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Jude Che Anye, Loveline Lum Niba, Omarine Njimanted, Eugene Enah Fang, Ndundat Ahmed Chafa, Ebua Gallus Fung, Helen Kuokuo Kimbi

Corresponding author: Jude Che Anye, Department of Public Health, University of Bamenda, Bamenda, Cameroon. anyechejude@gmail.com

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Enhancing malaria vaccine, RTS,S/AS01 rollout for under-5 children in the South West Region of Cameroon: roles, challenges, and strategies of healthcare workers and managers (a qualitative study)

Jude Che Anye[1,&], Loveline Lum Niba[1], Omarine Njimanted[2], Eugene Enah Fang[3], Ndundat Ahmed Chafa[3], Ebua Gallus Fung[4], Helen Kuokuo Kimbi[5,6]

[1]Department of Public Health, University of Bamenda, Bamenda, Cameroon, [2]Department of Medical Laboratory Science, University of Bamenda, Bamenda, Cameroon, [3]Department of Microbiology and Parasitology, University of Buea, Buea, Cameroon, [4]Department of Sociology and Anthropology, University of Buea, Buea, Cameroon, [5]Department of Biomedical Sciences, University of Bamenda, Bamenda, Cameroon, [6]Department of Animal Biology and Conservation, University of Buea, Buea, Cameroon

[&]Corresponding author

Jude Che Anye, Department of Public Health, University of Bamenda, Bamenda, Cameroon

Abstract

Introduction: *malaria remains a major cause of morbidity and mortality among children under five in Cameroon. The recent introduction of the malaria vaccine, RTS,S/AS01 marks significant progress in malaria control. However, its success depends on the effective roles of healthcare workers and managers in implementation. This study explored their perceptions, roles, and challenges during the pilot rollout in the South West Region (SWR) of Cameroon.* ***Methods:*** *a qualitative exploratory design was used, involving focus group discussions and key informant interviews with healthcare workers and managers engaged in the malaria vaccine rollout program in the SWR of Cameroon. Data were thematically analyzed to identify key roles, barriers, and strategies for enhancing uptake and sustainability.* ***Results:*** *healthcare workers exhibited positive attitudes, moderate-to-high knowledge, and strong willingness to promote the malaria vaccine. Yet, knowledge gaps particularly on side effects and effectiveness along with vaccine shortages, limited community sensitization, and parental hesitancy impeded full implementation. Managers reported strong vaccine availability but poor accessibility due to difficult terrain, logistical challenges, and inadequate funding. Leadership through supervision, training, and data-driven monitoring was critical to sustaining coverage, though policy rigidity and infrastructural deficits limited scalability.* ***Conclusion:*** *strengthening the capacity, motivation, and autonomy of healthcare workers and managers is essential to sustain malaria vaccine implementation. Enhanced training, community engagement, flexible policies, and logistical support will promote equitable access and long-term program success. These findings provide context-specific insights/strategies to guide the national scale-up of the malaria vaccine across Cameroon.*

Introduction

Malaria is an infectious disease caused by *Plasmodium* parasites and is transmitted to humans through the bite of an infected female *Anopheles* mosquito. It remains one of the world´s most significant public health challenges, with sub-Saharan Africa bearing the greatest burden of morbidity and mortality, particularly among children under five years of age [1,2]. Despite ongoing global and national control efforts, malaria still accounts for more than 220 million cases and approximately 620,000 deaths annually worldwide [3,4]. Sub-Saharan Africa disproportionately carries 93.6% of all malaria cases and 95.4% of malaria-related deaths, with 78.1% of these occurring in children under five [5,6]. Cameroon remains among the 15 most affected countries, where malaria is the leading cause of morbidity and mortality in young children. In the country, malaria contributed to about 3% of global cases and 1.9% of global malaria deaths in 2023 [7,8]. These figures highlight its persistent threat to child health and national development.

Nationally, it accounts for nearly half of hospital admissions, and 65% of these involve children below five years [9,10]. As of 2020, 66.5% of its reported cases were classified as severe [10], thereby urgently requiring control measures. Multiple preventive strategies, including long-

lasting insecticidal nets (LLINs), environmental hygiene measures, indoor residual spraying, and chemoprophylaxis, have been implemented with varying degrees of success [1]. Although these interventions have contributed to reducing transmission, gaps in accessibility, adherence, and sustained use persist, especially among caregivers [1,7]. These limitations underscore the need for complementary approaches.

