Barriers to Malaria Vaccine Delivery in the Bono East Region, Ghana: A Qualitative Study among Healthcare Workers

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***Abstract*—Background The RTS,S/AS01E malaria vaccine was introduced in the Bono East Region of Ghana in 2019 as part of the national scale-up of the Malaria Vaccine Implementation Programme. Despite demonstrable reductions in malaria morbidity at the population level, persistent operational challenges including high fourth-dose dropout, cold chain constraints, and financing gaps — continue to limit the vaccine's realized impact. Understanding the lived experience of frontline healthcare workers responsible for delivering the vaccine is essential for designing context-specific programmatic solutions.**

Methods

A descriptive qualitative study was conducted using in-depth key informant interviews (KIIs) with twelve healthcare workers purposively sampled across six districts and municipalities of the Bono East Region. Participants included Disease Control Officers, Field Technicians, EPI Coordinators, Technical Officers, and Community Health Nurses with between 4 and 16 years of professional experience. Interviews were audio-recorded, transcribed verbatim, and analyzed using Braun and Clarke's six-phase thematic analysis framework, supported by NVivo software. The study adhered to the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist.

Results

Four major theme categories were identified: (1) RTS,S/AS01E effectiveness perceptions and dose adherence; (2) vaccine delivery, logistics, and cold chain management; (3) community acceptance, caregiver trust, and AEFI communication; and (4) funding, sustainability, and local ownership. Participants universally reported perceived reductions in paediatric malaria burden since vaccine introduction but identified systemic barriers that constrain programme performance. Fourth-dose dropout was attributed to caregiver mobility,

inadequate defaulter tracing resources, and the extended interval between dose three and dose four. Logistical barriers included bulky packaging incompatible with CHPS cold storage capacity, motorbike-dependent outreach, poor road conditions, and recurrent fuel shortages. Pre-rollout training was described as adequate but refresher training was absent, creating competency gaps among new staff. Community acceptance was generally positive, attributable to visible health improvements, but persistent misinformation including rumours associating the vaccine with infertility and AEFI-driven hesitancy undermined dose completion. Funding emerged as the most critical sustainability concern, with districts dependent on Internally Generated Funds (IGF) following Gavi and PATH withdrawal, and no dedicated malaria vaccine budget line established at district level.

Conclusions

The malaria vaccine programme in the Bono East Region demonstrates operational feasibility and visible health impact, yet its long-term sustainability and effectiveness are threatened by remediable structural and financial barriers. Context-specific interventions including dedicated district budget lines for malaria vaccination, cold chain infrastructure investment at the CHPS level, mandatory refresher training, culturally sensitive AEFI communication strategies, and fourth-dose schedule alignment are needed to close the gap between the vaccine's established efficacy and its realized population-level impact.

***Index Terms*—malaria vaccine; RTS,S/AS01E; vaccine delivery; implementation barriers; qualitative research; healthcare workers; Ghana; cold chain; vaccine hesitancy; health financing**

I. BACKGROUND

Malaria remains the leading preventable cause of morbidity and mortality among children under five years of age in sub-Saharan Africa. In 2023, the African region accounted for 94% of approximately 263 million global malaria cases and 95% of approximately 597,000 malaria-related deaths worldwide (World Health Organization [WHO], 2024a). The introduction of the RTS,S/AS01E (Mosquirix) vaccine the world's first approved malaria vaccine and its recommendation by WHO for broad use in moderate-to-high transmission areas in 2021, subsequently updated in 2024 to include R21/Matrix-M as a second approved option, represents a landmark development in the global response to this disease (WHO, 2024b). Ghana was among the first three countries to implement RTS,S/AS01E at scale under the WHO-coordinated Malaria Vaccine Implementation Programme (MVIP), alongside Kenya and Malawi, beginning in 2019.

Evidence from the MVIP pilots demonstrates that the vaccine, delivered through routine Expanded Programme on Immunization (EPI) platforms, achieves a 22–32% reduction in hospitalized severe malaria and a 9–13% reduction in all-cause mortality among age-eligible children (Asante et al., 2024; WHO, 2024b). However, realizing the vaccine's full potential requires completing a four-dose schedule, with the fourth booster dose administered in the second year of life being the single

greatest determinant of sustained immunity into the 24–59-month age group (Dicko et al., 2024; White et al., 2015). Across pilot countries, median fourth-dose coverage reached only approximately 46% by 2023, compared with dose-one initiation rates approaching 80% a delivery–outcome gap that directly undermines the vaccine's public health impact (Jalang'o et al., 2025; Programme for Appropriate Technology in Health [PATH], 2024).

