

Article in Press

Caregivers awareness, knowledge, attitudes, and perceptions towards malaria vaccine in Kole and Kwanja Districts, Northern Uganda

Received: 13 Oct 2025

Accepted: 06 Jan 2026

Published online: 23 January 2026

Sean Puleh, Joan Kalyango, Moses Ocan, Adoke Yeka, Godfrey Siu, Richard Idro, Stella Akech, Joy Acen, David Ejalu, Ziadah Nankinga, Robert Afayo & Joaniter Nankabirwa

Cite this article as: Puleh, S., Kalyango, J., Ocan, M. *et al.* Caregivers awareness, knowledge, attitudes, and perceptions towards malaria vaccine in Kole and Kwanja Districts, Northern Uganda. *Malar J* (2026).

<https://doi.org/10.1186/s12936-026-05789-0>

We are providing an unedited version of this manuscript to give early access to its findings. Before final publication, the manuscript will undergo further editing. Please note there may be errors present which affect the content, and all legal disclaimers apply.

If this paper is publishing under a Transparent Peer Review model then Peer Review reports will publish with the final article.

CAREGIVERS AWARENESS, KNOWLEDGE, ATTITUDES, AND PERCEPTIONS TOWARDS MALARIA VACCINE IN KOLE AND KWANIA DISTRICTS, NORTHERN UGANDA

Sean Steven Puleh^{1,2}, Joan N. Kalyango^{1,3}, Moses Ocan⁴, Adoke Yeka^{5,6}, Godfrey Siu⁷, Richard Idro⁸, Stella Immaculate Akech^{1,2}, Joy Acen¹, David L. Ejalu¹, Ziadah Nankinga¹, Robert Afayo¹, and Joaniter I. Nankabirwa^{1,6}

Affiliations

¹*Clinical Epidemiology Unit, School of Medicine, Makerere University College of Health Sciences, Kampala City, Uganda.*

²*Department of Epidemiology and Biostatistics, Faculty of Public Health, Lira University, Lira City, Uganda.*

³*Department of Pharmacy, Makerere University College of Health Sciences, Kampala City, Uganda.*

⁴*Department of Pharmacology and Therapeutics, Makerere University College of Health Sciences, Kampala City, Uganda.*

⁵*Department of Disease Control and Environmental Health, School of Public Health, Makerere University College of Health Sciences, Kampala City, Uganda.*

⁶*Infectious Diseases Research Collaboration, Kampala City, Uganda.*

⁷*Department of Child Health and Development Centre, College of Health Sciences, Makerere University, Kampala City, Uganda.*

⁸*Department of Paediatrics and Child Health, College of Health Sciences, Makerere University, Kampala City, Uganda.*

Corresponding author: Sean Steven Puleh, Email: spuleh@lirauni.ac.ug

Abstract

Background: The R21 malaria vaccine has recently been rolled out in Uganda and other endemic settings across sub-Saharan Africa. Its implementation, faces many potential challenges. We assessed caregivers' awareness, knowledge, attitude, and perceptions towards the vaccine in northern Uganda.

Methods: A sequential explanatory mixed methods study was conducted in Kole and Kwanja districts, Northern Uganda. Quantitative data were collected through a structured survey of 574 randomly selected caregivers of age-eligible children. Qualitative data were gathered through follow-up focus group discussions with caregivers. Descriptive statistics and exploratory factor analysis were used to assess knowledge and latent dimensions of attitudes and perceptions. Qualitative data were transcribed verbatim, anonymized, organized within ATLAS.ti version 25, and analysed using deductive thematic analysis.

Results: Among the 574 caregivers 90.1%, (95% CI: 87.3–92.4) were aware of malaria vaccine. However, only 13.9% (95% CI: 11.2–17.0) demonstrated factual knowledge regarding key aspects of malaria vaccine including; number of doses required (16.4%), dosing intervals (21.0%), and age eligibility (34.2%). Overall, 57.4% of the caregivers expressed positive attitudes and 57.5% reported positive perceptions towards the vaccine. Common factor analysis (CFA) revealed two key dimensions of vaccine attitudes: caregiver confidence (54.9%) and safety concerns (49.7%). Regarding perceptions, three factors emerged: vaccine confidence (56.5%), trust in delivery (54.9%), and safety concerns. While most caregivers stated confidence and trust, nearly half reported lingering concerns. Qualitative data reinforced these results and revealed five central themes: caregivers' knowledge and awareness of the malaria vaccine; enduring community misconceptions; mixed attitudes reflecting trust, and fear; and perceptions related to vaccine's safety, effectiveness, and value for child-health.

Conclusion: Although, factual knowledge was limited, caregivers reported high awareness of malaria vaccine, alongside positive attitudes and perceptions tempered by safety concerns. The Ministry of Health needs to implement regular, nationwide community education campaigns anchored in locally tailored communication strategies.

Keywords: *Malaria, R21 Malaria vaccine, vaccine uptake, barriers, Northern Uganda*

Background

Malaria remains a major and increasing global health threat, with 263 million cases reported in 2023, an increase of 11 million cases compared with 2022 [1]. Sub-Saharan Africa accounts for approximately 95% of the global malaria burden, with children under five years and pregnant women being the most vulnerable to the disease [2]. Uganda is one of the major contributors to the global malaria cases. In 2023 alone, Uganda was the 3rd highest contributor to the malaria cases accounting for 5% to the global burden [1, 2]. Over 90% of the entire population in the country is at risk of malaria, accounting for 40% of all outpatient visits [3].

The proven malaria control strategies recommended by the World Health Organization (WHO) include chemoprevention, use of insecticide-treated nets, indoor residual spraying, effective case management, and most recently the malaria vaccine in children [4]. Two malaria vaccines are now available and are being rapidly adopted by multiple countries. The RTS,S/AS01 (Mosquirix®) and R21/Matrix-M (R21) have been endorsed by WHO and are being implemented in children aged 5 to 17 months in high-transmission settings in sub-Saharan Africa. In a major public health milestone, Uganda introduced the R21 vaccine in April 2025, targeting 105 districts with high malaria transmission. With an efficacy of up to 75% and a strong safety profile [4], the R21 vaccine offers a powerful new tool for reducing malaria burden in endemic areas and accelerating progress toward elimination [5].

