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# Uptake of R21/Matrix-M malaria vaccine and associated factors among children eligible for vaccination in Kole and Kwania districts, Northern Uganda: a cross-sectional study

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## Abstract

**Background** The introduction of R21/Matrix-M (R21) vaccine as a malaria control strategy provides an opportunity to reduce the disease burden. However, there is limited evidence on its uptake and what affects the uptake, information that is important for the successful implementation of the vaccine. We assessed the level of uptake and associated factors among caregivers of children eligible for malaria vaccination in northern Uganda.

**Methods** Between September and October 2025, a cross-sectional survey was conducted among 557 caregivers of children eligible for malaria vaccination. Data were collected using pretested structured questionnaires in KoboCollect and exported into Stata version 18 for analysis. Child health cards were used to verify vaccine status. Uptake was defined as the proportion of caregivers whose eligible children received at least one dose of the vaccine. Factors associated with vaccine uptake were determined using modified Poisson regression, adjusting for village-level clustering and reported as adjusted prevalence ratio (aPR) with their 95% confidence intervals.

**Results** Of the 557 caregivers interviewed, 269 reported that their children had received the first dose of the malaria vaccine, putting uptake at 48.3% (95% confidence interval CI: 44.0% −52.0%). Vaccine uptake was positively associated with exposure to community-based health campaigns (aPR = 1.32, 95% CI: 1.01–1.72); caregivers' receiving advice from healthcare workers about the vaccine (aPR = 2.61, 95% CI: 1.55–4.40); perceived increased susceptibility of the child to malaria (aPR = 2.26, 95% CI: 1.67–3.04); ease of accessing the vaccine (aPR = 1.47, 95% CI: 1.25–1.73); and trust in government programs (aPR = 1.80, 95% CI: 1.43–2.25). Negative interaction effects were observed between health-worker advice combined with perceived malaria susceptibility (aPR = 0.44; 95% CI: 0.29–0.66) and long queues combined with poor information (aPR = 0.12; 95% CI: 0.02–0.89).

**Conclusion** The level of R21 malaria vaccine uptake was sub-optimal, with less than half of eligible children receiving their first dose. Multiple factors influenced uptake, including those affecting caregiver knowledge and

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vaccine access. The Ministry of Health should strengthen factors improving uptake including, caregiver education on benefits of the vaccine and expanding access through different channels including campaigns.

**Keywords** Malaria vaccine · Uptake · Determinants of vaccination · Caregivers · Northern Uganda

## Background

Malaria remains a major public health concern in sub-Saharan Africa (SSA) despite increased efforts to reduce its burden [1]. Currently, SSA accounts for 94% of the cases and 95% of the deaths [1, 2]. Uganda is one of the worst affected countries in the region, ranking as the third highest contributor to the number of cases in 2024 alone [1]. The country has over 90% of its population at risk of the disease and malaria is the leading cause of all outpatient visits and hospital admissions for children under 5 years of age [3].

To combat this burden, Uganda's National Malaria Elimination Program (NMEP) has deployed a range of proven malaria control interventions, including chemoprevention, use of long-lasting insecticide-treated nets, indoor residual spraying, and effective case management with artemisinin Combination Therapy [4]. In April 2025, the NMEP rolled out the R21/Matrix-M (R21) malaria vaccination for children under five years as part of the routine immunisation program, a significant milestone in malaria prevention and control [3, 4]. The vaccine provides an additional layer of protection alongside existing interventions. Clinical trials of the R21 malaria vaccine were conducted before the recommendation by WHO in 2023. The clinical trials prior to approval of the vaccine showed an efficacy rate of up to 75% and a favourable safety profile [4, 5]. Malaria vaccination, if implemented properly, can prove to be a significant step forward in protecting vulnerable populations, such as children under five, from the deadly impact of the disease [4, 6, 7]. Although the vaccine represents a major advancement in malaria prevention [8, 9], limited evidence exists on its uptake in the real-world setting.

The success of the malaria vaccination programs depends not only on clinical efficacy, which is conducted under controlled settings, but also on uptake. Studying uptake and associated factors can help in identifying the strategies that can be employed to improve coverage and effectiveness of the vaccine. Recent studies have documented several factors that affect uptake of vaccines, including vaccine hesitancy, misinformation, access challenges, and caregiver-related factors [10, 11]. As the drive to roll out malaria vaccines gains momentum, country and context specific evidence on factors associated with vaccine uptake in high-burden settings, such as northern Uganda, is essential to guide strategies that can be used to improve malaria vaccine coverage. Our study contributes to this literature by exploring the level of uptake and associated factors among caregivers of children eligible for the malaria vaccine in northern Uganda, six months after its rollout for the very first time in the country.