A major milestone in malaria control occurred in October 2023 when the World Health Organization endorsed the RTS,S/AS01 vaccine for children in high-risk areas. The vaccine has shown approximately 40% reduction in malaria episodes and a significant decline in severe *Plasmodium falciparum* malaria [5,6]. However, vaccine uptake in many African settings remains suboptimal due to socio-economic, cultural, and health-system barriers [8,11]. Challenges such as limited awareness, misconceptions, weak service delivery systems, and logistical constraints continue to hinder effective uptake [8]. To ensure equitable introduction of the vaccine, a WHO framework prioritized 12 high-burden countries, including Cameroon, for initial vaccine allocation [12,13]. Cameroon integrated the malaria vaccine into its Expanded Programme on Immunization (EPI) in 48 high-burden health districts for the pilot phase [1]. In the South West Region, the districts of Limbe, Tiko, and Mamfe were chosen due to their elevated morbidity and mortality among children under five [13].

Healthcare workers and managers play essential roles in vaccine rollout. Frontline providers, including clinicians, nurses, immunization personnel, and community health volunteers, support caregiver counselling, dose administration, safety monitoring, and the completion of multi-dose schedules [14,15]. Community health volunteers further extend services to rural and peri-urban settings, although their effectiveness depends on adequate training, supportive supervision, and motivation [16]. Pharmacists and cold-chain technicians ensure vaccine potency through proper storage and logistics, while managers and policymakers provide governance, resource allocation, and oversight necessary for integration into routine EPI systems [15-19].

Despite these coordinated efforts, several operational and sociocultural barriers persist. Operational constraints include cold-chain gaps, unreliable transportation, power instability, staffing shortages, and heavy workloads. Sociocultural barriers such as misinformation, mistrust, limited caregiver knowledge, and confusion between malaria vaccination and other prevention methods also reduce demand. Weak data systems, inconsistent communication strategies, decentralization difficulties, and inadequate funding further complicate implementation at district and facility levels [14,20,21]. Given the critical roles of healthcare workers and managers in the success of the pilot malaria vaccine program, there is a need to better understand their knowledge, experiences, and challenges within the South West Region of Cameroon.

Objective of the study: this study set out to investigate the roles played by healthcare workers and managers and challenges faced in the strategic implementation of malaria vaccine programs to enhance uptake for Children under 5 years in the South West Region of Cameroon. This was achieved by working with healthcare workers/managers to get their perceptions on the rollout of the pilot phase of the program in the region.

Methods

Study design and setting: this study employed an exploratory qualitative design to examine roles, challenges, and strategies of healthcare workers/managers in the malaria vaccine rollout. The qualitative component formed part of a larger mixed-methods research project aimed at understanding and improving malaria vaccine uptake in the South West Region of Cameroon.

Data were collected in 3 purposively selected communities - two urban and one rural within high-burden health districts participating in Cameroon´s pilot introduction of the RTS,S/AS01 malaria vaccine [5].

Study population and sampling: the study population consisted of healthcare workers and healthcare managers involved in malaria prevention and immunization services within the selected districts and at the regional level. A total of ten health care workers participated, comprising nurses, midwives, psychosocial workers, community health workers, and a medical laboratory technician from both public and private health facilities. Their ages ranged from 31 to 50 years, and they had 5 to 25 years of professional experience, with the majority having more than six years in service. In addition, eight health care managers were included in the study. This group consisted of five males and three females, aged 39 to 52 years, all occupying senior administrative or managerial positions within district health services and at the regional level. Their roles included Chief of Integrated Health Centre, Chief of Centre, Chief of Bureau Health, district or regional malaria coordinator, and Expanded Programme on Immunization (EPI) focal persons. The managers had 10 to 22 years of professional experience, reflecting extensive involvement in health system leadership and governance. These participants represented diverse administrative units, offering perspectives from both clinical management and health administration.

A purposive sampling technique was employed to recruit participants with direct experience in malaria prevention and malaria vaccine implementation. Participants were selected based on their involvement in the rollout and management of vaccination services. Two focus group discussions (FGDs) were conducted: one with healthcare workers and another with healthcare managers. The FGDs comprised 8 healthcare workers and 7 healthcare managers, yielding a total of 15 participants across both groups. To further enrich the depth of information and capture perspectives from individuals with specialized knowledge and operational responsibilities in vaccine delivery, three additional participants (two healthcare workers and one healthcare manager) were purposively selected for in-depth interviews (IDIs). This resulted in an overall sample size of 18 participants. Sample size determination followed the principle of data saturation rather than statistical representativeness, consistent with qualitative research standards. Recruitment ceased at 18 participants, as thematic saturation was achieved, with no new concepts or insights emerging during the final interviews and discussions.

