

RESEARCH

Open Access



General knowledge and attitude of healthcare professionals and infrastructural readiness prior to implementation of malaria vaccine in selected hospitals in Tororo district, Uganda: a cross-sectional study

Lillian Asio^{1*}, Innocent Besigye², Steven Sean Puleh³, Norah Nazziwa⁴ and Moses Ocan¹

Abstract

Background The introduction of malaria vaccines (RTS, S/SA01 and R21/Matrix-M) in malaria control brings hope for malaria burden reduction globally. Uganda is one of the countries that applied for support to introduce R21 malaria vaccine and expects to commence with its implementation in April/May 2025. However, as the country prepares for R21 malaria vaccine rollout, the extent to which hospitals are ready for its implementation remains unclear. This study therefore assessed the general knowledge, attitudes of all healthcare professionals regardless of their role in providing immunization services and infrastructural readiness prior to rolling out of R21 malaria vaccine in an endemic setting, Tororo district.

Methods This cross-sectional study was conducted at Tororo General hospital and St. Anthony Hospital in Tororo district. Data was collected before the vaccine was rolled out through interviews with purposively selected healthcare professionals irrespective of their role in vaccination programs. Additional data was collected through inspection of the hospital infrastructure for malaria vaccine implementation. Data on healthcare professionals' knowledge and attitudes was collected using self-administered questionnaires, while a checklist was used to capture data on the availability and functional state of the infrastructure in hospitals for vaccine roll-out. Fully completed questionnaires were entered into Epi-data version 4.7 for coding and cleaning, thereafter exported to STATA version 16 for analysis.

Results A total of 211 healthcare professionals were included into the study. The study participants had predominantly negative attitudes towards the malaria vaccine, with 70% (147/211, 95% CI: 63–76) displaying unfavorable attitudes compared to 30% (64/211, 95% CI: 25–37) with positive attitudes, and the overall mean score (SD) of 3.30 (0.489), many of whom expressed concerns about its affordability, accessibility and effectiveness. Knowledge on the malaria vaccine was notably low, with 99% (208/211, 95% CI: 96–100) of respondents demonstrating poor knowledge, while only 1% (3/211, 95% CI: 0.5–4.4) had good knowledge.

*Correspondence:

Lillian Asio
liliandoren22@gmail.com

Full list of author information is available at the end of the article



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

Conclusion The knowledge gap coupled with negative attitudes on malaria vaccine were prevalent among all healthcare professionals prior to the roll-out of R21 vaccine in Tororo district. There was limited preparedness as regards the infrastructure required for the malaria vaccine implementation. The Ministry of Health should consider conducting targeted training programs for all healthcare professionals and provision of additional essential infrastructure to accommodate the inclusion of the malaria vaccine roll-out with other routine vaccines.

Keywords Malaria vaccine implementation, Knowledge, Attitude, Infrastructure

Background

Malaria is a life threatening disease transmitted by mosquito and caused by the plasmodium parasite, and continues to pose a significant public health problem in many regions worldwide [1]. World Health Organization's (WHO) 2024 malaria report highlights that children below five years remain disproportionately affected by malaria, with 76% of global malaria deaths occurring in this age group; 95% of these were from Africa [2]. Uganda is one of the African countries that has registered a substantial increase in malaria cases over the past five years between 2019 and 2023 where Tororo district in eastern Uganda contributes to 48% of these cases [3].

Globally, several malaria control interventions have been implemented, including use of artemisinin-based combination therapy (ACT), indoor residual spraying (IRS), and Insecticide treated nets (ITNs) [4]. In Uganda, the use of IRS and ITNs led to a significant decline in malaria incidence in 2014, with IRS reducing cases by 97.6% and ITNs by 99.5% [4]. Despite the proven effectiveness of these interventions, malaria has remained a significant health challenge, particularly among children under five in Uganda [5]. The ongoing challenges to malaria control include the growing resistance to insecticides, and emerging partial resistance to ACTs [6]. The malaria vaccines have been the long-awaited dream interventions in the fight against malaria.