## Methods

### Study design and setting

This cross-sectional study was carried out between September and October, 2025 in Kole and Kwania districts, northern Uganda. These two districts are among the 105 high to moderate-malaria transmission areas that were prioritized in Uganda's 2025 national rollout of the R21 malaria vaccine. Both Kole and Kwania have extensive mass of land covered by swamps that serve as mosquito breeding sites, and they are classified as moderate to high malaria transmission districts. According to 2024 Health Management Information System (HMIS) data, the malaria test positivity rates in the whole population were estimated at 45% in Kole and 42% in Kwania districts.

Kole district is served by one level IV health center, nine level III health centers, and one Private Not for Profit (PNFP) facility. Kwania district has a similar structure, with one level IV and eight level III health centers. Malaria control in the districts has primary focused on the use of LLINs, use of ACTs and IRS. The R21 malaria

vaccine was rolled out for the first time in April 2025 in both districts. Children aged 6 months to 11 months at the time of roll out were eligible to receive the vaccine. In the study region, routine immunization services are primarily delivered through dedicated health facilities, complemented by periodic outreach campaigns conducted by trained healthcare workersto reach remote communities. Vaccines are provided through the national immunization program infrastructure, which relies on both fixed posts and mobile outreach to ensure coverage. To support the uptake of the vaccine, the rollout was accompanied by intensive community mobilisation. Mobilisation included radio announcements, megaphone sensitization campaigns across the villages, engagement of local leaders, and active involvement of Village Health Teams (VHTs) to share information and encourage caregivers to bring eligible children for vaccination.

## Study population and eligibility criteria

The study population comprised children who were eligible for the malaria vaccination and their primary caregivers at the time of the survey. Based on the national guideline children were enrolled at 6–11 months, but by the time of survey some had aged into the 12–18 month range. A caregiver was defined as someone who helps a child with their day-to-day duties, including eating, washing, emotional support, and assisting them to get health services. Children were eligible to participate in the study if they were (i) aged between 6 months and 18 months at the time of the survey, because the vaccine had been introduced 6 months prior to the study, (ii) if their primary caregiver were aged at least 18 years, (iii) they were living as permanent residents in the study area for at least six months, and (iv) their caregivers provided informed consent to participate in the study. In addition, we also excluded caregivers living in areas that were flooded and inaccessible to the research team and those with critical illnesses that significantly limited their ability to participate in this study.

## Sample size determination

The sample size was determined using the formula for estimating a single proportion, adjusting for clustering [12]. We assumed a 95% confidence level, a 5% margin of error, and adjusted for a design effect of 1.5 to account for intra-cluster correlation. The prevalence (P) of vaccine uptake is 32.2% based on the study by Abiache et al. (2025) in Cameroon [13]. After adjusting for a 10% non-response rate, the minimum sample size required was 557 participants.

## Sampling procedures

A multi-stage cluster sampling technique was used to select participants for the study. The two districts (Kwania and Kole) were purposively selected. Two sub-counties in each of the district were selected by simple random sampling. Using simple random sampling, three parishes were selected from each of the two selected sub-counties. Two villages were then selected using simple random sampling from each of the three parishes. In each of the selected villages, a comprehensive household listing was developed with the help of a community health worker and/or local council leader. An average of 23 participants were randomly selected from each of the villages using systematic random sampling. The sampling interval (denoted as k) was determined by dividing the total number of households in the village by the average number of individuals targeted per village 23. A random starting number between 1 and k was then determined by dividing the number of households with eligible children with the targeted number. And households were systematically selected (every kth 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 outcome variable was uptake of the R21 malaria vaccine, defined as uptake of at least one dose of R21, verified on the child's health card. Because the survey was conducted six months after vaccine introduction, many children had not yet reached the age for subsequent doses, and full schedule completion could not be reliably assessed. Caregiver knowledge on the vaccine was assessed descriptively including knowing the recommended age for vaccination; the required number of doses to be fully vaccinates; and the timing of the next dose among those whose children had begun vaccination. In addition, exposure variables including demographic characteristics of both caregivers and of eligible children (age, sex, marital status, education, occupation, religion, household size), healthcare access (distance to facility, transportation, cost, availability), and community factors such as cultural beliefs and social norms were collected.