Although the clinical efficacy and safety of the R21 vaccine have been demonstrated in a number of trials [6], the real world effectiveness and uptake of the vaccine may be affected by a number of factors including the community's knowledge, attitudes, and perceptions [7]. This is even more important in settings with health system constraints, and in areas with historical mistrust of new health interventions, which may affect the roll-out [8]. Indeed, previous studies have shown that hesitancy, mistrust in health systems, and concern over safety can affect uptake vaccines [9-12]. To mitigate this, the Ugandan Ministry of Health (MoH) conducted several training sessions of healthcare workers, and massive vaccine promotional activities in the communities prior to vaccine roll-out to ensure knowledge, awareness, and uptake [13]. However, previous studies have shown varied levels of knowledge, attitudes, and perceptions and hesitancy surrounding malaria vaccines, despite focused communications prior to roll out [7, 14-18]. For example, Yusuf et al. (2025) reported that 97% of caregivers in Nigeria had a positive attitude toward the vaccine, yet only 19.5% demonstrated good knowledge [19]. Mwingira et al. (2025) found that just 14.7% of

caregivers in Tanzania were aware of the malaria vaccine prior to its launch [18]. This study assessed the awareness, knowledge, attitudes and perceptions of the R21 malaria vaccine among caregivers of children eligible for the vaccine in selected communities of Northern Uganda following the roll-out of the intervention.

Methods

Study design

This was a sequential explanatory mixed methods study conducted in June 2025. First, a survey was conducted to collect quantitative data among caregivers of children eligible for the vaccine. In order to complement and interpret the quantitative data, follow-up qualitative interviews were conducted with selected caretakers.

Study setting

The study was conducted in two districts of moderate-to-high malaria transmission (Kole and Kwanja) in Northern Uganda. These districts are predominantly rural areas with limited urban centers such as Aboke and Aduku town councils. The districts, as pointed out above, experience moderate-to-high malaria transmission, with test positivity rates exceeding 50%, and malaria remains the leading cause of outpatient visits, especially among children under five. Malaria control interventions include long-lasting insecticidal net (LLIN) distribution, intermittent indoor residual spraying (IRS), and integrated community case management (iCCM). The malaria vaccine is provided through public health facilities via the National Medical Stores under Uganda's Vaccine Last-Mile Delivery initiative launched in April 2025 [20]. In preparation for the vaccine rollout, the MoH implemented a range of community engagement activities, including health education campaigns, radio talk shows, school sensitization programs, and community mobilization efforts to enhance vaccine awareness.

Study population and eligibility criteria for the quantitative survey

The study was conducted among caregivers aged 18 years and above of children aged 5 to 24 months who were eligible for R21 malaria vaccine, in selected villages of Kole and Kwanja districts. At each selected household, the purpose of the study was explained in the appropriate language, and informed consent prior to participation in the study. Caregivers were eligible to join the study if they fulfilled the following eligibility criteria: 1) They had children aged 6 to 24 months

residing in the selected village at the time of data collection; 2) Caregivers who were permanent residents of the village and available to provide informed responses; 3) Caregivers who consented to participate in the study; 4) An adult at least 18 years of age. Caregivers were excluded if: 1) They were members of a households where the child was temporarily visiting; 2) Had children with severe illness at the time of data collection that prevented participation.

Sample size

The sample size was computed using the formula for single proportions with adjustment for clustering [21]. Based on that formula, the parameters used were 95% confidence level, 5% sampling error, design effect of 1.5, an estimated prevalence of caregivers pooled awareness was 32% as reported in a systematic review by Bushi et al., (2025) [17], and an average of 22 participants per cluster. The number of participants per cluster was estimated from WHO methods for cluster survey [22]. A minimum of 24 clusters were needed for the survey inclusive of a 10% adjustment for missing data.

Procedures for sampling, screening, and household enrollment in the quantitative survey

A cluster was defined as a village within Kileleshwa or Kileleshwa district, and was used as the primary sampling unit for data collection. Kileleshwa and Kileleshwa districts were purposively selected due to the presence of Malaria Reference Centers (MRCs). To ensure equal representation of clusters within Kileleshwa and Kileleshwa, two sub-counties within the district were randomly selected to participate in the study. From each selected sub-county, three parishes were then randomly selected and within each parish, two villages were randomly selected, giving a total of 24 villages for the study (12 from each district).

In each of the selected villages, a comprehensive household listing was developed with the help of a community health worker and/or local leader. A total of 22 participants per cluster/village (one participant per household) were needed for the study. To select the 22 households to participate in the study, a sampling interval (denoted as k) was calculated by dividing the total number of households in the village by the average number of individuals targeted per village being 22. A random starting number between 1 and k was then selected, and households were systematically selected by choosing every k^{th} (different for every cluster) household from that starting point. If a selected household did not have an eligible child, the next immediate household in the listing was approached. This substitution continued until an eligible participant was found, ensuring that the target number of participants per cluster was achieved.

Study variables

The study assessed respondents' socio-demographic characteristics, knowledge, attitudes, and perceptions of the R21 malaria vaccine, alongside contextual influences on vaccine uptake. Socio-demographic information, included age, sex, marital status, education, occupation, and religion. Knowledge was measured through questions on awareness of the vaccine, its purpose, eligibility criteria, number of doses, intervals between doses, route of administration, and whether the vaccine reduces malaria risk. These responses were used to generate an overall knowledge index that categorized respondents as knowledgeable (>70%) or not knowledgeable (<70%).

Attitudes and perceptions were measured using Likert-scale statements. Attitudes focused on the caretakers' viewpoints and emotions using a range of quantitative and qualitative techniques to obtain an in-depth understanding of their beliefs regarding the malaria vaccination. Perceptions focused on the individual's interpretation and response to information they hear about the R21 malaria vaccine and their willingness to vaccinate their children. The study used a structured approach to categorize participants' attitudes and perceptions in a survey. Median scores were calculated, and participants scoring above the median were classified as "positive attitudes" or "high concern." Variables were created and analyzed using frequency tables and summary statistics.

Data collection for the quantitative study

Eligible caregivers were provided with detailed information about the study in appropriate language and gave written informed consent before participating in the survey. If the respondent was unable to read or write their fingerprint was used and an impartial witness included in the consent discussion.

Quantitative data were collected using structured interviewer-administered questionnaire designed to assess caregivers' knowledge, attitudes, and perceptions regarding the R21 malaria vaccine (*Supplementary 1*). Prior to data collection, the questionnaire was pretested in Dokolo District to evaluate its consistency, appropriateness, and content validity. The covariance of 0.915 and Cronbach's alpha of 0.807 were found in the pre-test analysis of the tool. The tool was adjusted based on the pre-test results. Research assistants with bachelor's degrees in Public Health administered the questionnaire. All data collectors were trained on the tool and ethical conduct of research prior to field data collection. Data was collected electronically using KoBoCollect® application from the KoBoToolbox platform (<http://www.kobotoolbox.org/>).

Quantitative data management and analysis

Data analyses accounted for the clustered nature of the sample, with all estimates adjusted for clustering at the village level using robust standard errors in Stata v18. Descriptive results, including proportions and means, are presented with corresponding 95% confidence intervals adjusted for clustering. Associations between knowledge, awareness, and demographic characteristics were assessed using cluster-adjusted chi-square tests.

