Experiences of community-based health workers with COVID-19 rapid diagnostic testing after training in Abuja, Nigeria, 2022-2023

KEYWORDS: COVID-19, RDT, Healthcare Providers

Ekerette Emmanuel Udoh[1], Osayamen Paula Okonkwo[1], Godpower Osamudiamen Omoregie[1], Joshua Opeyemi Folorunsho[1,&], Evelyn Theodora Orakwelu[1], Victoria Ehikowoicho Ura-Akubo[1], Nnamdi Alphonsus Anosike[1], John Samson Bimba[2]

[1]STAR COVID-19 Project, Society for Family Health, Abuja, Nigeria, [2]Zankli Research Centre, Bingham University, Nasarawa, Nigeria

[&]CORRESPONDING AUTHOR
Joshua Opeyemi Folorunsho, STAR COVID-19 Project, Society for Family Health, Abuja, Nigeria,
Email: joshfolorun@gmail.com,
ORCID:https://orcid.org/0000-0002-5571-6423

ABSTRACT

Introduction: Professional-use COVID-19 antigen-rapid diagnostic tests (SARS-CoV-2 Ag-RDT) are used in Nigeria to scale up testing into novel settings (community pharmacies and patent medicine stores). The theoretical domain framework posits that providers need knowledge, self-efficacy, belief in and motivation to adopt Ag-RDT. Additionally, it is crucial to understand the environmental context, including the demand, acceptability, and barriers associated with the implementation of a novel healthcare program. This study aimed to present insights on these domains for pharmacists and patent medicine vendors, and primary healthcare workers delivering COVID-19 Ag-RDT following the training of providers in Nigeria. **Methods:** Funded by Unitaid through the Self-testing COVID Project, researchers designed a quantitative tool to assess the domains of belief, perception and knowledge administered, demand, and barriers among 116 providers: 73 primary healthcare workers, 31 community pharmacists, and 12 patent medicine vendors between September 2022 and January 2023. **Results:** Across all healthcare provider categories, knowledge and self-efficacy regarding COVID-19 Ag-RDT were notably high. Nearly all community pharmacists (97%, 30/31) and all primary health center workers (100%, 73/73) reported experience with rapid diagnostics for other health conditions, compared to 75% (9/12) of patent medicine vendors. Performing Ag-RDT was perceived as easy by all pharmacists and PHC workers, versus 92% (11/12) of PMVs. Regarding the adequacy of clinical symptoms for diagnosing COVID-19, 55% (6/12) of PMVs disagreed, a smaller proportion than pharmacists (75%, 21/31) and PHC workers (75%, 53/73). Confidence in interpreting RDT results was lowest among PMVs (17%, 2/12), compared to pharmacists (35%, 11/31) and PHC workers (30%, 22/73). Educational background varied, with all pharmacists and PHC workers holding tertiary degrees, compared to only 33% (4/12) of PMVs. Additionally, 84% (26/31) of pharmacists and 70% (51/73) of PHC workers reported well-equipped facilities, versus 58% (7/12) of PMVs. **Conclusion:** Novel settings for COVID-19 Ag-RDTs depend on healthcare providers' knowledge and perceptions. Better knowledge and perceptions are observed in higher-qualified healthcare centers, with greater demand primarily in public sector facilities such as primary health centers. Patent medicine vendors and pharmacists may benefit from enhanced support when implementing novel services, such as community-delivered COVID-19 testing.

RECEIVED
16/12/2024

ACCEPTED
18/07/2025

PUBLISHED
18/07/2025

LINK

https://afenet-journal.org/experiences-of-community-based-health-workers-with-covid-19-rapid-diagnostic-testing-after-training-in-abuja-nigeria-2022-2023/

CITATION
Joshua Opeyemi Folorunsho et al Experiences of community-based health workers with COVID-19 rapid diagnostic testing after training in Abuja, Nigeria, 2022-2023. Journal of Interventional Epidemiology and Public Health. 2025 Jul; 8(3):54.
DOI: https://doi.org/10.37432/jieph-d-24-02047

Introduction

Antigen-based rapid diagnostic tests (Ag-RDTs) have gained popularity as diagnostic tools for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19), replacing the more complex and time-consuming nucleic acid amplification testing (NAAT) methods for identifying cases. Real-world evaluations have already established their performance characteristics, demonstrating their accuracy in detecting SARS-CoV-2 infections in active cases [1]. Despite the declining number of cases of COVID-19 in Nigeria, where the reported daily number of cases decreased from approximately 4,035 cases at the peak of the pandemic in the country in December 2021 to approximately 197 cases by the end of March 2022 [2], testing capacity remains a critical component of public health strategies, ensuring early detection and effective containment of the virus. Additionally, there is limited coverage for COVID-19 testing in the country [3].