Among the healthcare workers, eight participants were recruited from both public and private health facilities across two health areas in Mamfe, while two additional healthcare workers from the Tiko and Limbe Health Districts participated in in-depth interviews. These individuals were selected due to their leadership roles in key vaccination units at the facility level and their extensive experience in immunization service delivery. The urban districts of Tiko and Limbe are geographically proximate and share similar sociocultural characteristics, health-seeking behaviors, and service delivery contexts, allowing for meaningful comparison while minimizing unnecessary duplication. The seven healthcare managers were drawn from various levels of the health system, including health facilities within Mamfe Health District, the District Health Services of Mamfe, Tiko, and Limbe, and one participant from the Regional Delegation of Public Health. This ensured representation across facility, district, and regional level decision-making, thereby providing diverse managerial perspectives. Consequently, all three health districts involved in the pilot rollout of the RTS,S/AS01 malaria vaccine in the South West Region were represented. Two FGDs were conducted to explore shared norms, experiences, and group dynamics among healthcare workers and managers, while the three in-depth interviews

enabled deeper exploration of specialized roles and sensitive operational experiences. This combined approach enhanced both the breadth and depth of understanding of malaria vaccine implementation within the study context.

Eligibility criteria: participants were eligible for the study if they were healthcare workers who had been involved in malaria prevention activities for at least one year, or healthcare managers working within government health departments, non-governmental organizations, or private health facilities. Healthcare managers were additionally required to have a minimum of two years of experience in public health or malaria control programs. Individuals from either group were excluded if they did not meet the required level of experience or if they declined to provide informed consent to participate in the study.

Recruitment procedures: based on the eligibility criteria, participants were identified through collaboration with the district chief of service and the chief of bureau health in identifying eligible healthcare workers and managers across different healthcare facilities (public and private) and health areas.

Data collection procedure

Qualitative study approach (healthcare workers and healthcare managers): the focus group discussion (FGD) and interview guides were developed for each participant category and used at the selected health facilities during data collection. These tools enabled the research team to explore participants´ perceptions of malaria vaccine awareness, acceptance, uptake, and perceived efficacy. They also captured the roles played by respondents in the vaccine rollout, the challenges encountered during implementation, and their views on strategies that could be integrated into a proposed framework aimed at supporting healthcare providers in optimizing malaria vaccine uptake. The guides were adapted from previous qualitative studies relevant to this research context, with necessary modifications to ensure contextual appropriateness [22-25]. They directed data collectors on the key issues and questions to explore with healthcare managers, particularly regarding their roles and challenges in the strategic rollout of the malaria vaccination program. Participants included healthcare workers and managers of varying ages, facility types, and professional roles. These ranged from community health workers to nurses, laboratory technicians, Chiefs of Health Centres, and District Chiefs of Service, all of whom contributed to the discussions. Information from participants was collected through audio recordings and note-taking, which was later on transcribed verbatim.

Pre-testing of tool: the data collection tool designed by the investigator was pre-tested two weeks before the start of the main research amongst 12 healthcare workers/managers (6 in each group) in the Bonjongo health area in the South West Region, which wasn´t part of the study, to ensure data quality and validity of the data collection tool. This was to help correct lapses and errors on the data collection tool before the final printing of the tool in order to make the tool valid and reliable.

Transcription and translation: recordings were transcribed verbatim. Pidgin English responses were translated into English by bilingual researchers. Accuracy was ensured through cross-checking by an independent reviewer

Data management and analysis: thematic analysis following Braun and Clarke´s phases was used. An inductive-deductive approach guided coding. A preliminary codebook was developed and applied using NVivo 12. Two analysts independently coded transcripts, with 10% double-coded for triangulation. Themes were refined collaboratively. This was to reduce bias and revise the themes that might have occurred due to discrepancies and unexpected findings. The entire team subsequently reviewed the generated themes to ensure that they reflect respondents´ ideas as opposed to the likelihood of bias often

associated with a single analyst, to ensure clarity and trustworthiness.

Ethical considerations: ethical approval for the study was obtained from the University of Bamenda Institutional Review Board hosted by the Faculty of Health Sciences (Ref. 2025/0002H/Uba/IRB) and the South-West Regional Ethics Committee for Human Health Research (Ref. No. 771/CRERSH/SW/C/09/2025), alongside an authorization from the South-West Regional Delegation of Public Health. Written informed consent was obtained from all participants before each focus group discussion or in-depth interview, after the study objectives and procedures were clearly explained to them. Verbal consent was further sought for audio recording. Confidentiality was ensured through the use of identification codes, with no names or facility identifiers disclosed, and participants were free to express themselves in any preferred language, including Pidgin English. The study posed no major risks, and all participants were treated equally and fairly throughout the research process.