After several decades of research by GlaxoSmithKline (GSK), a British pharmaceutical company. In 2019, the first malaria vaccine RTS, S/AS01 (mosquirix), was piloted under the Malaria Vaccine Programme (MVP) in Ghana, Kenya, and Malawi [7]. To date, over 1.7 million children in these countries have received the vaccine, which has been shown to be safe and effective [8]. On October 2, 2023, WHO approved the inclusion of a second malaria vaccine, R21/Matrix-M for malaria control among children under five years following clinical trial findings that demonstrated an estimated efficacy of 68% with age based delivery and approximately 75% with seasonal administration, measured over a 12 months follow-up period after three doses [9]. R21 vaccine underwent clinical testing in four African countries; Burkina Faso, Kenya, Mali, and Tanzania and a total of 4,878 children aged 5 to 36 months received the vaccine in a four dosed manner. In December 2021 the MVP approved by the board of Gavi, the vaccine Alliance, expanded the rollout

of both R21 and RTS, S in Gavi-eligible countries, in areas of moderate and high malaria transmission. Uganda is one of the countries that applied for support to introduce malaria vaccines and is expected to rollout R21 in April/ May, 2025. As Uganda prepares for R21 vaccine rollout, the extent to which hospitals are ready for the vaccine implementation remains unclear. According to the Pan American Health Organization (PAHO), key factors for successful vaccine rollout include adequate preparation of health workers, strengthening of cold chain capacity, establishing safety surveillance systems for adverse events, expediting regulatory processes, and developing comprehensive national vaccination plans [10].

Although malaria vaccines have shown to be effective in clinical trials, their implementation and scale up in resource limited settings may face challenges similar to those encountered with other routine vaccines such as ensuring adequate infrastructure for transportation, cold chain system and availability of trained staff [11]. This study therefore assessed the general knowledge and attitudes of all healthcare professionals involved in patient care regardless of their role in immunization services, and infrastructural readiness of hospitals in Tororo district prior to implementation of the R21 vaccine.

Methods

Study design and participants

This was a cross-sectional study conducted at Tororo general hospital and St. Anthony hospital, eastern Uganda. Tororo district is approximately 208 km east of the capital, Kampala and was purposively selected since it is one of the areas where the vaccine will be rolled out in addition to fighting the malaria burden. The two hospitals were purposively selected based on the bed capacity and the catchment area they serve in Tororo district. The primary study unit was a hospital made up of healthcare professionals (HCPs) that are directly involved in patient care regardless of whether they were involved in providing immunization services or not and the key infrastructure needed for implementation of the malaria vaccine. Data was collected before the vaccine was rolled out with an aim to capture baseline data of general knowledge, attitudes and infrastructural readiness of these hospitals. The study population included HCPs such as clinicians, physicians, nurses, midwives, clinical officers, pharmacy technicians, pharmacists, and key administrative staff

like the medical superintendent of the hospitals, consultants, senior medical officers in charge of vaccination. Inventory of all available key infrastructure that would be used during the vaccination program was also assessed as summarized in Table 1 below. The target sample size was 384 HCPs. However, only 211 HCPs met the inclusion criteria (being 18 years or older, willing to provide consent and present at either hospital during the time of data collection).

Variables used in this study and their measurement are summarized in Table 1 below.

Data collection

Data was collected using self-administered questionnaires that was adopted and modified using information

Table 1 Summary of study variables

Variable	Type of variable	Measurement
Socio-demographics		
Age	Categorical	Age in completed years, self-reported
Hospital	Categorical (Nominal)	Self-reported hospital where the HCP serves
Gender	Categorical (Nominal)	Self-reported
Professional	Categorical (Nominal)	Self-reported
Qualification		
Education level	Categorical (Ordinal)	Self-reported
Years of work experience	Categorical	Self-reported complete years
Role in hospital vaccination program	Categorical (Nominal)	Self-reported
Knowledge refers to the understanding of the R21 malaria vaccine, which includes dosage, target age group, cold chain management and any associated side effects.		
Level of Knowledge of HCPs	Categorical (Good/Poor)	Self-reported, 12 knowledge items scored: correct = 1, wrong = 0; score ≥ 6 = Good knowledge, < 6 = Poor knowledge
Attitude refers to opinions or perceptions of health care professionals towards implementation of the malaria vaccine.		
Attitude towards malaria vaccine	Categorical (Positive/Negative)	Self-reported, 9 Likert scale items (1–5); Grand mean score ≥ 3.30 = Positive attitude, < 3.30 = Negative attitude.
Infrastructural readiness refers to the availability of health facility basic amenities (essential infrastructure such as reliable electricity, water source, communication equipment and access to transportation), essential equipment and Human resource (trained HCPs including vaccinators, cold chain handlers, and support staff) at Tororo general and St. Anthony hospitals.		
Infrastructural readiness	Categorical (Available/Not Available)	Facility checklist based on WHO SARA tool: Observed, reported, or Not Available