To expand access to COVID-19 testing, large-scale community programs have deployed SARS-CoV-2 Ag-RDT to reach a wider population with testing [4,5]. The implementation of these scaled-up strategies requires the adoption of novel approaches for delivery. In Nigeria, the introduction of SARS-CoV-2 Ag-RDT testing explored delivery through decentralization, involving community-level health settings such as community pharmacies, patent medicine shops and primary healthcare centers. This decentralized Ag-RDT approach differs from conventional methods for SARS-CoV-2 testing methods, which primarily relied on NAATs such as reverse transcription polymerase chain reaction (RT–PCR) [6], typically conducted in larger health facilities. During the peak of the pandemic in the country in 2021, testing services were mainly centralized in these facilities limiting accessibility. Despite efforts to expand Ag-RDT use, PCR testing still accounted for 90.4% of all tests, indicating limited penetration of rapid testing in decentralized settings [6]. However, in the decentralization of testing at the community level via Ag-RDT, there is wider community involvement [7] in engaging community-level healthcare workers, making testing more accessible and convenient for the population. While studies have highlighted the potential benefits of decentralization initiatives, [5,7], there is limited evidence regarding the experiences, motivations, acceptability, demand, challenges, and barriers of this innovative approach.

In Nigeria, a community-based based intervention was implemented as part of the national effort to introduce, scale-up, and decentralize testing for COVID-19 in the FCT in 2022. This intervention was implemented by Society for Family Health (SFH) in partnership with the Nigeria Centre for Disease Control (NCDC), Federal Capital Territory Administration/Public Health Department/Human and Health Services Secretariat (FCTA/PHD/HSS), and Zankli Research Centre, Bingham University, Nigeria, as part of a lager implementation study called Self-Testing Africa (STAR) Africa, Asia, Americas COVID-19 Preparedness (3ACP) project, funded by UNITAID via Population Services International. The intervention aimed to enhance the supply chain and accelerate the adoption of COVID-19 testing, isolation, and treatment strategies within established health system frameworks. The intervention involved routine diagnostic COVID-19 Ag-RDTs in selected community-level health facilities, including primary healthcare centers, patent and proprietary medicine vendors (PPMVs), and community pharmacies, using country-approved professional-use and self-test SARS-CoV-2 Ag-RDTs (Standard Q SD Biosensor and Abbott Panbio). The implementation program included training of healthcare providers, with certification provided by the African Society for Laboratory Medicine (ASLM), identifying and testing symptomatic patients, supporting self-testing for eligible individuals, conducting risk and severity assessments, providing risk communication to patients and communities, facilitating linkages to prevention and safer home-management strategies, and capturing routine programmatic data.

To better understand the factors influencing the adoption of decentralized testing, it is essential to examine the experiences of implementing new health practices. According to experts, implementing new health promotion practices requires changes in the behavior of relevant actors [8]. The Theoretical Domains Framework provides a framework for understanding and addressing the behavioral factors that influence healthcare providers' adoption of healthcare innovations and practices [8,9]. The framework posits that healthcare providers need knowledge, self-efficacy, belief in, and motivation to adopt healthcare innovations and practices

successfully. The Theoretical Domains Framework provides a structured approach to understanding the barriers and enablers associated with behavioral change in healthcare settings. This makes it particularly useful for designing interventions aimed at improving the adoption and sustainability of healthcare innovations [10]. The assessment in this study focused on highlighting the experiences influencing healthcare providers' implementation practice of rapid diagnostic testing for the COVID-19 antigen, including their knowledge, self-efficacy, motivation, and perceptions of the innovation. Additionally, understanding the environmental context,such as demand and barriers to novel health program implementation, provides the opportunity to develop tailored strategies and interventions to overcome these obstacles effectively [9,11]. This study examines the knowledge, self-efficacy, perceptions, and experiences of healthcare providers on the adoption of SARS-CoV-2 Ag-RDT services at the community level in Nigeria. Findings will help identify barriers and inform strategies to enhance testing uptake and effectiveness.

Methods

Study setting and study design

This cross-sectional study was conducted over a period of 5 months, from September 2022 to January 2023, among community health providers implementing a decentralised SARS-CoV-2 Ag-RDT program in the Federal Capital Territory (FCT) of Nigeria. The evaluation focused on healthcare providers' experiences in practice following training, including their motivations, challenges faced during service delivery, demand for testing services, and healthcare system barriers encountered while conducting rapid diagnostic testing for the COVID-19 antigen.

