

Community Pharmacies and Malaria Surveillance in an Elimination Setting in Ghana: A Cross-Sectional Study of Infrastructure, Documentation Systems, and Provider Willingness

Harriet Affran Bonful

habonful@ug.edu.gh

University of Ghana

Micheal Opoku-Mireku

Catholic University of Ghana

Hainau Iddrisu

University of Ghana

Victoria Anima Fordjour

University of Ghana

Colette Santah

University for Development Studies

Joel J. Idun-Acquah

National Malaria Elimination Program

Kezia L. Malm

National Malaria Elimination Program

Paul Boateng

National Malaria Elimination Program

Dr. Paul Hilarius Asiwome Kosi Abiwu

National Malaria Elimination Program

Adolphina Addo-Lartey

University of Ghana

Donatus Yaw Atiglo

University of Ghana

Frances Baaba Vroom

University of Ghana

Livesy Naafoe Abokyi

University for Development Studies

Irene A. Kretchy

Research Article

Keywords: Malaria, surveillance, community pharmacies, elimination, health information systems, willingness to support, Ghana

Posted Date: October 22nd, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11453646/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.
[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Introduction

Ghana's malaria elimination agenda depends on complete surveillance, yet community pharmacies, which manage a large share of febrile and suspected malaria cases in the private sector remain poorly integrated into routine reporting. We assessed the infrastructure, documentation systems, and willingness of community pharmacies to participate in malaria surveillance in an elimination setting.

Methods

We conducted a descriptive cross-sectional study in Tema West Municipality, Greater Accra, from February to August 2025, as the quantitative component of a larger mixed-methods project. A structured questionnaire and a malaria data reporting tool were administered to 135 staff in 65 community pharmacies that stocked at least one first-line artemisinin-based combination therapy and/or rapid diagnostic test. Infrastructure readiness was scored from four items, and willingness to participate in malaria surveillance was assessed through a described hypothetical scenario. Data were summarised with proportions and 95% confidence intervals in Stata 16.

Results

Infrastructure readiness was almost universal (93.8%), with most pharmacies having functioning phones (98.5%), computers (96.9%), generators (92.3%), and internet access (87.7%). However, only 13.8% of pharmacies had a fully operational documentation system, and epidemiologically important variables were captured inconsistently, including age (36.8%), sex (32.9%), diagnosis (15.8%), test results (22.4%), and referral (3.9%). Willingness to participate in malaria surveillance was high: 69.6% were willing to give time only, 17.0% both time and resources, and 0.7% resources only, while 12.6% were unwilling. Financial support and training were the most cited enablers, and time constraints and behavioural resistance were the main barriers.

Conclusion

Community pharmacies were physically and digitally equipped and largely willing to participate in malaria surveillance, but gaps in standardised documentation and in the capture of surveillance-relevant data limit their immediate readiness. Integration will require standardised reporting tools, interoperable systems, provider training, and sustainable financing, alongside pilot studies to assess whether willingness translates into sustained reporting.

Introduction

The Global Technical Strategy for Malaria 2016–2030 (GTS) aims to reduce malaria morbidity and mortality by at least 90% and eliminate malaria in at least 35 countries by 2030 (1, 2). Encouragingly, several countries have been certified malaria-free in recent years, while others are in their pre-elimination

and elimination stages (3). Ghana is one of the countries in the World Health Organization (WHO) Africa region currently with a subnational/territorial elimination programme (3). The Strategic Plan of the National Malaria Elimination Program (NMEP) of Ghana seeks to reduce malaria case incidence by 50% by 2028 (using 2022 as a baseline) and to eliminate malaria in 21 districts by 2028 (4). To achieve this, the NMEP intends to strengthen malaria surveillance, monitoring and evaluation systems by 2028 (4).

The WHO GTS for Malaria 2016–2030 recognizes malaria surveillance as a core intervention and emphasizes its critical role in malaria control and elimination (2, 5). The WHO defines malaria surveillance as *'the continuous and systematic collection, analysis and interpretation of malaria-related data, and the use of data in the planning, and evaluation of public health practice'* (5). Effective surveillance systems enable countries to monitor changes in disease burden, identify high-risk populations and transmission hotspots, detect outbreaks early, evaluate the effectiveness of therapies, and allocate resources efficiently (5). Surveillance is particularly important in low-transmission and elimination sites, where prompt case detection and intervention are required to prevent the re-establishment of transmission (5), underscoring the need to engage both the public and private healthcare sectors in surveillance activities (6).

Across Africa, community pharmacies and over-the-counter medicine sellers (OTCMS) serve as the primary points of care for febrile illnesses and suspected malaria cases (7, 8). Community pharmacies have several advantages, making them an important alternative to public health facilities. Due to their accessibility and flexible operating hours, community pharmacies play a major role in the management of febrile illnesses in many low- and middle-income countries (9, 10). In Ghana, a significant number of febrile cases seek care from the private sector (11). Community pharmacies and OTCMS are the leading providers of care in the private sector for children under five, with community pharmacies contributing 13.6% and OTCMS contributing 13.0% of the total 33.6% of care sought in the private sector in Ghana (12). Despite their contribution to malaria care, evidence suggests that malaria encounters in community pharmacies are not reported due to poor integration into national surveillance systems, inadequate reporting tools, limited supervision, and weak regulatory enforcement (13).

Infrastructure and human resources are indispensable for effective malaria surveillance. The WHO emphasizes the need for documentation tools, reporting forms, computers and electronic systems, internet connectivity, diagnostic capacity, and trained personnel for malaria surveillance to be successful (13). Additionally, standardized and accurate documentation systems are central to malaria surveillance because they support timely data collection, improve data consistency, analysis, and transmission of malaria data (5). The use of standardized case definitions, reporting forms, and electronic reporting systems improves data quality and interpretation (14). Despite all these, several studies have reported that private medical outlets in sub-Saharan Africa often lack adequate diagnostic and record-keeping infrastructure. Wafula *et al* found inconsistencies in documentation systems and poor regulatory compliance among Kenyan medicine retailers (7). Similarly, Bamiselu and colleagues reported significant gaps in malaria documentation and reporting capacity among Nigerian private sector providers (15). In Ghana, a study in Hohoe municipality exploring documentation and reporting practices

in malaria tracking among formal drug retail outlets reported that malaria documentation and reporting were low (16). Weaknesses in infrastructure or workforce capacity can directly affect the quality, completeness, accuracy, and timeliness of malaria data, ultimately undermining malaria control and elimination efforts (17, 18).

Beyond infrastructure and documentation systems, providers' willingness to support surveillance is essential to the sustainability of surveillance programmes (19, 20). Healthcare providers are responsible for detecting suspected malaria cases, confirming diagnoses, completing reporting forms, and submitting data to surveillance systems (13). Inadequate participation may contribute to delayed reporting, underreporting, and data gaps that weaken disease monitoring and outbreak detection (13, 20). However, studies show that private-sector willingness to participate in surveillance is often limited by increased workload, lack of incentives, complicated reporting procedures, inadequate training, concerns about regulatory scrutiny, poor feedback from health authorities, and limited resources (13, 20). As malaria elimination efforts rely on timely reporting, a scenario-based assessment of willingness may be a useful tool for assessing community pharmacies' willingness to support surveillance systems (21).

A scenario-based assessment of willingness is a useful approach for assessing willingness to participate in public health interventions, especially when it is voluntary and may require effort, time, or resources (21). Related willingness-assessment methods have been widely applied in health economics to assess willingness to pay, willingness to accept compensation, and willingness to participate in health programs (21–23). In the context of malaria surveillance, a scenario-based assessment provides a framework for gauging community pharmacies' willingness to participate in malaria surveillance and exploring conditions under which participation may improve. Because we did not estimate a monetary value, a bidding amount, or a willingness-to-pay threshold, we describe this as a scenario-based assessment of willingness rather than a contingent valuation.

