



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Contents lists available at ScienceDirect

## International Journal of Infectious Diseases

journal homepage: [www.elsevier.com/locate/ijid](http://www.elsevier.com/locate/ijid)

# Barriers and enablers experienced by health care workers in swabbing for COVID-19 in Papua New Guinea: A multi-methods cross-sectional study



Bernnedine S. Smaghi<sup>a,b</sup>, Julie Collins<sup>d</sup>, Rosheila Dagina<sup>a,b</sup>, Gilbert Hiawalyer<sup>a,b</sup>, Stefanie Vaccher<sup>c</sup>, James Flint<sup>d</sup>, Tambri Housen<sup>d,\*</sup>

<sup>a</sup> Papua New Guinea Field Epidemiology Training Program, AOPI Building Centre, Waigani Drive, Tower One, PO Box 807, Waigani 121, Port Moresby, National Capital District, Papua New Guinea

<sup>b</sup> National Department of Health, Papua New Guinea, AOPI Building Centre, Waigani Drive, Tower One, PO Box 807, Waigani 121, Port Moresby, National Capital District, Papua New Guinea

<sup>c</sup> Independent Consultant, Papua New Guinea

<sup>d</sup> University of Newcastle, School of Medicine, University Dr, Callaghan NSW 2308, Australia

## ARTICLE INFO

## Article history:

Received 28 February 2021

Received in revised form 23 April 2021

Accepted 26 April 2021

## Keywords:

COVID-19

Papua New Guinea

Swabbing

Barriers

Enablers

Health Care Workers

## ABSTRACT

**Objective:** We aimed to identify the barriers and enablers that Health Care Workers (HCWs) in Papua New Guinea experienced in swabbing for COVID-19.

**Methods:** We conducted a cross-sectional multi-methods study: a qualitative scoping exercise and a telephone survey. The target population was COVID-19-trained HCWs from all provinces of Papua New Guinea. A descriptive analysis of survey responses was conducted alongside a rapid qualitative analysis of interviews and open-ended survey questions.

**Results:** Four thematic areas were identified: human resources, logistics, HCW attitudes and community attitudes. The survey response rate was 70.3% (407/579). Commonly reported barriers to COVID-19 swabbing were insufficient staff trained (74.0%, n = 301), inadequate staffing in general (64.9%, n = 264), insufficient supply of personal protective equipment (60.9%, n = 248) and no cold chain to store swabs (57.5%, n = 234). Commonly reported enablers to swabbing were community awareness and risk communication (80.8%, n = 329), consistent and sufficient supplies of personal protective equipment (67.8%, n = 276), increased surge workforce (63.9%, n = 260) and having a fridge to store swabs (59.7%, n = 243).

**Conclusions:** A comprehensive community and HCW engagement strategy combined with innovations to improve the supply chain are needed to increase COVID-19 swabbing in Papua New Guinea to reach national testing targets. Investments in increasing numbers of frontline workforce, consistent supplies of PPE, swabs, transport medium, cold boxes and ability to make ice packs, in addition to establishing regular transport of specimens from the facility to the testing site will strengthen the supply chain. Innovations are needed to address these issues.

© 2021 Published by Elsevier Ltd on behalf of International Society for Infectious Diseases. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

COVID-19 is an infectious respiratory disease caused by the SARS-CoV-2 virus. In March 2020, in response to increasing international transmission of the SARS-CoV-2 virus combined with

increasing reports of COVID-19 cases, the World Health Organization (WHO) declared a pandemic (Cucinotta and Vanelli, 2020). Papua New Guinea (PNG) recorded its first COVID-19 case on 20 March 2020, and by the end of 2020, a total of 780 confirmed cases had been reported with 9 deaths (National Department of Health, 2020b).

Testing is an essential component of the COVID-19 response. Without testing, cases and contacts will not be identified, isolated and quarantined to prevent further transmission. The PNG COVID-19 testing strategy included testing targets for each province based on the availability of polymerase chain reaction (PCR) tests (National Department of Health, 2020a). In March 2020, the

\* Corresponding author at: 7 Bremer St, Griffith, ACT, 2603, Australia.