Results

Sociodemographic characteristics of health care workers/managers: a total of ten health care workers participated in the discussion. Their ages ranged from 31 to 50 years, representing a mature and experienced workforce. The group was composed of nurses, midwives, psychosocial workers, community health workers, and a medical laboratory technician working in both public and private clinics. Years of professional experience amongst the health care workers ranged from 5 to 25 years, with most participants having over 6 years of service in their respective positions. As for health care managers, eight took part in the discussion, comprising five males and three females, aged between 39 and 52 years. All participants held senior administrative or managerial roles within the district health services and facilities, including positions such as Chief of Integrated Health Center, Chief of Bureau Health, Chief of Center, and regional coordinator for malaria, Focal point in charge of Expanded program of immunization, etc. Their years of experience ranged from 10 to 22 years, reflecting a highly seasoned managerial group with long-standing involvement in health system governance. The managers represented various administrative units within the district, bringing perspectives from both clinical leadership and health administration.

Findings from healthcare workers (FGDs and in-depth interviews)

Evaluation on how healthcare workers' knowledge, attitudes, and practices regarding malaria vaccination influence their ability and willingness to recommend the vaccine to mothers and caregivers (qualitative approach): healthcare workers generally demonstrated favourable attitudes and willingness to support the rollout of the RTS,S/AS01 malaria vaccine, supported by moderate-to-high baseline knowledge of its purpose and target population. Most participants understood that the vaccine reduces malaria severity rather than providing complete protection. However, knowledge gaps persisted, particularly regarding expected side effects, management of post-vaccination reactions, and interpretation of vaccine effectiveness, which at times limited the clarity of caregiver counselling. Perception of effectiveness of the malaria vaccine was largely based on routine clinical observations and laboratory trends, with participants reporting fewer malaria-confirmed cases among vaccinated children. Some of the healthcare workers expressed caution in attributing these trends solely to vaccination, noting seasonal variations in malaria transmission and the absence of structured effectiveness monitoring at the facility level.

In terms of practice, malaria vaccine promotion was mainly embedded within routine service delivery, often occurring opportunistically during facility visits rather than through sustained outreach. Workload pressures, intermittent

vaccine stock-outs, especially in private clinics, limited community sensitization, and caregiver hesitancy influenced the consistency of vaccine recommendations by healthcare workers. Fear and misinformation, sometimes linked to prior COVID-19 vaccine experiences, were also frequently reported, as stated by the healthcare workers, though resistance was perceived to decrease following appropriate explanation and reassurance of caregivers. Participants highlighted the need for continuous professional training, strengthened community engagement, improved communication on side effects, and reliable vaccine supply, especially in private clinics, to enhance confidence and uptake. A detailed thematic presentation with illustrative quotes from both FGDs and in-depth interviews is provided in Table 1and Table 1.1.

Findings from healthcare managers (FGDs and in-depth interviews)

Investigation of the perspectives of healthcare managers on the strategic implementation of malaria vaccination programs with emphasis on the challenges they face in ensuring vaccine availability and accessibility in the target communities: the analysis explored the experiences, strategies, and challenges faced by healthcare managers in planning, coordinating, and implementing malaria vaccination programs in the South West Region. Emphasis was placed on identifying barriers to vaccine availability and accessibility, systemic issues, and strategic solutions proposed by managers.

Presentation of findings

Healthcare managers reported adopting a coordinated implementation approach that combined routine immunization services, outreach activities, and periodic campaigns to ensure coverage of eligible children. The malaria vaccine schedule was described as fully integrated within the Expanded Programme on Immunization, with managers providing oversight through supervision, coordination, training, and performance monitoring. Although vaccine availability at the district level was reported to be generally adequate, participants emphasized persistent accessibility challenges, particularly in remote and crisis-affected areas. These challenges were attributed to difficult terrain, insecurity, population displacement, inadequate cold-chain infrastructure, and limited electricity supply, which constrained last-mile delivery despite planned allocation mechanisms. Additional barriers included human resource shortages, delayed reimbursement of operational costs, and policy rigidity, which limited adaptive responses to local contexts. Managers also noted that caregiver misinformation increased counselling time and staff workload, indirectly affecting service efficiency.

Monitoring relied primarily on routine health information systems like DHIS2, enabling tracking of coverage and identification of drop-out between doses. However, the use of outcome data to assess vaccine impact (morbidity/mortality) was reported to be limited. To strengthen implementation, managers proposed enhanced community sensitization, improved logistics and cold-chain support, increased staffing and motivation, flexible funding mechanisms, and context-responsive policy adjustments. A detailed thematic summary with supporting quotations is presented in Table 2.

Discussion

This exploratory qualitative study examined the perceptions, experiences, roles, and challenges of healthcare workers (HCWs) and healthcare managers involved in the early rollout of the RTS,S/AS01 malaria vaccine in pilot districts of the South West Region of Cameroon. As part of a larger mixed-methods investigation, these findings provide insight into implementation dynamics that complement quantitative assessments of uptake.

