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Perceived safety, effectiveness and acceptability of R21/Matrix-M malaria vaccine among pediatric health practitioners and caregivers in Southeast Nigeria: a cross-sectional study

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Abstract

Background

Nigeria has the highest number of malaria deaths globally, and children bear the greatest burden. Although major investments have supported the development and clinical trials of the novel R21/Matrix-M malaria vaccine, little attention has been given to how frontline pediatric health practitioners and caregivers perceive this new intervention, especially in high-burden settings. Their confidence and acceptance are critical to successful vaccine rollout. This study therefore explored the perceptions of safety, effectiveness, and acceptability of the R21/Matrix-M malaria vaccine among pediatric health practitioners and caregivers in Southeast Nigeria, with the goal of generating context-specific evidence to guide implementation strategies in malaria-endemic regions.

Methods

The study adopted a descriptive cross-sectional design using a quantitative approach. 406 pediatric health practitioners and caregivers in Awka, Southeast Nigeria, were recruited for the study by stratified sampling. Data were collected using structured questionnaire that assessed socio-demographic characteristics, awareness of the R21/Matrix-M malaria vaccine, perceived safety, perceived effectiveness, acceptability, and perceived barriers and facilitators to vaccine uptake. Data were analyzed using IBM SPSS version 20. Descriptive statistics summarized key variables, while Chi-square tests examined associations between perceptions and willingness to recommend or accept the vaccine, with statistical significance set at $p < 0.05$.

Results

Awareness of the R21/Matrix-M vaccine was relatively low among pediatric health practitioners (52.7%) and caregivers (38.6%). Most pediatric practitioners perceived the vaccine as safe (83.8%) and effective (86.9%), and 75.7% were willing to recommend it. Caregivers demonstrated moderate perceptions of safety (57.1%) and effectiveness (54.9%), with 53.3% expressing willingness to vaccinate their children. Perceived safety was significantly associated with willingness to recommend the vaccine among practitioners ($p < 0.001$) and with acceptability among caregivers ($p < 0.001$). Key facilitators for vaccine acceptance included targeted health education, positive media coverage, and government endorsement, while major barriers encompassed insufficient information, safety concerns, and parental resistance.

Conclusions

Perceptions of safety and effectiveness are key drivers of advocacy and acceptability of the R21/Matrix-M malaria vaccine. Targeted health education, proactive management of misinformation, and reliable vaccine access are essential to support effective rollout. Policy-driven interventions engaging both healthcare professionals and caregivers can accelerate uptake and strengthen malaria control efforts in Nigeria.

1. Background

Malaria is a life-threatening parasitic disease caused by *Plasmodium* species [1]. It is transmitted through the bite of infected *Anopheles* mosquitoes and typically presents with recurrent fever, chills, anemia, and splenomegaly due to cyclic red blood cell destruction [1]. Five *Plasmodium* species infect humans, with *P. falciparum* and *P. vivax* posing the greatest global threat. *P. falciparum* is the most lethal and is highly prevalent in Africa, whereas *P. vivax* predominates in many regions outside sub-Saharan Africa. *P. malariae*, *P. ovale*, and *P. knowlesi* also contribute to human malaria infections [2].

Despite decades of control efforts, malaria remains a major global health challenge. In 2022, an estimated 249 million cases and 608,000 deaths occurred across 85 countries [2]. The World Health Organization (WHO) African Region accounted for 94% of all cases and 95% of deaths, with children under five years constituting the majority of fatalities [2]. Nigeria alone contributed 26.8% of global malaria deaths, followed by the Democratic Republic of the Congo, Uganda, and Mozambique [2].

Conventional control strategies—including insecticide-treated nets, indoor residual spraying, vector control, and artemisinin-based combination therapies—have been essential [3–4], but the growing emergence of insecticide and drug resistance continues to undermine progress [5–6]. These challenges highlight the need for complementary tools such as vaccination, which has historically been pivotal in reducing the burden of infectious diseases including polio, measles, diphtheria, tetanus, rabies, and smallpox [7–12].

Developing a malaria vaccine has long been hindered by the complexity of the parasite's life cycle and antigenic diversity [13]. Important progress was achieved with the WHO-recommended RTS,S/AS01 vaccine, which demonstrated 36% efficacy against *P. falciparum* malaria in phase 3 trials among children aged 5–17 months [14, 15]. Implementation in Ghana, Kenya, and Malawi showed high uptake and reductions in severe malaria hospitalizations and all-cause mortality [16, 17]. Additional evidence from Burkina Faso and Mali demonstrated that seasonal RTS,S administration, alone or combined with chemoprevention, substantially reduced malaria incidence and related deaths [18]. Continued progress toward malaria elimination requires new vaccine candidates capable of achieving higher efficacy and broader coverage, in line with the WHO target of at least 75% efficacy by 2030 [19].

The R21/Matrix-M pre-erythrocytic vaccine, developed at the University of Oxford and manufactured by the Serum Institute of India, represents one such advancement [20]. Designed to enhance anti-circumsporozoite immune responses, R21/Matrix-M demonstrated 77% efficacy over two years in a phase 2b trial in Burkina Faso [20] and achieved 67–72% efficacy across diverse transmission settings in phase 3 trials in East and West Africa [21]. The vaccine was

endorsed by the WHO in October 2023 and added to the WHO prequalified list in December 2023 [22]. Nigeria provisionally approved its use in April 2023 [23].

However, the successful rollout of malaria vaccines in Nigeria may be challenged by past experiences of low vaccination coverage and public hesitancy, as seen in the country's prolonged struggle with poliovirus transmission [24]. Cultural, social, and religious factors have also historically influenced vaccine acceptance and compliance [25]. Pediatric health practitioners and caregivers are central to vaccine advocacy and uptake, yet little is known about their perceptions of the R21/Matrix-M vaccine in Nigeria. Understanding their views is essential for anticipating potential barriers and designing effective communication strategies.

This study therefore explored the perceptions of pediatric health practitioners and caregivers in Awka, Southeast Nigeria, focusing on the perceived safety, effectiveness, and acceptability of the R21/Matrix-M malaria vaccine. Findings from this research will support efforts to integrate the vaccine into national malaria control strategies and improve child health outcomes in Nigeria.

2. Methods

2.1 Study Area

The study was conducted in Awka, Southeast, Nigeria. The city is geographically positioned between latitude 6.2°N and longitude 7.1°E, covering an approximate area of 72 square kilometers [26]. Awka is home to a diverse population, estimated at over 300,000 residents, comprising various ethnic groups, though predominantly Igbo. The city has a mix of urban and semi-urban settlements, with varying socio-economic statuses among its inhabitants. Awka is known for its warm tropical climate, characterized by two distinct seasons: the rainy season (April to October) and the dry season (November to March) [27]. Awka is particularly relevant to this study due to its high malaria prevalence (87.3%) [28], which aligns with Nigeria's status as one of the countries with the highest malaria burden globally.