In Nigeria, community pharmacists are licensed pharmacists under the Pharmacy Council of Nigeria (PCN) who operate outside the hospital and are registered as private pharmaceutical premises. They are charged with the management of the supply of medicines directly to consumers and the delivery of other healthcare services, including patient counselling and health promotion. Similarly, PPMVs operate under regulation and licensing by the PCN and are registered with the National Association of Proprietary and Patent Medicine Dealers (NAPPMED). These types of providers are defined as "persons without formal training in pharmacy who sell orthodox pharmaceutical products on a retail basis for profit" [12]. They are privately owned outlets that are legally authorized to operate and sell a limited number of prepackaged and over-the-counter medical products. Generally, national surveys have shown that community pharmacies and patent medicine outlets contribute significantly to healthcare services in Nigeria [13,14]. On the other hand, primary health center providers are public sector healthcare workers in the primary health sector,which is under the leadership of the local government authority [15], and they are tasked with providing essential healthcare delivery in the community [16]. These types of facilities are staffed mainly with cadres, such as community health workers (CHWs), nurses/midwives, doctors, pharmacy technicians, and laboratory technicians.

Sample size and sampling

A total of 116 adult (18 years and above) community health providers – comprising 31 community pharmacists, 12 patent and proprietary medicine vendors, and 73 primary healthcare workers – were assessed during programmatic monitoring visits to the facilities. The participants in this study were purposefully selected, as they are healthcare providers who had recently been trained on and implementing COVID19 Ag-RDT in the study site. The sample comprised of all the trained healthcare providers.

Eligibility criteria (inclusion and exclusion)

Participants aged 18 years and older who were healthcare providers trained in the SFH STAR COVID-19 project initiative, approximately within the last four months, on COVID-19 Ag-RDT service provision in the implementing facilities were included in the study. All participants who never consented to be interviewed were excluded.

Data collection and measures

Data were collected for this study via an interviewer-administered questionnaire designed and adapted by the authors to collect information on the sociodemographic characteristics of the health providers and objectives of the study, including providers' knowledge of and self-efficacy for rapid diagnostic test kits, provider perceptions of the COVID-19 antigen RDT, demand for and acceptability of the COVID-19 antigen RDT, and barriers to rapid diagnostic testing of the COVID-19 antigen at the study site. Data collection was done

in the process of conducting joint-supervisory visits to the testing sites. The data collectors were trained stakeholders on COVID-19 response including the FCT government representative and non-government partners while conducting the joint-supervisions to the facilities. These evaluators were trained by the program and study managers, on how to use the questionnaire and data collection performed using KoboCollect hosted on android digital mobile devices.

A pre-test of the questionnaire was conducted with a small group of different health providers (not part of final study sample) to assess its clarity, consistency, and overall reliability. This pre-test enabled the research team to refine the instrument, ensuring that it validly captured the intended information.

Knowledge and Competence: The questionnaire assessed providers' knowledge and self-efficacy regarding rapid diagnostic test kits. Questions explored familiarity with various rapid test kits—not only COVID-19 antigen RDTs but also those for malaria, HIV, hepatitis, and pregnancy. In addition, providers were queried about the performance and accuracy of these kits and the different sample collection methods (e.g., nasal and nasopharyngeal) employed for Ag RDTs. Information on competence in the use of COVID-19 test kits was also assessed.

Perception: Perception of the COVID-19 antigen RDT was assessed via 10-item questions. This section of the questionnaire was designed to capture attitudes and opinions toward the test kits, providing insight into how the providers viewed the utility and reliability of the COVID-19 antigen RDT.

Demand and Acceptability: Demand for the COVID-19 RDT was assessed by asking providers different questions related to client attendance at the facility to take up the COVID-19 RDT, client comfort, the most comfortable sample collection methods, and client interest in paying for COVID-19 testing, among other questions.

Barriers: Information on barriers to COVID-19 testing was also assessed, and questions elicited information about facility conduciveness and the ability to perform COVID-19 testing, the readiness of providers to perform COVID-19 testing, and culture and religion as hindrances to COVID-19 uptake.

Data management and analysis

Data analysis for the study was performed using R: A Language and Environment for Statistical Computing (version 3.6.1) [17]. Two composite score outcome variables were created to summarize the knowledge and perception questions in the study. The composite knowledge score was generated from 6 knowledge questions by scoring each correct question as '1' point and each incorrect question as '0' points. The sum of all the knowledge points were calculated to obtain the knowledge score. The total achievable score ranged from 0–6 points, with 6 as the highest possible score for a participant. The composite knowledge score was classified as poor if a participant scored ≤3 and better if the score was ≥4 points. This classification was to reflect a meaningful distinction in knowledge levels, ensuring a clear interpretation of participants' understanding. The perceptions composite score was generated from all the perception questions assessed, with the scores determined via a Likert scale ranging from 0–4 points (based on question options ranging from strongly disagree, disagree, neutral, agree, and strongly agree), with increasing scoresindicating positive perceptions and reduced scores indicating negative perceptions. Question items that did not follow this order were reversed for scoring. Descriptive statistics were used to present the data by comparing the community pharmacies and patent medicine vendors with the primary health center workers in the study, and the differences in the proportions and central estimates of the variables were tested as appropriate via the Kruskal–Wallis rank sum test, Fisher's exact test, and Pearson's chi-square test.