Summary and interpretation of key findings: study findings revealed that healthcare workers

displayed positive attitudes, moderate-to-high knowledge, and strong willingness to promote the malaria vaccine. However, gaps in technical knowledge (especially regarding side effects), initial community fear, and inconsistent sensitization, caregiver communication, scientific rationale for dosage schedules, and limited knowledge on monitoring of efficacy were key challenges. Similar knowledge gaps have been documented in studies from Ghana [11] and Kenya [12], where HCWs reported uncertainty in addressing caregiver concerns and explaining post-vaccination reactions. Strengthening training, community partnerships, and continuous data monitoring can enhance the sustainability and public confidence in the malaria vaccine rollout, which is similar to reports from Mwende WG [26] following a comprehensive review of malaria control strategies in Africa.

Caregiver fears, misinformation, and comparisons with the COVID-19 vaccine emerged as recurring barriers. Similar findings were also reported by Sudari *et al.* [3] in a study conducted in Indonesia. Limited sensitization further contributed to these concerns, highlighting the need for clear, consistent Social and Behaviour Change (SBC) messaging aligned with WHO guidance on new vaccine introduction [4]. Community leader engagement was described as effective in improving trust, consistent with evidence from immunization programs in other parts of sub-Saharan Africa [11]. Healthcare managers emphasized strong vaccine availability but uneven accessibility due to difficult terrain, insecurity, electricity shortages, and population mobility. These system-level issues mirror broader challenges documented in other similar low-resource settings introducing new vaccines. Managers also identified gaps in the interpretation and use of DHIS2 data to inform actionable decisions [14,20].

Comparison with broader literature and programmatic implications: the findings align with global evidence that HCWs and managers are central to successful vaccine introduction, particularly in settings where communication, trust, and system capacity influence uptake. Studies from other malaria vaccine pilot countries emphasize the importance of strengthened HCW training, supportive supervision, and reliable supply chains. This study similarly underscores the need for enhanced capacity-building and improved communication strategies for frontline workers [14,20,21]. Terrain, insecurity, resource limitations, and rigid policies were identified as major barriers within the SWR. These findings were consistent with a report by Galadima *et al.* [8] following a systematic review on factors influencing vaccine uptake in Africa. Addressing these challenges will be essential for sustained malaria vaccine implementation as national scale-up progresses (see recommendations).

The study findings align with health systems strengthening [27] and implementation science frameworks [28], particularly the WHO health system building blocks [27]. Challenges related to health workforce capacity (training gaps, workload), service delivery (outreach constraints, terrain, and insecurity), health information systems (limited use of DHIS2 data for decision-making), leadership and governance (policy rigidity), and financing (delayed reimbursements) illustrate how weaknesses across interconnected system pillars collectively constrain malaria vaccine uptake. This underscores that successful RTS,S/AS01 scale-up requires integrated system-level interventions rather than isolated programmatic efforts [27,28].

Limitations: this study has several limitations. Firstly, data were collected from only three districts within the South West Region that were involved in the pilot phase of RTS,S/AS01 malaria vaccine rollout, which may limit transferability to other regions. The use of purposive sampling may introduce selection bias, as several participants were actively involved in the malaria vaccine rollout. To protect confidentiality, detailed identifiers related to participants´ exact roles and facility locations were intentionally withheld, which may limit contextual specificity. However,

these measures were essential to ensure ethical integrity and open participation.

Conclusion

This exploratory qualitative study examined the experiences and perspectives of healthcare workers and healthcare managers involved in the pilot rollout of the RTS,S/AS01 malaria vaccine in selected districts of the South West Region of Cameroon. While participants expressed strong support for the vaccine and recognized its potential to reduce malaria burden among children, they also highlighted key barriers affecting early implementation, including communication gaps, caregiver concerns, logistical constraints, and system-level limitations. These findings offer context-specific insights that can inform broader malaria vaccine introduction efforts as Cameroon prepares to move toward national scale-up. Strengthening training for frontline workers, enhancing community sensitization using Social and Behaviour Change approaches, and addressing logistical and infrastructural gaps may contribute to improved uptake and dose completion. As part of a larger mixed-methods study, these qualitative results will support the interpretation of quantitative findings and guide future research aimed at optimizing malaria vaccine delivery within Cameroon´s Expanded Programme on Immunization.