## Data collection methods and tools

Six research assistants competent in Luo (Lango the most commonly spoken language in the study area) administered the structured questionnaires using smartphones programmed with KoBoCollect® application from the KoBoToolbox platform (http://www.kobotoolbox.org/) to the caregivers. In addition, the assistants reviewed the child's health cards to verify the vaccine status. The phones were used to collect data, enabling real-time validation and secure storage. Real-time data checks were performed using the KoboToolbox dashboard.

## Data management and analysis

Data was exported into Microsoft Excel format for cleaning and validation and then Stata version 18.0 for analysis. Descriptive statistics were used to summarize quantitative data, and these were reported as frequencies and percentages for categorical variables and median with interquartile ranges (IQR) for continuous variables. The descriptive statistics were generated using Stata survey commands (svyset), specifying villages as primary sampling units. Sampling weights were not applied because all eligible participants within sites were included. Given that uptake of the R21 malaria vaccine exceeded 10%, generalized linear models (GLM) with a Poisson regression distribution and log link function were used to determine factors associated with uptake and presented as adjusted prevalence ratios (aPR) [14]. Clustered robust standard errors were used to account for intra-cluster correlation, reduce bias, and improve precision of the estimates. During model building, variables with a $p$-value of 0.2 or less at bivariable analysis were considered for inclusion in the multivariable model. A stepwise backward elimination procedure was then applied using a threshold of $p < 0.05$ to refine the model. The effects of interaction were assessed using likelihood ratio tests comparing modified Poisson regression models with and the one without interaction terms. A statistically significant likelihood ratio test supported inclusion of interaction terms in the final model. We evaluated the data for multicollinearity using variance inflation factors (VIF and Tolerance 1/VIF); any variable with a VIF greater than 10 indicates collinearity and was excluded from the final model. Any outliers and influential observations were identified using standardized residuals, Cook's distance, dbeta, and leverage statistics. One observation was excluded because it was an outlier and had undue influence on the model estimates.

In addition, we also assessed for confounders after the backward elimination. To check whether other factors might be influencing our results, we looked at potential confounders such as caregiver age, education level, household income, and distance to the nearest health facility. These were added one at a time into the regression models so we could see how much they affected the estimates of vaccine uptake. Variables that changed the effect estimate of vaccination uptake by more than 10% were considered confounders and retained in the final model. The final model fit was assessed using the deviance and Pearson chi-square statistics, with values close to 1 indicating an adequate goodness-of-fit test. Additionally, we conducted a grouped Pearson goodness-of-fit test to check how well your observed data fit the expected distribution under the model you specified.

## Results

### Socio-demographic characteristics of the participant

A total of 557 children were enrolled in the study. More than half of the children (52.8%, $n=294$) were classified as infants (6–11 months). The median age of the enrolled caregivers was 25 years (IQR: 21–28 years). The majority of the caregivers were female (87.3% $n=486$), biological mothers of the children (86.9%, $n=484$), and married (80.3%, $n=447$). Primary education was the most common level of education attained (78.8%, $n=439$) and most respondents were peasant farmers (82.4%, $n=459$) (Table 1). Of the 557 caregivers enrolled, 269 reported their child having received at least one dose of the R21 malaria vaccine putting the uptake at 48.1% (95% CI: 44.0% − 52.0%).

### Caregiver knowledge and R21 malaria vaccine uptake among caregiver of eligible children

Of the 557 caregivers enrolled, only 245 (44.0%) correctly stated the required number of doses of the vaccine, and 187 (33.6%) knew the recommended age for the vaccination. Of the 557 caregivers enrolled, 269 had received at least one dose of R21 vaccine putting the uptake at 48.3% (95% CI: 44.0% − 52.0%). However, of the 269 caregivers whose children were vaccinated, 211 (78.7%) of the respondents whose children had at least one dose could recall the timing of the next dose (Table 2).