As Ghana transitions towards elimination, it requires robust and comprehensive surveillance systems that incorporate both public and private sectors (24). Despite the significant contribution of community pharmacies to malaria care, most studies in community pharmacies in Ghana have focused on malaria treatment and dispensing practices (25–27). Additionally, there is limited evidence on surveillance infrastructure within community pharmacies, including registers, electronic systems, reporting tools, and internet access. Furthermore, studies that assessed willingness in this way have focused mainly on willingness to pay for malaria insurance and support malaria interventions, such as malaria larviciding programs, rather than willingness to participate in malaria surveillance (22, 23).

This study was part of broader research that sought to support the NMEP's target of achieving malaria elimination in Ghana through improved malaria case management and surveillance in the private sector (community pharmacies in Ghana). This study therefore assessed infrastructure and workforce capacity readiness, the availability of documentation systems and documentation practices, and the willingness

of community pharmacies to participate in malaria surveillance using a scenario-based willingness assessment in an elimination site in Ghana.

Methods

Study design and setting

The broader research study employed a mixed-methods approach comprising both qualitative and quantitative studies. The current study reports the standalone quantitative component of that larger project. It is a descriptive cross-sectional study conducted in Tema West Municipality, located in the Greater Accra Region (GAR). Tema West is among the 21 districts targeted for malaria elimination in Ghana (24). It is situated in the southeastern part of the GAR, and it is estimated to have a population of 226,097 from a count of 196,224 in the 2021 Ghana Population and Housing Census (28). The municipality was purposively selected because it has the highest number of pharmacies (291) of all 21 districts targeted for malaria elimination in the GAR (29). The study population comprised pharmacists and other dispensing staff such as pharmacy technicians and Medicine Counter Assistants (MCAs) who usually provide services in community pharmacies. Data were collected from February to August 2025.

Sample size and sampling procedures

Sixty-five community pharmacies were purposively selected and enrolled in the study because the broader study focused on pharmacies likely to encounter and manage malaria cases; A sampling frame of the 291 pharmacies registered in the municipality was obtained from the Pharmacy Council for that broader selection process.

Within each of the 65 pharmacies, the pharmacist(s) or dispensing staff who usually provided care to clients were invited to participate; between one and four staff participated per pharmacy depending on availability and willingness on the day of data collection, yielding a total of 135 pharmacy staff respondents.

Community pharmacies with at least one first-line Artemisinin-based Combined Therapy (ACT) and/or Rapid Diagnostic Test (RDTs) in stock on the survey day were included, excluding pharmacies that offer only wholesale services. This criterion was applied because only pharmacies that stock antimalarials or diagnostic tests routinely attend to suspected malaria cases and would therefore be eligible to contribute to malaria surveillance. We recognise that it may preferentially select outlets already engaged in malaria services, which could bias the readiness and willingness estimates upward, a point we return to in the study limitations.

Data collection and analysis

Data collection

Data were collected from pharmacists/dispensing staff using a structured questionnaire and a malaria data reporting tool. The structured questionnaire was used to solicit data on sociodemographic factors, socioeconomic factors, human resource strength, participation in malaria case management training, training needs, availability of guidelines, supportive supervision, and other background characteristics. These independent variables were adapted from the WHO malaria surveillance framework (5), Phalkey and colleagues, 2015(30) and Brock and colleagues, 2006 (31). The malaria data reporting tool was used for the scenario-based willingness assessment.

The scenario-based willingness assessment comprised a hypothetical scenario that described what the malaria surveillance program will entail, i.e., the patient data form that community pharmacy staff will be expected to complete, the potential benefits, limitations, and prospects of the program. The malaria surveillance reporting form (Supplementary file 1) was given to the community pharmacy staff to engage with to appreciate the data they will be required to report to the next level. After assessing the form, community pharmacy staff then answered subsequent questions.

It was more convenient for most community pharmacy staff to complete the paper-based questionnaire rather than the originally intended computer-assisted personal interviewing (CAPI) using a KoBoCollect form. Responses recorded on paper were subsequently entered into the KoBoCollect platform by trained data-entry personnel and exported for analysis, and the entered records were checked against the paper forms to correct errors before analysis.

The data collection tools, including the Community Pharmacy malaria surveillance form, were initially developed by the research team and shared with the NMEP for technical review. Four experts at the NMEP, including the focal person for malaria case management, Monitoring and Evaluation Specialist, and Head of Procurement and Supply Chain, reviewed the data collection tools and approved the use of the tools. The review focused on the relevance, clarity, and completeness of the items against national malaria case-management and surveillance requirements, and the wording and response options of several items were revised before the tools were finalised.

Before data collection, research assistants and field supervisors were recruited, trained, and then conducted two rounds of pre-testing of the tools on a sample of 12 community pharmacies in the Ayawaso West District in the GAR. Pre-testing checked how respondents understood the questions and how long it took to administer, and items that were unclear or repeatedly misinterpreted were rephrased or dropped. The questionnaire was administered in English. Field staff were trained before data collection, and completed forms were checked daily for completeness and consistency.

Measurement of variables

The primary outcome, willingness to participate in malaria surveillance, was assessed using structured questions adapted from Atiglo and colleagues 2018 (23). One categorical question with four options was used to assess willingness to support malaria surveillance data as follows:

‘To support malaria data reporting in your community pharmacy, are you willing to contribute resources or time or both resources and time?’ The options were i) *Willing to contribute time only*, ii) *Willing to contribute resources only*, iii) *Willing to contribute both time and resources*, and iv) *Not willing*.

Proportions were used to describe the distribution of community pharmacy staff according to their willingness to support malaria surveillance.

We measured infrastructural readiness using a four-item composite score comprising whether the pharmacy had a functioning phone, a functioning computer, internet access, and a backup power generator (REF). Each pharmacy earned one point for every item it had, yielding an overall readiness score ranging from 0 to 4. Pharmacies with at least three of the four items (score of 3–4) were classified as having high readiness, and the rest as having limited readiness. The infrastructure readiness score was a simple additive count of four items rather than a reflective scale, so a measure of internal-consistency reliability was not computed for it.

Responses to the perception items on documentation system availability were measured on a five-point numeric scale ranging from 1 (strongly disagree) to 5 (strongly agree), recategorized into three levels (yes completely, yes partially, and no). This was cross-tabulated against the type of documentation system in use at the pharmacy, that is, a paper system, a commercial computer system, or a personally developed computer system (31). For perception on documentation system availability and to estimate the willingness to support, the unit of analysis was the individual community pharmacy staff, while for infrastructure the unit of analysis was the pharmacy. Data were therefore captured at two levels: facility-level characteristics, such as the pharmacy’s infrastructure and documentation systems, were recorded once per pharmacy using the pharmacy identifier, whereas individual-level characteristics, such as each staff member’s background and willingness to support, were collected from every respondent.

Barriers to surveillance reporting and preferred incentives were multiple-response questions, so respondents could select more than one option. We report the percentage of respondents selecting each option, and free-text responses under "other" were recoded into the existing categories where they clearly belonged. The barrier and incentive categories were defined operationally from the questionnaire responses: knowledge and skill gaps referred to limited training or unfamiliarity with malaria reporting; technological barriers to the absence of, or difficulty using, computers, internet, or reporting software; financial constraints to the costs of documentation and reporting; regulatory barriers to concerns about oversight and compliance; behavioural barriers to reluctance or low motivation to take on reporting; trust and confidentiality concerns to worries about how patient data would be used; and integration challenges to difficulty fitting reporting into existing workflows and the wider health system. Results are presented in tables, bar charts and pie charts.

Data analysis

Collected data were checked for completeness and accuracy. The data from the survey were exported in Comma Separated Variable (CSV) format and imported into Stata version 17.0 (Stata Corporation, College Station, Texas) for further data analysis.

Analysis consisted primarily of descriptive statistics. Categorical variables were presented as frequencies, percentages, and their associated 95% confidence intervals. Continuous variables were summarized using the mean and associated standard deviation or median and interquartile range, depending on the distribution's adherence to normality. The study was reported in line with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline for cross-sectional studies. Denominators differ across variables because not every respondent answered every item and because some characteristics were recorded at the level of the pharmacy rather than the individual respondent. All analyses used the available responses for each variable, and missing values were not imputed.