2.2 Study Design

The study adopted a descriptive cross-sectional design using a quantitative approach. This approach is well-suited for assessing the perceptions, knowledge, and attitudes of specific populations at a single point in time [27].

2.3 Study Population

The study population comprised pediatric health practitioners (pediatric doctors, nurses, nurse practitioners, pharmacists, laboratory technicians, and public health practitioners who are involved in providing care and services to pediatric patients) and caregivers in Awka, Southeast, Nigeria. Eligible participants were those aged 18 years and above and who provided informed consent. Individuals who had significant health or cognitive limitations were excluded.

2.4 Sample Size Determination

The sample size for the study was determined using the Fisher's formula for calculating minimum sample size for cross sectional studies

$$n = \frac{Z^2 * p(1-p)}{e^2}$$

Where

n – minimum sample size required

Z – Z-score corresponding to 95% confidence level (1.96)

p – Awareness level of the new malaria vaccine in the region, set at 48.2% [29],

e – Margin of error tolerated (0.05)

Hence,

$$n = \frac{1.96^2 * 0.482(1-0.482)}{0.05^2} \approx 384$$

To account for non-response, 10% (38 participants) was added to give a final sample size of 422.

2.5 Sampling Technique

The study employed a stratified sampling approach to ensure representation of the two key groups: pediatric health practitioners and caregivers. Stratification allowed for proportional inclusion of both groups to capture varied perspectives on the perceived safety, effectiveness, and acceptability of the R21/Matrix-M malaria vaccine:

1. **Pediatric health practitioners** – including pediatricians, nurses, nurse practitioners, pharmacists, laboratory technicians, and public health practitioners involved in child healthcare.
2. **Caregivers** – parents, guardians, and primary caregivers of children eligible for the R21/Matrix-M malaria vaccine.

Within each stratum, participants who met the inclusion criteria and were available during the study period were consecutively recruited until the target sample size was achieved. Population estimates were based on previous studies at Chukwuemeka Odumegwu Ojukwu University Teaching Hospital (COOUTH), Awka [26, 27], reporting 288 health practitioners [26] and 250 caregivers [27].

Proportional allocation of the total sample size (422) was applied:

Pediatric health practitioners: $\frac{288}{(288+250)} * 422 \approx 226$

Caregivers: $\frac{250}{(288+250)} * 422 \approx 196$

Thus, 226 pediatric health practitioners and 196 caregivers were consecutively recruited for participation.

2.6 Instrument for Data Collection

Data collection was carried out using a structured questionnaire. The questionnaire was developed based on a review of existing literature and validated scales used in similar studies. The questionnaire was tailored to the specific context of this study, capturing both pediatric health practitioners and caregivers.

The questionnaire included the following sections:

Section A: Demographic information of respondents

This section contained information on the socio-demographic characteristics of the respondents. There were eight items for pediatric health practitioners and nine items for caregivers. Variables included age, gender, marital status, educational level, among others.

Section B: Perceived safety of the vaccine

This variable refers to beliefs about the safety of the R21/Matrix-M malaria vaccine for children. It was measured quantitatively using a 4-point Likert scale with items such as "I believe the R21/Matrix-M malaria vaccine is safe for children," ranging from 1 (strongly disagree) to 4 (strongly agree). The mean score was determined. Mean score of < 2.5 indicated negative perception, mean score = 2.5 indicated neutral perception, whereas mean score > 2.5 indicated positive perception.

Section C: Perceived effectiveness of the vaccine

This variable refers to beliefs about the effectiveness of the R21/Matrix-M malaria vaccine in preventing malaria. There were five items in this section. It was measured quantitatively using a 4-point Likert scale with items such as "I believe the R21/Matrix-M malaria vaccine is effective in preventing malaria," ranging from 1 (strongly disagree) to 4 (strongly agree). The mean score was determined. Mean score of < 2.5 indicated negative perception, mean score = 2.5 indicated neutral perception, whereas mean score > 2.5 indicated positive perception.

Section D: Acceptability of the vaccine

This variable refers to the acceptability of the R21/Matrix-M malaria vaccine. There were five items for pediatric health practitioners and four items for caregivers. It was quantitatively measured using a 4-point Likert scale with items such as "I am willing to recommend the R21/Matrix-M malaria vaccine to parents" ranging from 1 (strongly disagree) to 4 (strongly agree). The mean score was determined. Mean score of < 2.5 indicated low acceptability, mean score = 2.5 indicated average acceptability, whereas mean score > 2.5 indicated high acceptability.

The mean score for each perception statement was calculated based on the 4-point Likert scale (1 to 4).

The formula used for calculating the mean score was:

$$MeanScore = \frac{\sum (Frequency * Scalevalue)}{Totalresponses}$$

Section E: Perceived barriers and facilitators for acceptability of the vaccine

These variables refer to the perceived factors that hinder or promote the acceptability and uptake of the R21/Matrix-M malaria vaccine. These were identified using multiple-choice questions in the questionnaire, such as "What factors might prevent you from recommending the vaccine?" and "What barriers do you foresee in recommending or administering this vaccine?" and "What factors would make you more supportive of this vaccine?"

2.7 Validation of Instruments

The questionnaire underwent face and content validation. A Professor of Epidemiology and a Public Health Research Consultant reviewed the items to ensure they were clear, relevant, and adequately covered all constructs of interest.

2.8 Procedure for Data Collection

Data were collected between September and October 2024, using a structured questionnaire distributed in paper format. Six trained research assistants, who received comprehensive training on the study objectives, ethical considerations, and questionnaire administration, facilitated the process. Participants were recruited from healthcare facilities and community centers in Awka. While the questionnaire was primarily self-administered, research assistants provided

guided administration for participants requiring assistance due to literacy challenges or other limitations. Completed questionnaires were collected immediately after completion, with research assistants ensuring thorough checks for completeness and legibility. The principal investigator supervised the process, conducting regular debriefing sessions to address challenges and maintain adherence to the study protocol. This structured approach ensured the collection of reliable and high-quality data for analysis.

2.9 Data Management

All collected questionnaires were digitized and stored electronically using the Kobo Toolbox, and original paper copies kept secured and accessible only to the principal investigator.