**Table 1** Socio-demographic characteristics of 557 participants in Kwania and Kole districts, Northern Uganda

| Variable | Category | Frequency (*n*) | Percentage (%) |
|---|---|---|---|
| Age group of children | Infants | 294 | 52.8 |
| | Toddlers | 263 | 47.2 |
| Sex of children | Female | 315 | 56.6 |
| | Male | 242 | 43.4 |
| Sex of caregiver | Male | 71 | 12.8 |
| | Female | 486 | 87.3 |
| Age of caregiver | ≤25 | 320 | 57.5 |
| | 26–35 | 191 | 34.3 |
| | ≥36 | 46 | 8.3 |
| Relationship to child | Biological mother | 484 | 86.9 |
| | Biological father | 58 | 10.4 |
| | Others (guardian, aunt) | 15 | 2.7 |
| Marital status | Married | 447 | 80.3 |
| | Single | 110 | 19.8 |
| Education level | None | 22 | 3.9 |
| | Primary | 439 | 78.8 |
| | Secondary | 75 | 13.5 |
| | Tertiary | 21 | 3.8 |
| Occupation | Peasant farmer | 459 | 82.4 |
| | Business | 46 | 8.3 |
| | Civil servant | 18 | 3.2 |
| | Other (Hair dressers, builders etc.) | 34 | 6.1 |
| Religion | Catholic | 280 | 50.3 |
| | Anglican | 189 | 33.9 |
| | Pentecostal | 73 | 13.1 |
| | Others (Muslim, Seventh day Adventist) | 15 | 2.7 |
| Household size | ≤4 | 329 | 59.1 |
| | >5 | 228 | 40.9 |

**Table 2** Caregiver knowledge of the R21 malaria vaccine and vaccination practices among eligible children in Kole and Kwania districts, Northern Uganda ($n=557$ caregivers; $n=269$ vaccinated children)

These variables are presented to provide contextual background for interpreting vaccine uptake patterns; they were not considered study outcomes

| Indicator | Response Category | Frequency ($n$) | Percentage (%) |
|---|---|---|---|
| Caregiver knows the recommended age to start the vaccination | No | 370 | 66.4 |
| | Yes (5months) | 187 | 33.6 |
| Knowledge of required doses | Incorrect (≤3 doses) | 312 | 56.0 |
| | Correct (4 doses) | 245 | 44.0 |
| Caregivers know the timing of next dose | No | 57 | 21.3 |
| | Yes | 211 | 78.7 |
| Number of doses received by the child | 1 | 90 | 33.5 |
| | 2 | 78 | 29.0 |
| | 3 | 101 | 37.5 |
| Caregiver ever missed a dose | No | 188 | 70.2 |
| | Yes | 80 | 29.8 |

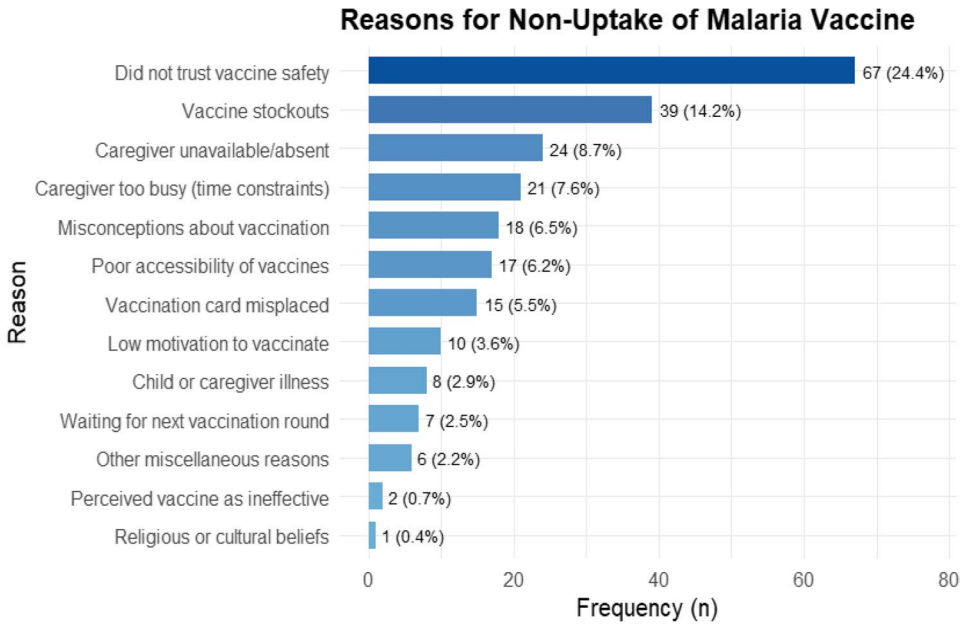



**Fig. 1** Caregiver-reported reasons for the absence of card-verified R21 uptake among eligible children in Kole and Kwania districts ($n=275$)