The dataset was then transferred into Stata v18, and cleaned prior to analysis. Data analyses accounted for clustered nature of the sample. Descriptive statistics were performed to summarize respondent characteristics and key study variables, including frequencies, percentages, means, and standard deviations. Point estimates were presented with corresponding 95% confidence intervals (CIs) adjusted for clustering to reflect the precision of the findings. Associations between knowledge, awareness, and demographic characteristics were assessed using cluster-adjusted chi-square tests.

To explore underlying patterns in attitudes and perception-related items, common factor analysis with rotation method *Varimax with Kaiser Normalization* was conducted. Prior to analysis, the suitability of the data was assessed. The measure of sampling adequacy Kaiser-Meyer-Olkin (KMO) threshold of at least 0.7 indicated that the sample was adequate for factor analysis. Additionally, a Bartlett's test of sphericity [23] (χ^2 , $p < 0.05$) was statistically significant, confirming that the correlation matrix was sufficiently factorable [24]. This involved assessing inter-item correlations, applying principal component extraction, and using varimax rotation to identify latent constructs. The number of items retained under each identified factor was determined using a minimum factor loading threshold of 0.35, in accordance with the guidelines proposed by Costello and Osborne [25]. Factor retention decisions were guided by eigen values greater than 1, scree plot inspection, and theoretical relevance [25].

Population for the qualitative study

Local leaders and village health teams (VHTs), who were familiar with the community, helped identify potential participants for the qualitative part of the study, based on set inclusion criteria. These were: adults aged 18 or above who were currently caring for an eligible child. Efforts were made to reflect gendered experiences by organizing two focus group discussion (FGD) with female

caregivers and two with male caregivers. This approach allowed each group to express their thoughts freely in a comfortable environment. The final participants were invited verbally, and participation was voluntary.

Qualitative data collection methods and tools

A total of four focus group discussions were conducted among purposively selected caregivers of children eligible for the malaria vaccine. Following insights from preliminary quantitative analysis, FGDs were used to explore caregivers' knowledge, perceptions, and experiences regarding malaria vaccine. The FGD interview guides were developed using information from quantitative analysis and results from pre-testing of the tool. Each FGD session included 6–10 participants recruited through support from VHTs using purposive sampling. Sessions were held in quiet, familiar settings such as sub-county premises or health facilities to encourage open dialogue. Prior to commencing the discussion, participants were introduced to the purpose of the study, and asked for written consent, including permission for audio recording.

Trained research assistants facilitated the sessions, one acting as moderator and the other as note taker. An FGD guide covering awareness, perceived benefits and risks of the vaccine, and sources of information was used to facilitate the discussions. Each session lasted approximately one hour, and digital voice recorders were used to ensure completeness of data. The field notes were used to capture supplementary contextual details and group dynamics. The discussions were conducted in the local language (Luo) and recorded using voice recorders. Reflexivity was integrated throughout the process via structured field notes, which documented researchers' positionality and observations, strengthening credibility and analytical depth.

Qualitative data management and analysis

All recordings were transcribed verbatim and translated into English. The thematic analysis involved a systematic and iterative process that includes data familiarization, coding, identification of themes, and interpretation of findings [26]. This approach was intended to ensure rigor and reliability throughout the analysis. A coding framework was developed by the principal investigator in collaboration with the study advisors. Two experienced research assistants MM and AJ independently applied the codes to the transcripts. The discrepancies in coding was reviewed by the SSP, and resolved through discussion, clarification of coding guidelines, or re-evaluation

of the data [27]. Inter-rater reliability was periodically assessed, with a Cohen's kappa score of ≥ 0.80 used as the benchmark for agreement. This iterative process improved the codebook's clarity and consistency, thereby reinforcing the credibility and rigor of the thematic analysis (supplementary 2).

Results

Awareness, knowledge of R21 malaria vaccine among study participants

Caregiver knowledge about the malaria vaccine is presented in Table 1. Among the 574 respondents, high overall awareness of the malaria vaccine was reported by 90.0%, (95% CI: 87.3–92.4) based on four awareness variables. However, only 13.9% (80) participants (95% CI: 9.8 – 18.6) had adequate knowledge on malaria vaccine (a composite based on six knowledge items) (Table 1).

Table 1: Level of awareness and knowledge on the malaria vaccine (n=574)

	Variable	Category	Frequency	Percent
Awareness	Overall awareness	Low	57	9.9
		High	517	90.0(95% CI: 86.3–92.8)
	Aware of the existence new malaria vaccine ^a	No	52	9.1
		Yes	521	90.9
	Aware of the primary source of malaria vaccine information	No	54	9.4
		Yes	520	90.6
	Aware of the of R21 vaccine roll out in Uganda	No	95	16.5
		Yes	479	83.5
R21 malaria vaccine knowledge	Overall knowledge	No	65	11.4
		Yes	507	88.6
	Knowledge of the purpose of malaria vaccine ^c	Low	494	86.4
		High	80	13.6 (95% CI: 9.8 – 18.6)
	Knowledge of the purpose of malaria vaccine ^c	No	128	22.4

	Yes	444	77.6
Knowledge of the malaria vaccine effectiveness ^d	No	39	6.8
	Yes	533	93.2
Knowledge of age eligibility for malaria vaccine	No	378	65.9
	Yes	196	34.1
Knowledge of number of doses required	No	480	83.6
	Yes	94	16.4
Knowledge of the interval between vaccine doses ^e	No	452	79.0
	Yes	120	21.0
Knowledge on route of administration of vaccine	No	236	41.1
	Yes	338	58.9
Knowledge of inclusion of the malaria vaccine into routine immunization schedule ^f	No	557	97.4
	Yes	15	2.6

^{a, b, c, d, e} Means some of the totals do not add up to 574 because of missing values.

Distribution of knowledge and awareness by demographic characteristics of caregivers

A total of 574 participants were enrolled into the study. The mean age (standard deviation) of the participants was 29.3(9) years. Majority of the participants were females (82.9%, 476/574) and were peasant farmers (73.7%, 423/574). Table 2 presents results of distribution of knowledge and awareness by demographic characteristics. Younger caregivers demonstrated greater knowledge than older ones, with the highest proportions of high knowledge observed among those aged 15–19 years. Statistically, this difference was meaningful ($\chi^2 = 7.9$, $p = 0.019$). A larger share of women (15.6%) reported having knowledge compared to men (6.1%), and this difference was statistically significant ($\chi^2 = 6.0$, $p = 0.014$). Awareness was higher among individuals aged 26–35 (84.7%) compared to those aged 18–25 (15.3%) and 36–69 (4.1%), and the association was statistically significant ($\chi^2 = 17.3$, $p < 0.001$). Awareness level was suggestively associated with education; individuals who had secondary (13.2%) or higher education (5.2%) showing greater

awareness compared to those with only primary education (77.0%) or none at all (8.5%), a difference that was statistically significant ($\chi^2 = 10.0$, $p = 0.019$) (Table 2).