The implementation literature has consistently identified structural barriers to new vaccine delivery in sub-Saharan Africa, including cold chain inadequacy, transport infrastructure deficits, health worker training gaps, community hesitancy rooted in misinformation, and financial sustainability constraints following the transition from donor-supported piloting to domestically financed routine delivery (Adamu et al., 2024; Bekolo et al., 2019; Dimala et al., 2018). While the MVIP pilots have generated important aggregate-level data, detailed qualitative evidence capturing the lived operational experiences of frontline health workers in specific district contexts remains sparse, particularly in regions outside the original pilot framework. Such evidence is essential for translating broad implementation lessons into context-specific, locally actionable programmatic solutions.

The Bono East Region of Ghana characterized by moderate-to-high perennial malaria transmission, predominantly rural communities, limited health infrastructure density, and high poverty rates represents a high-priority implementation context in which these structural barriers are expected to operate with particular force. This qualitative study was conducted to systematically characterize the barriers and facilitators experienced by frontline healthcare workers responsible for delivering the RTS,S/AS01E vaccine in this region, with the aim of generating evidence to inform targeted programmatic improvements in the Bono East Region and comparable sub-Saharan African settings.

II. METHODS

Study design and theoretical framework

A descriptive qualitative study design was employed, using in-depth key informant interviews (KIIs) as the primary data collection method. This design was selected because it is well-suited to generating rich, contextually nuanced accounts of participants' operational experiences, perceptions, and decision-making processes — forms of evidence that quantitative surveillance data cannot provide (Braun & Clarke, 2006; Creswell & Plano Clark, 2018). Data were analyzed inductively using Braun and Clarke's six-phase thematic analysis framework: familiarization with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report (Braun & Clarke, 2006). This study formed the qualitative strand of a convergent mixed-methods design; the quantitative results are reported separately.

Study setting

The study was conducted in the Bono East Region of Ghana across six purposively selected districts and municipalities: Atebubu-Amanten, Kintampo North Municipal, Kintampo South, Pru

West, Techiman Municipal, and Techiman North. These districts were selected to capture geographic variation across the region, including both urban and rural settings, districts with relatively stronger and weaker health system infrastructure, and both well-performing and lower-performing districts in terms of vaccine coverage data. The RTS,S/AS01E vaccine was introduced in all six districts in 2019 as part of Ghana's national programme scale-up.

Participants and sampling

Participants were purposively sampled to capture maximum variation in professional roles, levels of experience, and geographic contexts. Eligibility criteria required that participants were healthcare workers directly involved in malaria vaccine implementation activities including vaccination sessions, outreach, cold chain management, AEFI reporting, or programme supervision in one of the six study districts. Two healthcare workers were recruited per district, yielding a total sample of twelve participants. Cadres represented included Disease Control Officers (n=5), Field Technicians (n=4), EPI Coordinators (n=2), and Technical Officers/Community Health Nurses (n=1). Years of professional experience ranged from 4 to 16 years, with a mean of approximately 10 years, ensuring that the sample encompassed both more recently trained staff and those with substantial institutional memory of the pre-vaccine era. Sample size was determined on the basis of thematic saturation, with saturation achieved by the tenth interview and confirmed through the eleventh and twelfth. The sample size of 12 participants is consistent with established qualitative standards indicating that theme saturation is commonly achieved with 9–12 purposively selected key informants (Guest et al., 2006; Nowell et al., 2017).

Data collection

A semi-structured KII guide was developed in English based on the study objectives and informed by a review of the implementation science literature on new vaccine delivery barriers in sub-Saharan Africa. The guide was structured to explore: feasibility and acceptability of vaccine delivery; cold chain and logistical challenges; health worker training and motivation; community knowledge, acceptance, and misinformation; AEFI experiences and their impact on caregiver behaviour; and programme financing and sustainability. Questions were open-ended to encourage detailed narrative responses and to allow elaboration on issues not pre-specified in the guide. The guide underwent expert review by two senior immunization officers with experience in Ghanaian EPI programming and was pilot-tested with two non-study participants to refine question wording, sequencing, and cultural appropriateness. All interviews were conducted individually in private settings conducive to candid discussion, lasted approximately 45–60 minutes, and were conducted by the principal investigator and one trained research assistant. All sessions were audio-recorded with written informed consent and supplemented by contemporaneous field notes to capture non-verbal cues and contextual observations.