from a recent study [12]. The data collection tool was pre-tested at Tororo General Hospital among five HCPs and the identified errors were refined for clarity. This data was however not included in the main study sample as well as analysis. Data collection was done by trained research assistants who obtained informed consent, distributed the questionnaires to the HCPs and ensured that questionnaires were thoroughly checked for completeness before filing. The questionnaire collected information on sociodemographic characteristics, knowledge of the upcoming malaria vaccine and attitudes towards its implementation. Attitudes were scored using a Likert scale with five response options: strongly agree, agree, neutral, disagree and strongly disagree. Respondents selected the options that best represented their views.

In addition to the questionnaire, a checklist was employed to assess the readiness of the health facilities in terms of infrastructure. This checklist was adopted and modified from the WHO Service Availability and Readiness Assessment (SARA) tool and evaluated the availability of health facility basic amenities (essential infrastructure such as reliable electricity, water source, communication equipment and access to transportation), essential equipment, and Human resource (HR), these referred to availability of trained HCPs including vaccinators, cold chain handlers, and support staff) at Tororo general and St. Anthony hospitals. Infrastructure components were recorded as either observed, reported available or not available depending on whether they were physically verified by the research team or reported by the hospital staff. To ensure data accuracy, the research assistants (study nurses) were trained in both the questionnaire administration and infrastructure assessment processes, and measures were taken to minimize bias.

Data analysis

Data from fully completed questionnaires were entered into Epidata version 4.7 cleaned and coded, then exported to STATA version 16 for analysis. For knowledge assessment, each correct answer was awarded one point, with the total knowledge score ranging from 0 (with no correct answer) to 12 (all correct answers). Responses were categorized either as correct or wrong, with correct answers coded 'yes' and 'no' for the wrong answers. Overall knowledge was classified into two categories: good knowledge, defined as respondents who had an average score of ≥ 6 questions answered correctly out of 12 and poor knowledge defined as respondents who had an average score of < 6 questions answered correctly. Results were presented in form of frequencies and percentages.

For attitude assessment, participants' responses were measured using a Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Negatively phrased

Table 2 Sociodemographic characteristics of healthcare professionals in Tororo and St. Anthony general hospitals in Tororo district, April -May 2024 (N= 211)

Characteristic	Description	Frequency, n (%)
Age (years)	20–35	124 (59)
	36–50	53 (25)
	51+	34 (16)
Hospital	St. Anthony hospital	50 (24)
	Tororo general hospital	161 (76)
Gender	Male	92 (44)
	Female	119 (56)
Professional qualification	Nurse/Midwife	106 (50)
	Clinical officer	17 (8)
	Medical officer	32 (15)
	Laboratory technologist	18 (9)
	Pharmacist	8 (4)
Educational attainment	Others	30 (14)
	Certificate	79 (37)
	Diploma	75 (36)
	Bachelor's degree	44 (21)
Years of work experience	Graduate degree	13 (6)
	1–11	139 (66)
	12–24	49 (23)
Roles in hospital vaccination program	25+	23 (11)
	Cold chain management	22 (10)
	Administering vaccines	49 (23)
	Record keeping	16 (8)
	Monitoring and supervision	20 (10)
	Health promotion	18 (9)
	None	86 (40)

questions were reverse coded to ensure consistency. The individual scores for each study participant were summed, and with responses rated as 'strongly disagree', 'disagree' and neutral were categorized as negative attitude, while 'agree' and 'strongly agree' were considered for positive attitudes. Mean scores for each attitude item was computed and a grand mean was derived (3.30). A mean score of 3.30 or higher was considered as a positive attitude, while a mean score < 3.30 indicated a negative attitude. Therefore, the lower the attitude scores were, the higher the likelihood of negative attitudes and vice versa. Descriptive analysis, including frequencies, percentages and mean scores, was conducted to summarize the findings.