Ethical considerations

Ethical approval for this study was granted as part of a wider research "3ACP-Nigeria: Enhancing Access to COVID-19 Rapid Tests and Self-Testing." Approval was obtained from the Federal Capital Territory Health Research Ethics Committee (FHREC) under approval number FHREC/2022/01/29/09-03-22. Prior to their involvement in the study, the participants were provided with detailed information regarding the purpose, procedures, potential risks, and benefits of participation. Written informed consent was obtained from all participants, and they were assured

that their participation was voluntary, with the right to withdraw at any time without consequences.

Results

A total of 116 adult (18yrs and above) community health providers participated in the study. Table 1 presents the demographic characteristics of study participants. The median age of participants was 37 years (IQR: 32–43), while nearly half (47%, 54/116) were aged 30–40 years. Patent medicine vendors were the oldest (median: 48 years, IQR: 40, 53) and primary healthcare workers youngest (median: 35 years, IQR: 30–39). Approximately 53% (61/116) of the participants were male, and patent medicine vendors had the greatest proportion of males (83%, 10/12). On the other hand, primary healthcare centers had the greatest proportion of females (55%, 40/73). Most of the participants had a tertiary level of education (93%, 108/116), the rest had a secondary level of education (6.9%, 8/116). Secondary education level was only report among the patent medicine vendors accounting for 67% (8/12). With respect to the duration of employment of health providers, 49% (49/116) have had employment in their field as health providers for approximately 10 years or more, with patent medicine vendors having the highest proportion (75%, 9/12).

Health providers' knowledge of and self-efficacy in rapid diagnostic kits

The results concerning the various knowledge attributes of health providers on RDTs and their self-efficacy in the use of COVID-19 antigen RDTs are presented in Table 2. High knowledge of other rapid test kits in addition to COVID-19 rapid test kits was observed (96%; 112/116), with all primary health center workers (100%; 73/73) being knowledgable, compared to 97% of community pharmacists (30/31) and 75% of patent medicine vendors (9/12). Similarly, 95% (110/116) of all providers reported ever using RDT test kits other than COVID-19 RDT kits, with all primary health center workers (100%) reporting that they had used other RDT kits compared to 94% (29/31) community pharmacists and 67% (8/12) patent medicine vendors. Similarly, a high proportion of all providers had used other specific rapid diagnostic test kits, such as malaria test kits (93%) and HIV rapid test kits (87%), with most usages reported mainly among primary health center workers for malaria (96%) and HIV test kits (93%).

Approximately 93% (108/116) of all types of providers reported believing that RDTs give accurate results. About 73% (85/116) of providers reported ever collecting a nasopharyngeal sample, with a higher proportion reported among primary health center workers. Overall, theknowledge of all health providers was assessed, and all providers fell into the category of better knowledge.

Perceptions of COVID-19 Antigen RDT

Various perceptions of the COVID-19 antigen rapid test kits of the providers were assessed (Table 3). When participants were asked if clinical symptoms and signs alone could be an accurate way of confirming COVID-19, most providers either disagreed or strongly disagreed (71%, 78/116), with patent medicine vendors having the lowest proportion who affirmed this position (36%, 4/12). A high proportion of all providers (70%) either disagreed or strongly disagreed that confirming a COVID-19 diagnosis via laboratory tests before treatment is important. This position was significantly different across all providers, with the lowest proportion (33%, 4/12) observed among patent medicine vendors and highest among primary health center workers (76%). A high proportion of all providers agreed or strongly agreed that a negative RDT result is truly negative (60%), with a significantly greater proportion among primary health center workers (70%, 51/73).

Demand and acceptability of the COVID-19 antigen RDT

The results indicated that the median daily facility attendance across all facilities was 20 (IQR: 14–40), with the highest median attendance recorded among community pharmacists (50, IQR: 30–50) and the lowest among patent medicine vendors (18, IQR: 10–22). In terms of the number of COVID-19 antigen RDT tests performed at the facilities, the overall median across all facilities was 1 test per day (IQR: 0–3.2), with a significantly higher median reported among primary health center workers (2 tests per day, IQR: 1–7), followed by patent medicine vendors (1 test per day, IQR: 0–2) Table 4.

Barriers to rapid diagnostic testing for COVID-19 antigens

Table 5 shows results for barriers to diagnostic testing for COVID-19 antigen test. The results indicated that 90% (104/116) of all providers believed that their facility was conducive for testing for COVID-19 via antigen RDT kits. Similarly, a

high proportion of all providers (72%, 84/116) believed that their facility was well equipped to manage COVID-19 antigen RDT testing. These results did not present any significantly different evidence across all three providers. While approximately 69% of all providers reported that other health providers in facilities refer clients to facilities for COVID-19 tests, a significantly greater proportion of primary health center workers (82%, 60/116) noted this than other providers did.