Recommendations

Adoption of a strategic framework component for improvement of malaria vaccine uptake based on qualitative feedback from healthcare workers and managers to strengthen malaria vaccine uptake, service delivery, and sustainability during scale-up of the RTS,S/AS01 vaccine in Cameroon.

i) Guiding principles

Community-centeredness: engage and empower local actors (mothers, caregivers, religious leaders, and community health volunteers).

Health system strengthening: build capacity and resilience within existing immunization structures.

Data-driven adaptability: use continuous feedback loops for program improvement.

ii) Framework components (2-level model)

A) Health workforce level (healthcare workers)

Goal: strengthen the capacity, motivation, and consistency of healthcare workers as vaccine advocates.

Proposed strategies/interventions: a) healthcare workers expressed strong support for the malaria vaccine but reported gaps in technical knowledge, particularly regarding vaccine safety and effectiveness, occasional shortages in private clinics, and role clarification during implementation. Thus, institutionalizing regular in-service training and refresher sessions within the Expanded Programme on Immunization (EPI) is therefore recommended. b) Training should also emphasize pharmacovigilance, counselling on adverse events, and clear delineation of responsibilities across clinical and community-based cadres. Integration of malaria vaccine content into routine EPI training platforms will also help to support consistent messaging and caregiver engagement. c) Inadequate community sensitization and persistent misinformation were identified as key barriers to uptake. Therefore, the development and dissemination of standardized information, education, and communication (IEC) materials across health facilities and outreach services are recommended. d) Structured involvement of community health workers, traditional leaders, and religious authorities in community dialogue may enhance trust and acceptance, particularly in settings with heightened vaccine hesitancy. e) Strengthening vaccine stock monitoring and reporting mechanisms, including simple mobile-based systems, is essential to reduce stock-outs and sustain healthcare worker confidence in service delivery.

B) Health system and managerial level (healthcare managers/policymakers)

Goal: ensure an enabling system for vaccine delivery, accessibility, and sustainability.

Proposed strategies/interventions

a) Despite reported vaccine availability, access remained constrained in hard-to-reach and crisis-affected communities due to terrain, insecurity, and cold-chain limitations. Therefore, expanding outreach and mobile vaccination strategies, supported by community health volunteers and appropriate transport, is critical to improving equitable access. b) Investment in solar-powered refrigeration and cold-chain maintenance should be prioritized in facilities with unreliable electricity supply. c) Greater operational flexibility at district and facility levels is recommended to support context-responsive implementation, such as the integration of LLINs distribution during 7thand 24thmonths of vaccination. d)Timely reimbursement of operational costs and strengthened collaboration with development partners, non-governmental organizations, and the private sector may enhance program sustainability. e) Routine monitoring systems should be strengthened to assess malaria vaccine effectiveness by linking vaccination status with trends in malaria morbidity and mortality, including *Plasmodium*species identification and classification of disease severity among children under five. Integrating these indicators into existing surveillance platforms such as DHIS2 and strengthening laboratory/clinical data use will support evidence-informed program adaptation during scale-up. f) Routine health information systems, including DHIS2, should also be more effectively utilized to monitor dose completion, identify dropouts, and inform local supervision and planning.

C) Adaptability and scale-up mechanism

As Cameroon advances toward national malaria vaccine scale-up, systematic documentation and evaluation of pilot experiences are essential. Therefore, phased regional adaptation should precede national expansion to ensure contextual relevance. Embedding these strategies/interventions within national EPI guidelines and malaria control policies will support sustained and equitable malaria vaccine uptake among children under five years of age.

D) Expected outcomes from adoption of the proposed interventions/strategies

a) Improved malaria vaccine awareness and understanding among caregivers. b) Strengthened capacity and motivation among healthcare workers. c) Enhanced managerial coordination and logistics support. d) Increased and equitable malaria vaccine uptake among children under 5. e) A tested and adaptable model to guide national scale-up.

What is known about this topic

- *Healthcare workers and managers play a pivotal role in the successful rollout of new vaccines, including RTS,S/AS01, particularly through caregiver sensitization, cold-chain management, supervision, and monitoring responsibilities;*
- *Barriers such as inadequate community awareness, logistical constraints, misinformation, and limited infrastructure commonly hinder vaccine uptake and equitable access in low-resource settings, especially during the early phases of vaccine introduction.*

