer	− 0.407	0.557	0.666 [0.224–1.982]	0.465
Deputy Director of Nursing	0.150	0.953	1.162 [0.179–7.527]	0.875
Nursing Officer II	− 0.284	0.447	0.753 [0.314–1.807]	0.525
Principal Nursing Officer	− 0.253	0.601	0.777 [0.239–2.524]	0.675
Assistant Chief Nursing Officer	− 0.327	0.623	0.721 [0.213–2.446]	0.600
Director of Nursing Services	− 0.650	1.309	0.522 [0.040–6.788]	0.619
Assistant Director of Nursing/Head of Nursing Services	1.00 (reference)	–	–	–
Awareness of the vaccine				
Aware	0.136	0.311	1.145[0.623–2.107]	0.662
Not aware	1.00 (reference)	–	–	–
Perception of the efficacy of the vaccine				
High	3.033	0.302	20.768 [11.479–37.573]	0.000**
Low	1.00 (reference)			

** Significant at 1% (p < 0.01), *Significant at 5% (p < 0.05)

a poor understanding of the malaria vaccines in general. It has previously been reported that Nigerian healthcare personnel had relatively poor levels of knowledge regarding other vaccines, such as the human papillomavirus (HPV) vaccine [16] and the hepatitis B vaccine [17].

Furthermore, this current study finding contrasts strongly with high knowledge levels among nurses regarding malaria vaccine regimens reported in the research by Mugasia et al. [18] and Otieno et al. [19] among nurses in Kenya. Nigeria approved the new R21 malaria vaccine on April 17, 2023, but at the time the study was conducted, it was not part of the country's national immunization programme or expanded immunization programme. This could be one factor contributing to the majority of study participants'low level of vaccine knowledge.

Additionally, the low level of knowledge regarding several vaccine-related topics, including the recommended dosage schedule, the age at which children should receive the vaccine used in this study, and awareness campaigns, indicates that national malaria education training programmes and awareness campaigns have not been successful in providing nurses and other healthcare professionals in Nigeria with critical information.

In Nigeria, nurses are vital because they administer life-saving vaccines and are frequently in charge of immunization programmes, which include educating parents [20]. As a result, it is imperative that nurses and other medical workers receive training on how to prevent malaria with the latest immunizations.

This present study that the majority of respondents scored 10 for their willingness to recommend malaria vaccinations. However, a sizable proportion of respondents scored 5, which is similar to the border score on a scale of 0 to 10. This emphasize the need for more enlightenment to boost their willingness to recommend the vaccines. Similarly, nurses'willingness to recommend malaria vaccination to parents was significantly associated with their knowledge of the vaccines and their perception of the vaccine's efficacy. According to a recent

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systematic analysis, healthcare workers with low trust in the benefits and safety of vaccines are less willing to recommend vaccines to their patients [21].

It has also been documented that healthcare professionals'perceptions of vaccine efficacy and safety should be considered not only as a measure of their attitudes toward vaccines but also as an indicator of their vaccine-related knowledge [22]. The study's findings show that raising awareness about malaria vaccines and boosting perceptions of their efficacy will increase nurses'readiness to promote them.

Study strengths and limitations

The study included nurses from all six geopolitical zones of Nigeria, providing a representative sample of the nursing population and increasing the generalizability of the findings. By focusing on nurses, who are crucial to vaccination programmes, the study gives invaluable insights into a critical group of professionals that has a direct impact on vaccine implementation and uptake. However, the study employed an online survey, which may have excluded nurses with poor internet access or technological skills, potentially introducing sampling bias. The use of self-reported surveys may have created response bias, as participants may have exaggerated their knowledge or willingness to recommend the vaccine.

Recommendations

This study recommends incorporating comprehensive vaccine training sessions into the national nursing curricula and continuous professional development programmes. Similarly, there is an urgent need to implement targeted training programmes to help nurses learn more about RTS, S/AS01, and R21 Matrix M malaria vaccines, with an emphasis on vaccine efficacy, dosing regimens, and eligible age ranges.

Conclusion

This study highlights major gaps in Nigerian nurses'knowledge and awareness of malaria vaccines, as well as their willingness to recommend them to caregivers. Knowledge and perception of vaccination efficacy were important predictors of nurses'willingness to recommend the vaccines. To enhance the impact of malaria vaccine programs, nurses must receive extensive education and training. Addressing these gaps will enable nurses to play a critical role in the successful implementation of malaria immunization campaigns in Nigeria, lowering the illness burden among vulnerable populations.

Declarations

Ethics approval and consent to participate
Ethical approval was given by the Nigerian National Health Research Ethics Committee (NHREC) under authorization number NHREC/01/01/2007-12/11/2023. The Declaration of Helsinki's principles are followed in the methods employed in this investigation. The survey lacked any personally identifiable information in order to maintain anonymity and participants gave their consent to participate in the study by signing a consent form.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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