Results

Participants' demographic characteristics

A total of 211 healthcare professionals participated in this study. From Table 2 below, majority, 59% (124/211), were aged between 20 and 35 years, and 76% (161/211) were affiliated with Tororo general hospital. More than half, 56% (119/211) were female, and 50% (106/211) were nurses/midwives. Most participants, 66% (139/211) had

Table 3 Knowledge of health care professionals about the prospective malaria vaccine (N= 211)

Knowledge Item	Frequency n (%)
Have you heard of the prospective malaria vaccine?	
Yes	102 (48)
No	109 (52)
Which vaccine will be implemented in Uganda?	
R21	14 (7)
Don't know	197 (93)
What was your primary source of information about the malaria vaccine?	
Radio	36 (17)
MOH/HWs	30 (14)
None	102 (48)
Others	43 (21)
Are you aware of the recommended schedule for malaria vaccine to be implemented in Uganda?	
Yes	40 (19)
No	171 (81)
How many doses of malaria vaccine is recommended?	
4 doses	4 (10)
Don't know	207 (90)
What is the recommended schedule for malaria vaccine to be implemented in Uganda?	
6,7,8 & 18 months	16 (8)
Don't know	195 (92)
What is the target population for the vaccine?	
Children below 5 years	116 (55)
Don't know	95 (45)
What is the site of administration of this vaccine?	
Upper arm	24 (11)
Don't know	187 (89)
Are you aware of when the malaria vaccination will be in Uganda?	
Yes	4 (2)
No	207 (98)
Are you aware of the storage conditions of the malaria vaccine that will be used in Uganda?	
Yes	18 (8)
No	193 (91)
Have you had any training on the malaria vaccine by the MOH, Uganda?	
Yes	6 (3)
No	205 (97)
Are you aware of how to administer the malaria vaccine?	
Yes	8 (4)
No	203 (96)

between 1 and 11 years of professional experience, while 40% (86/211) had reported having no experience in vaccination programs.

Knowledge of health care professionals about the prospective malaria vaccine

Table 3 below shows that knowledge of respondents about the malaria vaccine was extremely low, with

Table 4 Attitude of health care professionals towards the prospective R21, vaccine for malaria control in Tororo district, April – May 2024 (N = 211)

Attitude Item	Proportion of respondents with positive attitude n (%)	Proportion of respondents with negative attitude n (%)	Mean score (SD)
I will take my children for malaria vaccination without hesitation.	181(86)	30 (14)	4.37(4.370)
I will encourage my patients/family/friends to vaccinate their children.	190(90)	21 (10)	4.37(4.379)
Malaria cannot be controlled without vaccination. There is need for the malaria vaccine	108(51)	103(49)	3.34(3.346)
Mass vaccination can reduce the mortality rate among children due to malaria	141(67)	70 (33)	4.00(4.009)
The best prevention method against malaria is to take the malaria vaccine	130(62)	81 (38)	3.72(3.720)
After vaccination against malaria other preventive measures can be avoided.	34 (16)	177(84)	2.26(1.225)
Malaria vaccine was tested adequately for its effectiveness.	74 (35)	137(65)	3.35(0.966)
Malaria vaccine is being implemented for financial reasons.	24 (11)	187(89)	2.46(1.029)
It's preferable to acquire immunity against malaria naturally than by vaccination.	53 (25)	158(75)	2.72(1.199)
Malaria vaccine will not be affordable and accessible by the common person	32 (15)	179(85)	2.37(1.154)

SD Standard deviation

Table 5 Health facility infrastructure for supporting malaria vaccination at Tororo general and St. Anthony hospitals, Tororo district, Uganda

Domain	Indicator (Planned to accommodate the additional malaria vaccine)	Observed available		Reported available		Not available	
		TGH	SAH	TGH	SAH	TGH	SAH
Basic Amenities	Communication equipment					✓	✓
	Access to computer					✓	✓
	Transportation					✓	✓
Basic Equipment	Vaccine carriers/cold box	(7)	(3)				
	Temperature monitoring tools	✓	✓				
	Refrigerator of (2 °C to 8° C)	(2)	(1)				
	Stable power source (electricity & generator)	✓	✓				
	Child scale	(1)	✓				
	BP apparatus	(1)					✓
	Immunization cards indicating malaria vaccine schedule					✓	✓
	Immunization tally sheets					✓	✓
	AE reporting tools highlighting malaria vaccine					✓	✓
Infection prevention	Containers for storage of sharps & infectious wastes	✓	✓				
	Personal Protective Equipment for HCPs					✓	✓
Staff and guidelines	Guidelines for malaria vaccination					✓	✓
	Additional staff dedicated for routine immunization	(2)	(5)	✓	✓		

TGH Tororo general hospital, SAH St. Anthony hospital

overall proportions of poor and good knowledge at 99% (208/211, 95%CI: 96–100), 1% (3/211, 95%CI: 0.5–44) respectively. This finding is likely due to the fact that this study was conducted before the implementation of the malaria vaccine and healthcare professionals had not yet been trained.