## Reported reasons for non-uptake of the R21 malaria vaccine among caregivers of children unvaccinated ($N=275$)

Among the 288 children who were unvaccinated, only 275 had child health cards. Additionally, of the 275 respondents, 40 reported that their children had received the malaria vaccine, but it was not indicated in the child health card and the response could not be confirmed. The commonly reported reasons for non-vaccination included: 1) not trusting the vaccine (24.4%, $n=67$); 2), vaccine stockouts (14.2%, $n=39$); 3), caregivers' absence during vaccination days (8.7%, $n=24$); and being too busy (7.6%, $n=21$) to take the children for vaccination. Commonly reported barriers such as the long lines and distance to facilities were reported by a smaller proportion of caregivers in this study (Fig. 1).

## Factors associated with the uptake of R21 malaria vaccine among caregivers

In Table 3, of 557 enrolled, one participant was excluded due to extreme outlier values that unduly influenced model estimates, leaving 556 for analysis. the factors that remained significant associated with vaccine uptake at

**Table 3** Crude and adjusted prevalence ratios for factors associated with uptake of R21 vaccine uptake among 556 participants in Kwania and Kole districts

| Variable | Uptake | | cPR(95% CI) | aPR(95% CI) |
|---|---|---|---|---|
| | Yes, *n*(%) | No, *n* (%) | | |
| Perceived susceptibility of child to malaria | 194 (69.8) | 84 (30.2) | 2.62 (2.12–3.23) *** | 2.26 (1.67–3.04) *** |
| Knows correct vaccination start age | 143 (76.5) | 44 (23.5) | 2.26 (1.92–2.66) *** | 1.40 (1.13–1.72) ** |
| Lack of awareness about malaria vaccination campaign | 66 (39.5) | 101 (60.5) | 0.76 (0.62–0.94) ** | 0.84 (0.65–1.07) |
| Caregiver business person | 37 (80.4) | 9 (19.6) | 1.85 (1.55–2.20) *** | 1.72 (1.23–2.41) ** |
| Caregiver civil servant) | 11 (61.1) | 7 (38.9) | 1.40 (0.96–2.06) | 1.29 (0.72–2.33) |
| Caregiver has other (hair dresser, builder, etc.) | 20 (60.6) | 13 (39.4) | 1.39 (1.04–1.87) | 1.25 (0.76–2.06) |
| Caregiver has support of household head | 30 (90.9) | 3 (9.1) | 2.00 (1.73–2.31) *** | 1.99 (1.47–2.68) *** |
| Caregiver received advice from a health worker | 145 (74.4) | 50 (25.6) | 2.18 (1.85–2.58) *** | 2.61 (1.55–4.40) *** |
| Caregiver has easy access to vaccination services | 61 (96.8) | 2 (3.2) | 2.31 (2.06–2.58) *** | 1.47 (1.25–1.73) *** |
| Caregiver trusts government programs | 47 (90.4) | 5 (9.6) | 2.06 (1.80–2.35) *** | 1.80 (1.43–2.25) *** |
| Caregiver exposed to community-based health campaigns | 134 (63.8) | 76 (36.2) | 1.65 (1.39–1.95) *** | 1.32 (1.01–1.72) ** |
| Long queues and waiting time | | | – | 0.89 (0.76–1.05) |
| Health worker advice * Perceived susceptibility | | | — | 0.44 (0.29–0.66) *** |
| Long queues * Lack of information | | | — | 0.12 (0.02–0.89) * |
| Household head support * Knowledge of start age | | | — | 0.54 (0.39–0.76) *** |
| Business * Health worker advice | | | — | 0.67 (0.45–0.98) * |
| Civil servant * Health worker advice | | | — | 0.55 (0.24–1.24) |
| Informal work * Health worker advice | | | — | 0.83 (0.44–1.57) |

aPR is adjusted prevalence ratio, cPR is crude prevalence ratio, 95%CI Confidence interval, Statistical significanceat5%: *$p<0.05$ **$p<0.01$ ***$p<0.001$

multivariate analysis were: perceived susceptibility of the child to malaria infection (aPR = 2.26, 95% CI: 1.67–3.04, $p<0.001$); knowledge of recommended vaccination start age (aPR = 1.40, 95% CI: 1.13–1.72, $p=0.002$); support from household head (aPR = 1.99, 95% CI: 1.47–2.68, $p<0.001$); receiving advice from healthcare workers about the vaccine (aPR = 2.61, 95% CI: 1.55–4.40, $p<0.001$); easy access to vaccination services (aPR = 1.47, 95% CI: 1.25–1.73, $p<0.001$) and trust in government health programs (aPR = 1.80, 95% CI: 1.43–2.25, $p<0.001$).