Data analysis

Audio recordings were transcribed verbatim and imported into NVivo 12 (QSR International) for systematic coding. Analytic memos were maintained throughout the coding process to document interpretive decisions and capture emerging insights. An initial code list was generated inductively from close reading of the data, without reference to a pre-existing coding framework, to ensure that the analysis remained grounded in participants' accounts. Codes were subsequently grouped into candidate themes, reviewed iteratively against the full dataset, refined for internal coherence, and assigned descriptive names. The analytical process followed Braun and Clarke's (2006) six phases strictly. To enhance analytical rigour and reduce interpretive bias, a second coder independently reviewed a 30% subsample of transcripts; inter-coder agreement was assessed, and discrepancies were resolved through discussion until consensus was reached. Reflexive practices including the maintenance of a reflexivity journal by the principal investigator and peer debriefing sessions with a qualitative methodologist further strengthened trustworthiness. Member checking was conducted by sharing a thematic summary with three participants to confirm interpretive accuracy. The reporting of this study adheres to the Consolidated Criteria for Reporting Qualitative Research (COREQ) 32-item checklist (Tong et al., 2007).

Ethical considerations

Ethical approval was obtained from the Ethics Review Board of the University of Port Harcourt and the Ghana Health Service Ethics Review Committee. Written informed consent was obtained from all participants prior to interview. Participants were assured of voluntary participation and the right to withdraw at any point without penalty or consequence for their employment. All transcripts were anonymized, with participants identified by role descriptor and participant code only (e.g., Disease Control Officer, P-3). Audio recordings were stored on password-protected devices and deleted following completion of transcription and accuracy verification. No personal identifiers appear in any reported findings.

III. RESULTS

Participant characteristics

Twelve healthcare workers participated in the study, two from each of the six study districts. The sample comprised Disease Control Officers (n=5), Field Technicians (n=4), EPI Coordinators (n=2), and one Technical Officer/Community Health Nurse. Years of professional experience ranged from 4 to 16 years (mean approximately 10 years). All participants had been involved in RTS,S/AS01E implementation activities since the vaccine's introduction in their respective districts in 2019. The sample included participants from both fixed-site and outreach-based service delivery contexts and from facilities ranging from district hospitals to CHPS compounds. Balanced geographic representation across urban and rural sub-districts within the six study districts was achieved.

Thematic analysis identified four major theme categories: (1) perceived effectiveness of RTS,S/AS01E and challenges to dose completion; (2) vaccine delivery, cold chain management, and logistical barriers; (3) community knowledge, caregiver trust, and AEFI communication; and (4) funding, sustainability, and local ownership of the programme. Each theme is presented below with supporting participant quotations.

Theme 1: Perceived effectiveness of RTS,S/AS01E and challenges to dose completion

1a. Universal perception of reduced malaria burden

All twelve participants, without exception, reported a visible and meaningful reduction in paediatric malaria burden in their districts since the introduction of the vaccine. This perception was expressed spontaneously and consistently across professional cadres, geographic settings, and levels of experience, and was grounded in direct clinical observation reduced facility attendance for malaria-related illness, fewer severe malaria admissions, and decreased demand for antimalarial treatment among the under-five age group. Several participants framed this reduction in terms that were personally meaningful, reflecting both professional satisfaction and community-level trust in the vaccine's benefits.

"Since the malaria vaccine started, we hardly record malaria cases among the under-fives. It has reduced compared to previous years." (Field Technician, P-3)

"The children no longer fall sick frequently with malaria, and mothers are happy about that." (Disease Control Officer, P-10)

"You can see the difference, before, mothers used to come every week with malaria cases, but now it has gone down." (Field Technician, P-6)

"After the vaccine was introduced, we realized fewer admissions due to malaria in our facility." (EPI Coordinator, P-11)

The improvement in community confidence in immunization services was also noted as an associated benefit, with participants observing that visible health gains among vaccinated children had dispelled early skepticism and encouraged broader engagement with EPI services.

"Mothers are now confident in bringing their children for immunization because they see that it helps prevent malaria." (Field Technician, P-2)

"At first, people doubted the vaccine, but when they saw that the children are healthy, the fear went away." (Technical Officer, P-8)

1b. Fourth-dose dropout as the dominant programme challenge

Despite the positive effectiveness perceptions, participants across all districts identified the completion of the four-dose schedule and specifically the drop in attendance between the third and fourth dose as the most significant and persistent programmatic challenge. The structural root cause identified by participants was the extended interval between dose three, administered at nine months, and dose four, not due until twenty-four months of age. This fifteen-month gap created conditions in which caregiver memory faded, family circumstances changed, and the logistical continuity required for follow-up broke down.