Attitude of healthcare workers towards malaria vaccine in Tororo district, Eastern Uganda

Table 4 below summarizes the attitude of respondents towards the malaria vaccine. Attitude was generally bad, with overall proportions of bad and good attitude at 70% (147/211, 95%CI: 0.631–0.755), 30% (64/211, 95%CI: 0.245–0.369) respectively, and grand mean score (SD) of

3.30 (0.489). This outcome may also be explained by the fact that this study was conducted prior to the implementation of the malaria vaccine. At this time, participants had not yet received training on the vaccine which likely contributed to the observed bad attitudes.

Health facility infrastructure for supporting malaria vaccination at Tororo general and St. Anthony hospitals

Generally, no additional basic amenities, basic equipment, or human resources required to accommodate the additional malaria vaccination program were observed at either hospital, as summarized in Table 5 below. The infrastructure that was available is what was being used to support the routine vaccination programs. And among

the infrastructure that were observed available and in a functional state at Tororo general hospital were 7 vaccine carriers, 1 child scale, 1 BP apparatus, and 2 refrigerators at a temperature of (2 °C to 8 °C) under a stable power source (electricity and an automatic generator as an alternative), with a thermometer and monthly updated temperature log sheets. While in St. Anthony hospital the following were observed available and in functional state; 3 vaccine carriers, one refrigerator at a temperature of (2 °C to 8 °C) under a stable power source (electricity and an automatic generator as an alternative), with a thermometer and monthly updated temperature log sheets. The refrigerators in both hospitals contained other vaccines and ice packs that are routinely used at the facilities with very minimal space to accommodate any additional vaccines. Additionally, only two staff were reported available as dedicated staff for routine child immunization at Tororo general hospital and 5 staff for St. Anthony hospital.

Discussion

Level of knowledge of health care professionals

This study is among the first in Uganda to assess healthcare professionals' general knowledge, attitudes, and infrastructural readiness before implementing a health intervention. While most prior research have focused on caregivers' willingness to accept the vaccine, our findings reveal an alarmingly low level of knowledge among all HCPs, with 99% demonstrating poor understanding of the vaccine. This knowledge gap may be attributed to the fact that 40% of the study participants had no prior training on the malaria vaccine that was yet to be introduced. In contrast to our findings, a study conducted among healthcare workers in Maharashtra, India, reported that 90% had knowledge about COVID-19 vaccines [13]. The variation in the findings could be because the malaria vaccine had not yet been rolled out in Uganda at the time of this study and HCPs may not have had much information about the malaria vaccine. This therefore indicates a need for dissemination of information about a new health intervention like the malaria vaccine prior to its implementation to all HCPs.

A major knowledge gap identified in our study is that majority of HCPs had never heard of the malaria vaccine, were unaware of its storage conditions and lacked information on its administration. These gaps highlight the need for increased communication and training from the ministry of health in Uganda before roll out of the vaccine. Similar challenges were observed in Ghana during the pilot phase of the malaria vaccine where inadequate sensitization and training for all healthcare professionals prior to implementation of the malaria vaccine were noted as key obstacles [14]. In Kenya, gaps in HCPs' understanding of the malaria vaccine's four dose schedule

were addressed through consistent training programs, which significantly improved the vaccine delivery [15].

Despite the overall low level of knowledge among HCPs, more than half of them knew the target population as children below five years, this is a positive indication that targeted training would help fill the knowledge gaps. Elsewhere, evidence suggest that training programs for all HCPs can significantly influence uptake of health interventions and patient trust [16].