2.10 Data Analysis

Data in electronic format was uploaded into IBM SPSS version 20. The data was checked for completeness, accuracy, and consistency. Missing data was addressed appropriately. Descriptive statistics was used to summarize the demographic characteristics. Descriptive measures such as frequencies and percent were used to summarize the responses for perceived safety, perceived effectiveness, and acceptability of the R21/Matrix-M malaria vaccine. Chi-square test was used to test associations between variables with p-value set at < 0.05 for significant associations.

3. Results

Out of the 422 questionnaires distributed (226 for pediatric health practitioners and 196 for caregivers), 406 (96.2%) were returned, with a response rate of 98.2% (222 out of 226) for pediatric health practitioners and 93.9% (184 out of 196) for caregivers.

3.1 Socio-demographic characteristics of respondents

The demographic characteristics of pediatric health practitioners as reported in Table 1 revealed that the majority were female 171 (77.0%) and predominantly aged 21–30 years 115 (51.8%). Most were single 166 (74.8%) and held a Bachelor's degree 124 (55.9%). Nearly all participants identified as Christians 221 (99.5%). Professionally, the largest groups were Nurses 72 (32.4%) and Public Health practitioners 61 (27.5%). Regarding experience, 104 (46.8%) had less than one year of professional practice, and 67 (30.2%) had 1–5 years

Table 1
Socio-demography of pediatric health practitioners

Variable	Frequency	Percent (%)
Gender		
Female	171	77
Male	51	23
Total	222	100
Age Group		
Less than 20 years	42	18.9
21–30 years	115	51.8
31–40 years	47	21.2
41–50 years	18	8.1
Total	222	100
Marital Status		
Single	166	74.8
Married	55	24.8
Separated	1	0.5
Total	222	100
Highest Educational Attainment		
National Diploma	68	30.6
Bachelor's Degree	124	55.9
Master's Degree	23	10.4
Doctoral Degree	5	2.3
Postdoctoral Training	2	0.9
Total	222	100
Religion		
Christianity	221	99.5
Islam	1	0.5
Total	222	100
Role		
Nurse	72	32.4
Public Health Practitioner	61	27.5
Laboratory Technician	26	11.7
Pharmacist	25	11.3
Nurse Practitioner	22	9.9
Pediatric Doctor	16	7.2
Total	222	100
Years of Experience		
Less than 1 year	104	46.8
1–5 years	67	30.2
6–10 years	39	17.6
11–15 years	12	5.4
Total	222	100

Values are presented as frequencies and percentages. Percentages were calculated based on the total number of pediatric health practitioners (n = 222)

The socio-demographic characteristics of caregivers in Table 2 revealed that most were female 135 (73.4%) and aged 41–50 years 81 (44.0%). The majority were married 168 (91.3%) and had tertiary 86 (46.7%) or secondary 74 (40.2%) education. All caregivers identified as Christians 184 (100%), with most employed in non-healthcare sectors 123 (66.8%). Parents constituted 170 (92.4%) of the caregivers, and 52 (28.3%) had three children, followed by 42 (22.8%) with four children.

Table 2
Socio-demography of caregivers

Variable	Frequency	Percent (%)
Gender		
Female	135	73.4
Male	49	26.6
Total	184	100
Age Group		
Less than 20 years	1	0.5
21–30 years	20	10.9
31–40 years	40	21.7
41–50 years	81	44
51 years and above	42	22.8
Total	184	100
Marital Status		
Married	168	91.3
Single	9	4.9
Widowed	7	3.8
Total	184	100
Educational Attainment		
Primary	24	13
Secondary	74	40.2
Tertiary	86	46.7
Total	184	100
Religion		
Christianity	184	100
Occupation		
Healthcare sector	15	8.2
Non-healthcare sector	123	66.8
Student	8	4.3
Unemployed	38	20.7
Total	184	100
Relationship with the Child		
Parent	170	92.4
Guardian	6	3.3
Grandparent	4	2.2
Sibling	4	2.2
Total	184	100
Number of Children		
1	30	16.3
2	25	13.6
3	52	28.3
4	42	22.8

Values are presented as frequencies and percentages. Percentages were calculated based on the total number of pediatric health practitioners (n = 184)

Variable	Frequency	Percent (%)
Gender		
5 and above	35	19
Total	184	100
Values are presented as frequencies and percentages. Percentages were calculated based on the total number of pediatric health practitioners (n = 184)		

3.2 Awareness of the R21/Matrix-M malaria vaccine

From Table 3, among pediatric health practitioners, 117 (52.7%) were aware of the R21/Matrix-M Malaria Vaccine. In contrast, among caregivers, only 71 (38.6%) were aware of the vaccine.

Table 3
Awareness of pediatric health practitioners and caregivers regarding the R21/Matrix-M malaria vaccine

Awareness Statement	Pediatric Health Practitioners (n = 222)	Caregivers (n = 184)	Total (n = 406)
Heard of R21/Matrix-M Vaccine	117 (52.7%)	71 (38.6%)	188 (46.3%)
Not Heard of R21/Matrix-M Vaccine	105 (47.3%)	113 (61.4%)	218 (53.7%)

Values are presented as frequencies and percentages. Percentages were calculated within each respondent group.

3.3 Perceived safety of the R21/Matrix-M malaria vaccine

The results in Table 4 revealed that majority (83.8%, 186) agreed or strongly agreed that the vaccine is safe for children, with a mean score of 3.1. Despite this, concerns about potential side effects were prevalent, as 87.4% (194) agreed or strongly agreed with this statement, yielding a lower mean score of 1.9. Confidence in the clinical trials was high, with 78.4% (174) expressing agreement or strong agreement and a mean score of 2.9. Similarly, 80.2% (178) believed the benefits of the vaccine outweigh its risks, with a mean score of 2.9. Trust in safety information provided by health authorities was strong, as 83.4% (185) agreed or strongly agreed, resulting in a mean score of 3.0.

Table 4
Perceived safety of pediatric health practitioners regarding the R21/Matrix-M malaria vaccine

Perceived Safety Statement	Option	Frequency (n = 222)	Percent (%)	Mean Score
I believe the R21/Matrix-M malaria vaccine is safe for children	Strongly agree	51	23.0	3.1
	Agree	135	60.8	
	Disagree	22	9.9	
	Strongly disagree	4	1.8	
	Non-response	10	4.5	
I am concerned about potential side effects of the R21/Matrix-M malaria vaccine	Strongly agree	40	18.0	1.9
	Agree	154	69.4	
	Disagree	17	7.7	
	Strongly disagree	5	2.3	
	Non-response	6	2.7	
I have confidence in the clinical trials conducted for the R21/Matrix-M malaria vaccine	Strongly agree	11	5.0	2.9
	Agree	163	73.4	
	Disagree	27	12.2	
	Strongly disagree	5	2.3	
	Non-response	16	7.2	
I believe the benefits of the R21/Matrix-M malaria vaccine outweigh its risks	Strongly agree	12	5.4	2.9
	Agree	166	74.8	
	Disagree	23	10.4	
	Strongly disagree	8	3.6	
	Non-response	13	5.9	
I trust the safety information provided by health authorities regarding the R21/Matrix-M malaria vaccine	Strongly agree	25	11.3	3.0
	Agree	160	72.1	
	Disagree	19	8.6	
	Strongly disagree	5	2.3	
	Non-response	13	5.9	

Values are presented as frequencies and percentages. Mean scores were calculated using a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree) according to the formula: Mean Score = (Σ(Frequency × Scale value)) / Total responses. Non-responses were recorded to ensure transparency in interpretation. For interpretation, mean scores < 2.5 indicate negative perception, a mean score of 2.5 indicates neutral perception, and mean scores > 2.5 indicate positive perception regarding the safety of the R21/Matrix-M malaria vaccine.