What this study adds

- *This study reveals context-specific implementation challenges and strengths unique to the South West Region of Cameroon, including strong vaccine availability but limited accessibility due to terrain, insecurity, workforce shortages, and policy rigidity during the RTS,S/AS01 pilot rollout;*
- *It provides an evidence-based, adaptable strategic framework outlining workforce-level, managerial/system-level and community-level solutions aimed at optimizing malaria vaccine uptake and strengthening routine immunization systems in preparation for national-scale up.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Jude Che Anye: conceived and designed the study, developed the research protocol and data collection tools, supervised the fieldwork, conducted and validated the qualitative data analysis, interpreted the findings, drafted the manuscript, and coordinated all revisions until submission. Loveline Lum Niba: provided academic supervision during study design, contributed to the development of the methodological approach, reviewed the protocol and analysis framework, and critically revised the manuscript. Omarine Njimanted: contributed to the study design and qualitative methodology, reviewed data analysis outputs, provided supervisory guidance, and critically reviewed and approved the final manuscript. Eugene Enah Fang: contributed to the design of the data collection instruments, supported training of field data collectors, participated in data collection, assisted in organizing qualitative data, and contributed to preliminary analysis. Ndundat Ahmed Chafa: participated in field data collection, contributed to transcription, coding and initial thematic analysis, and provided input during interpretation of findings. Ebua Gallus Fung: assisted in refining the data collection tools, contributed to field data collection and data management, participated in data cleaning and initial coding, and reviewed the methods and results sections of the manuscript. Helen Kuokuo Kimbi: provided overall academic supervision, guided the study design and methodological decisions, contributed to interpretation of results, critically reviewed multiple manuscript drafts. All the authors have read and approved the final version of this manuscript.

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Tables

Table 1: thematic analysis from FGD/in-depth interviews of health care workers in the South West region

Table 1.1: thematic analysis from FGD/in-depth interviews of health care workers in the South West region

Table 2: thematic analysis from FGD with health care managers

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Table 1: thematic analysis from FGD/in-depth interviews of health care workers in the South West region

Theme	Sub-theme	Quote	Interpretation/relevance
Knowledge	Understanding of vaccine purpose	"The malaria vaccine is given to prevent frequent malaria infections in children…it helps reduce severity."-P5	Shows basic understanding and awareness of vaccine introduction.
		"It has reduced malaria incidence and healthcare costs for families."-IDI	Demonstrates recognition of the vaccine´s effectiveness and economic benefits
		"The malaria vaccine is relatively new; it was introduced into the childhood vaccination calendar less than four years ago."-IDI	Shows basic understanding and awareness of vaccine introduction.
	Target age group awareness	"The malaria vaccine is for children aged zero to five years only."-Group response	Shows basic understanding and awareness of vaccines. However, limited knowledge on the exact age target during roll-out
	Information sources	"We first heard about it as a rumor, later confirmed by the Ministry of Public Health."-P2	Limited information during the early phase of roll-out
	Knowledge gaps (side effects)	"Sometimes a child receives a vaccine and then has a reaction, but we don't always know how to explain it."-P5 "I still have questions, such as why it is only given to children and not adults."-IDI	Highlights areas needing further professional clarification.
Effectiveness	Perceived reduction in malaria cases	"Since we started giving the malaria vaccine, the number of children who come with malaria has reduced drastically."-P7	Demonstrates recognition of the vaccine´s effectiveness
	Observed side effects	"Some had minor reactions like swelling or mild fever."-P1	Indicates some level of vaccine vigilance during roll-out
	Need for long-term observation	"Malaria is a seasonal disease…we should observe it longer before concluding."-P3	
	Need for elaboration of the roles of each member of the clinical team	"We can't say for sure whether the vaccine is effective because we're not directly involved in administering it to children. The people who can best judge its effectiveness are those who vaccinate children between zero and five years. However, we do contribute by collecting and reviewing data. We take laboratory statistics that show the number of malaria cases over time. From those statistics, we can make some observations about trends in malaria cases". "No, it is through regular statistical analysis. The people who collect and record malaria test results can help show whether malaria cases are decreasing. Right now, statisticians handle most of that data, so they're the ones who can best determine if there's been improvement." -P2 (Lab technician)	Illustrate knowledge gaps in terms of the roles of each member of the team in the vaccine roll-out phase
Attitudes towards the vaccine	Positive perception	"I was very happy. I knew it would help reduce malaria cases."-P4 "I strongly support it. It shows Cameroon is taking proactive steps."-IDI	Reflects enthusiasm and trust in national policy.
	Parental response	"Initially, some parents refused… but seeing benefits has built trust."-IDI	Indicates a knowledge gap among parents, creating resistance.