Discussion

This study provided evidence that the decentralization of COVID-19 testing with Ag-RDT kits at the community level is a feasible approach for the scale-up of testing given the results of the study. The evidence of high knowledge and self-efficacy across all types of community healthcare providers in terms of rapid diagnostic testing and COVID-19 testing in this study indicates a greater capacity for service delivery. These findings support the well-established position that if healthcare providers are provided with adequate knowledge and enhanced self-efficacy they are more likely to deliver effective and efficient services to patients, including services for COVID-19 [18] [19].However, studies have shown that other factors such as quantity and quality of their experience, encountering unexpected events, client trust, self-concept, professional knowledge and skill, also play vital roles on provider self-efficacy [20].

Public sector health providers showed higher knowledge and self-efficacy, particularly in established public health practices like HIV diagnosis and traditional nasopharyngeal sample collection. This may be because these procedures require more complex management and have not been widely introduced in private community health services. Public sector health providers typically have access to more extensive training, resources, and exposure to a broader range of healthcare practices, contributing to their expertise in these areas [21]. The findings suggest the important role public sector health systems have in addressing complex healthcare needs, particularly in LMICs where the public sector often serves as the backbone of healthcare delivery [16]. To address disparities between the public and private health sectors, training interventions should focus on addressing the peculiarities of each sector, such as variations in infrastructure, equipment, and operational protocols, to ensure that healthcare professionals are equipped to provide high-quality care regardless of the setting.

Additionally, the findings regarding healthcare providers' perceptions of COVID-19 antigen diagnostic tests were encouraging. For example, the fact that providers do not rely solely on clinical symptoms to confirm COVID-19 shows that they understand the limitations of symptomatic case confirmation and the importance of using diagnostic tools such as rapid test kits to confirm cases. Similarly, the trust in both positive and negative RDT results among providers is important, as it indicates confidence in diagnostic accuracy. Previous studies have shown that positive health beliefs and trust in diagnostic tools are linked to better acceptance and integration of new healthcare practices [22], which can have a significant impact on healthcare outcomes, including the effective management and control of infectious diseases like COVID-19 [23].

Anecdotal evidence and previous studies have shown that there is apathy for COVID-19 testing due to several factors, such as fear of positive COVID-19 results, lack of access to testing, cost, concerns about the accuracy of tests, and personal beliefs [24] [25]. Our study found similar trends, with low demand for COVID-19 testing relative to the daily number of visits to facilities. These findings reflect the challenges in COVID-19 testing uptake, particularly in low- and middle-income countries (LMICs), where economic and cultural barriers significantly influence healthcare-seeking behavior [26]. This study was subject to several limitations that should be considered when the findings are interpreted. First, the study participants were healthcare providers who had all received training on antigen diagnostic testing for COVID-19 under the same program, and they were all in a single study location. This could restrict the generalizability of the findings and their applicability to different providers trained under other programs or in different geographic regions. Second, the sample size, which was relatively small, was not calculated via a scientific method but rather was adopted through the sampling of only providers trained on an intervention program, which might limit the statistical power and generalizability of the findings to a broader population. Additionally, analyzing the

determinants of key outcome domains in this study were not feasible due to the small sample size. This study is also limited by its use of quantitative methods to explore participants' experiences, which provided numerical data but may not fully capture the depth nuance of participants' experiences, perceptions, and contextual factors influencing their responses. Despite these limitations, this study provides valuable insights into new initiatives for promoting COVID-19 decentralized community testing in the country and the potential for such initiatives to be replicated in other settings.

Conclusion

This study provides valuable insights into the experiences and motivations of healthcare providers involved in decentralized COVID-19 testing. High provider self-efficacy is pivotal for the effective deployment of decentralized RDT testing. Also, the observed disparities between public and private sector providers highlights the need for tailored training and resource allocation to bridge competency gaps. Furthermore, the lower number of tests performed compared to facility attendance points to challenges with community demand creation towards COVID-testing. To address these, developed policies should enhance capacity building initiatives, foster robust public-private partnerships, and implement targeted community engagement and subsidization strategies to boost testing uptake and strengthen overall disease control.

What is already known about the topic

- Ag-RDTs are widely recognized as fast and simple alternatives to NAATs, such as RT-PCR, for detecting SARS-CoV-2.
- Real-world studies have validated their accuracy in identifying active infections.
- To increase access to testing, especially in underserved areas, decentralized testing approaches have been introduced, utilizing community settings like pharmacies and healthcare centers.
- Behavioral factors, including knowledge, motivation, and self-efficacy, are critical for adopting healthcare innovations.
- However, there is limited understanding of the experiences and challenges faced by healthcare providers involved in decentralized testing programs.

What this study adds

- This study offers key insights into the knowledge, confidence, and perceptions of healthcare providers using Ag-RDTs in community-level settings.
- It highlights challenges such as logistical barriers and cultural factors that affect testing implementation.
- The findings underscore the importance of training and motivation in scaling up testing services.
- Additionally, the study explores the demand for and acceptability of Ag-RDTs among clients in Nigeria.
- These insights inform strategies to enhance decentralized COVID-19 testing and improve public health outcomes in low-resource settings.