E-mail addresses: [b.smaghi@gmail.com](mailto:b.smaghi@gmail.com) (B.S. Smaghi), [juliecollins017@gmail.com](mailto:juliecollins017@gmail.com) (J. Collins), [rtdagina@gmail.com](mailto:rtdagina@gmail.com) (R. Dagina), [gilberthiawalyer@gmail.com](mailto:gilberthiawalyer@gmail.com) (G. Hiawalyer), [stefanie.vaccher@gmail.com](mailto:stefanie.vaccher@gmail.com) (S. Vaccher), [james.flint@hnehealth.nsw.gov.au](mailto:james.flint@hnehealth.nsw.gov.au) (J. Flint), [tambri.housen@newcastle.edu.au](mailto:tambri.housen@newcastle.edu.au) (T. Housen).

PNG National Control Centre partnered with the WHO to train health care workers (HCWs) across PNG to take nasopharyngeal swabs for COVID-19. Sites included ports of entry, quarantine hotels, provincial and district hospitals, health centers and other health facilities established specifically for COVID-19, such as temporary testing sites. The national monthly testing target was 4656 tests (National Department of Health, 2020a). Box 1 describes the testing facility types. The number of swabs sent for testing has remained much lower than monthly targets and does not correspond to national surveillance data on people presenting to health facilities with respiratory symptoms.

A limited supply of personal protective equipment (PPE) and stigmatization of HCWs by communities have been documented as barriers to HCW capacity to complete routine and COVID-19-specific health care tasks in other countries (Vindrola-Padros et al. 2020; Nanda et al. 2020). It is vital to understand the challenges and barriers contributing to low rates of COVID-19 swabbing across PNG to inform targeted response measures to increase specimen collection. This study aimed to engage with HCWs to explore the barriers and enablers to COVID-19 swabbing in PNG.

Research questions

The research questions guiding the study were:

- 1 What are the barriers that prevent HCWs in PNG from being able to collect swabs for COVID-19?
- 2 What are the enablers that could be implemented to increase swab collection and testing rates for COVID-19 in PNG?

Methods

Study design

A cross-sectional multi-method study design was employed. An initial qualitative scoping exercise was conducted to identify the critical issues faced by HCWs related to COVID-19 swabbing. Findings were used to inform survey development and contextualize survey findings. A telephone-administered survey was conducted between 30 November and 18 December 2020.

**Box 1.** Description of health facilities in Papua New Guinea.

Community/Village/Ward	<b>Aid Post</b> - 1 community health worker (CHW) Community Health Post - 2 CHWs Population served: 500–2000
Ward/Local-level government or Urban council	<b>Health subcenter/Urban clinic</b> 300–1500 inpatients per year 100–150 deliveries per year 2000–5000 rural >10 000 urban 1 nurse, 3 CHWs <b>Health centre</b> 2 nurses, 5 CHWs 5000–10 000 population 400–600 inpatients/year 100–150 deliveries/year
District	<b>District health centre</b> 1 Health Extension Officer (HEO), 6 nurses, 7 CHWs <70 000 population 30 beds <b>Level 5 Rural hospital</b> 1 Medical Officer (MO), 3 HEOs, 9 nurses, 22 CHWs 70 000+ population No more than 2 in a province 50 beds
Province	<b>Level 4 hospital</b> 2 MOs, 1 HEO, 25–35 nurses, 25–30 CHWs <b>Level 3 hospital</b> 10–20 MOs, 5–10 HEOs, 30–80 nurses, 50–90 CHWs
Province/Region	<b>Level 2 hospital</b> 25 MOs, 5+ HEOs, 100–200 nurses, 70–120 CHWs (Western Highlands province, Morobe province, East New Britain province) <b>Level 1 hospital</b> 30 MOs, 5+ HEOs, 100–200+ nurses, 70–120 + CHWs Port Moresby General Hospital

### Participant selection

For the initial scoping exercise, a snowballing recruitment strategy was used to identify key informants from national, provincial, district and remote health centers. We aimed to interview 2–3 individuals working at each level until data saturation was reached and no new concepts were being raised.