This study observed significant sub-multiplicative interactions among some key variables. For example, the joint association between receiving health-worker advice and perceived susceptibility (aPR = 0.44, $p<0.001$), and between long queues and poor information about malaria vaccination (aPR = 0.12, $p=0.038$), was weaker than expected under a multiplicative model (Table 3).

### The interaction effect and model fit

Interaction effects were assessed using a likelihood ratio test comparing a reduced model without interaction terms to a full model including interaction terms. The likelihood ratio test was statistically significant ($\chi^2 = 20.63$, degree of freedom = 6, $p<0.01$), indicating that inclusion of interaction terms significantly improved model fit, therefore the model with interaction terms was retained. Model fit assessment for the final model showed low deviance (0.47) and Pearson (0.43) values relative to their degrees of freedom.

## Discussion

In this study, we assessed the level of uptake of the R21 malaria vaccine and its associated factors among children eligible for vaccination in two districts with moderate to high transmission in northern Uganda. The level of uptake of the R21 malaria vaccine six months after rollout was sub-optimal with fewer than half of the eligible children receiving the first dose. This low uptake suggests that many of the eligible children had not yet received the potentially important malaria prevention intervention during early implementation particularly in routine

implementation settings. Although the low uptake may be expected during the early stages of introducing the new vaccine, it highlights potential challenges related to service delivery and caregiver access that need to be addressed [15].

First-dose uptake in our study (48.3%) was far lower than in Malawi (90.5%) and Ghana (94.1%) [16, 17], and further contrasts with evidence from Nigeria, where awareness of the R21 malaria vaccine was very limited (9.7%) yet caregiver acceptability remained high (76.6%) [18]. Malawi and Ghana were conducted under highly supported introduction conditions [19, 20]. The Nigerian findings show that willingness to accept vaccination may be present even in the absence of knowledge. It highlights the fact that awareness, confidence and service availability are separate components of vaccine uptake. In Uganda, uptake may have been influenced by access-related barriers and health systems challenges, similar to findings from Cameroon, where malaria vaccine uptake was 32% [13].

Easy access to the vaccination services was an important facilitator of the R21 malaria vaccine uptake. Our findings also show that caregivers who reported having easy access to malaria vaccination services were significantly more likely to have their children vaccinated with the R21 malaria vaccine. These findings highlight and emphasise the importance of logistical and infrastructural factors as major drivers of malaria vaccination. These results are consistent with evidence from Uganda, where access has also been shown as a key factor influencing whether children receive their vaccines [10]. From a programme perspective, strengthening access through expanded outreach programmes, improving vaccine availability, reducing vaccine stockouts and minimizing logistical barriers in such settings will be important [11]. The relatively low uptake observed in our study may reflect limited caregiver level and various system-level challenges, including restricted access.

Our study also found that support from the household head was strongly associated with uptake of the first dose of the R21 malaria vaccine. Children whose caregivers received support from the household head were nearly twice as likely to be vaccinated as those whose caregivers did not receive such support. This finding implies that household support may influence vaccination decisions and access to services. In many settings, household heads may influence decisions about when and where to seek healthcare and often provide the financial and social support needed to access health services. Similar findings have been reported in other studies from sub-Saharan Africa, where involvement of fathers or household heads has been linked to higher uptake of childhood immunisation and other preventive health services [21, 22]. Together, these findings suggest that decisions about malaria vaccination may be shaped not only by individual caregivers' factors but also by household support structures [23, 24]. Therefore, interventions to improve R21 malaria vaccine uptake should engage fathers and other household decision-makers alongside caregivers through community dialogue, health education, and behaviour change communication.

One of the strongest findings in this study was the role of healthcare workers in promoting vaccination. In this study the caregivers who were advised by the healthcare workers to vaccinate were more likely to do so. This finding highlights the important role of healthcare workers in influencing vaccine uptake, consistent with previous studies demonstrating their contribution to vaccine confidence and acceptance [13, 25, 26]. Healthcare workers are an important factor associated with vaccine uptake in Uganda because their recommendation may help address misconceptions, clarify doubts and reinforce the importance of immunisation [27]. This implies that their advice can reassure caregivers, address concerns about safety, and explain why completing the vaccination schedule is important.