Results

Characteristics of pharmacy staff in Tema West

Overall, 135 pharmacy staff were interviewed from 65 pharmacies. The respondents had a median age of 28 years (IQR: 26–31), and most were female (83.7%). The proportion who reported attainment of tertiary education was 45.2%, while 73.3% were Medicine Counter Assistants. Those with a pharmacist qualification (BPharm or PharmD) formed 20.0% of respondents. The median duration of practice in a pharmacy was 4 years (IQR: 2–5) (Table 1).

Table 1
Characteristics of pharmacy staff in Tema West

Characteristics	Frequency	Percent (%)
Age in years (n = 101) ☒	28.0	26.0–31.0
Sex (n = 135)		
Female	113	83.7
Male	22	16.3
Highest level of Education (n = 135)		
Tertiary	61	45.2
Secondary/Senior high	74	54.8
Highest relevant qualification (n = 135)		
BPharm or PharmD	27	20.0
Higher National Diploma	9	6.7
Medicine Counter Assistant	99	73.3
Duration of practice in a pharmacy (n = 127) ☒	4.0	2.0–5.0

☒ median and interquartile range reported; BPharm, Bachelor of Pharmacy; PharmD, Doctor of Pharmacy; denominators vary across variables because of item-level missing responses .

Infrastructure capacity of pharmacies

Among the 65 pharmacies, the median duration of operation was 6 years (IQR: 3–15). Respondents perceived a median of 50 patients per day (IQR: 30–75), including a median of 10 febrile patients daily (IQR: 10–15) and 8 daily requests for antimalarial medicines (IQR: 5–10). Among the 65 pharmacies, nearly all had functioning phones (98.5%) and computers (96.9%), and most reported generator backup power (92.3%) and internet access (87.7%). Consistent with these findings, overall infrastructure readiness was almost universal (93.8%) (Table 2).

Table 2
Service characteristics and infrastructure readiness of pharmacies

Characteristics	Frequency	Percent (%)
Number of years facility has been functional (n = 52) ☒	6.0	3.0–15.0
Perceived average number of patients per day (n = 96) ☒	50	30–75
Perceived average number of febrile patients per day (n = 113) ☒	10	10–15
Perceived average number of patients requesting antimalarials daily (n = 119) ☒	8.0	5.0–10.0
Having a functioning phone (n = 65)		
No	1	1.5
Yes	64	98.5
Having a generator (n = 65)		
No	5	7.7
Yes	60	92.3
Having a functioning computer (n = 65)		
No	2	3.1
Yes	63	96.9
Having internet access (n = 65)		
No	8	12.3
Yes	57	87.7
Infrastructure readiness (n = 65)		
Limited readiness	4	6.2
High readiness	61	93.8
☒ median and interquartile range reported; denominators vary across variables because of item-level missing responses and because facility-level characteristics were recorded once per pharmacy		

Case recording and patient-level documentation systems

Availability and Type of Documentation Systems

Figure 1 presents the distribution of community pharmacies by availability and type of documentation systems reported by pharmacy personnel, as a foundation for recording malaria-related encounters and supporting routine surveillance reporting. At the facility level, 13.8% of pharmacies had a fully operational documentation system, while 49.2% kept records partially and 36.9% kept no structured

documentation system at all. Among the pharmacies that maintained some form of documentation (Panel B), paper-based systems were the most common (50.0%), followed by personally developed computer systems (32.5%), while commercial electronic systems were the least common (17.5%).

Notes: A is a bar chart showing the availability of documentation systems at pharmacies (n = 65). B depicts the types of documentation systems used by pharmacies that maintain them (n = 40).

Patient Information Captured within Documentation Systems

Table 2 summarizes the type and completeness of patient-level information recorded by pharmacy documentation systems, with emphasis on variables essential for malaria case definition, follow-up, and epidemiological analysis. This table is restricted to the 76 respondents who reported having a fully or partially operational documentation system (Fig. 1, Panel A); of these, 74 specified the type of system in use, forming the base for Table 3. A large majority of respondents documented patient names (82.9%) and phone numbers (78.9%). Key demographic variables essential for epidemiological analysis were collected less frequently: only 36.8% recorded patient age, 32.9% documented sex, and 26.3% captured patient addresses. For clinical information, respondents who recorded prescriptions dispensed were 52.6%, with even fewer documenting diagnoses (15.8%), laboratory test results (22.4%), and referrals (3.9%). Anthropometric measurements such as height (7.9%) and weight (13.2%) were rarely collected. Information on referral status was the most seldom collected.

Table 3
Patient data routinely collected using pharmacy documentation
systems (N = 76)

Patient data	Number that record (N = 76)	Percent (%)
Name	63	82.9
Age	28	36.8
Sex	25	32.9
Address	20	26.3
Occupation	8	10.5
Height	6	7.9
Weight	10	13.2
Prescription	40	52.6
Diagnosis	12	15.8
Test results	17	22.4
Referral	3	3.9
Phone number	60	78.9

Perceived Performance of Documentation Systems

Table 3 presents how pharmacy staff perceive the performance of their documentation systems in supporting malaria surveillance functions, including data entry, retrieval, report generation, and secure handling of patient information. Commercial systems had the highest agreement for standardization of patient data (94.1%), generation of patient reports (88.2%), ease of retrieving patient data (100.0%), security (100.0%), ease of tracking patient outcomes (76.5%), and linkage with dispensing systems (76.5%). Paper-based systems did not score the highest agreement proportion in any domain. It showed the lowest agreement for ease of use (80.6%), patient data retrieval (64.5%), security (35.5%), and free-form text entry (51.6%). Self-developed systems demonstrated the highest agreement for ease of use (100.0%), requiring little time to use (96.2%), and free-form text entry (84.6%), and the lowest agreement for report generation (30.8%), ease of patient outcome tracking (46.2%), linkage with dispensing systems (26.9%), and provision of technical support (30.8%).

Table 4

Respondents perceived characteristics of pharmacy documentation systems by system type

Perceived characteristics of facility's documentation system	Paper system	Commercial computer system	Self-developed computer system	Total
	N = 31	N = 17	N = 26	N = 74
Easy to use	25 (80.6)	15 (88.2)	26 (100.0)	66 (89.2)
Cost of the system is reasonable	23 (74.2)	13 (76.5)	8 (30.8)	44 (59.5)
Adds value to the pharmacy	27 (87.1)	15 (88.2)	21 (80.8)	63 (85.1)
Requires little time to use	23 (74.2)	14 (82.4)	25 (96.2)	62 (83.8)
Provides opportunity to standardize patient data	23 (74.2)	16 (94.1)	20 (76.9)	59 (79.7)
Provides compact storage of data	20 (64.5)	14 (82.4)	13 (50.0)	47 (63.5)
Meets the needs of the pharmacy	18 (58.1)	14 (82.4)	15 (57.7)	47 (63.5)
Generates patient data reports	16 (51.6)	15 (88.2)	8 (30.8)	39 (52.7)
Easily retrieves patient data	20 (64.5)	17 (100.0)	23 (88.5)	60 (81.1)
Easily tracks patient outcomes	21 (67.7)	13 (76.5)	12 (46.2)	46 (62.2)
Secure	11 (35.5)	17 (100.0)	22 (84.6)	50 (67.6)
Allows entry of free-form text	16 (51.6)	13 (76.5)	22 (84.6)	51 (68.9)
Links with dispensing system	12 (38.7)	13 (76.5)	7 (26.9)	32 (43.2)
Has billing capabilities	5 (16.1)	10 (58.8)	6 (23.1)	21 (28.4)
Requires additional software	9 (29.0)	9 (52.9)	5 (19.2)	23 (31.1)
Technical support is provided for the system*		14 (82.4)	8 (30.8)	31 (41.9)
*Not applicable for paper-based systems				

Willingness of pharmacy staff to participate in malaria surveillance

Figure 2. Bar chart with 95% confidence intervals showing the willingness of pharmacy personnel to support malaria surveillance.

s

Almost 70% of the pharmacy staff were willing to contribute time only (Fig. 2).