From Table 5, while 98 caregivers (53.3%) agreed that the vaccine is safe for children, a significant portion, 64 caregivers (34.8%), disagreed, yielding a moderate mean score of 2.6. Similarly, 95 caregivers (51.6%) believed the vaccine's benefits outweigh its risks, although 67 caregivers (36.4%) disagreed, with a mean score of 2.6. Concerns about potential side effects were prevalent, with 103 caregivers (56.0%) expressing worry, reflected in a mean score of 2.4. Confidence in clinical trials for the vaccine was notably low, with only 88 caregivers (47.8%) agreeing and 71 caregivers (38.6%) disagreeing, resulting in the lowest mean score of 1.7. Trust in safety information from health authorities showed moderate levels, with 89 caregivers (48.4%) expressing trust and a mean score of 2.6.

Table 5
Perceived safety of caregivers regarding the R21/Matrix-M malaria vaccine

Perceived Safety Statement	Option	Frequency (n = 184)	Percent (%)	Mean Score
I believe the R21/Matrix-M malaria vaccine is safe for children	Strongly agree	7	3.8	2.6
	Agree	98	53.3	
	Disagree	64	34.8	
	Strongly disagree	6	3.3	
	Non-response	9	4.9	
I am concerned about potential side effects of the R21/Matrix-M malaria vaccine	Strongly agree	8	4.3	2.4
	Agree	103	56.0	
	Disagree	64	34.8	
	Strongly disagree	4	2.2	
	Non-response	5	2.7	
I have confidence in the clinical trials conducted for the R21/Matrix-M malaria vaccine	Strongly agree	4	2.2	1.7
	Agree	88	47.8	
	Disagree	71	38.6	
	Strongly disagree	4	2.2	
	Non-response	17	9.2	
I believe the benefits of the R21/Matrix-M malaria vaccine outweigh its risks	Strongly agree	5	2.7	2.6
	Agree	95	51.6	
	Disagree	67	36.4	
	Strongly disagree	3	1.6	
	Non-response	14	7.6	
I trust the safety information provided by health authorities regarding the R21/Matrix-M malaria vaccine	Strongly agree	8	4.3	2.6
	Agree	89	48.4	
	Disagree	66	35.9	
	Strongly disagree	4	2.2	
	Non-response	17	9.2	

Values are presented as frequencies and percentages. Mean scores were calculated using a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree) according to the formula: Mean Score = (Σ(Frequency × Scale value)) / Total responses. Non-responses were recorded to ensure transparency in interpretation. For interpretation, mean scores < 2.5 indicate negative perception, a mean score of 2.5 indicates neutral perception, and mean scores > 2.5 indicate positive perception regarding the safety of the R21/Matrix-M malaria vaccine.

3.4 Perceived effectiveness of the R21/Matrix-M malaria vaccine

Findings from Table 6 revealed that, among pediatric health practitioners, a significant majority perceive the R21-Matrix-M malaria vaccine as effective. Specifically, 169 respondents (76.1%) indicated that they believe the vaccine is effective in preventing malaria in children, with a mean score of 3.0. Additionally, 170 respondents (76.6%) agreed that the vaccine will reduce the incidence of malaria in their community, supported by a mean score of 2.9. Regarding trust in the effectiveness data, 159 respondents (71.6%) expressed confidence, with a mean score of 2.9. Furthermore, 175 respondents (78.8%) believed the vaccine would have a long-term impact on malaria eradication, reflecting a strong positive perception. 171 respondents (77.0%) supported the idea that the vaccine will help in reducing morbidity and mortality associated with malaria, maintaining a mean score of 3.0.

Table 6
Perceived effectiveness of pediatric health practitioners regarding the R21/Matrix-M malaria vaccine

Perceived Effectiveness Statement	Option	Frequency (n = 222)	Percent (%)	Mean Score
I believe the R21-Matrix-M malaria vaccine is effective in preventing malaria in children	Strongly agree	24	10.8	3.0
	Agree	169	76.1	
	Disagree	13	5.9	
	Strongly disagree	6	2.7	
	Non-response	10	4.5	
I think the R21-Matrix-M malaria vaccine will reduce the incidence of malaria in our community	Strongly agree	17	7.7	2.9
	Agree	170	76.6	
	Disagree	14	6.3	
	Strongly disagree	10	4.5	
	Non-response	11	5.0	
I trust the effectiveness data presented in the research studies on the R21-Matrix-M malaria vaccine	Strongly agree	16	7.2	2.9
	Agree	159	71.6	
	Disagree	26	11.7	
	Strongly disagree	4	1.8	
	Non-response	17	7.7	
I believe the R21-matrix-M malaria vaccine will have a long-term impact on malaria eradication	Strongly agree	13	5.9	2.9
	Agree	175	78.8	
	Disagree	21	9.5	
	Strongly disagree	4	1.8	
	Non-response	9	4.1	
I believe the R21-Matrix-M malaria vaccine will help in the reduction of morbidity and mortality associated with malaria	Strongly agree	25	11.3	3.0
	Agree	171	77.0	
	Disagree	17	7.7	
	Strongly disagree	3	1.4	
	Non-response	6	2.7	

Values are presented as frequencies and percentages. Mean scores were calculated using a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree) according to the formula: Mean Score = (Σ(Frequency × Scale value)) / Total responses. Non-responses were recorded to ensure transparency in interpretation. For interpretation, mean scores < 2.5 indicate negative perception, a mean score of 2.5 indicates neutral perception, and mean scores > 2.5 indicate positive perception regarding the safety of the R21/Matrix-M malaria vaccine.