Competing Interest

The authors of this work declare no competing interests

Availability of data and materials

The data supporting this study's findings are available on Figshare: 10.6084/m9.figshare.25673625

Funding

Funding for this study was received under the STAR COVID-19 grant by UNITAID through Population Services International (grant ref/code: 2017-16-PSI-STAR).

Acknowledgements

The authors would like to thank the heads and proprietors of the health facilities and the healthcare providers for granting permission and consent to take part in this study.

Authors´ contributions

E.U. and O.O. conceptualized the study. E.U. conducted the data analysis, while E.U., O.O., and J.F. prepared the main manuscript text. All authors E.U, O.O, G.O, J.F, E,O, V.U, N.A and J.B supervised the study and reviewed and approved the final manuscript.

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Table 1: Health provider demographic characteristics					
Characteristic	**Overall, N = 116[1] n (%)**	**Community pharmacies, N = 31[1] n (%)**	**Patent medicine vendors, N = 12[1] n (%)**	**Primary health center workers, N = 73[1] n (%)**	**p value**
Age (in years)	37 (31, 43)	40 (32, 48)	48 (40, 53)	35 (30, 39)	<0.001#
Age (grouped)					
< 30 years old	22 (19%)	5 (16%)	0 (0%)	17 (23%)	<0.001†
30 to 40 years old	54 (47%)	10 (32%)	3 (25%)	41 (56%)	
40 years and more	40 (34%)	16 (52%)	9 (75%)	15 (21%)	
Sex					
Female	55 (47%)	13 (42%)	2 (17%)	40 (55%)	0.038 ^
Male	61 (53%)	18 (58%)	10 (83%)	33 (45%)	
Education					
Secondary	8 (6.9%)	0 (0%)	8 (67%)	0 (0%)	<0.001†
Tertiary	108 (93%)	31 (100%)	4 (33%)	73 (100%)	
Professional cadre					
Doctor	1 (0.9%)	0 (0%)	0 (0%)	1 (1.4%)	<0.001#
Junior CHEW*	2 (1.7%)	0 (0%)	0 (0%)	2 (2.7%)	
Lab scientist/technician	62 (53%)	1 (3.2%)	1 (8.3%)	60 (82%)	
Nurse/Midwife	6 (5.2%)	4 (13%)	0 (0%)	2 (2.7%)	
Others	4 (3.4%)	2 (6.5%)	0 (0%)	2 (2.7%)	
Pharmacist	22 (19%)	22 (71%)	0 (0%)	0 (0%)	
PPMV!	11 (9.5%)	0 (0%)	11 (92%)	0 (0%)	
Senior CHEW	8 (6.9%)	2 (6.5%)	0 (0%)	6 (8.2%)	
Years in employment/practicing (years)					
10 years and more	49 (42%)	15 (48%)	9 (75%)	25 (34%)	0.010†
5 to 9 years	34 (29%)	11 (35%)	3 (25%)	20 (27%)	
Less than 5 years	33 (28%)	5 (16%)	0 (0%)	28 (38%)	
Residence					
Rural	60 (52%)	4 (13%)	9 (75%)	47 (64%)	<0.001†
Semi urban	32 (28%)	14 (45%)	2 (17%)	16 (22%)	
Urban	24 (21%)	13 (42%)	1 (8.3%)	10 (14%)	

[1]Median (IQR); # Kruskal-Wallis rank sum test; † Fisher's exact test; ^ Pearson's Chi-squared test; * CHEW – Community Health Extension Workers; ! PPMV – Patent and Proprietary Medicine Vendor