Among the staff who were willing to contribute, the median time they were prepared to devote to malaria data reporting was 60 minutes per month (IQR: 60–120). When asked how they would prefer to report, most preferred a digital channel: 53.3% chose a web-based platform and 26.7% a mobile application, while 18.5% preferred hardcopy and 1.5% another format. A large majority (77.8%) reported that they would be comfortable with the reporting format being integrated into the national surveillance system, 17.0% were unsure, and 3.7% were not comfortable. Of the 23 (17.0%) staff willing to contribute both time and resources, 12 specified what they would provide; setting aside time, which was assessed separately, these were money (3, 13.0%), malaria test kits or related consumables (3, 13.0%), computers or technical support (2, 8.7%), skills or expertise (2, 8.7%), and human resource or facility support (1, 4.3%).

Enablers and incentives within the surveillance enabling environment.

Figure 3 depicts the incentives and support that pharmacy personnel perceived as being important for enabling effective malaria documentation and reporting within the surveillance system. The most reported incentive was financial support, cited by 57.8% (n = 78) of respondents. This was followed by training, reported by 48.1% (n = 65). Human resource support was reported by 34.8% (n = 47), while technological support and logistics supply were cited by 33.3% (n = 45) and 28.9% (n = 39), respectively.

Notes: Multiple responses allowed.

System-level and provider-level barriers to pharmacy integration in malaria surveillance.

Figure 4 presents perceived barriers that hinder community pharmacies from participating fully in malaria surveillance, spanning knowledge, technological, financial, regulatory, and behavioural constraints. Time constraints due to high patient volumes (41.5%) and behavioural barriers (39.3%) were the most frequently cited by respondents as barriers requiring elimination. Knowledge and skill gaps (35.6%), technological barriers (34.1%), and financial constraints (34.1%) were also identified. Conversely, trust and confidentiality concerns (17.0%), regulatory barriers (15.6%), and integration challenges with the broader health system (12.6%) were endorsed less frequently.

Notes: Multiple responses allowed.

Discussion

In this elimination setting, community pharmacies appeared physically and digitally equipped to participate in malaria surveillance, yet their existing documentation systems were not configured to generate the standardised epidemiological data that surveillance requires. Infrastructure readiness was almost universal, but fewer than half of the pharmacies had a fully operational documentation system, and variables central to malaria case definition, such as age, sex, diagnosis, and test results, were captured inconsistently. Willingness to participate was high, although it was expressed mainly as a willingness to give time rather than resources. The central message of this study is that willingness and hardware readiness coexist with a substantial gap in the documentation systems needed to turn pharmacy encounters into usable surveillance data.

Willingness to participate in malaria surveillance

This study assessed the infrastructure and workforce capacity readiness, the availability of documentation systems and documentation practices, and the willingness of community pharmacies to participate in malaria surveillance using a scenario-based willingness assessment, in a pre-elimination site in Ghana. This study found a high level of willingness among community pharmacy staff to support malaria surveillance but mostly through time rather than resources. One possible explanation, which requires further investigation, is that the high willingness observed reflects their frequent exposure to malaria-related cases and their recognition of their frontline role in community healthcare. This finding is consistent with previous evidence showing that private-sector providers recognize the value of contributing to disease surveillance. For instance, Phalkey *et al* reported that private providers were generally open to surveillance participation; however, actual participation remained low due to weak institutional support, unclear reporting mechanisms, and feedback(20). Similarly, Makinde and colleagues reported that only 40% of private facilities in South-West Nigeria complied with disease surveillance reporting, resulting in missed opportunities for prompt identification and response to disease outbreaks(32). It is worth noting that this study assessed willingness rather than observed reporting practices, which may partly explain the higher levels of expressed engagement. The preference for contributing time rather than resources suggests that community staff perceive reporting as an extension of their responsibilities, whereas committing resources may be constrained by limited operational budget and expectation of institutional support. In keeping with this, most staff were prepared to give only a modest amount of time each month, yet a clear majority preferred digital reporting channels and were comfortable with integration into the national surveillance system. This suggests an openness to electronic, workflow-light reporting that the NMEP could build on when designing pharmacy reporting tools. Interestingly, a few participants were unwilling to support. This may be because they perceived surveillance reporting as an added workload that could disrupt routine pharmacy operations, especially in high-volume settings. It is therefore important to identify and address specific concerns of unwilling providers to improve participation and support.

Infrastructure readiness and the documentation gap

A high level of infrastructure readiness was observed in this study, suggesting that pharmacies possess the minimum physical and technological resources required to participate in malaria surveillance activities. High infrastructure readiness was observed here; one possible explanation, which we could not assess directly, is that pharmacies have in recent times become more technology-driven (33). Pharmacies have adopted technology for improving stock management, billing, dispensing, reducing medication errors, enhancing workflow efficiency, improving patient care, and medication adherence (34–36). Availability of infrastructure such as mobile phones, internet, and computers is essential for effective disease surveillance (37). It enables real-time data collection, rapid communication, and analysis, facilitating timely response to public health threats and enhancing the overall efficiency of digital health technologies (37–40). Additionally, generators provide a continuous supply of electricity to these technologies in case of power outages, facilitating uninterrupted reporting, monitoring, and response (37, 39). Notwithstanding the high infrastructure readiness, most of the pharmacies did not have fully operational documentation systems, indicating that the availability of hardware does not necessarily translate into surveillance functionality. Data comparability, aggregation, and interoperability are crucial in disease surveillance as they facilitate timely and effective standardized data exchange, improve surveillance performance, and enhance collaboration in addressing threats (41–43). Despite this, this study showed that documentation systems varied among community pharmacies, limiting data comparability, aggregation, and interoperability. The majority used paper-based systems, which may be attributable to perceived advantages as being cost-effective, operationally flexible, and requiring minimal training (44); though, they pose significant challenges in terms of efficiency, durability, accessibility, and scalability (44). Furthermore, community pharmacies lacked standardized documentation systems, a key limitation to the systematic capture of epidemiologically relevant surveillance data. Efforts to integrate community pharmacies in malaria surveillance should focus more on improving data standardization, completeness of patient information, and interoperability with national surveillance systems.

Pharmacy staff held positive perceptions of the available documentation systems, suggesting a good foundation for surveillance integration; however, performance varied considerably by system type. In this study, commercial systems had higher reported agreement proportions than both paper-based and self-developed systems in important surveillance-related characteristics such as data standardization, report generation, patient outcome, and security. Because these were descriptive proportions from small subgroups and were not compared using formal statistical tests, they should be read as reported differences rather than as demonstrated superiority. This finding is consistent with a study by Brock et al, which reported higher performance of commercial systems over paper-based and self-developed systems(31). The higher reported agreement for commercial systems may be attributed to their design, which facilitates accurate capture of data, data retrieval, report generation, and timely reporting, all of which are essential for disease surveillance. In contrast, paper-based systems depend on manual documentation processes that may hinder surveillance reporting. Likewise, self-developed systems may be useful only for business purposes, limiting their use in public health surveillance. To enhance the suitability of existing documentation systems for malaria surveillance, priority should be given to

optimizing functionality that improves the quality, timeliness, and reliability of pharmacy-generated surveillance data.

Enablers, barriers, and implications for implementation

Financial support, training, human resource support, and technological support were identified as the most important facilitators, while time constraints, behavioural resistance, knowledge and skills level, and financial constraints emerged as the principal barriers. These findings align with previous evidence on private-sector participation in disease surveillance, which identified inadequate training, weak institutional support, workload, and limited resources as factors associated with effective surveillance (20). Similarly, previous studies among healthcare workers have shown that financial motivation, training, good knowledge, and clear reporting procedures are critical to improving documentation practices and effective surveillance participation (45–48). In this study, financial support was the strongest facilitator, which may be attributable to the profit-making objective of most community pharmacies. Consequently, pharmacy staff may be more sensitive to costs associated with additional documentation and reporting responsibilities. To encourage community pharmacies to support malaria surveillance, resources should be allocated by the NMEP to compensate reporting-related costs. Additionally, the reporting process should be simplified and integrated into existing pharmacy workflow to reduce the burden associated with documentation. Engaging pharmacy staff during program design, regular training, clear reporting guidelines, and supportive supervision could enhance compliance with surveillance activities. A practical pathway for integration would begin with a standardised minimum malaria dataset and a simple digital reporting interface that is interoperable with the national surveillance system, supported by workflow-sensitive reporting processes, provider training and supportive supervision, and a feedback loop that monitors the completeness and timeliness of reporting.