Table 2. Knowledge and awareness by demographic characteristics of caregivers (N = 574)

Variable	Variable attribute	Knowledge		Awareness		p-value
		No (n, %)	Yes (n, %)	No (n, %)	Yes (n, %)	
Age category	18–25	210 (83.7%)	43 (16.3%)	19 (8.7%)	79 (91.3%)	Knowledge $p = 0.013$
	26–35	176 (85.4%)	30 (14.6%)	38 (5.8%)	438 (94.2%)	Awareness $p < 0.001$
	36–69	108 (93.9%)	7 (6.1%)	5 (20.0%)	21 (80.0%)	
Gender	Male	92 (93.9%)	6 (6.1%)	45 (19.4%)	356 (80.6%)	Knowledge $p = 0.026$
	Female	402 (84.8%)	74 (15.2%)	2 (8.0%)	95 (92.0%)	Awareness $p = 0.001$
Education Level	No formal education	24 (92.3%)	2 (7.7%)	5 (19.2%)	44 (80.8%)	Knowledge $p = 0.218$
	Primary education	351 (87.8%)	50 (11.2%)	45 (11.3%)	398 (88.7%)	Awareness $p = 0.019$
	Secondary education	78 (81.3%)	19 (18.7%)	11 (2.1%)	68 (97.9%)	
	Higher education	40 (81.6%)	9 (18.4%)	1 (10.2%)	27 (89.8%)	
Occupation	Peasant farmer	383 (86.9%)	60 (13.1%)	45 (10.2%)	398 (89.5%)	Knowledge $p = 0.431$
	Business	70 (88.6%)	9 (11.4%)	11 (13.9%)	68 (86.1%)	Awareness $p = 0.325$
	Civil servant	21 (75.0%)	7 (25.0%)	1 (3.6%)	27 (96.4 %)	
	Others	20 (83.3%)	4 (16.7%)	0(0.0%)	24 (100.0%)	
Religion	Catholic	174 (85.7%)	30 (14.3%)	19 (9.4%)	185 (90.6%)	Knowledge $p = 0.979$
	Anglican	210 (87.1%)	31 (12.9%)	24 (10.0%)	217 (90.0%)	Awareness $p = 0.635$
	Pentecostal	99 (86.1%)	16 (13.9%)	14 (12.2%)	101 (87.8%)	

Other religions (Muslims and SDA)	11 (84.6%)	3 (15.4%)	0 (0.0%)	438(100.0%)
-----------------------------------	------------	-----------	----------	-------------

Attitudes towards the R21 malaria vaccine

Our findings show that majority 57.4% (330) of the caregivers expressed positive attitudes towards the malaria vaccine.

Factor Analysis of community's attitude domains of the R21 malaria vaccine

Supplementary file 3 presents the rotated factor loadings for seven items assessing caregivers' attitudes toward the malaria vaccine, yielding a Kaiser-Meyer-Olkin of 0.8 and a statistically significant ($\chi^2 (21) = 964.4, p < 0.001$) Bartlett's test of sphericity. Two distinct factors emerged from the analysis. **Factor 1**, labeled *Positive vaccine attitudes and self-assurance*, accounted for 54.9% of the sample (315 participants), indicating a slightly above-average prevalence of favorable attitudes toward the malaria vaccine. In contrast, **Factor 2**, associated with *Safety Concerns*, included 285 participants (49.7%) who nonetheless expressed positive attitudes toward the vaccine, suggesting that concerns about safety do not necessarily equate to outright rejection.

Perceptions towards the malaria vaccine

Out of the 574 respondents, more than half 57.3% (n=329) expressed a positive perception towards the malaria vaccine, while 42.7% (n=245) had a negative perception towards the malaria vaccine.

Factor Analysis of community's perceptions domains of the R21 malaria vaccine

Supplementary file 4 presents the rotated factor loadings for seven items assessing caregivers' perceptions toward the malaria vaccine, yielding a Kaiser-Meyer-Olkin of 0.729 and a statistically significant ($\chi^2 (45) = 1486.89, p < 0.001$) Bartlett's test of sphericity. Three distinct factors emerged from the analysis.

We identified three main factors that seemed to shape how people felt about the malaria vaccine. First, vaccine confidence: just over half of the participants 56.5% (324) who felt confident about the vaccine also had a positive overall perception of it. Second, trust in delivery: 54.9% (315) of those who trusted the way the vaccine was being delivered viewed it positively. And third, **safety**

concerns: interestingly, even among those who had concerns about the vaccine's safety, 54.9% (315) still held a positive perception.

Results of the qualitative interviews

Demographic characteristics of the FGD respondents

The age range among the FGD participants was 20 to 46 years, with a mean age of 30.2 ± 7 years. Most (46.2%, 21/26) of the participants were in the 25–34 age group. We had roughly equal number of female and male participants. The majority (61.5%, 16/26) of respondents had primary-level education (Table 3).

Table 3: Demographic characteristics of the FGD participants (n=26)

Variables	Category	Frequency	Percent (%)
Sex	Male	13	50.0
	Female	13	50.0
Age Group (years)	18–24	6	23.1
	25–34	12	46.2
	35–44	5	19.2
	45 and above	3	11.5
Education Level	Primary (P1–P7)	16	61.5
	Secondary (S1–S6)	7	26.9
	Tertiary	3	11.5
	Junior	2	7.7

Through the voices of caregivers in FGDs, four main themes emerged that captured how communities are making sense of the R21 malaria vaccine. These included: caregivers' knowledge and awareness of the malaria vaccine; enduring community misconceptions; attitudes reflecting trust, fear, and willingness to vaccinate; and perceptions describing how caregivers interpret the vaccine's safety, efficacy, and overall value for child health.

Theme 1: Caregivers' knowledge and awareness of the malaria vaccine

Varied understanding and knowledge of purpose of the malaria vaccine

Qualitative data largely show similarity with quantitative data regarding caregivers' knowledge of the malaria, though in some instances suggesting some contradictions, as presented below.

Correct understanding as prevention

The study participants demonstrated varied breadth of knowledge about the purpose of the new malaria vaccine. Some caregivers indicated that the vaccine was introduced to protect children from malaria, which many referred to as “a killer disease.” These participants associated the malaria vaccine with strengthening immunity and reducing the severity of the illness. Some had the following to say:

“It improves our children’s immunity to fight malaria.” (Female Participant 4, Ayer Town Council)

“Even if mosquitoes bite them, the vaccine is already in them. They will be protected from malaria.” (Male Participant 2, FGD Abongomola)

Confusion around dosage and schedule

While most participants were aware that their children needed to be vaccinated, few were knowledgeable the vaccine schedules, number of doses, and target age group. Some reported not having come across such information before, leaving them with a sense of confusion that needed to be resolved. Reflecting on this topic, one participant wondered:

“Is this vaccination going to be only once or not?” (FGD Ayer Town Council, Female Participant 1)

Others reported that they had not been told how to track the vaccine doses:

“No one has told us whether there are cards or how to track the doses.” (FGD Ayer Town Council, Female Participant 7)

Deviations from age eligibility

While the malaria vaccine was intended for a specific age group, some community members reported instances where caregivers took children outside the recommended age range for vaccination. This behavior may reflect misunderstandings about eligibility criteria, or strong motivation to protect all children from malaria.