Results from Table 7 revealed that caregivers largely agreed on the effectiveness of the R21/Matrix-M malaria vaccine. Specifically, 51.6% (95) of caregivers believe the vaccine is effective in preventing malaria in children and 47.8% (88) think the vaccine will reduce the incidence of malaria in their community. While 50.5% (93) trust the effectiveness data presented in research studies on the vaccine, 50.0% (92) believe the vaccine will have a long-term impact on malaria eradication. 51.6% (95) also agreed that the vaccine will help reduce morbidity and mortality associated with malaria. The mean scores ranged from approximately 2.6 to 2.7 across the different statements.

Table 7
Perceived effectiveness of caregivers regarding the R21/Matrix-M malaria vaccine

Perceived Effectiveness Statement	Option	Frequency (n = 184)	Percent (%)	Mean Score
I believe the R21-Matrix-M malaria vaccine is effective in preventing malaria in children	Strongly agree	6	3.3	2.6
	Agree	95	51.6	
	Disagree	67	36.4	
	Strongly disagree	2	1.1	
	Non-response	14	7.6	
I think the R21-Matrix-M malaria vaccine will reduce the incidence of malaria in our community	Strongly agree	10	5.4	2.6
	Agree	88	47.8	
	Disagree	66	35.9	
	Strongly disagree	1	0.5	
	Non-response	19	10.3	
I trust the effectiveness data presented in the research studies on the R21-Matrix-M malaria vaccine	Strongly agree	7	3.8	2.6
	Agree	93	50.5	
	Disagree	63	34.2	
	Strongly disagree	3	1.6	
	Non-response	18	9.8	
I believe the R21-matrix-M malaria vaccine will have a long-term impact on malaria eradication	Strongly agree	11	6.0	2.7
	Agree	92	50.0	
	Disagree	65	35.3	
	Strongly disagree	2	1.1	
	Non-response	14	7.6	
I believe the R21-Matrix-M malaria vaccine will help in the reduction of morbidity and mortality associated with malaria	Strongly agree	9	4.9	2.6
	Agree	95	51.6	
	Disagree	62	33.7	
	Strongly disagree	4	2.2	
	Non-response	14	7.6	

Values are presented as frequencies and percentages. Mean scores were calculated using a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree) according to the formula: Mean Score = (Σ(Frequency × Scale value)) / Total responses. Non-responses were recorded to ensure transparency in interpretation. For interpretation, mean scores < 2.5 indicate negative perception, a mean score of 2.5 indicates neutral perception, and mean scores > 2.5 indicate positive perception regarding the safety of the R21/Matrix-M malaria vaccine.

3.5 Acceptability of the R21/Matrix-M malaria vaccine

From Table 8, a significant majority of pediatric health practitioners expressed willingness to recommend the vaccine to parents, with 154 (69.4%) agreeing and a mean score of 2.9. Similarly, 170 (76.6%) were willing to have their own children vaccinated, and 167 (75.2%) would administer the vaccine in their practice. High agreement was also observed regarding community acceptance, with 160 (72.1%) believing parents would accept the vaccine. Additionally, most practitioners 173 (77.9%) emphasized the importance of vaccine availability in local health facilities, with a mean score of 3.0.

Table 8
Pediatric health practitioners' acceptability of the R21/Matrix-M malaria vaccine

Acceptability Statement	Option	Frequency (n = 222)	Percent (%)	Mean Score
I am willing to recommend the R21-Matrix-M malaria vaccine to parents for their children	Strongly agree	14	6.3	2.9
	Agree	154	69.4	
	Disagree	28	12.6	
	Strongly disagree	6	2.7	
	Non-response	21	9.5	
I would be willing to have my own children vaccinated with the R21-Matrix-M malaria vaccine	Strongly agree	13	5.9	2.9
	Agree	170	76.6	
	Disagree	14	6.3	
	Strongly disagree	10	4.5	
	Non-response	11	5.0	
I would be willing to administer the R21-Matrix-M malaria vaccine in my practice	Strongly agree	13	5.9	2.9
	Agree	167	75.2	
	Disagree	22	9.9	
	Strongly disagree	3	1.4	
	Non-response	17	7.7	
I believe parents in my community will accept the R21-Matrix-M malaria vaccine	Strongly agree	9	4.1	2.8
	Agree	160	72.1	
	Disagree	25	11.3	
	Strongly disagree	12	5.4	
	Non-response	16	7.2	
I think the availability of the R21-Matrix-M malaria vaccine in local health facilities is important	Strongly agree	19	8.6	3.0
	Agree	173	77.9	
	Disagree	10	4.5	
	Strongly disagree	3	1.4	
	Non-response	17	7.7	

Values are presented as frequencies and percentages. Mean scores were calculated using a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree) according to the formula: Mean Score = (Σ(Frequency × Scale value)) / Total responses. Non-responses were recorded to ensure transparency in interpretation. For interpretation, mean scores < 2.5 indicate low acceptability, a mean score of 2.5 indicates average acceptability, and mean scores > 2.5 indicate high acceptability of the R21/Matrix-M malaria vaccine among pediatric health practitioners.

From Table 9, almost half of the caregivers, 86 (46.7%), agreed to recommend the vaccine to parents, while 89 (48.4%) were willing to have their own children vaccinated, both with mean scores of 2.6. Additionally, 93 (50.5%) believed that parents in their community would accept the vaccine. The importance of vaccine availability in local health facilities was also emphasized, with 87 (47.3%) agreeing.

Table 9
Caregivers' acceptability of the R21/Matrix-M malaria vaccine

Acceptability Statement	Option	Frequency (n = 184)	Percent (%)	Mean Score
I am willing to recommend the R21-Matrix-M malaria vaccine to parents for their children	Strongly agree	6	3.3	2.6
	Agree	86	46.7	
	Disagree	73	39.7	
	Strongly disagree	3	1.6	
	Non-response	16	8.7	
I would be willing to have my own children vaccinated with the R21-Matrix-M malaria vaccine	Strongly agree	9	4.9	2.6
	Agree	89	48.4	
	Disagree	66	35.9	
	Strongly disagree	5	2.7	
	Non-response	15	8.2	
I believe parents in my community will accept the R21-Matrix-M malaria vaccine	Strongly agree	5	2.7	2.6
	Agree	93	50.5	
	Disagree	62	33.7	
	Strongly disagree	1	0.5	
	Non-response	23	12.5	
I think the availability of the R21-Matrix-M malaria vaccine in local health facilities is important	Strongly agree	12	6.5	2.7
	Agree	87	47.3	
	Disagree	56	30.4	
	Strongly disagree	1	0.5	
	Non-response	28	15.2	

Values are presented as frequencies and percentages. Mean scores were calculated using a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree) according to the formula: Mean Score = (Σ(Frequency × Scale value)) / Total responses. Non-responses were recorded to ensure transparency in interpretation. For interpretation, mean scores < 2.5 indicate low acceptability, a mean score of 2.5 indicates average acceptability, and mean scores > 2.5 indicate high acceptability of the R21/Matrix-M malaria vaccine among pediatric health practitioners.