Study Limitations

This study has a few limitations that should be considered when interpreting the findings. First, the cross-sectional design limits the ability to establish a causal relationship between pharmacy characteristics and willingness to participate in malaria surveillance. Secondly, the study relied on self-reported data, which may introduce social desirability bias. Willingness to support and the functionality of the documentation systems may have been overstated. Thirdly, the study assessed willingness to support rather than actual participation; therefore, reported willingness may not necessarily translate into reporting practices when the programme is implemented.

A further limitation of this study is the inclusion of pharmacists and other pharmacy staff with varying levels of professional training and expertise. This diversity may have introduced variability in how information was perceived, interpreted, and reported, potentially affecting the consistency and comparability of the findings across respondents.

Other limitations should also be noted. The study was carried out in a single municipality, so the findings may not generalise to community pharmacies in other districts or regions. Restricting eligibility to pharmacies that stocked antimalarials or diagnostic tests may have selected outlets already oriented

towards malaria services, which could overstate readiness and willingness. Because willingness was assessed through a hypothetical scenario, the responses are also open to hypothetical bias. We did not use a validated composite instrument for overall surveillance readiness. Instead, we measured selected readiness domains, and the results should be read as evidence on those domains rather than on readiness as a single validated construct. More than one staff member could contribute from the same pharmacy, so the responses were not fully independent at the facility level.

Finally, the performance of the documentation systems was not evaluated based on objective measures but rather the users' perceptions. Notwithstanding these limitations, this study provides important baseline evidence on the willingness of community pharmacies to support malaria surveillance in Ghana and identifies key implementation considerations for future programme development.

Conclusion

The high willingness of community pharmacy staff to participate in malaria surveillance and the availability of infrastructure indicate the potential for community pharmacies to complement existing surveillance systems by contributing data on malaria cases encountered and managed in community pharmacies. Incorporating community pharmacies into Ghana's malaria surveillance system could improve the coverage and representativeness of surveillance data, provided that standardized documentation and reporting mechanisms are established. However, successful implementation will require investments in standardized documentation systems, interoperable reporting platforms, provider training, and sustainable financing to address the barriers identified in this study. Successful implementation will also require sustained collaboration between the NMEP, Ghana Health Service, Pharmacy Council, and pharmacy owners. Formal policies, reporting frameworks, and communication channels should be developed to support the sustainability of community pharmacies in malaria surveillance.

Future research should go beyond assessing readiness and willingness of community pharmacies to support malaria surveillance. Assessing readiness and willingness does not establish whether such participation actually translates into accurate, timely, and useful surveillance data. Readiness and willingness are necessary preconditions, but they do not guarantee sustained engagement, data quality, or measurable impact on malaria case detection and reporting once pharmacies are integrated into a surveillance system. Pilot implementation studies should be conducted to determine whether the high willingness observed in this study will translate into sustained reporting behaviour and improved surveillance performance. Additionally, studies should evaluate strategies to address the barriers identified in this study, such as provider training, documentation systems, financial incentives, knowledge and skills level, and supportive supervision.

Abbreviations

ACT

Artemisinin-based Combined Therapy

GAR

Greater Accra Region

GTS

Global Technical Strategy

MCA

Medicine Counter Assistant

NMEP

National Malaria Elimination Programme

OTCMs

Over-the-counter Medicine sellers

RDT

Rapid Diagnostic Test

WHO

World Health Organisation.

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from the Ethical and Protocol review committee of the College of Health Sciences, University of Ghana as well as the Ethics and Protocol Review Committee of the Ghana Health Service. Permission was sought from all participating pharmacies, and informed written consent was obtained from community pharmacy staff.

Consent for publication

Not applicable

Availability of data and materials

The dataset that supports the study findings can be obtained from the corresponding author (habonful@ug.edu.gh) upon reasonable request.

Competing interests

The authors declare have no competing interests.

Funding

This study was funded through the University of Ghana Research Fund (UGRF), a small-grants programme administered by the Research and Innovation Directorate (RID) of the University of Ghana.

Authors' contribution

HAB conceptualized the study. HAB, LNA, PB, MOM, and JJIA contributed to the study design. VAF and CS coordinated data collection. MOM and HAB contributed to data analysis and interpretation. HAB, HI, and MOM, drafted the initial manuscript. IAK, VAF, KLM, PHAKA, AAL, DYA, FBV, and LNA contributed to the review and revision of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors gratefully acknowledge all study participants for their time and willingness to participate in the study, as well as the data collection team for their dedication and valuable contributions to the successful conduct of the study.

References

1. World Health Organization. Global technical strategy for malaria, 2016–2030 [Internet]. Global Malaria Programme, World Health Organization. 2015 [cited 2026 Jun 1]. 29 p. Available from: <https://www.paho.org/sites/default/files/2023-06/2ncd-roadmap.pdf>
2. World Health Organization. Global technical strategy for malaria, 2016–2030. Global Malaria Programme. World Health Organization; 2015. p. 29.
3. World Health Organization. World Malaria Report 2025: addressing the threat of antimalarial drug resistance. Geneva: World Health Organization; 2025.
4. Ministry of Health/Ghana Health Service. National Malaria Elimination Programme (NMEP). NATIONAL MALARIA ELIMINATION STRATEGIC PLAN STRATEGIC PLAN. 2023.
5. World Health Organization. Malaria surveillance, monitoring and evaluation A reference manual, second edition. 2025.
6. Berlin E, Lourenço C, Poyer S. Surveillance for Action: Operationalizing Private Sector Surveillance and Service Delivery across the Malaria Transmission Continuum. *Am J Trop Med Hyg*. 2025;112(1Suppl):66–9. 10.4269/ajtmh.23-0447.
7. Wafula FN, Miriti EM, Goodman CA. Examining characteristics, knowledge and regulatory practices of specialized drug shops in Sub-Saharan Africa: a systematic review of the literature. *BMC Health Serv Res*. 2012;12:223. 10.1186/1472-6963-12-223 . PubMed PMID: 22838649.
8. Afuye S, Yusuf A, Adeseun R. <https://africanarguments.org/2024/10/the-digital-future-of-pharmacy-in-africa/>. 2024. The Digital Future of Pharmacy in Africa.
9. Smith F. Community pharmacy in Ghana: enhancing the contribution to primary health care. *Health Policy Plan*. 2004;19(4):234–41. 10.1093/heapol/czh028.
10. Okai GA, Abekah-Nkrumah G, Asuming PO. Perceptions and trends in the use of community pharmacies in Ghana. *J Pharm Policy Pract*. 2019;12:25. 10.1186/s40545-019-0186. -x PubMed PMID: 31548892.
11. Ansah EK, Gyapong M, Narh-Bana S, Bart-Plange C, Whitty CJM. Factors influencing choice of care-seeking for acute fever comparing private chemical shops with health centres and hospitals in