In this study, perceived susceptibility of the children to malaria infection was associated with malaria vaccine uptake. The caregivers who perceived their child as susceptible to malaria infection were at least twice as likely to have them vaccinated with the R21 malaria vaccine compared to those who did not. The findings of this study are consistent with evidence from elsewhere that shows that the perception that malaria poses a serious threat to their families especially among children, is associated with a greater demand for the vaccine [28]. The critical role of perceived risk in shaping people's health behavior is the central part of the Health Belief Model [29]. Drawing on this framework, these findings suggest an association between caregiver-perceived vulnerability to malaria and their motivation to get their children immunised [11]. These findings underscore the importance of

risk communication strategies that accurately communicate both the burden of malaria and the protective benefits of vaccination while avoiding unnecessary fear or misinformation.

Our findings show that trust in government programmes was another factor associated with the uptake of the first dose of R21 malaria vaccine. The children whose caregivers had trust in government programmes were nearly twice as likely to be vaccinated compared to those who did not trust in the government programmes such as health initiatives. This suggests that trust in government health initiatives may be an important factor influencing willingness to participate in vaccination campaigns. Our findings align with evidence from elsewhere that caregivers are willing to vaccinate their children if they demonstrate trust in public health initiatives [30, 31]. This implies that, in order to strengthen public confidence and improve coverage of malaria vaccination, the government needs to provide consistent delivery and community engagement.

## Limitations

The study had a number of limitations which should be considered when interpreting the findings. First, a cross-sectional design was used which restricts drawing causal inferences between uptake of the R21 malaria vaccine and its predictors. Second, relying on child health cards may have introduced some bias, since about 13 caregivers did not have the child-health cards. However, our results are still valid, despite this limitation, since only 5.5% did not have the child health cards. Lastly, because this study was carried out in northern Uganda a high-transmission setting the findings are highly relevant for malaria control efforts there. However, they may not apply in the same way to other regions with different health system structures or malaria transmission patterns. We recommend expanding the study to include multiple regions with diverse cultural, economic, and health system contexts. Despite adjusting for measured covariates, residual confounding may remain due to unmeasured factors such as household mobility, informal care practices, or undocumented health interventions. These influences could bias effect estimates, and future studies with more granular data or randomized designs are needed to minimize this limitation.

## Conclusion and recommendation

This study found that uptake of the first dose of the R21 malaria vaccine among eligible children in northern Uganda was low six months after its introduction into routine immunisation. While lower coverage can be expected in the early stages of a new vaccine rollout, the results point to persistent barriers that need urgent attention. Long waiting times, limited awareness, and poor access to services were linked to lower uptake, whereas healthcare worker recommendations, caregivers' perception of their child's vulnerability to malaria, trust in government programmes, easy access to services, and exposure to community campaigns were all associated with higher uptake. Together, these findings show that improving coverage will require tackling both supply-side and demand-side challenges. Strengthening communication by health workers, expanding community engagement, improving access, ensuring consistent vaccine availability, and reducing waiting times are practical steps that could help increase uptake as Uganda scales up routine malaria vaccination.

### Abbreviations

| | |
|---|---|
| aPR | Adjusted Prevalence Ratio |
| cPR | Crude Prevalence Ratio |
| CI | Confidence interval |
| EPI | Expanded programme for immunization |
| HMIS | Management Information System |

IRS Indoor Residual Spraying
NMEP National Malaria Elimination Program
PNFP Private not for Profit
SSA Sub–Saharan Africa
VHT Village health team
WHO World Health Organization

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1186/s12889-026-29508-1.

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**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, contributed to interpretation of findings and writing of the manuscript. SIA, JA, DLE, RA, and FO supported data collection supervision, quantitative data management and statistical analysis and manuscript revision. JNK 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.

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

## 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. We obtained further clearance from the Uganda National Council for Science and Technology (UNCST) under approval number HS5968ES. Administrative permission was obtained from the relevant authorities of the participating districts, selected health facilities and local leaders. Written informed consent was obtained from all participants prior to the commencement of interviews. Confidentiality, anonymity, and voluntary participation were ensured throughout 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.

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