3.6 Perceived barriers and facilitators to acceptability of the R21/Matrix-M malaria vaccine

From Table 10, both pediatric health practitioners and caregivers identified several barriers to recommending the R21/Matrix-M malaria vaccine, with notable differences in emphasis. Among pediatric health practitioners, 51.4% (114) cited a lack of sufficient information about the vaccine as a significant barrier, followed by 38.7% (86) who expressed concerns about safety. Similarly, caregivers highlighted insufficient information as the primary barrier, with 63.0% (116) reporting this issue, while 38.0% (70) pointed to negative media reports as a major concern. Parental resistance was also notable, with 34.7% (77) of pediatric health practitioners and 34.2% (63) of caregivers indicating this as a challenge. Other barriers such as concerns about effectiveness, cost, cultural beliefs, and limited vaccine availability were raised by both groups, though the proportions varied, with cultural beliefs being mentioned by 27.6% (60) of pediatric health practitioners and 29.9% (55) of caregivers.

Table 10
Perceived barriers to recommendation of the R21/Matrix-M malaria vaccine

Perceived Barrier Statement	Pediatric Health Practitioners (n = 222)		Caregivers (n = 184)	
	Frequency	Percent (%)	Frequency	Percent (%)
Lack of sufficient information about the vaccine	114	51.4	116	63.0
Concerns about safety	86	38.7	68	37.0
Concerns about effectiveness	76	34.2	57	31.0
Cost of the vaccine	79	35.6	52	28.3
Parental resistance	77	34.7	63	34.2
Cultural beliefs and practices	60	27.6	55	29.9
Limited availability of the vaccine	56	25.2	51	27.7
Lack of trust in healthcare providers	40	18.0	57	31.0
Negative media reports	59	26.6	70	38.0
Values are presented as frequencies and percentages. Multiple responses were permitted; therefore, percentages may exceed 100% within each group.				

Results from Table 11 revealed that both pediatric health practitioners and caregivers identified key facilitators for recommending the R21/Matrix-M malaria vaccine. Among pediatric health practitioners, 49.5% (110) emphasized the importance of health education and awareness campaigns, followed closely by positive clinical trial results cited by 49.1% (109). Positive media coverage was also significant, with 41.0% (91) considering it a facilitator. Government support and subsidies were mentioned by 39.6% (88), and 36.0% (80) highlighted the importance of availability in local health facilities. Caregivers, on the other hand, also prioritized positive media coverage, with 49.5% (91) citing it as a key factor, along with positive clinical trial results (47.8%, 88) and availability in local health facilities (39.1%, 72). Endorsement by health authorities (37.0%, 68) and health education campaigns (38.0%, 70) were similarly recognized by caregivers.

Table 11
Perceived facilitators to recommendation of the R21/Matrix-M malaria vaccine

Perceived Facilitators Statement	Pediatric Health Practitioners (n = 222)		Caregivers (n = 184)	
	Frequency	Percent (%)	Frequency	Percent (%)
Positive clinical trial results	109	49.1	88	47.8
Endorsement by health authorities	71	32.0	68	37.0
Cost-effectiveness	71	32.0	60	32.6
High demand from parents	37	16.7	59	32.1
Health education and awareness campaigns	110	49.5	70	38.0
Government support and subsidies	88	39.6	50	27.2
Availability in local health facilities	80	36.0	72	39.1
Trust in healthcare providers	71	32.0	53	28.8
Positive media coverage	91	41.0	91	49.5
Values are presented as frequencies and percentages. Multiple responses were permitted; therefore, percentages may exceed 100% within each group.				

3.7 Inferential Statistics

Chi-square tests were performed to examine differences and associations between perceptions of the R21/Matrix-M malaria vaccine among pediatric health practitioners and caregivers. Key findings include:

Awareness

There was a statistically significant difference in vaccine awareness between pediatric health practitioners and caregivers ($\chi^2 = 8.063$, $p < 0.005$).

Perceived Safety

Pediatric health practitioners reported significantly higher perceived safety compared to caregivers ($\chi^2 = 39.556$, $p < 0.001$). Among practitioners, years of experience was significantly associated with perceived safety ($\chi^2 = 48.915$, $p < 0.001$), while among caregivers, level of education was significantly associated with perceived safety ($\chi^2 = 416.452$, $p < 0.001$).

Perceived Effectiveness

Pediatric health practitioners perceived the vaccine as more effective than caregivers ($\chi^2 = 54.788$, $p < 0.001$). Years of experience among practitioners ($\chi^2 = 377.156$, $p < 0.001$) and level of education among caregivers ($\chi^2 = 411.191$, $p < 0.001$) were significantly associated with perceived effectiveness.

Willingness to Recommend and Acceptability

Among pediatric health practitioners, perceived safety was strongly associated with willingness to recommend the vaccine ($\chi^2 = 447.667$, Cramer's V = 0.741, $p < 0.001$). Among caregivers, perceived safety ($\chi^2 = 533.485$, Cramer's V = 0.809, $p < 0.001$) and perceived effectiveness ($\chi^2 = 531.588$, Cramer's V = 0.807, $p < 0.001$) were strongly associated with vaccine acceptability. Additionally, caregivers' perceived effectiveness was significantly associated with willingness to recommend the vaccine ($\chi^2 = 589.855$, Cramer's V = 0.850, $p < 0.001$).

4. Discussion

The demographic profile of pediatric health practitioners provides important context for understanding their perspectives on the R21/Matrix-M malaria vaccine. The predominance of females (77.0%) reflects typical gender distributions in pediatric healthcare, which may influence communication styles and patient interactions. A youthful workforce, with over half aged 21–30 years (51.8%) and predominantly single (74.8%), may be more receptive to innovative interventions but could lack extensive experience in implementing long-term vaccine programs. The high proportion of Bachelor's degree holders (55.9%) suggests a group capable of critically evaluating evidence, yet nearly half had less than one year of professional experience, potentially limiting their confidence in advocating for novel vaccines. Professionally, nurses (32.4%) and public health practitioners (27.5%) form the backbone of child and community health promotion, emphasizing their pivotal role in vaccine delivery. The near-homogeneity in religious affiliation (99.5% Christian) may also shape attitudes toward vaccine acceptance, particularly if linked to faith-based norms. These findings highlight the importance of targeted capacity-building and educational interventions that address both knowledge gaps and practical confidence in vaccine advocacy.