Attitudes of health care professionals

Our study found that HCPs exhibited a generally negative attitude towards the implementation of the upcoming malaria vaccine, with many expressing concerns about its affordability and accessibility. Notably, 89% of the respondents believed that the malaria vaccine was being introduced for financial reasons and therefore would not be affordable and accessible by the general population. This align with findings from a study conducted in Nigeria, where caregivers similarly expressed concerns about the vaccine cost [17]. Research has shown that cost-related barriers often limit the success of health interventions in low resource settings [18]. Therefore, affordability and accessibility should be key considerations in the vaccine rollout to avoid hampering uptake.

Another significant concern is that in 75% of the HCPs acquisition of natural immunity against malaria is preferred to vaccination, and 65% doubted the vaccine's effectiveness. This negative attitude is likely a consequence of the knowledge gaps; as previous research suggests that a lack of knowledge contributed to poor attitudes. HCPs are often the most trusted source of information on vaccination for communities [19], underscoring the importance of training all patient-care HCPs irrespective of their role in providing immunization services, because their awareness and attitude may significantly influence vaccine uptake and patient trust.

Despite the safety, accessibility and affordability concerns, 86% of HCPs indicated they would vaccinate their own children against malaria and 6% believed that mass vaccination would reduce mortality among children under five years. This willingness is promising for vaccine uptake and suggests that, with the right intervention, HCPs can play a pivotal role in promoting the vaccine. A similar finding was reported in Nigeria, where 92% of the healthcare professionals were willing to vaccinate their children [20].

Availability of critical infrastructure required for implementation of the prospective malaria vaccine

Our findings revealed a lack of additional critical infrastructure at both Tororo General Hospital and St. Anthony's Hospital that would accommodate the implementation of the malaria vaccination program with

other routine vaccines. Available infrastructure primarily supported routine vaccination programs, with significant deficiencies in basic amenities like communication equipment and transportation, as well as essential equipment such as immunization tally sheets, immunization cards for the malaria vaccine, refrigerators to accommodate additional malaria vaccine doses and adverse event reporting tools. Similar challenges were observed in Ghana, where inadequate cold chain resources and transportation which impeded malaria vaccine delivery [14]. While functional refrigerators for vaccine storage were present, their limited capacity may pose logistical challenges as additional doses of malaria vaccines are introduced. Moreover, the limited number of staff dedicated to the malaria vaccination program could hinder its effectiveness. In Bangladesh, health facilities with sufficient vaccine storage capacity and dedicated staff reported higher levels of service delivery [21]. Readiness for any vaccination program depends on the availability of skilled healthcare professionals, adequate medical equipment, and diagnostic capacity [22], suggesting that significant efforts are needed to address these infrastructural bottlenecks before implementing the malaria vaccine in Uganda.

Limitations

Our study had a number of limitations: (1) The participants may have provided responses they deemed socially acceptable, leading to overestimated knowledge and positive attitudes. To mitigate that, we assured them of anonymity, and triangulate with objective assessments. (2) The study focused on only two hospitals, limiting generalizability of the findings across the whole country. We advise that future studies can expand to more hospitals and use probability sampling methods. (3) Although the initial target sample was 384, only 211 eligible and available health care professionals were enrolled. While this reduced sample size may have affected precision and generalizability of descriptive estimates, it does not compromise the study's objectives. We suggest that future studies can extend data collection period and employ targeted recruitment strategies as well as assess associations between variables which can help identify factors that affect knowledge and attitudes. (4) We only managed to conduct a quantitative study that was fully descriptive. We advise future studies to include qualitative data from key immunization officials for in-depth information and also consider an analytical study design that assess association of HCPs' knowledge and attitude to preparedness for implementation of the vaccine. (5) This study assessed general Knowledge and attitudes among all HCPs irrespective of their role in immunization services; we recommend future studies to focus specifically

on immunization staff or compare findings across cadres to tailor capacity-building efforts.

Policy and practice implications

The study findings have important implications for malaria vaccine rollout in Uganda, East Africa, and Sub-Saharan Africa. In Uganda, the very low knowledge and negative attitudes among healthcare professionals emphasize the need for targeted training, sensitization, and strengthening of cold chain and reporting systems with the R21 vaccine introduction. For East Africa, regional collaboration through the EAC could harmonize guidelines, strengthen infrastructure, and facilitate shared learning across countries with similar challenges. More broadly in Sub-Saharan Africa, the results highlight systemic gaps in health system readiness for new vaccines, calling for investments in supply chains, human resource training, and public education to enhance healthcare worker and community confidence in the malaria vaccine.