"The first and second doses go well, but by the time we get to the fourth, most mothers stop coming." (Disease Control Officer, P-5)

"Some mothers travel or forget about the last dose; we try to follow up but not all are reached." (Disease Control Officer, P-12)

Defaulter tracing was acknowledged as a formal system responsibility but described as chronically under-resourced, relying on manual registers and field visits by motorbike, with fuel and time constraints severely limiting its reach.

"We do defaulter tracing manually, sometimes on motorbikes, but fuel and time are issues." (Field Technician, P-4)

"When the mothers miss doses, we try to call, but network and transport problems make it difficult." (Disease Control Officer, P-7)

1c. Data quality and monitoring limitations

Participants also identified inconsistencies in data monitoring and reporting as a systemic challenge that undermined programme management. Discrepancies between facility registers and DHIMS-2 entries were attributed to poor connectivity, manual documentation processes, and inadequate supervisory feedback. The tracking of mobile populations children whose families relocated between communities was described as particularly difficult, resulting in incomplete vaccination histories and underreporting.

"The data we submit doesn't always match what appears in DHIMS because of poor connectivity and reporting delays." (EPI Coordinator, P-9)

"When families relocate, they don't always bring the child health record, so we can't continue accurately." (EPI Coordinator, P-9)

"We send reports but rarely get feedback unless there is a major problem." (Disease Control Officer, P-3)

Theme 2: Vaccine delivery, cold chain management, and logistical barriers

2a. Cold chain infrastructure gaps at peripheral levels

While participants described the national vaccine supply chain as generally reliable with vaccines arriving at district stores on schedule they identified significant cold chain infrastructure gaps at the sub-district and CHPS levels that created bottlenecks in the last mile of delivery. The RTS,S/AS01E vaccine's bulky two-vial presentation was incompatible with the limited refrigeration capacity of smaller facilities, and several CHPS compounds lacked functional cold storage entirely, requiring vaccines to be transported between facilities a practice that increased handling complexity and cold chain break risk.

"The supply of vaccines is regular, but sometimes the packages are too bulky for the small fridges we have." (Disease Control Officer, P-5)

"Some CHPS compounds do not have fridges, so they depend on nearby facilities to store vaccines." (Disease Control Officer, P-3)

"We have to move the vaccines between facilities because not all CHPS points have working fridges." (Field Technician, P-6)

Shortages of reconstitution syringes and consumables which were not consistently co-delivered with vaccine supplies were also reported as recurring disruptions to scheduled vaccination sessions.

"Sometimes we go to the store and get the vaccines, but there are no syringes or cotton wool; we have to buy some from our IGF." (Disease Control Officer, P-7)

"We face shortages of syringes sometimes, and it delays the sessions until we find our own means." (Technical Officer, P-4)

2b. Transport and infrastructure constraints

Motorbikes were described across all six districts as the primary and frequently the only mode of vaccine transport for outreach activities, particularly to remote communities. This dependency created multiple operational constraints: limited cargo capacity for vaccines and logistics, vulnerability to poor road conditions, and exposure to physical risk for health workers. Poor road conditions, particularly during the rainy season, were cited as a major impediment to timely outreach, with some communities becoming completely inaccessible for weeks at a time.

"We use motorbikes to carry the vaccines from the district to the communities; it's the only option we have." (Field Technician, P-4)

"Some of the communities are very far, and the roads are bad, so during the rainy season, we struggle to reach them." (Disease Control Officer, P-7)

"The roads are bad, and sometimes we fall on the way, but we still try to deliver the vaccines." (Field Technician, P-8)

Fuel shortages constituted a recurring and directly quantifiable operational barrier. When facility funds were exhausted and NHIS reimbursements were delayed, outreach sessions were cancelled or indefinitely postponed, resulting in communities being missed entirely.

"Sometimes we have the vaccines ready, but there's no fuel to go for outreach, so we have to wait." (Field Technician, P-6)

"Fuel shortages delay our work; even when we plan outreach, we can't go without funds for fuel." (Disease Control Officer, P-3)

2c. Health worker training and motivation

Pre-rollout training was uniformly described as comprehensive and adequate participants recalled the initial training as providing clear guidance on reconstitution procedures, dosing schedules, cold chain management, and AEFI reporting. However, the absence of structured refresher training was identified as a growing problem as staff turned over and the programme matured. New and transferred staff were left to acquire skills through informal peer mentoring rather than through formal capacity-building, creating uneven competency profiles across facilities and districts.