- Ghana: a study using case-control methodology. *Malar J.* 2016;15(1):290. 10.1186/s12936-016-1351-1 . PubMed PMID: 27225480.
12. Ghana Statistical Service (GSS). ICF. The 2019 Ghana Malaria Indicator Survey (GMIS). 2019.
 13. World Health Organization. *MALARIA SURVEILLANCE, MONITORING & EVALUATION: A REFERENCE MANUAL.* 2018.
 14. National Research Council. *Malaria Control During Mass Population Movements and Natural Disasters.* Washington, D.C.: National Academies; 2002. 10.17226/10539.
 15. Bamiselu OF, Ajayi I, Fawole O, Dairo D, Ajumobi O, Oladimeji A, et al. Adherence to malaria diagnosis and treatment guidelines among healthcare workers in Ogun State, Nigeria. *BMC Public Health.* 2016;16(1):828. 10.1186/s12889-016-3495-x.
 16. Loglo V, Gmayinaam VU, Ampomah MA, Boateng P, Ansah EK. Exploring documentation and reporting practices in malaria tracking: a mixed-methods study among formal drug retail shops in Hohoe Municipal, Ghana. *Malar J.* 2025;24(1):399. 10.1186/s12936-025-05645-7 . PubMed PMID: 41239439.
 17. Bennett A, Avanceña ALV, Wegbreit J, Cotter C, Roberts K, Gosling R. Engaging the private sector in malaria surveillance: a review of strategies and recommendations for elimination settings. *Malar J.* 2017;16(1):252. 10.1186/s12936-017-1901-1.
 18. Nuh AY, Fikru C, Regassa D, Serba HA, Abreham A, Matthew B, et al. Evaluation of the malaria surveillance system and trends in Jimma town, Southwest Ethiopia, 2024: a mixed-method study. *Sci Rep.* 2026;16(1):3404. 10.1038/s41598-025-33344-5.
 19. German RR, Lee LM, Horan JM, Milstein RL, Pertowski CA, Waller MN et al. Update Guidelines for Evaluating Public Health Surveillance Systems [Internet]. 2001 [cited 2026 May 19]. Available from: https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5013a1.htm?utm_source=chatgpt.com#top
 20. Phalkey RK, Butsch C, Belesova K, Kroll M, Kraas F. From habits of attrition to modes of inclusion: enhancing the role of private practitioners in routine disease surveillance. *BMC Health Serv Res.* 2017;17(1):599. 10.1186/s12913-017-2476-9.
 21. Asenso-Okyere WK, Osei-Akoto I, Anum A, Appiah EN. Willingness to pay for health insurance in a developing economy. A pilot study of the informal sector of Ghana using contingent valuation. *Health Policy.* 1997;42(3):223–37. 10.1016/s0168-8510. (97)00069-9 PubMed PMID: 10176302.
 22. Asafu-Adjaye J, Dzator J. Willingness to Pay for Malaria Insurance: A Case Study of Households in Ghana Using the Contingent Valuation Method. *Econ Anal Policy.* 2003;33(1):31–47. 10.1016/S0313-5926(03)50003-0.
 23. Atiglo DY, Larbi RT, Kushitor MK, Biney AAE, Asante PY, Dodoo ND, et al. Sense of community and willingness to support malaria intervention programme in urban poor Accra, Ghana. *Malar J.* 2018;17(1):289. 10.1186/s12936-018-2424-0.
 24. National Malaria Elimination Programme (NMEP). *NATIONAL MALARIA ELIMINATION STRATEGIC PLAN STRATEGIC PLAN.* 2023.

25. Tettey EA, Dzantor EK, Akomaning E. Community Pharmacies Treatment Practices of Malaria and Residents' Pattern of Antimalarial Drug Use in Abura Community, Cape Coast Metropolis-Ghana. *J Adv Med Med Res*. 2021;79–87. 10.9734/jammr/2021/v33i830889.
26. Amankwa CE, Bonful HA, Agyabeng K, Nortey PA. Dispensing practices for anti-malarials in the La Nkwantanang-Madina municipality, Greater Accra, Ghana: a cross-sectional study. *Malar J*. 2019;18(1):260. 10.1186/s12936-019-2897-5.
27. Audu R, Anto B, Koffuor G, Abruquah A, Buabeng K. Malaria rapid diagnostic test evaluation at private retail pharmacies in Kumasi, Ghana. *J Res Pharm Pract*. 2016;5(3):175. 10.4103/2279-042X.185723.
28. Ghana Statistical Service. Ghana 2021 Population and Housing Census [Internet]. 2022 [cited 2024 Aug 22]. Available from: <https://census2021.statsghana.gov.gh/subreport.php?readreport=MjYzOTE0MjAuMzc2NQ==&Ghana-2021-Population-and-Housing-Census-General-Report-Volume-3B>
29. Phalkey RK, Kroll M, Dutta S, Shukla S, Butsch C, Bharucha E, et al. Knowledge, attitude, and practices with respect to disease surveillance among urban private practitioners in Pune, India. *Glob Health Action*. 2015;8(1):28413. 10.3402/gha.v8.28413.
30. Brock KA, Casper KA, Green TR, Pedersen CA. Documentation of Patient Care Services in a Community Pharmacy Setting. *J Am Pharmacists Association*. 2006;46(3):378–84. 10.1331/154434506777069642.
31. Makinde OA, Odimegwu CO. Compliance with disease surveillance and notification by private health providers in South-West Nigeria. *Pan Afr Med J*. 2020;35:114. 10.11604/pamj.2020.35.114. .21188 PubMed PMID: 32637012.
32. Martini N, Sajtos L, Idio L, Kaur M, Sweeney N, Zhang C, et al. The future of pharmacy work: How pharmacists are adapting to and preparing for technology infusion. *Exploratory Res Clin Social Pharm*. 2024;15:100472. 10.1016/j.rcsop.2024.100472.
33. Poon EG, Cina JL, Churchill W, Patel N, Featherstone E, Rothschild JM, et al. Medication Dispensing Errors and Potential Adverse Drug Events before and after Implementing Bar Code Technology in the Pharmacy. *Ann Intern Med*. 2006;145(6):426–34. 10.7326/0003-4819-145-6-200609190-00006.
34. Baines D, Nørgaard LS, Babar ZUD, Rossing C. The Fourth Industrial Revolution: Will it change pharmacy practice? *Res Social Administrative Pharm*. 2020;16(9):1279–81. 10.1016/j.sapharm.2019.04.003.
35. Law M, Zeng S, Koo J, Verches D, Lam L, Martini N. Perceptions of community pharmacists to implementing technologies in the workplace: an exploratory study. *Int J Clin Pharm*. 2021;43(5):1227–36. 10.1007/s11096-021-01238-x.
36. Ahmed R. Global Surveillance Systems for Emerging Infectious Diseases: A Critical Review of Infrastructure, Policy, and Data Sharing. *Premier J Data Sci*. 2025 Jul;24. 10.70389/PJDS.100004.
37. Mitas SK, Munira S, Lisun TH. Digital Health Technologies for Disease Surveillance and Monitoring. *North Am Acad Res*. 2024;7(9):1–19. 10.5281/zenodo.13824247.

38. Kuponiyi A, Oluwanifemi Akomolafe O. Digital Transformation in Public Health Surveillance: Lessons from Emerging Economies. *Int J Adv Multidisciplinary Res Stud*. 2025;5(4):1702–13. 10.62225/2583049X.2025.5.4.4836.
39. Sirisha MN, Lakshmi TJ, TECHNOLOGICAL INNOVATIONS IN COMMUNICABLE, DISEASES SURVEILLANCE: A NEW ERA OF PUBLIC HEALTH INTELLIGENCE. *Eur J Biomedical Pharm Sci* www.ejbps.com. 2025;12. 10.5281/zenodo.17276759.
40. George J, Häsler B, Mremi I, Sindato C, Mboera L, Rweyemamu M, et al. A systematic review on integration mechanisms in human and animal health surveillance systems with a view to addressing global health security threats. *One Health Outlook*. 2020;2(1):11. 10.1186/s42522-020-00017-4.
41. Rajamani S, Chakoian H, Bieringer A, Lintelmann A, Sanders J, Ostadkar R, et al. Development and implementation of an interoperability tool across state public health agency's disease surveillance and immunization information systems. *JAMIA Open*. 2023;6(3). 10.1093/jamiaopen/ooad055.
42. Why Do We Need Multinational EHR Interoperability Strategies? In. *Approaches and Implementation of Multinational Electronic Health Record Interoperability*. IGI Global Scientific Publishing; 2025. pp. 1–16. 10.4018/979-8-3693-2027-3.ch001.
43. Maiti L, Sharma U. From Paper to Digital: A Comparative Analysis of Conventional Records and Electronic Health Records [Internet]. 10.5281/zenodo.17060102
44. Demsash AW, Kassie SY, Dubale AT, Chereka AA, Ngusie HS, Hunde MK, et al. Health professionals' routine practice documentation and its associated factors in a resource-limited setting: a cross-sectional study. *BMJ Health Care Inf*. 2023;30(1):e100699. 10.1136/bmjhci-2022-100699.
45. Mutshatshi TE, Mothiba TM, Mamogobo PM, Mbombi MO. Record-keeping: Challenges experienced by nurses in selected public hospitals. *Curationis*. 2018;41(1). 10.4102/curationis.v41i1.1931.
46. Kebede M, Endris Y, Zegeye DT. Nursing care documentation practice: The unfinished task of nursing care in the University of Gondar Hospital. *Inf Health Soc Care*. 2017;42(3):290–302. 10.1080/17538157.2016.1252766.
47. Kasaye MD, Beshir MA, Endehabtu BF, Tilahun B, Guadie HA, Awol SM, et al. Medical documentation practice and associated factors among health workers at private hospitals in the Amhara region, Ethiopia 2021. *BMC Health Serv Res*. 2022;22(1):465. 10.1186/s12913-022-07809-6.