“Many took their children for malaria vaccination, including those above the recommended age groups.” (Female Participant 6, FGD Ayer Town Council)

Another respondent also had the following to say:

“This vaccine should not only stop for children; the whole community should be vaccinated including the adults.” (Female Participant 3, FGD Ayer Town Council)

Multiple but ineffective sources of malaria vaccine information

Community members received vaccine information through multiple channels. The common sources of vaccine information included, community health workers, community leaders, and religious leaders. Radio advertisements, talk shows, posters, and community social gatherings were reported as main avenue for public dissemination of vaccine information.

“I first heard it in church. Later the VHTs came to my place while moving door-to-door to explain more.” (Women, Participant 3, FGD Abongomola)

Some participants reported that the information had not reached all sections of the community especially in areas where there were uncommitted community health workers. Participants’ voices suggested that the malaria vaccine information had not yet penetrated their community sufficiently enough. A number of them reported yearning for deeper and more purposeful dissemination and engagement as noted:

“Some villages were not covered. In our case, the LCI was not involved, so we heard about the malaria vaccine..... and from other places.” (Male Participant 5 FGD Bung Village,)

Another FGD participant also said:

“In our area, the VHTs didn’t pass around during the second dose. People thought the program had ended.” (Women, Participant 2 FGD Ayer)

Theme 2: Intersecting socio-demographic factors in caregiver knowledge of malaria vaccination

Qualitative analysis revealed key contextual influences of age, education and location as described below.

The influence of the age of caregivers

The younger caregivers, especially those in their 20s and early 30s often expressed greater clarity about the vaccine’s preventive role and showed strong motivation to protect their children.

“When I heard about the malaria vaccine, I knew my child is now safe from malaria, since even if malaria catches her, the rate will be low.” (Female Participant 2, Age 26, FGD Ayer Town Council)

Others also said they were told of the benefits of the vaccine:

“Because of the sickness that my child is always falling sick, when I was told about the malaria vaccine, I had to just take my child for this malaria vaccination.” (Female Participant 3, Age 21, FGD Ayer Town Council)

The benefits of education

The thematic analysis showed a patterns or differences in knowledge perspectives that appeared to align with education level. Participants with secondary level education were more able to articulate specific benefits of the vaccine, such as reduced severity and improved immunity. Reflecting on the same a respondent with secondary level education had the following to say:

“The vaccine will help the community in saving money since the rate of malaria will be low and they will not spend a lot on treatment.” (Male Participant 2, FGD Bung)

The respondents who had primary education often sometimes misunderstood the vaccine’s purpose with some for example suggesting that the vaccine cures malaria. A respondent with primary level education had the following to say:

“I have not yet seen it with my own eyes, but I am hearing about it on the radio, so what is coming to my mind is that this vaccine will cure malaria.” (Male Participant 5, FGD Abongomola)

The variations based on the influence of location

In rural villages such as Bung and Abongomola, traditional beliefs and limited access to health education contributed to more misconceptions and hesitancy.

“Some people are saying maybe the government is just playing tricks because they have seen that people are overproducing, so they want to reduce the number of people.” (Male Participant 1, FGD Bung Village)

The participant in the urban areas like Ayer Town Council showed higher exposure to sensitization efforts for example the use of megaphones, posters, church announcements. A female respondent had the following to say:

“My home is around the trading centre, so I always get to know about any health-related issue through a megaphone.” (Female Participant 4, FGD Ayer Town Council)

Theme 3: Enduring misconceptions and misinformation about the malaria vaccine

Other caregivers demonstrated a mixed understanding of the role of the vaccine, associating it with curative outcomes. Such caregivers believed that the vaccine could treat or eliminate existing malaria infections. Their opinions did not seem to have a gendered pattern:

“What is coming to my mind is that this vaccine will cure malaria.” (Male Participant 5, Abongomola Village)

“When I heard about the newly introduced malaria vaccine, I went straight and took my child for vaccination since I knew that would be the end of my suffering because of malaria treatment.” (Female Participant 5, Ayer Town Council,)

Misinformation and rumors

We found that rumors also influenced perceptions of the respondents. Stories that the vaccine came “from underwater” or could cause infertility or death were cited by a number of respondents in the FGDs. Some participants had the following to share:

“Some people are saying the vaccine is from under water... that it’s to reduce population.” (Male, Participant 5, FGD Abongomola)

“Some people are saying maybe the government is just playing a trick because they have seen people are overproducing and the population is growing.” (FGD Bung Village, Male Participant 1)

Spiritual beliefs in malaria cause

Some participants associated malaria with spiritual or supernatural causes, suggesting that prayer and religious practices could be effective in managing the illness. A male participant from Bung stated:

“Religion can also help, because sometimes malaria comes in the form of evil spirits. If you pray, the child gets well. We don’t know if this vaccine touches that kind of sickness.” (Male Participant 1, FGD Bung)

Cultural comparisons and traditional healing

Some caregivers expressed uncertainty toward the R21 malaria vaccine, shaped by long-standing cultural practices and ancestral knowledge systems. While participants acknowledged that malaria was a serious health threat, they also referenced traditional rituals such as passing children under granaries as methods historically used to treat the illness.

“My elders used to say that when children were passed under the granary, malaria would disappear. That used to work. But now this vaccine I’m not sure it will help like those methods.” (Male Participant 5, FGD Bung)

Intentional exclusion

Some participants perceived the age limitation as intentional exclusion or part of a larger hidden agenda.

“They’re saying the vaccine is not for everyone because there’s something behind it. Why leave out older children when malaria affects them too?” (Male Participant 3, FGD Bung)

Theme 4: Caregivers’ attitudes reflecting trust, mistrust, and social influence toward the malaria vaccine

Qualitative analysis identified important themes on community attitudes, as described below:

Positive sentiments about the vaccine

Caregivers expressed positive attitudes toward the malaria vaccine. Many described frequent hospital visits, missed work, and economic strain due to repeated illness. For these participants, the vaccine represented relief and a path to better health. One woman shared:

“Malaria has been disturbing my child for a very long time. I’m always in the hospital, disrupting my work.... some people even think I don’t have a home.” (Female Participant 1, Abongomola)

The potential economic impact of the vaccine was a recurring theme across the focus groups. A number of caregivers welcomed the vaccine as an opportunity to save money that would have otherwise gone to treatment, engendering hope for family financial stability. A participant remarked:

“This vaccine is good because we shall get money and buy some goats and chicken to maintain our homes. What I have been wasting for treatment has been saved.” (Female Participant 3, FGD Ayer Town Council)