"We were trained before the rollout, but since then, there have not been many refresher trainings for new staff." (Disease Control Officer, P-2)

"The first training was good, but after that, we only learn when there's a problem or a change in policy." (Technical Officer/EPI Coordinator, P-11)

"When new staff come, we teach them what we know from experience since there's no formal refresher training." (Field Technician, P-1)

Financial incentives specifically training allowances and outreach per diems — were described as chronically inadequate and frequently delayed, contributing to low morale and reduced motivation among frontline health workers. Participants framed this as a structural demotivating factor rather than an individual attitudinal problem.

"We attend the training but the allowances are too small, and sometimes they delay, so people lose interest." (EPI Coordinator, P-9)

"Motivation is low because the training and outreach funds are not enough to cover our costs." (Disease Control Officer, P-5)

Theme 3: Community knowledge, caregiver trust, and AEFI communication

3a. Health education strategies and their effectiveness

Participants across all districts attributed improvements in community awareness and vaccine uptake, particularly for the first and second doses, to deliberate health education strategies including community durbars, local radio announcements, and school-based sensitization. These strategies were described as culturally well-accepted and effective at reaching diverse caregiver populations, including those with limited formal literacy.

"We organize community durbars to educate mothers about the malaria vaccine, and that has helped a lot in acceptance." (Disease Control Officer, P-3)

"We use the local radio stations to announce vaccination days, and people listen and come." (Technical Officer, P-8)

"When the announcements go on air, even those who miss durbars get the message and bring their children." (Field Technician, P-5)

"The school sensitization helped because the children become advocates at home, telling their parents to take them for vaccination." (Technical Officer/EPI Coordinator, P-11)

3b. Persistent misinformation and community hesitancy

Despite the general progress in community awareness, participants consistently described the persistence of specific misinformation narratives that undermined caregiver confidence and contributed to incomplete dose adherence. Three recurring false narratives were identified across multiple districts: the belief that the vaccine causes illness or physical weakness; concerns about over-injection, with caregivers perceiving the malaria vaccine as adding an unnecessary additional injection to an already complex EPI schedule; and, most alarmingly, rumours associating the vaccine with infertility or permanent health consequences in later life.

"Some parents say the vaccine gives their children fever or makes them weak, so they don't want to continue." (Field Technician, P-4)

"Once one mother complains her child got sick after the injection, others become afraid and refuse." (Disease Control Officer, P-7)

"Parents complain that there are too many injections for the children, and they get tired of bringing them every time." (Disease Control Officer, P-10)

"Some people spread rumours that the vaccine can cause infertility when the children grow, and that makes others panic." (Disease Control Officer, P-2)

"Even after we explain, a few still believe the vaccine will affect the child later in life, especially among older mothers." (Field Technician, P-1)

3c. AEFI experiences and their impact on dose adherence

Mild adverse events following immunization predominantly fever and localized swelling at the injection site were reported as routine and predictable occurrences that health workers described as clinically manageable. However, these mild reactions generated disproportionate caregiver anxiety that directly translated into missed subsequent doses. Participants described a community information cascade in which a single child's adverse reaction, shared informally among caregivers, could deter multiple families from returning for the next dose.

"Most of the side effects we see are fever and small swelling, but mothers get worried and think it's serious." (Field Technician, P-5)

"Some parents come back to complain of fever, and after that, they don't bring the child for the next dose." (Disease Control Officer, P-8)

"After their child gets a reaction, some mothers refuse to take the next dose even when we assure them it's normal." (Field Technician, P-6)

"Once they hear that another child got sick after the vaccine, they all get scared and don't want to come." (EPI Coordinator, P-11)

A systemic gap identified by multiple participants was the delayed feedback from the pharmacovigilance system following AEFI reporting. Health workers described a pattern in which AEFI cases were duly submitted through the routine surveillance system but responses from the regional or national level were slow sometimes taking weeks leaving frontline workers unable to authoritatively reassure caregivers about the investigation status and outcomes. This communication vacuum was perceived by caregivers as evidence that something was being withheld.