Conclusion

There is a notably low level of awareness among HCPs regarding the upcoming malaria vaccine rollout. And furthermore, there is limited preparation for additional infrastructure required for implementation of the malaria vaccine in Tororo district. While some of the HCPs are not directly involved in immunization services, their general knowledge and attitudes toward the vaccine are critical as they significantly influence vaccine uptake, public trust and overall institutional readiness. We therefore recommend implementation of targeted training programs to all patient-care HCPs and investment in additional essential infrastructure.

Abbreviations

HCPs	Healthcare professionals
MVIP	Malaria vaccine implementation program
ACT	Artemisinin-based combination therapy
IRS	Indoor residual spray
LLINs	Long-lasting insecticide treated nets
WHO	World health organization

Acknowledgements

We would like to acknowledge all the Healthcare Professionals at Tororo general and St. Anthony hospitals who participated in the study. And additionally, the study nurses who assisted in data collection.

Authors' contributions

AL, MO & IB designed the study. AL, IB & MO conceptualization of the analysis. NN & SSP analyzed the data. All authors interpreted the results. AL & NN wrote the first draft of the manuscript. MO, IB & SSP contributed to the critical review & editing of the manuscript. All authors approved the final manuscript.

Funding

This study was not supported with funds from any organization or institution.

Data availability

The datasets used and/or analyzed during the current study are not publicly available but upon reasonable request from corresponding authors, can be availed.

Declarations**Ethics approval and consent to participate**

This study was conducted using principles of the revised Declaration of Helsinki. Furthermore, ethical approval was sought from School of Biomedical Sciences Research and Ethics Committee (SBS-REC) at the college of Health Sciences, Makerere University (Approval number SBS-2023-493). Further permission was obtained from the Tororo district and the study hospitals (Tororo general hospital and St. Anthony hospital). A written Informed consent was obtained from all study participants prior to enrolment into the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Clinical trial number

Not applicable.

Author details

¹Department of Pharmacology and Therapeutics, College of Health Sciences, Makerere University, Kampala, Uganda

²Department of Family Medicine, College of Health Sciences, Makerere University, Kampala, Uganda

³Department of Epidemiology and Biostatistics, Faculty of Public Health, Lira University, Lira, Uganda

⁴Department of Epidemiology and Biostatistics, School of Public health, Makerere University, Kampala, Uganda