Among caregivers, the predominance of females (73.4%) underscores the central role of mothers in child health decision-making. Most caregivers were aged 41–50 years (44.0%), married (91.3%), and had moderate to high educational attainment (86.9% with secondary or tertiary education), indicating a mature population with established decision-making patterns and the ability to comprehend health information. Nonetheless, a substantial proportion work outside the healthcare sector (66.8%) and may have limited exposure to clinical knowledge, reinforcing the need for accessible, community-based educational campaigns. The majority being parents (92.4%) and households with three or more children (51.1%) suggest a strong investment in interventions that protect child health. The homogeneity of religious affiliation (100% Christian) further indicates that culturally and faith-sensitive messaging may enhance vaccine uptake.

The study revealed a notable disparity in awareness of the R21/Matrix-M malaria vaccine between pediatric health practitioners and caregivers. Among practitioners, just over half (52.7%) were aware of the vaccine, leaving nearly half uninformed. This gap highlights that even among healthcare professionals, dissemination of information about new vaccines may be insufficient, potentially limiting their confidence and effectiveness in advocating for vaccine uptake. Caregivers demonstrated an even lower awareness level, with only 38.6% informed about the vaccine. Given that caregivers are the primary decision-makers for their children's health, this lack of awareness represents a significant barrier to successful vaccine implementation. The difference between practitioners and caregivers likely reflects variations in access to health information, health literacy, and engagement with professional versus community-based communication channels. Comparatively, caregiver awareness in this study was lower than the 48.2% reported by Chukwuocha *et al.* [29] in Owerri, Imo State. This discrepancy may stem from regional differences in health education initiatives, timing of the studies, or differential access to information.

The study highlights nuanced perceptions of vaccine safety among pediatric health practitioners. A substantial majority (83.8%) considered the R21/Matrix-M vaccine safe, and 80.2% believed its benefits outweigh potential risks. Confidence in clinical trial integrity (78.4%) and trust in health authority information (83.4%) further indicate a generally positive attitude. However, concerns about potential side effects were high (87.4%), revealing a persistent tension between overall confidence and apprehensions about adverse effects. This suggests that while practitioners are inclined to support the vaccine, targeted communication that transparently addresses risk-benefit profiles and side effect data is essential to ensure strong, unequivocal advocacy.

Caregivers demonstrated a more cautious stance. Only 57.1% perceived the vaccine as safe, and 54.3% believed its benefits outweighed risks, with significant proportions expressing disagreement. Concerns about side effects (60.3%) and moderate confidence in clinical trials (50%) point to underlying hesitancy, compounded by only 52.7% trusting safety information from health authorities. Compared to Chukwuocha *et al.* [29], who reported 88.2% positive perception among caregivers in Owerri, these findings suggest contextual differences in community sensitization, trust in health authorities, and exposure to vaccine advocacy may influence perceptions.

Pediatric health practitioners demonstrated overwhelmingly positive perceptions of the R21/Matrix-M vaccine's effectiveness. The majority (86.9%) regarded it as effective in preventing malaria in children, and 84.3% believed it could reduce community-level malaria incidence. Strong trust in the supporting evidence (78.8%) and endorsement of long-term benefits, including contributions to malaria eradication (84.7%) and reduction in morbidity and mortality (88.3%), underscore practitioners' confidence in the vaccine as a pivotal public health tool. These findings suggest that practitioners' evidence-based optimism is likely to facilitate strong advocacy, recommendation, and uptake within clinical and community settings.

Caregivers also expressed generally positive perceptions, though with more variability. Slightly over half believed the vaccine is effective (54.9%) and capable of reducing malaria incidence (53.2%), while similar proportions trusted the supporting research data (54.3%) and recognized its potential to contribute to long-term malaria control (56%). Just over half (56.5%) acknowledged its role in reducing malaria-related morbidity and mortality. Although mean scores indicate only moderate agreement (2.6–2.7), the overall trend reflects a cautiously favorable perception, tempered by reservations and uncertainty regarding long-term benefits.

Pediatric health practitioners demonstrated strong support for the R21/Matrix-M vaccine. Most practitioners were willing to recommend it to parents (75.7%) and to have their own children vaccinated (82.5%), reflecting high confidence in the vaccine's safety and efficacy. Additionally, 76.2% believed the vaccine would be widely accepted in their communities, and 86.5% emphasized the importance of vaccine availability in local health facilities. These findings highlight practitioners' recognition of both the clinical and logistical factors essential for successful vaccination programs. While overall endorsement was strong, some variability regarding community acceptance and implementation indicates a need for targeted strategies to address specific concerns and promote equitable access. Comparative evidence supports these findings. Isah *et al.* [30] reported lower willingness among hospital pharmacists to vaccinate their children (54.1%) and recommend the vaccine (50.4% at UNTH, 62.5% at ESUTH). This discrepancy suggests that professional roles influence advocacy, with pediatric practitioners directly involved in child health demonstrating higher endorsement than pharmacists, who may prioritize safety concerns over proactive recommendation.

Caregivers showed a more cautious yet moderately supportive stance. Half (50%) were willing to recommend the vaccine to others, and 53.3% were inclined to vaccinate their own children. Similarly, 53.2% believed parents in their community would accept the vaccine, and 53.8% emphasized the importance of local availability. These moderate levels, reflected in mean scores of 2.6, indicate lingering reservations and uncertainties, emphasizing the need for tailored education, community outreach, and clear communication about safety and effectiveness to build trust and enhance uptake. Contextual comparisons further highlight variability in acceptance. Chukwuocha *et al.* [29] reported a 95.6% acceptability rate among caregivers in Owerri, while Bongomin *et al.* [31] recorded 91.4% in Uganda, contrasting sharply with the moderate acceptance observed in Awka. This underscores the influence of regional context, trust in healthcare providers, and effectiveness of public health campaigns on vaccine acceptance. Addressing these factors through culturally sensitive advocacy, transparent messaging, and community engagement is essential to improve uptake and achieve public health objectives in malaria prevention.