Table 1.1: thematic analysis from FGD/In-depth interviews of health care workers in the South West region			
Theme	**Sub-theme**	**Quote**	**Interpretation/relevance**
	Willingness to recommend	"I have confidence to speak to parents about the vaccine."-P5	Reflects enthusiasm and trust in the vaccine as well as willingness to recommend to caregivers
	Use of community leaders	"We first contact a local leader or advocate, then I feel confident to speak."-P1	Emphasize the essential role of community leaders in enhancing trust in caregivers
Practices in promotion	Counselling	"I use visual aids like calendars and vaccination cards to explain."-IDI	It reflects practical strategies to improve parent understanding.
	Opportunistic promotion	"I mainly bring it up when a child comes to the facility."-IDI	It suggests limited proactive promotion, linked to workload and context.
Challenges/barriers	Fear and misinformation	Some parents say, "We don´t know what this vaccine does, what if it kills my child?"-P5	Myth surrounding vaccination that could create resistance
	COVID-19 vaccine comparison	They said, "You´ve come again like before, you want to kill our children."-P7	Myth surrounding vaccination that could create resistance
	Limited sensitization	"Some mothers said no one had told them about it before."-P1	Limited sensitization creates knowledge gaps
	Parental refusal	Some parents say, "I´ve vaccinated all my other children but never heard of this one."-IDI	Indicates a knowledge gap among parents, creating resistance.
	Supply issues	"Sometimes, the malaria vaccine is out of stock, discouraging for mothers."-IDI	Shows structural barriers affecting confidence and recommendation rates.
	Cultural beliefs	"Some Nigerian and Muslim families refuse due to unfamiliarity."-IDI	Demonstrates how cultural beliefs affect uptake.
Recommendations/strategies for improvement	Pre-vaccination testing	"There should be a rapid diagnostic test before giving the vaccine."-P3	Indicates difficulties of caregivers in screening and identifying children with possible symptoms before the vaccine
	More training on side effects	"We should be given more detailed information about possible side effects."-P5	Indicates a knowledge gap of some healthcare workers on side effects
	Community collaboration	"Local chiefs were informed and helped to spread the message."-P7	Advocacy with traditional authorities
	Campaigns	"Government should launch campaigns to raise awareness."-IDI	Suggests macro-level intervention to support uptake.
	Incentives	"Providing small gifts at key doses could encourage mothers."-IDI	Shows creative local solutions for community motivation.
	Continuous Training	"Regular workshops should be conducted to update staff."-IDI	Emphasizes professional development for better knowledge and confidence.

Table 2: thematic analysis from FGD with health care managers			
Theme	**Sub-theme**	**Illustrative quote**	**Interpretation/relevance**
Strategic Implementation Approaches for Malaria Vaccine	Routine immunization, Outreach & campaigns	"We use routine vaccination, outreach, and campaign strategies. Community health workers assist nurses." P4	Reflects multi-strategy implementation to improve coverage.
	Catch-up programs	"During outreach… we locate children who missed vaccines and administer them." P3	Demonstrates adaptability to reach missed children.
Health Care Managerial Roles	Supervision & monitoring	"We supervise vaccination sessions, analyze data, monitor vaccine administration, and provide feedback." P2A.	Highlights leadership role in ensuring quality control.
	Training	"We conduct refresher training to correct mistakes identified during supervision." P4	Shows commitment to continuous capacity building.
Vaccine Availability & Accessibility	Logistics & access	"Some centers lack electricity or solar fridges. Cold boxes are used." "Yeah, still talking about the access, since we have just limited health districts implementing, the person that starts taking the vaccine in the health district that is implementing and is displaced to another health district that's not implementing, might find it very difficult for them to access them and need to travel back to the original health district to be served."	Points to infrastructural constraints affecting cold chain maintenance. Geographical factors might also influence accessibility and uptake, given that not all districts are involved in the pilot phase.
	Equity	"Each health facility was allocated vaccines based on the target population."	Illustrates a structured and fair distribution strategy.
Implementation Challenges	Funding	"Staff must pre-finance program activities reimbursement may take up to three months."	Reveals financial barriers that demotivate workers.
	Policy rigidity	"Vaccination is mandated for children aged six months. Older children not eligible."	Shows inflexibility, limiting coverage expansion. Also points to some level of knowledge deficit on age-duration for eligibility from some HCM
	Bureaucratic-delays	"Delays at police checkpoints due to transport regulations."	Identifies external factors causing logistical delays.
Monitoring & Evaluation	Data gaps	"The percentage of children receiving VAP2 and VAP3 is still low compared to VAP1."	Indicates gaps in follow-up and coverage tracking.
	Sub-optimal monitoring & evaluation of effectiveness	"We usually carry out regular monitoring to check progress, but so far, we have not been able to access the prevalence during discussion sessions/meetings	Indicates limited interest or concern with it when it comes to evaluating effectiveness by health care managers.
Strategic solutions/recommendations	Community sensitization	"Inform the population about the dangers of malaria and the importance of vaccination."	Suggests a solution targeting awareness and acceptance.
	Infrastructure support	"Provide solar-powered fridges, training materials, and posters to improve coverage."	Points to practical infrastructure and resource needs.