Figures

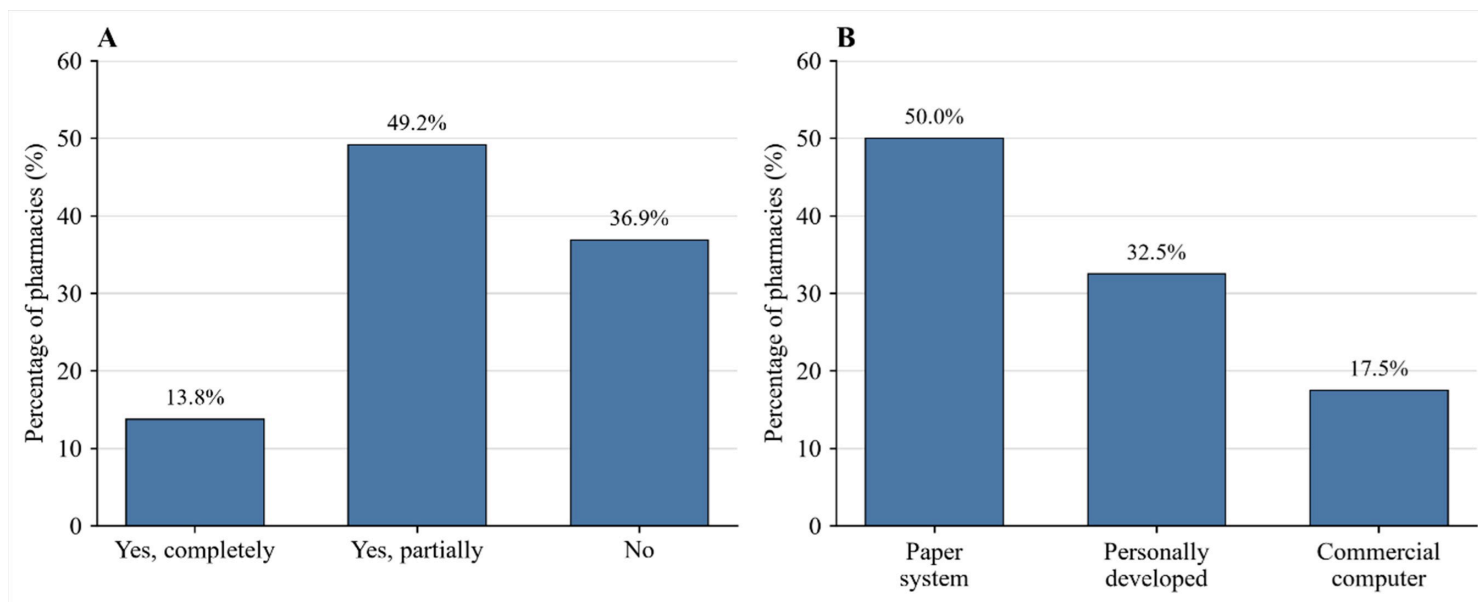


Figure 1

Charts showing documentation system availability and types of systems used by pharmacies

Notes: A is a bar chart showing the availability of documentation systems at pharmacies (n = 65). B depicts the types of documentation systems used by pharmacies that maintain them (n = 40).

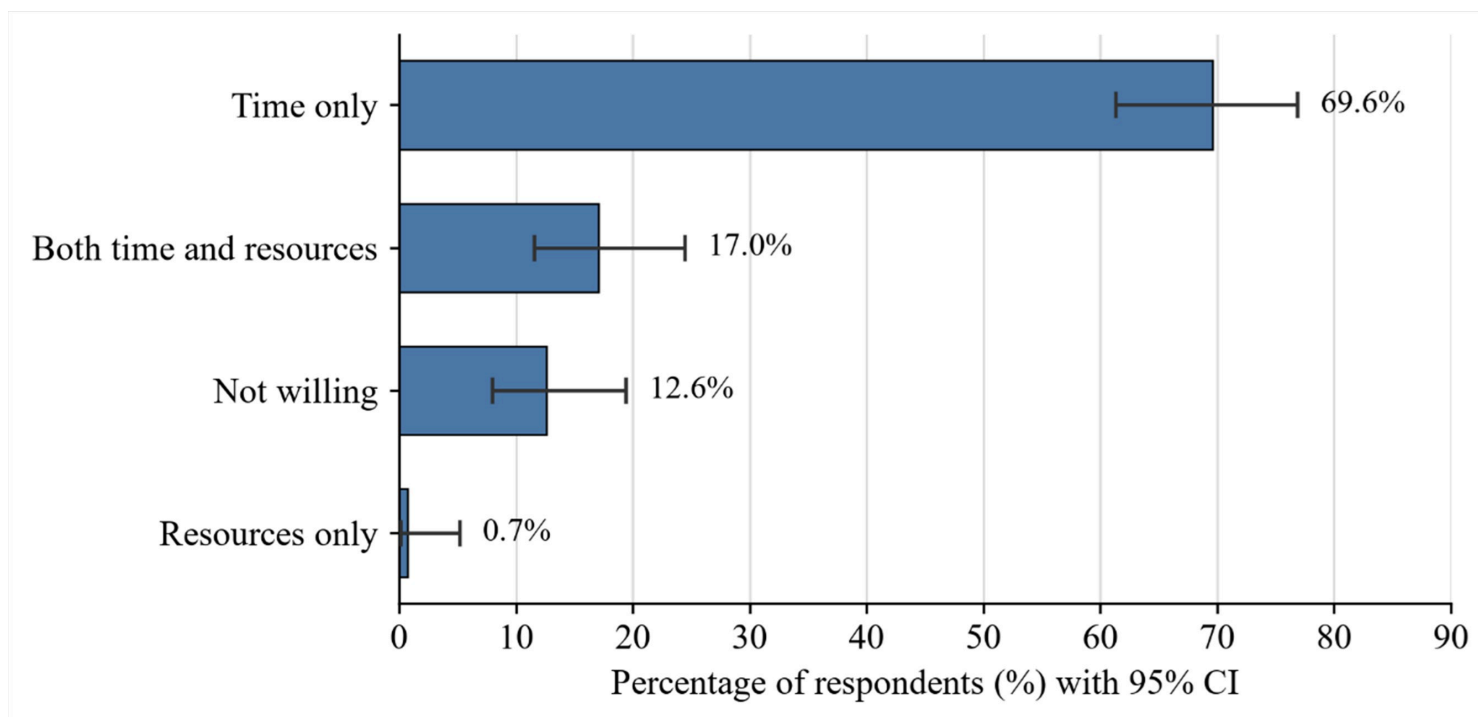


Figure 2

Bar chart with 95% confidence intervals showing the willingness of pharmacy personnel to support malaria surveillance.