Cautious acceptance

However, there was evidence of doubt and uncertainty as participants reported some hesitancy regarding the malaria vaccine. The hesitancy in part resulted from the limited information about

the adverse effects after vaccination. Some stated that the lack of detailed information caused anxiety, particularly among those who had never encountered the vaccine before:

“I will accept my child to be vaccinated if the health workers assure me of my child’s safety... but if they do not, then I will not allow my child to be vaccinated with the malaria vaccine.” (Male participant 1, FGD Abongomola)

Another participant also had the following to say:

“For me, I have not yet used it since it is a new vaccine on the market, so I fear that this vaccine may affect my child’s health in the future. I have not yet seen any child being vaccinated with it and its side effects.” (Female Participant 2, FGD Abongomola)

Need for personal vigilance

Some of the participants expressed the need to first observe the outcomes in other vaccinated children before deciding, indicating a cautious but hopeful stance. Among some caregivers, seeing friends or neighbours vaccinate their children without complications served as reassurance.

“When I have seen my friends who have taken their children, and I do not see any bad thing happening... I will be encouraged to take mine too.” (Female participant 5, FGD Ayer Town Council)

Observed attitude change and social reinforcement

Some participants commonly emphasized the role of social observation in shaping their decision to accept the malaria vaccine. Many reported that witnessing peers especially neighbours and community leaders vaccinate their children without complications helped to build confidence and reduce hesitancy. This current effect was particularly strong among mothers and first-time caregivers who often waited to see what others would do before deciding.

“When I saw my neighbours’, children were okay after vaccination, I also went ahead and took mine for the malaria vaccination.” (Female participant 5, FGD Ayer)

Another participant also had the following to say:

“In our community, people follow what others are doing. When the LC1’s child was taken for vaccination, many others followed.” (Female participant 3, FGD Abongomola)

Discontent with age limitations

Several participants expressed dissatisfaction with the age restriction of the vaccine, which only targeted infants between 5 and 12 months. The participant reported that the age restrictions created

confusion and frustration, particularly in households with multiple children who frequently contracted malaria.

“Why protect only the youngest child only? I have a 3-year-old who gets malaria every month.” (Female participant 2, FGD Abongomola)

This was also echoed by a male participant who said:

“The government should extend it to older children. We are all at risk.” (Male Participant 3, FGD Bung Village).

Theme 5: Social reinforcement of the caregiver perception towards the malaria vaccine

Our analysis identified key themes on community perceptions as described below.

Perceived health benefits

Perceptions of the R21 vaccine were shaped by optimism and occasional misinformation. Many caregivers saw it as life-saving especially in communities where malaria remains a leading cause of child mortality.

“The baby's body seems and feels stronger. She's not down with malaria like before.”
(Male Participant 2, FGD Bung)

Positive influence of the health workers

Some of the respondents stated that their acceptance depended on assurances from health workers about the safety of the vaccine, explanations of side effects, and respectful treatment during service delivery.

“If the health workers talk to me well and I understand the side effects, I will take my child. But if they talk arrogantly, I will not.” (Male participant 3, FGD Abongomola)

Trust in VHTs and local leadership

Despite these challenges, many reported trusts in VHTs were a strong counterbalance. Their role in sensitizing and reassuring caregivers was consistently praised by many respondents. Some of the respondents explained:

“Because of our VHT, has been moving around in the community sensitizing us on the benefits, side effects, and the end results if we do not vaccinate our children with R21... that's why I decided to take my child.” (Female Participant 1, FGD Ayer Town Council)

Another respondent also reflected on the same as follows:

“In my community, many health workers like community mobilizers, VHTs, and assistant health educators were deployed to sensitize people about the malaria vaccine.” (Male Participant 1, FGD Abongomola)

Discussion

The findings in this study provide important insights into the knowledge, attitudes, and perceptions of caregivers in communities of northern Uganda regarding the R21 malaria vaccine.

Caregivers’ awareness and knowledge of the malaria vaccine

The study found a very high level of awareness about the malaria vaccine in the quantitative part, with 9 out of 10 respondents having heard about the vaccine. This widespread awareness is encouraging and reflects effective community-level sensitization and lays a strong foundation for future uptake efforts. FGD participants echoed these findings, attributing their awareness to mass sensitizations through radio messages, community health campaigns led by VHTs, LCs, during local gatherings. Caregivers described learning about the vaccine at churches, markets, and through door-to-door outreach, reinforcing the role of grassroots communication in vaccine promotion. This finding does not align with prior literature suggesting that general malaria vaccine awareness is low in endemic areas [15, 28].

Deeper knowledge of the malaria vaccine remains limited. While many caregivers knew of its existence, only 13.9% demonstrated knowledge of R21 malaria vaccine on key aspects such as dosage, scheduling, route of administration, and age eligibility. This disconnect was echoed across FGDs, where caregivers reflected on limited knowledge. This can be due to the limited community engagement, the recency of the R21 vaccine introduction, and inadequate tailored messaging. These findings align with other evidence showing limited specific knowledge about the malaria vaccine [18, 29, 30] as seen in Uganda and Kenya where caregivers often struggle to recall dose schedules and administration procedures [31, 32].

Knowledge level and sociodemographic characteristics of the caregivers

The study found clear disparities in knowledge about the malaria vaccine, with age and education emerging as key factors. Younger caregivers, especially those aged 18–25, showed greater understanding of the vaccine’s preventive role and expressed strong motivation to protect their children. A likely explanation is due to their exposure to health campaigns and information shared through social and digital media. Similarly, caregivers with secondary or higher education were

more knowledgeable about the vaccine's purpose, schedule, and benefits. FGDs reinforced this trend, as participants with more schooling demonstrated clearer comprehension and understanding. This makes sense, since education provides people with the skills to interpret health messages, ask questions, and seek reliable information. Studies from other contexts also suggest that formal education plays a key role in shaping individuals' health-related knowledge and behaviors [33, 34].

Attitudes toward the malaria vaccine

This study found that caregivers generally held positive attitudes toward the malaria vaccine. This could have been largely because they saw clear benefits such as fewer illnesses in children, reduced healthcare costs, and improved household productivity. The findings are consistent with earlier research documenting the favorable reception of new vaccines when their benefits are tangible [7, 15, 35]. Moreover, acceptance was not unconditional. The concerns about safety, side effects, and long-term impacts were common. The same findings were echoed by FGD participants who highlighted evolving attitudes toward the malaria vaccine among caregivers. This could have often been fueled by past negative experiences, limited information, and lingering mistrust of the healthcare system. This aligns with the broader context of vaccine hesitancy in low-resource settings, where attitudes are shaped by historical distrust and perceived government agendas [12, 36]. This dynamic reflects principles of behavioural health models, which emphasize the role of perceived benefits and social cues in shaping health-related decisions [12, 37].