"We report the AEFI cases, but feedback takes long, and that makes mothers think we are hiding something." (Disease Control Officer, P-3)

"If we respond quickly to AEFI complaints and explain the cause, the mothers will not be afraid to continue." (Technical Officer, P-9)

Theme 4: Funding, sustainability, and local ownership

4a. Transition from donor to domestic financing

The transition from the Gavi and PATH-supported initial rollout to dependence on domestically generated resources was identified by participants as the most critical structural threat to the programme's long-term sustainability. The initial rollout had been well-resourced: external partners provided logistics, training, supervisory support, and operational allowances that enabled comprehensive coverage. The withdrawal of this support created an immediate and stark operational gap that facilities were not equipped to fill from existing revenue streams.

"PATH and Gavi helped a lot at the beginning; they provided logistics, training, and even allowances for the rollout." (Disease Control Officer, P-3)

"After the pilot, the support from Gavi stopped, and now everything depends on what the facilities can generate." (Technical Officer, P-10)

The withdrawal of the MCHPS programme a key supporter of outreach activities and supervision was cited as a specific and significant loss, with participants noting that no alternative funding mechanism had been identified to replace this support.

"When the MCHPS programme ended, it became difficult to continue some of the outreach activities." (Disease Control Officer, P-10)

"We used to get support for fuel and allowances from MCHPS, but now that has stopped." (Field Technician, P-5)

4b. Dependence on Internally Generated Funds and NHIS reimbursements

Following donor withdrawal, the operational costs of the malaria vaccine programme including fuel for outreach, cold chain maintenance, logistics procurement, and staff allowances devolved to facilities' Internally Generated Funds (IGF). The adequacy of IGF varied substantially across

facilities, creating an inequitable operational landscape in which wealthier facilities could maintain outreach frequency while poorer facilities typically those serving the highest-need remote communities were forced to reduce or cancel sessions.

"We use IGF to buy fuel and some logistics for outreach; there is no special funding for malaria vaccine activities." (Field Technician, P-6)

"Some facilities can support outreach better because they generate more IGF, but others really struggle." (Disease Control Officer, P-8)

Irregular and delayed NHIS reimbursements compounded this inequity, disrupting cash flow and making it impossible to pre-finance outreach sessions reliably. The combination of IGF variability and NHIS payment delays created a structurally unstable funding environment that participants described as the primary operational constraint on their ability to maintain consistent immunization schedules.

"Sometimes the NHIS payments delay for months, and it affects all our outreach schedules." (Disease Control Officer, P-2)

"When NHIS doesn't pay on time, we can't even buy fuel or support staff allowances for outreach." (Technical Officer, P-9)

4c. Absence of a dedicated malaria vaccine budget line

A theme that emerged with particular salience across participants from all six districts was the absence of a dedicated budget line for malaria vaccine activities at the district level. Without a specifically allocated and protected budget, malaria vaccination competed with all other EPI activities and health service priorities for a single pool of funds a competition that malaria vaccination frequently lost, particularly during periods of general resource scarcity.

"There is no budget line for malaria vaccine; we combine it with other EPI funds." (EPI Coordinator, P-11)

"Because there's no specific malaria vaccine budget, we always wait for general EPI funds before we can do outreach." (Field Technician, P-5)

"Districts can't plan independently because budgets come from higher levels, and malaria vaccine is not prioritized." (EPI Coordinator, P-11)

Participants expressed genuine concern about the long-term viability of the programme without a more secure and autonomous funding architecture, with several offering the view that the programme's survival depended on continued external support that could not be guaranteed.

"If Gavi and other partners withdraw completely, it will be difficult for us to sustain the malaria vaccine activities." (EPI Coordinator, P-9)

"The programme is good, but without continuous funding support, it won't survive on IGF alone." (Field Technician, P-6)

IV. DISCUSSION

This qualitative study provides systematic, in-depth evidence on the operational barriers experienced by frontline healthcare workers delivering the RTS,S/AS01E malaria vaccine in the Bono East Region of Ghana. The four theme categories identified effectiveness perceptions and

dose completion challenges; logistical and cold chain barriers; community acceptance and AEFI communication; and funding and sustainability collectively characterize an implementation environment in which genuine clinical impact is demonstrated but constrained by remediable structural failures operating at multiple levels of the health system.