Table 2: Health providers' Knowledge and self-efficacy of the COVID-19 Antigen RDT					
Characteristic	**Overall N = 116 n (%)**	**Community pharmacist N = 31 n (%)**	**Patent medicine vendors N = 12 n (%)**	**Primary health center workers N = 73 n (%)**	**p value†**
Knowledge of other Rapid test kits	112 (96%)	30 (97%)	9 (75%)	73 (100%)	0.009
Ever used any RDT other than COVID-19 RDT	110 (95%)	29 (94%)	8 (67%)	73 (100%)	<0.001
Ever used pregnancy RDT	92 (84%)	25 (86%)	7 (78%)	60 (85%)	0.8
Ever used malaria RDT	101 (93%)	26 (90%)	7 (78%)	68 (96%)	0.087
Ever used HIV RDT	95 (87%)	23 (79%)	6 (67%)	66 (93%)	0.024
Ever used Hepatitis RDT	41 (66%)	10 (71%)	0 (NA%)	31 (65%)	0.8
Think RDT give accurate result	108 (93%)	26 (84%)	12 (100%)	70 (96%)	0.075
Think RDT is easy to perform compared to other diagnostic tools	115 (99%)	31 (100%)	11 (92%)	73 (100%)	0.10
Ever collected nasal sample for COVID-19 test	89 (77%)	21 (68%)	10 (83%)	58 (79%)	0.4
Confidence in nasal collection method for COVID-19 test					
Confident	11 (12%)	4 (19%)	1 (10%)	6 (10%)	
Less confident	1 (1.1%)	0 (0%)	0 (0%)	1 (1.7%)	
Very confident	77 (87%)	17 (81%)	9 (90%)	51 (88%)	0.8
Ever collected nasopharyngeal sample for COVID-19 test	85 (73%)	20 (65%)	6 (50%)	59 (81%)	0.033
Confidence in nasopharyngeal collection method					
Confident	19 (22%)	5 (25%)	3 (50%)	11 (19%)	
Less confident	4 (4.7%)	1 (5.0%)	1 (17%)	2 (3.4%)	
Not confident	2 (2.4%)	1 (5.0%)	0 (0%)	1 (1.7%)	
Very confident	60 (71%)	13 (65%)	2 (33%)	45 (76%)	0.2
Overall knowledge status					
Better knowledge	116 (100%)	31 (100%)	12 (100%)	73 (100%)	
†Fisher's exact test					

Table 3: Perceptions of the COVID-19 Antigen RDT					
Characteristic	**Overall N = 116 n (%)**	**Community pharmacist N = 31 n (%)**	**Patent medicine vendors N = 12 n (%)**	**Primary health center workers N = 73 n (%)**	**p value**
Clinical symptoms and signs alone can be an accurate way of confirming COVID-19 diagnosis					
Agree or strongly agree	29 (26%)	6 (21%)	6 (55%)	17 (24%)	0.056†
Disagree or strongly disagree	78 (71%)	21 (75%)	4 (36%)	53 (75%)	
Neutral	3 (2.7%)	1 (3.6%)	1 (9.1%)	1 (1.4%)	
Instruction manuals on the test kits are easy to understand and adhere to					
Agree or strongly agree	86 (74%)	23 (74%)	7 (58%)	56 (77%)	0.3†
Disagree or strongly disagree	29 (25%)	7 (23%)	5 (42%)	17 (23%)	
Neutral	1 (0.9%)	1 (3.2%)	0 (0%)	0 (0%)	
It is important to always confirm COVID-19 diagnosis with lab test before treatment					
Agree or strongly agree	32 (28%)	8 (27%)	7 (58%)	17 (24%)	0.010†
Disagree or strongly disagree	80 (70%)	21 (70%)	4 (33%)	55 (76%)	
Neutral	2 (1.8%)	1 (3.3%)	1 (8.3%)	0 (0%)	
Use of RDT is an effective way of confirming COVID-19 diagnosis					
Agree or strongly agree	49 (43%)	12 (40%)	2 (17%)	35 (48%)	0.3†
Disagree or strongly disagree	57 (50%)	16 (53%)	9 (75%)	32 (44%)	
Neutral	9 (7.8%)	2 (6.7%)	1 (8.3%)	6 (8.2%)	
COVID-19 RDT is more effective than PCR in the diagnosis of COVID-19					
Agree or strongly agree	37 (32%)	10 (32%)	2 (17%)	25 (34%)	0.6†
Disagree or strongly disagree	52 (45%)	12 (39%)	6 (50%)	34 (47%)	
Neutral	27 (23%)	9 (29%)	4 (33%)	14 (19%)	
Fully trust a positive RDT result as being truly positive					
Agree or strongly agree	72 (63%)	13 (42%)	9 (75%)	50 (69%)	0.078†
Disagree or strongly disagree	36 (31%)	15 (48%)	3 (25%)	18 (25%)	
Neutral	7 (6.1%)	3 (9.7%)	0 (0%)	4 (5.6%)	
Fully trust a negative RDT result as being truly negative					