Perceptions of the malaria vaccine

Caregivers expressed a mix of positive and negative perceptions about the malaria vaccine. On one hand, many described it as protective and life-saving, noting the relief it brought to families by reducing illness and offering hope for healthier children. Additionally, the fears and doubts surfaced, especially among some caregivers, who worried about fertility issues or suspected hidden agendas or concerns that mirror conspiracy narratives seen in other vaccine rollouts. A possible explanation for these mixed perceptions is that caregivers' views were shaped by both tangible benefits and underlying doubts. The findings align well with conspiracy narratives documented elsewhere in other vaccine rollouts [16, 35, 38]. In addition, these perceptions mirror global patterns of vaccine resistance where suspicion of government motives, concerns about fertility, and myths about toxicity have hindered vaccine uptake [16, 39, 40]. A widespread lack of confidence in government authorities has been documented to significantly undermine effective

risk communication and public engagement efforts throughout sub-Saharan Africa during the pandemic [41].

Strengths and Limitations

This study has several strengths that make its findings both credible and practical. By using a mixed-methods design, it combined hard numbers with real-life stories from the community, giving a fuller picture of how people perceive the malaria vaccine. It also identified three clear domains of attitudes and perceptions, which adds weight to the results. Another important strength is its timing. Unlike many earlier studies that only looked at hypothetical views before rollout, this research captured what communities actually thought and experienced after the R21 malaria vaccine had already been introduced, making the insights especially relevant to real-world practice.

This study has some limitations to consider. It was done in only two districts, so the results may not reflect views in other parts of Uganda. Some people might have given answers they thought we wanted to hear, especially about government programs. This was countered by using research assistants who did not hold any social status in the communities. In addition, using a deductive thematic analysis may have limited the identification of unanticipated themes outside the predefined framework used. Future studies could take a more open-ended or mixed analytic approach to better capture caregivers' voices and uncover perspectives that may not emerge within our predefined frameworks. Another limitation was that at the time of data collection, the malaria vaccine was still new in these communities, meaning many caregivers had limited firsthand experience to draw from. Lastly, because this was a cross-sectional study, it provides only a snapshot in time, and community perceptions may continue to evolve as people gain more exposure to the vaccine. To enhance trustworthiness despite this limitation, we clearly documented the timing and context of data collection, allowing future researchers to assess whether conditions have changed.

Conclusion and recommendations

In its quantitative part, this study found high general awareness of the R21 malaria vaccine among caregivers, however, specific knowledge about its use, eligibility, and side effects remains limited. While attitudes were mostly positive, acceptance depends on trust, accurate information, and social influences. In the qualitative part, the FGDs confirmed the high awareness, as the communities learned through radio, churches, markets, and local leaders. The community views are shaped by

cultural and historical factors, with barriers stemming more from access and communication issues than outright rejection.

There is need for the MoH to strengthen community knowledge of the malaria vaccine through use of Information, Education, and Communication materials and engaging trusted local actors such as Village Health Teams, religious leaders, and community elders. Ensure that health messages are consistent, culturally and linguistically appropriate, and directly address community concerns. In addition, incorporate community feedback mechanisms to adapt programs to local needs and experiences.

Declaration

Abbreviations

EPI - Expanded programme for immunization

FGD – Focus group discussion

iCCM - Integrated Community Case Management

IP - Implementing Partners

KAP – Knowledge Attitudes and Perception

KII – Key informant interviews

KMO - Kaiser-Meyer-Olkin

LC – Local Council

PCA - Principal Component Analysis

SD - Standard Deviation

VHT - Village health team

Acknowledgements

We would like to acknowledge the invaluable contributions of the study participants, including caregivers, healthcare workers, and community leaders in Kole and Kwanja districts, whose openness and insights made this research possible. We also extend our gratitude to the research assistants Anyinge Harriet, Akello Stella, Achola Rita, Ajok Joyce and Okello Genesis for their dedication during data collection. Lastly to Mr. Musinguzi Marvin who helped with cleaning the data for analysis.

Funding

This study was supported by a research grant from the Royal Society of Tropical Medicine and Hygiene (Grant code: nihr24121). The funder had no role in the study design, data collection, analysis, interpretation of data, or in writing the manuscript.

Availability of data and materials

The dataset for this study can be made available at a reasonable request.

Authors' Contributions

SSP conceptualized the study, designed the methodology, led data collection, analysis, and drafted the initial manuscript. JNK, MO, AY, GS, RI and JIN provided guidance on study design, and contributed to interpretation of findings. DLE, SIA, JA, ZN and RA supported data collection supervision, qualitative analysis, quantitative data management and statistical analysis and manuscript revision. JIN provided overall scientific oversight, contributed to the interpretation of results, and critically revised the manuscript for intellectual content. All authors read and approved the final manuscript.

Ethics declarations

Ethics approval and consent to participate

The study received ethical approval from the Makerere University School of Medicine Research and Ethics Committee (Mak-SOMREC) under approval number Mak-SOMREC-2024-938. Further clearance was obtained from the Uganda National Council for Science and Technology (UNCST) under approval number HS5968ES. Written informed consent was obtained from all participants prior to their involvement in the study. For participants with limited literacy, the consent process was conducted orally in the presence of a witness, and documented accordingly with a thumb print. All methods were carried out in accordance with relevant guidelines and regulations of the Helsinki declaration.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Reference