Fourth-dose dropout as a systemic delivery failure

The near-universal identification of fourth-dose dropout as the dominant programme challenge aligns precisely with the global literature on RTS,S/AS01E coverage. Jalang'o et al. (2025) reported median fourth-dose coverage of approximately 46% across pilot countries by 2023, identifying the fifteen-month interval between dose three and dose four as the primary structural driver of dropout exactly the mechanism described by participants in this study. Moturi et al. (2023), in a subnational analysis across 23 sub-counties in western Kenya, documented a cascade from 96% first-dose coverage to approximately 28% fourth-dose coverage in some sub-counties, attributing the attrition to caregiver mobility, inadequate defaulter tracing infrastructure, and the absence of co-delivery with other second-year vaccines. The qualitative evidence from this study confirms and contextualizes these quantitative patterns, revealing that the barriers to fourth-dose completion are not primarily attitudinal — caregivers who complete doses one through three generally value the vaccine — but structural: the extended inter-dose interval, resource-constrained defaulter tracing systems, and the disconnection of the booster from other scheduled second-year health contacts. This finding supports the WHO (2024b) recommendation to align the RTS,S booster with existing 18–24-month EPI antigens, a strategy confirmed by administrative data from Ghana's national programme to have raised fourth-dose coverage to approximately 81% in districts that implemented co-scheduling (WHO MPAG, 2024).

Cold chain and logistical barriers: structural not incidental

The cold chain and logistical barriers documented in this study bulky packaging, CHPS-level refrigeration gaps, motorbike-dependent outreach, poor road conditions, and recurrent fuel shortages are consistent with findings across the implementation literature for sub-Saharan Africa. Ahmed et al. (2018) in Ghana, Oyieke et al. (2019) in Kenya, and Munguambe et al. (2019) in Mozambique all documented cold chain inadequacy and transport constraints as foundational barriers to vaccine delivery. Bekolo et al. (2019), in a systematic review across Sub-Saharan Africa, identified temperature maintenance between 2°C and 8°C as a binding operational constraint, particularly at the peripheral level a constraint made more acute by the RTS,S vaccine's two-vial reconstitution requirement, freeze sensitivity, and six-hour post-reconstitution window. The persistence of these barriers in the Bono East Region, despite the substantial infrastructure investments made during the Gavi/PATH-supported initial rollout, confirms that cold chain gaps at the CHPS level represent structural system deficiencies requiring sustained investment rather than one-time solutions. The motorbike dependency documented in this study is particularly concerning: it limits cargo capacity, exposes vaccines to physical and thermal stress, and creates

direct safety risks for health workers navigating poor road conditions a combination of risks that is not adequately addressed by existing national supply chain protocols.

Health worker training: an eroding asset

The finding that pre-rollout training was comprehensive but refresher training was absent points to a well-documented pattern in new vaccine introduction programmes: the concentration of capacity-building investment at the front end of implementation, with insufficient attention to sustaining competency as staff turn over and programme contexts evolve. Mrema et al. (2019) in Tanzania and Mbow et al. (2019) in Senegal both emphasized sustained health worker training as a critical enabler of vaccine delivery effectiveness, while Agbenu et al. (2019) in Ghana specifically linked the adequacy of training to the quality of cold chain management and AEFI reporting practices. The informal peer mentoring documented in this study as the de facto substitute for formal refresher training is a pragmatic coping strategy, but it is a fragile one that is inherently likely to introduce knowledge heterogeneity and gradual competency drift over time particularly for technically complex procedures such as two-vial reconstitution and AEFI documentation. The coupling of training gaps with low and delayed allowances creates a compound demotivation effect that the implementation literature consistently identifies as a predictor of programme attrition in low-resource settings (Adamu et al., 2024).

Community acceptance: genuine but fragile

The generally positive community acceptance described by participants is consistent with the high first-dose initiation rates documented in the quantitative strand of this study and across pilot implementation evaluations. However, the persistence of specific misinformation narratives particularly the infertility rumour — represents a qualitatively distinct and more serious form of hesitancy than general unfamiliarity with the vaccine, and one that is not amenable to resolution through standard health education messaging. Dimala et al. (2018), in their systematic review of malaria vaccine receptivity literature spanning 1947–2017, found that information deficiency and fear of side effects were the principal drivers of hesitancy in 6 and 5 of 8 reviewed studies respectively, and that effective misinformation counterstrategies consistently required trusted community messengers, active communication models, and integration with existing community engagement structures not passive information provision through durbars and radio alone. The AEFI-driven hesitancy cascade documented in this study in which a single adverse reaction, shared informally among community members, deters multiple families from returning for subsequent doses has direct implications for programme design. The delayed AEFI feedback loop identified by participants, in which reports were submitted but responses took weeks, amplified the community's perception that authorities were concealing information, creating a trust deficit that routine AEFI management guidance (Tinto et al., 2019) was not designed to address. This finding points to an urgent need for rapid, community-facing AEFI response protocols that treat pharmacovigilance communication as a trust-maintenance activity, not merely a safety surveillance function.