Table 3: Perceptions of the COVID-19 Antigen RDT					
Characteristic	**Overall N = 116 n (%)**	**Community pharmacist N = 31 n (%)**	**Patent medicine vendors N = 12 n (%)**	**Primary health center workers N = 73 n (%)**	**p value**
Agree or strongly agree	70 (60%)	11 (35%)	8 (67%)	51 (70%)	0.010†
Disagree or strongly disagree	40 (34%)	17 (55%)	3 (25%)	20 (27%)	
Neutral	6 (5.2%)	3 (9.7%)	1 (8.3%)	2 (2.7%)	
I am more confident in positive RDT result than in a negative one					
Agree or strongly agree	51 (44%)	11 (35%)	4 (33%)	36 (50%)	0.3†
Disagree or strongly disagree	33 (29%)	11 (35%)	2 (17%)	20 (28%)	
Neutral	31 (27%)	9 (29%)	6 (50%)	16 (22%)	
I have no confidence in both a positive and a negative RDT result					
Agree or strongly agree	35 (30%)	11 (35%)	2 (17%)	22 (30%)	0.5†
Disagree or strongly disagree	65 (56%)	14 (45%)	8 (67%)	43 (59%)	
Neutral	16 (14%)	6 (19%)	2 (17%)	8 (11%)	
The infection prevention and control (IPC) measures are easy to understand and adhere to					
Agree or strongly agree	74 (65%)	18 (58%)	5 (42%)	51 (72%)	0.2†
Disagree or strongly disagree	35 (31%)	12 (39%)	6 (50%)	17 (24%)	
Neutral	5 (4.4%)	1 (3.2%)	1 (8.3%)	3 (4.2%)	
Overall perception score [Median (IQR)]	21.0 (18.0, 22.0)	19.5 (16.0, 21.0)	21.0 (18.5, 22.0)	21.0 (19.0, 22.8)	0.062#
† Fisher's exact test # Kruskal-Wallis rank sum test					

Table 4: Demand and acceptability of the COVID-19 antigen RDT					
Characteristic	**Overall N = 116 n (%)**	**Community pharmacist N = 31 n (%)**	**Patent medicine vendors N = 12 n (%)**	**Primary health center workers N = 73 n (%)**	**p value[2]**
Daily facility attendance[1]	20 (14, 40)	50 (30, 50)	18 (10, 22)	20 (10, 30)	<0.001#
Daily number of tests[1]	1.0 (0.0, 3.2)	0.0 (0.0, 1.0)	1.0 (0.0, 2.0)	2.0 (1.0, 7.0)	<0.001#
Client's comfort at doing COVID-19 RDT test	47 (41%)	8 (26%)	6 (50%)	33 (45%)	0.14†
Providers most comfortable method					
Nasal	104 (90%)	27 (87%)	12 (100%)	65 (89%)	0.6†
Nasopharyngeal	12 (10%)	4 (13%)	0 (0%)	8 (11%)	
Sample collection method clients are most comfortable with					
Nasal	109 (94%)	30 (97%)	12 (100%)	67 (92%)	0.6†
Nasopharyngeal	7 (6.0%)	1 (3.2%)	0 (0%)	6 (8.2%)	
Client testing method rejection	71 (61%)	19 (61%)	5 (42%)	47 (64%)	0.3†
Difficulty to use method					
A little difficult	5 (4.3%)	0 (0%)	2 (17%)	3 (4.1%)	0.2†
Difficult	2 (1.7%)	0 (0%)	0 (0%)	2 (2.7%)	
Not difficult at all	109 (94%)	31 (100%)	10 (83%)	68 (93%)	
Client's concerns about time to result	13 (11%)	3 (9.7%)	2 (17%)	8 (11%)	0.8†
COVID-19 RDT test interfere with facility activity	36 (31%)	11 (35%)	5 (42%)	20 (27%)	0.4†
Client's interest to pay for COVID-19 testing					
No	82 (71%)	18 (58%)	9 (75%)	55 (75%)	0.2†
Not sure	24 (21%)	7 (23%)	3 (25%)	14 (19%)	
Yes	10 (8.6%)	6 (19%)	0 (0%)	4 (5.5%)	
[1] Median (IQR); [#] Kruskal-Wallis rank sum test; [†] Fisher's exact test					

Table 5: Barriers to rapid diagnostic testing for COVID-19 antigens					
Characteristic	**Overall N = 116 n (%)**	**Community pharmacist N = 31 n (%)**	**Patent medicine vendors N = 12 n (%)**	**Primary health center workers N = 73 n (%)**	**p value†**
Think facility conducive for testing	104 (90%)	28 (90%)	12 (100%)	64 (88%)	0.7
Think facility is well equipped for COVID-19 RDT testing	84 (72%)	26 (84%)	7 (58%)	51 (70%)	0.2
Colleagues feel comfortable to do COVID-19 RDT test	98 (84%)	26 (84%)	10 (83%)	62 (85%)	>0.9
Feel people are comfortable to do COVID-19 RDT test at the facility	93 (80%)	23 (74%)	11 (92%)	59 (81%)	0.5
Other health providers in facility refer clients to facility for test	80 (69%)	14 (45%)	6 (50%)	60 (82%)	<0.001
Most important factor considered when recommending COVID-19 RDT					
Ability to give accurate result	45 (39%)	11 (35%)	5 (42%)	29 (40%)	>0.9
Cost	31 (27%)	10 (32%)	2 (17%)	19 (26%)	
Others (specify)	16 (14%)	5 (16%)	2 (17%)	9 (12%)	
Time to result	24 (21%)	5 (16%)	3 (25%)	16 (22%)	
Culture/religious beliefs make people reject COVID-19 testing	40 (34%)	7 (23%)	3 (25%)	30 (41%)	0.2
† Fisher's exact test					