1. WHO, *World malaria report 2024: Addressing inequity in the global malaria response*. World Health Organization; Licence: CC BY-NC-SA 3.0 IGO. . 2024: Geneva, Switzerland
2. WHO, *World malaria report 2023*. World Health Organization. 2023.
3. MoH., *The Uganda malaria reduction strategic plan 2014-2020*. . 2014.
4. WHO, *WHO recommends R21/Matrix-M vaccine for malaria prevention in updated advice on immunization*. World Health Organization. 2023.
5. Seidlein, L.V., *Roll out and prospects of the malaria vaccine R21/Matrix-M*. PLoS Med, 2025. **22**(1): p. e1004515.
6. WHO, *How do the RTS,S and R21 malaria vaccines compare?* World Health Organization. 2024.
7. Amin, M.A., et al., *Knowledge and acceptance of malaria vaccine among parents of under-five children of malaria endemic areas in Bangladesh: A cross-sectional study*. Health Expect, 2023. **26**(6): p. 2630-2643.
8. Steenberg, B., et al., *COVID-19 Vaccination Rollout: Aspects of Acceptability in South Africa*. Vaccines (Basel), 2022. **10**(9).
9. Esposito, S., et al., *Barriers to the vaccination of children and adolescents and possible solutions*. Clin Microbiol Infect, 2014. **20 Suppl 5**: p. 25-31.
10. Olawade, D.B., et al., *Malaria vaccination in Africa: A mini-review of challenges and opportunities*. Medicine (Baltimore), 2024. **103**(24): p. e38565.
11. Price, J.A., et al., *"I go I die, I stay I die, better to stay and die in my house": understanding the barriers to accessing health care in Timor-Leste*. BMC Health Serv Res, 2016. **16**(1): p. 535.
12. Puleh, S.S., et al., *Parents' Readiness to Vaccinate Their Children Aged 5 to 17 Years Against Covid-19 and Its Associated Factors in Lira District, Uganda*. Pediatric Health Med Ther, 2023. **14**: p. 131-139.
13. El-Moamly, A.A. and M.A. El-Sweify, *Malaria vaccines: the 60-year journey of hope and final success—lessons learned and future prospects*. Tropical Medicine and Health, 2023. **51**(1): p. 29.
14. Kigongo, E., et al., *Community readiness and acceptance for the implementation of the malaria vaccine among caretakers of at-risk children in sub-Saharan Africa: a systematic review and meta-analysis*. Malaria Journal, 2025. **24**(1): p. 259.
15. Ajayi, M.Y. and D.C. Emeto, *Awareness and acceptability of malaria vaccine among caregivers of under-5 children in Northern Nigeria*. Malar J, 2023. **22**(1): p. 329.
16. Bam, V., et al., *Caregivers' perception and acceptance of malaria vaccine for Children*. PLoS One, 2023. **18**(7): p. e0288686.
17. Bushi, G., et al., *Determinants of Malaria Vaccine Acceptance: A Systematic Review and Meta-Analysis of Awareness, Acceptance, Hesitancy, and Willingness to Pay*. Immun Inflamm Dis, 2025. **13**(5): p. e70205.
18. Mwingira, F., D. Matiya, and F. Chacky, *Knowledge and willingness towards malaria vaccines among caregivers in Dar es Salaam, Tanzania*. Malaria Journal, 2025. **24**(1): p. 35.
19. Yusuf, H.F., et al., *Knowledge, acceptance and willingness to pay for malaria vaccine among residents of a semi-urban community in Kaduna State, North-western Nigeria*. Niger Med J, 2025. **66**(1): p. 266-278.

20. NMS. NATIONAL MEDICAL STORES LAUNCHES VACCINE LAST-MILE DELIVERY (VLMD) "TAKING VACCINES TO THE LAST MILE". 2025; Available from: <https://www.nms.go.ug/index.php/2025/05/05/national-medical-stores-launches-vaccine-last-mile-delivery-vlmd-taking-vaccines-to-the-last-mile/#:~:text=Under%20the%20new%20model%2C%20NMS,specialised%20vehicles%20to%20transport%20vaccines%E2%80%9D>.
21. Bennett, S., et al., *A simplified general method for cluster-sample surveys of health in developing countries*. World Health Stat Q, 1991. **44**(3): p. 98-106.
22. Bennett, S., et al., *EPIDEMIOLOGICAL AND STATISTICAL METHODS FOR RAPID HEALTH ASSESSMENT: A SIMPLIFIED GENERAL METHOD FOR CLUSTER-SAMPLE SURVEYS OF HEALTH IN DEVELOPING COUNTRIES* in W.H. Organization, Editor. 1991: Geneva. p. 98.
23. Bartlett, M.S., *A Note on the Multiplying Factors for Various Chi Square Approximations*. . Journal of the Royal Statistical Society, , 1954. **16**, : p. 296-298.
24. Kaiser, H., *An Index of Factorial Simplicity*. . Psychometrika, 1974. **39**,: p. 31-36.
25. Costello, A.B. and J. Osborne, *Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis*. Practical assessment, research, and evaluation, 2005. **10**(1).
26. Braun, V. and V. Clarke, *Using thematic analysis in psychology*. Qualitative research in psychology, 2006. **3**(2): p. 77-101.
27. O'Connor, C. and H. Joffe, *Intercoder Reliability in Qualitative Research: Debates and Practical Guidelines*. International Journal of Qualitative Methods, 2020.
28. Ntihebuwayo, E., et al., *Acceptance of a malaria vaccine among caregivers of sick children under 5 years of age in Burundi*. Malaria Journal, 2025. **24**(1): p. 90.
29. Okyere, J., et al., *RTS,S/AS01(E) vaccine defaults in Ghana: a qualitative exploration of the perspectives of defaulters and frontline health service providers*. Malar J, 2023. **22**(1): p. 260.
30. Yeboah, D., J. Owusu-Marfo, and Y.N. Agyeman, *Predictors of malaria vaccine uptake among children 6-24 months in the Kassena Nankana Municipality in the Upper East Region of Ghana*. Malar J, 2022. **21**(1): p. 339.
31. Hoyt, J., et al., *RTS,S/AS01 malaria vaccine pilot implementation in western Kenya: a qualitative longitudinal study to understand immunisation barriers and optimise uptake*. BMC Public Health, 2023. **23**(1): p. 2283.
32. Musoke, D., et al., *Facilitators and barriers to integrated malaria prevention in Wakiso district, Uganda: A photovoice study*. PLOS Glob Public Health, 2024. **4**(4): p. e0002469.
33. Wemakor, A., et al., *Prevalence and factors associated with incomplete immunization of children (12-23 months) in Kwabre East District, Ashanti Region, Ghana*. Arch Public Health, 2018. **76**: p. 67.
34. Emmanuel, B.N., et al., *Evaluating the knowledge, attitude, perception, and readiness of caregivers of under 5-year-old children to accept malaria vaccine in Nigeria*. Clin Exp Vaccine Res, 2024. **13**(2): p. 121-131.
35. Nnaji, A. and M.A. Ozdal, *Perception and awareness towards malaria vaccine policy implementation in Nigeria by health policy actors*. Malar J, 2023. **22**(1): p. 111.
36. Nossier, S.A., *Vaccine hesitancy: the greatest threat to COVID-19 vaccination programs*. Public Health Association Nossier Journal of the Egyptian Public Health Association, 2021(96): p. p. 18.

37. Buonsenso, D., et al., *Caregivers' Attitudes Toward COVID-19 Vaccination in Children and Adolescents With a History of SARS-CoV-2 Infection*. Front Pediatr, 2022. **10**: p. 867968.
38. Leask, J., et al., *Communicating with parents about vaccination: a framework for health professionals*. BMC Pediatr, 2012. **12**: p. 154.
39. Chou, W.Y.S., Gaysynsky, A. and Vanderpool, R. C. , *The COVID-19 Misinfodemic: Moving Beyond Fact-Checking*. Health Education and Behavior, 2021. **48**(1): p. 9–13.
40. Cooper, S., et al., *Using social media to build confidence in vaccines: lessons from community engagement and social science research in Africa*. BMJ, 2024. **384**: p. e075564.
41. Seytre, B., *Erroneous Communication Messages on COVID-19 in Africa*. Am J Trop Med Hyg, 2020. **103**(2): p. 587-589.

ARTICLE IN PRESS