Funding sustainability: the fundamental structural threat

The funding and sustainability findings represent the most structurally consequential theme category in this study. The documented transition from Gavi/PATH-supported piloting to IGF-dependent routine delivery, with no dedicated malaria vaccine budget line at district level, creates a financing architecture that is both inequitable and inherently unsustainable. Widdowson et al. (2019) identified vaccine cost and the absence of dedicated immunization financing as the primary barriers to sustainable RTS,S delivery in Kenya. Adeshina et al. (2023), in their qualitative force-field analysis of RTS,S scale-up forces in Ghana, identified logistics funding and the four-dose administration complexity as the two most consistently cited barriers among national stakeholders. The Bono East Region evidence extends and contextualizes these findings at the district level, revealing that the funding gap operates not merely through the formal budget architecture but through the micro-level operational decisions it forces: cancelled outreach sessions when fuel funds are exhausted, missed refresher training when no budget exists, and differentially impaired outreach in lower-revenue facilities that serve the highest-need populations. WHO (2024b) explicitly acknowledges that the transition from donor-supported piloting to domestically financed routine delivery is the most critical and most fragile juncture in the vaccine programme lifecycle a recognition that the evidence from this study confirms and deepens.

V. CONCLUSIONS

This qualitative study documents the operational barriers experienced by frontline healthcare workers delivering the RTS,S/AS01E malaria vaccine in the Bono East Region of Ghana, generating rich, contextually grounded evidence that complements the quantitative effectiveness analysis conducted in parallel. Four interconnected barrier categories dose completion and data quality failures; cold chain and logistical constraints; community acceptance and AEFI communication gaps; and funding and sustainability deficits collectively define an implementation environment in which the vaccine's demonstrated clinical impact is real but substantively constrained below its potential.

The findings generate five specific programmatic implications for the Bono East Region and comparable implementation settings. First, the fourth-dose booster must be formally co-scheduled with the 18-month MenA/MR2 EPI visit across all districts, supported by digital or paper-based defaulter tracking systems that are reliably resourced with fuel and supervision. Second, dedicated and ring-fenced district budget lines for malaria vaccine activities covering fuel, logistics, cold chain maintenance, and training must be established to replace the IGF-dependent model that has been demonstrated to be both inequitable and unsustainable. Third, cold chain infrastructure at CHPS-level facilities must be upgraded to accommodate the volume requirements of the RTS,S two-vial presentation, either through refrigeration investment or through operational protocols that reduce packaging constraints. Fourth, mandatory refresher training on reconstitution, dosing schedules, AEFI recognition and reporting, and caregiver communication should be institutionalized on a regular cycle and formally budgeted, not left to informal peer mentoring.

Fifth, AEFI communication and feedback systems must be redesigned to provide timely, community-facing responses to reported adverse events, reducing the trust deficit created by the current pharmacovigilance feedback delay.

These findings are directly relevant to health system managers in the Bono East Region, to the Ghana Health Service and National Malaria Control Programme in their national programme planning, and to global actors including Gavi, WHO, and PATH involved in the transition of malaria vaccination from pilot to sustainable routine delivery across sub-Saharan Africa.

List of Abbreviations

AEFI: Adverse Event Following Immunization | CHPS: Community-based Health Planning and Services | COREQ: Consolidated Criteria for Reporting Qualitative Research | EPI: Expanded Programme on Immunization | IGF: Internally Generated Funds | KII: Key Informant Interview | MCHPS: Maternal and Child Health Programme Support | MVIP: Malaria Vaccine Implementation Programme | NHIS: National Health Insurance Scheme | PATH: Programme for Appropriate Technology in Health | WHO: World Health Organization

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Ethics Review Board of the University of Port Harcourt (reference: [insert]) and the Ghana Health Service Ethics Review Committee (reference: [insert]). Written informed consent was obtained from all participants prior to their interview.

Consent for publication

All participants provided written consent for anonymized quotations to be used in publications arising from this research.

Availability of data and materials

The interview transcripts underpinning this study are not publicly available to protect participant confidentiality. Anonymized data are available from the corresponding author on reasonable request, subject to ethical governance conditions.

Competing interests

The authors declare no competing interests.

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Authors' contributions

MK designed the qualitative study, conducted all interviews, performed the thematic analysis, and wrote the manuscript. CW and VNO supervised the study, contributed to interpretation of findings, and critically reviewed the manuscript. All authors approved the final version.

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