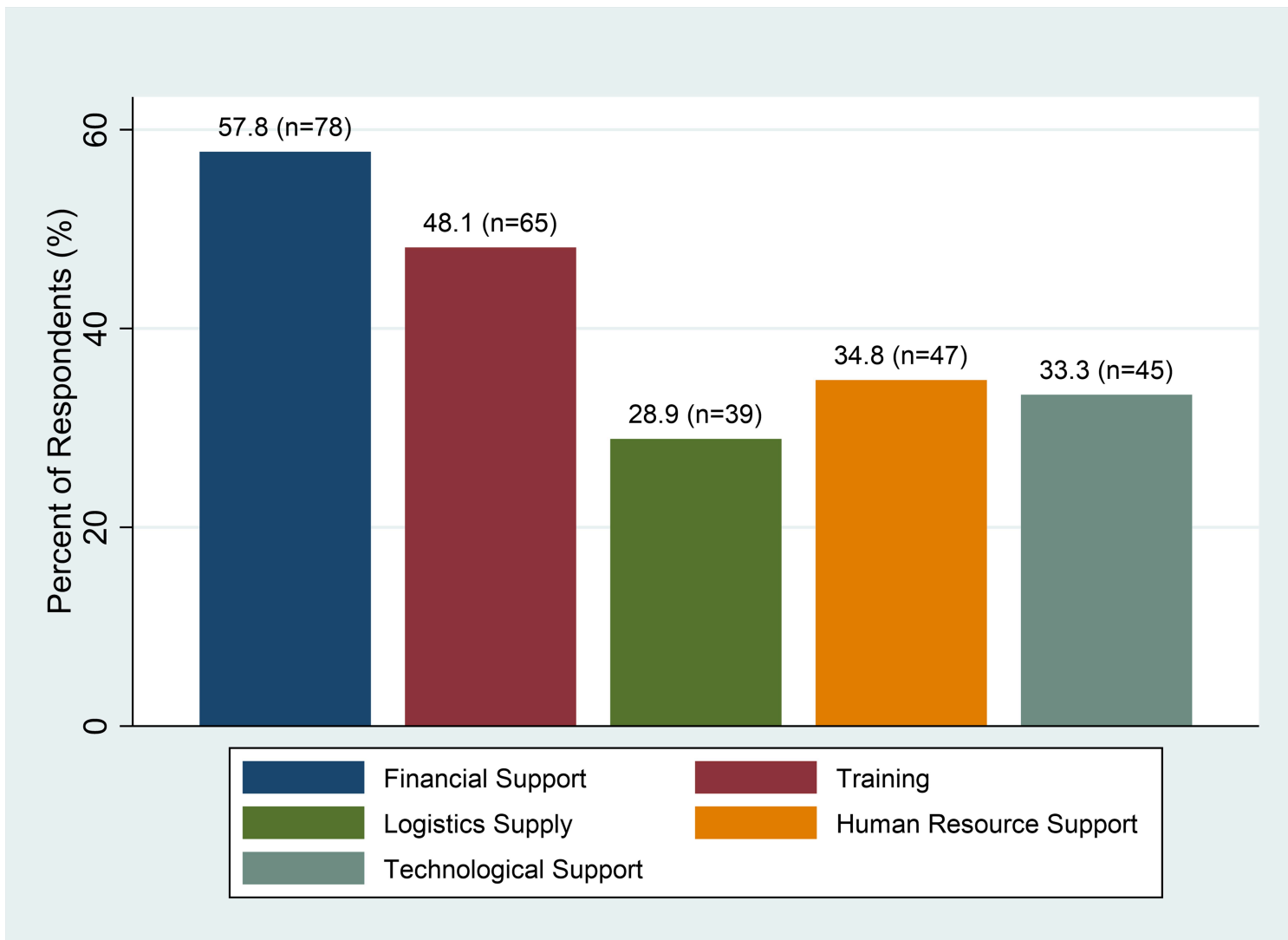


Figure 3

Perceived incentives for malaria documentation and reporting (N = 135)

Notes: Multiple responses allowed.

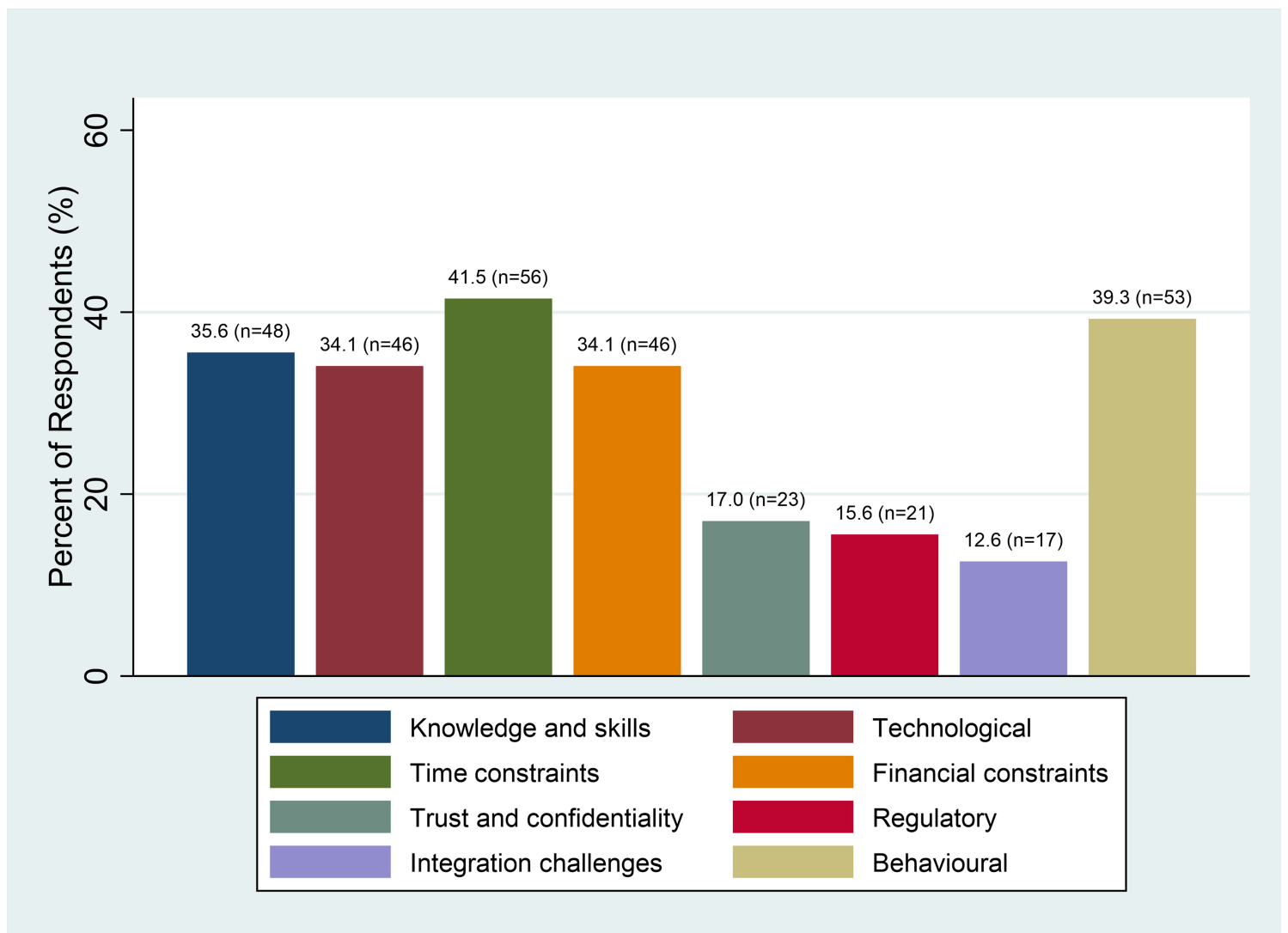


Figure 4

Perceived barriers to malaria surveillance reporting in community pharmacies (N = 135)

Notes: Multiple responses allowed.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [STROBEchecklistCommPharmMalaria.docx](#)