Both pediatric health practitioners and caregivers identified several barriers to recommending the R21/Matrix-M malaria vaccine, though there were notable differences in emphasis. Among pediatric health practitioners, 51.4% (114) highlighted a lack of sufficient information about the vaccine as a significant barrier, followed by 38.7% (86) expressing concerns about safety. Caregivers, on the other hand, ranked lack of sufficient information even higher, with 63.0% (116) reporting this as a primary concern, while 38.0% (70) pointed to negative media reports as a significant issue. Parental resistance was another common barrier, with 34.7% (77) of pediatric health practitioners and 34.2% (63) of caregivers identifying it as a challenge. Other barriers such as concerns about vaccine effectiveness, cost, cultural beliefs, and limited vaccine availability were acknowledged by both groups, though the prevalence varied slightly, with cultural beliefs being cited by 27.6% (60) of pediatric health practitioners and 29.9% (55) of caregivers. These findings suggest that while both groups face similar challenges, caregivers appear more influenced by external perceptions, such as media reports, whereas health practitioners are more concerned with informational gaps and direct patient resistance. Addressing these barriers through comprehensive education and improved communication strategies could help alleviate concerns, fostering greater acceptance and uptake of the vaccine. Similar to the findings of this study, Isah *et al.* [30] reported that 61.9% of pharmacists at UNTH and 67.3% at ESUTH expressed concerns about adverse effects, aligning with the current study's findings, where caregivers and pediatric health practitioners cited similar apprehensions. This widespread concern underscores the importance of addressing safety perceptions through robust post-marketing surveillance and transparent communication of safety data to build trust across all stakeholder groups.

Both pediatric health practitioners and caregivers identified key facilitators for recommending the R21/Matrix-M malaria vaccine, underscoring shared but distinct priorities. Among pediatric health practitioners, 49.5% (110) emphasized the importance of health education and awareness campaigns, highlighting the role of informed decision-making in vaccine acceptance. Positive clinical trial results were also a significant facilitator, cited by 49.1% (109), reinforcing confidence in the vaccine's safety and efficacy. Positive media coverage emerged as another important factor, with 41.0% (91) acknowledging its influence in shaping perceptions. Government support and subsidies were seen as essential, with 39.6% (88) recognizing them as pivotal for increasing vaccine adoption. Additionally, the availability of the vaccine in local health facilities was noted by 36.0% (80) as crucial for accessibility. Caregivers similarly prioritized positive media coverage (49.5%, 91), positive clinical trial results (47.8%, 88), and the availability of the vaccine in local health facilities (39.1%, 72) as key facilitators. Endorsement by health authorities (37.0%, 68) and health education campaigns (38.0%, 70) were also highlighted, demonstrating caregivers' reliance on trusted sources and comprehensive information to guide their decisions. These findings suggest that both groups value informed and accessible approaches to vaccine recommendation, with caregivers placing slightly more emphasis on external influences such as media coverage and health authority endorsement. Addressing these facilitators through targeted communication strategies and ensuring vaccine availability at the community level could enhance vaccine acceptance and trust, ultimately improving malaria prevention outcomes.

The study revealed several significant associations highlighting the critical role of perception in vaccine acceptance. Awareness of the R21/Matrix-M vaccine differed significantly between pediatric health practitioners and caregivers ($p = 0.005$), emphasizing the need for targeted information campaigns. Perceived safety also showed a highly significant difference ($p < 0.001$) between the groups, with pediatric practitioners' years of experience strongly linked to safety perceptions ($p < 0.001$), indicating that professional exposure enhances confidence in the vaccine. Similarly, caregivers' educational attainment significantly influenced their perception of vaccine safety, reinforcing the importance of tailored health education. Perceived effectiveness mirrored these patterns, with significant differences between practitioners and caregivers ($p < 0.001$) and strong associations with practitioners' experience ($p < 0.001$). These findings underscore that both education and professional experience shape attitudes toward vaccine safety and efficacy, highlighting the importance of continuous professional development and community-focused educational interventions. Crucially, perceived safety and effectiveness were strongly associated with willingness to recommend and accept the vaccine in both groups. Among practitioners, Cramer's V of 0.741 (safety → recommendation) and 0.850 (effectiveness → recommendation) indicates a very strong link, mirrored among caregivers (0.809 for safety → acceptability, 0.807 for effectiveness → acceptability). These results demonstrate that confidence in safety and efficacy directly drives advocacy and uptake, which is essential for successful vaccine deployment and public health impact.

These findings align with Chukwuocha *et al.* [29], who observed a significant association between caregivers' perceptions and intent to comply with a malaria vaccine ($p < 0.0001$), reinforcing that positive perceptions are pivotal to uptake. While Isah *et al.* [30] identified demographic predictors such as education and age influencing vaccine recommendation, this study found limited demographic associations, except for caregiver education and awareness. This suggests

that contextual factors and professional roles may moderate how demographics influence attitudes, underscoring the need for tailored interventions that address specific knowledge gaps and concerns to mitigate hesitancy and improve adoption of the R21/Matrix-M vaccine.

5. Conclusions

This study provides critical evidence on the perceived safety, effectiveness, and acceptability of the R21/Matrix-M malaria vaccine among pediatric health practitioners and caregivers in Awka, Southeast Nigeria. The findings demonstrate strong and consistent associations between perceptions of vaccine safety and effectiveness and both willingness to recommend and accept the vaccine, underscoring the central role of confidence in shaping vaccine advocacy and uptake. The observed Cramer's V values further highlight that improving these perceptions can substantially enhance support for malaria vaccination.

Overall, both pediatric health practitioners and caregivers expressed considerable confidence in the vaccine, reinforcing its potential for successful integration into routine immunization services. However, persistent concerns related to inadequate information, safety apprehensions, and parental resistance remain significant barriers. However, targeted health education, positive media engagement, and visible government endorsement emerged as powerful facilitators of acceptance.

These findings emphasize the urgent need for coordinated, evidence-based strategies that prioritize clear communication, proactive community engagement, and sustained professional training. Policymakers and public health stakeholders should strengthen health education campaigns, leverage trusted media platforms, and ensure reliable vaccine availability to build confidence and maximize uptake. Such targeted interventions are essential to support the effective rollout of the R21/Matrix-M malaria vaccine and to accelerate progress toward reducing childhood malaria morbidity and mortality in Nigeria and other malaria-endemic settings.

Abbreviations

COOUTH
Chukwuemeka Odumegwu Ojukwu University Teaching Hospital
WHO
World Health Organization

Declarations

Ethics approval and consent to participate

Ethical approval for the study was obtained from the Health Research Ethics Committee, University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu, with reference number NHREC/05/01/2008B-FWA00002458-1RB00002323. Informed consent was obtained from all participants, ensuring they understand the study's purpose, procedures, potential risks, and benefits, and their right to withdraw at any time without any repercussions. Confidentiality and anonymity were strictly maintained, with all data securely stored. Participants were treated with respect, and their responses were used solely for research purposes.

Consent for publication

Not applicable

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article (and its additional files).

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

LOP conceptualized the study, designed the methodology, supervised data collection, performed data analysis, and drafted the manuscript. NEA critically revised the manuscript. BIO contributed to conceptualization, methodology, questionnaire development and validation, supervision, and provided critical revisions to the manuscript. All authors read and approved the final manuscript and agree to be accountable for all aspects of the work.

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