Received: 17 February 2025 / Accepted: 21 August 2025

Published online: 09 October 2025

References

- Colón-González FJ, Sewe MO, Tompkins AM, Sjödin H, Casallas A, Rocklöv J, et al. Projecting the risk of mosquito-borne diseases in a warmer and more populated world: a multi-model, multi-scenario intercomparison modelling study. *Lancet Planet Heal*. 2021;5(7):e404–14.
- Jobe AH. Helping babies breathe. *J Pediatr*. 2012;160: A6.
- Oguttu DW, Matovu JKB, Okumu DC, Ario AR, Okullo AE, Opigo J, et al. Rapid reduction of malaria following introduction of vector control interventions in Tororo district, Uganda: a descriptive study. *Malar J*. 2017;16(1):1–8.
- Kamya MR, Kakuru A, Muhindo M, Arinaitwe E, Nankabirwa JJ, Rek J, et al. The impact of control interventions on malaria burden in young children in a historically high-transmission district of Uganda: a pooled analysis of cohort studies from 2007 to 2018. *Am J Trop Med Hyg*. 2020;103(2):785–92.
- Kigozi SP, Kigozi RN, Epstein A, Mpimbaza A, Sserwanga A, Yeka A, et al. Rapid shifts in the age-specific burden of malaria following successful control interventions in four regions of Uganda. *Malar J*. 2020;19(1): 128. <https://doi.org/10.1186/s12936-020-03196-7>.
- Carnevale P, Mangun S. Review of issues on residual malaria transmission. *J Infect Dis*. 2021;223(12 Suppl 2):S61–80.
- Okyere J, Bediako VB, Ackah JA, Acheampong E, Owusu BA, Agbemavi W et al. RTS,S/AS01E vaccine defaults in Ghana: a qualitative exploration of the perspectives of defaulters and frontline health service providers. *Malar J*. 2023;22(1):1–10. Available from: <https://doi.org/10.1186/s12936-023-04690-4>.
- Mumtaz H, Nadeem A, Bilal W, Ansar F, Saleem S, Khan QA, et al. Acceptance, availability, and feasibility of RTS, S/AS01 malaria vaccine: a review. *Immunity Inflamm Dis*. 2023;11(6): e899.
- Aderinto N, Olatunji G, Kokori E, Sikirullahi S, Aboje JE, Ojabo RE. A perspective on Oxford's R21/Matrix-M™ malaria vaccine and the future of global eradication efforts. *Malar J*. 2024;23(1):21–4. Available from: <https://doi.org/10.1186/s12936-024-04846-w>.
- Merle CS, Badiane NA, Affoukou CD, Affo SY, Djogbenou SL, Hounto A, et al. Implementation strategies for the introduction of the RTS,S/AS01 (RTS,S) malaria vaccine in countries with areas of highly seasonal transmission: workshop meeting report. *Malar J*. 2023;22(1):1–14.
- Olawade DB, Wada OZ, Ezeagu CN, Aderinto N, Balogun MA, Asaolu FT, David-Olawade AC. Malaria vaccination in Africa: a mini-review of challenges and opportunities. *Medicine*. 2024;103(24):e38565. <https://doi.org/10.1097/M00000000000038565>.
- Elhadi M, Alsoufi A, Alhadi A, Hmeida A, Alshareea E, Dokali M, et al. Knowledge, attitude, and acceptance of healthcare workers and the public regarding the COVID-19 vaccine: a cross-sectional study. *BMC Public Health*. 2021;21(1):1–21.
- Bassi S, Bahl D, Thapliyal N, Maity H, Marathe SD, Prakshale BB, et al. COVID-19 vaccine knowledge, attitudes, perceptions and uptake among healthcare workers of Pune district, Maharashtra. *J Glob Health Rep*. 2022;6:1–9.
- Grant J, Gyan T, Agbokey F, Webster J, Greenwood B, Asante KP. Challenges and lessons learned during the planning and early implementation of the RTS,S/AS01E malaria vaccine in three regions of Ghana: a qualitative study. *Malar J*. 2022;21(1):1–12. Available from: <https://doi.org/10.1186/s12936-022-04168-9>.
- Hill J, Bange T, Hoyt J, Kariuki S, Jalloh MF, Webster J, et al. Integration of the RTS,S/AS01 malaria vaccine into the essential programme on immunisation in Western Kenya: a qualitative longitudinal study from the health system perspective. *Lancet Glob Heal*. 2024;12(4):e672–84.
- Adams LB, Richmond J, Watson SN, Cené CW, Urrutia R, Ataga O, et al. Community health worker training curricula and intervention outcomes in African American and Latinx communities: a systematic review. *Health Educ Behav*. 2021;48(4):516–31.
- Chukwuocha UM, Okorie PC, Iwuoha GN, Ibe SN, Dozie IN, Nwoke BE. Awareness, perceptions and intent to comply with the prospective malaria vaccine in parts of South Eastern Nigeria. *Malar J*. 2018;17(1):1–7. Available from: <https://doi.org/10.1186/s12936-018-2335-0>.
- Yenet A, Nibret G, Tegegne BA. Challenges to the availability and affordability of essential medicines in African countries: a scoping review. *Clinicoecon Outcomes Res*. 2023;15:443–58.
- Loftus R, Sahm LJ, Fleming A. A qualitative study of the views of healthcare professionals on providing vaccines information to patients. *Int J Clin Pharm*. 2021;43(6):1683–92.
- Agyei-Baffour P, Asare M, Lanning B, Koranteng A, Millan C, Commeh ME, et al. Human papillomavirus vaccination practices and perceptions among Ghanaian healthcare providers: a qualitative study based on multi-theory model. *PLoS One*. 2020;15(10):e0240657.
- Shawon MSR, Adhikary G, Ali MW, Shamsuzzaman M, Ahmed S, Alam N, et al. General service and child immunization-specific readiness assessment of healthcare facilities in two selected divisions in Bangladesh. *BMC Health Serv Res*. 2018;18(1):39.
- Oyekale AS. Assessment of primary health care facilities' service readiness in Nigeria. *BMC Health Serv Res*. 2017;17(1):172.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.