Purposive sampling was used to identify participants for the telephone survey, based on lists of trained HCWs submitted by 21/22 provincial health authorities in PNG. The combined list with the contact details of 579 trained HCWs was used as the sampling frame. Anticipating a 50% response rate, a sample size of 290 HCWs was considered a sufficient sample for a descriptive analysis of barriers and enablers to inform targeted public health response.

### Data collection tools

The development of the survey was based on a rapid qualitative review of the initial scoping exercise. The PNG Standard Operating Procedure for COVID-19 swabbing provided the basis for developing questions about knowledge, attitudes and practice (National Department of Health, 2020c). The survey included questions on the type of health facility the HCW worked at, prior training on PPE and swab collection for COVID-19, access to supplies and transport, and barriers and enablers related to swabbing. Open-ended questions were included to encourage interviewees to provide additional detail not captured by the structured questions. Participants were asked to self-rate confidence using a 5-point scale in donning and doffing PPE and collecting a nasopharyngeal swab. They were also asked to self-rate fear of contracting COVID-19 while collecting a swab from a patient. The survey questions were initially structured in English and translated into Tok Pisin by professional translators. Bi-lingual HCWs conducted back translation to check for construct and content validity. The finalized survey was converted into an electronic data collection form using the Open-Source Data Kit.

### Data collection

The initial scoping exercise involved semi-structured interviews and group discussions. Field notes were collated daily, with team debriefings at the end of each day to triangulate findings and identify common themes and incongruences for clarification.

The telephone survey was conducted by 8 PNG university students. Interviewers underwent a 1-day training on interview techniques and use of the electronic data collection form using tablets. The survey and telephone interview format were pre-tested with 4 different district health facilities; these were excluded from the final sampling frame. Feedback from the pilot was used to improve the questionnaire and informed survey implementation. All HCWs in the sampling frame were initially contacted via text message. Due to connectivity challenges in PNG, 5 text messages and 15 call attempts per individual in the sampling frame were made over a 15-day period before classifying the HCW as non-contactable (lost to follow-up). Interviewers were monitored by a team leader who assessed interview quality and provided feedback as required.

### Data management and analysis

A rapid qualitative analysis was conducted on data from the scoping exercise and open-ended interview questions. An iterative approach was used, with a matrix created in Microsoft Word using the semi-structured interview guide to capture the initial set of themes. Qualitative survey responses were coded under these initial themes; new themes were created as they emerged from the

data. Rapid qualitative data analysis is considered acceptable in the context of resources and time constraints (Halcomb and Davidson, 2006; Johnson and Vindrola-Padros, 2017; Taylor et al., 2018). Illustrative quotes are presented with key themes identified.

Survey data was downloaded and stored securely on the 2 lead researchers' computers. Data were cleaned using Stata (StataCorp. v15) and analyzed using Microsoft Excel. Data analysis occurred throughout the data collection period. Descriptive analysis was conducted on the final dataset, with medians, interquartile ranges (IQR), means and standard deviations reported for scores, as relevant.

This study was approved by the PNG Medical Research Advisory Committee (MRAC # 20.24). Informed consent was sought from participants before interview. This study was developed by PNG health staff and therefore was sensitive to PNG culture and social values.

## Results

### Interview participant characteristics

Interviews were held with 19 key stakeholders during the scoping exercise: including clinical staff, health promotion officers, officers in charge at health facilities in Central Province, Chimbu, East New Britain and New Ireland, and representatives from the National Department of Health, National Control Centre (NCC), and the WHO. Interviewee demographics were not recorded to ensure anonymity.

### Survey participant characteristics

A total of 579 HCWs were eligible for inclusion in the telephone survey, and 407 agreed to participate (response rate 70.3%). Of the 19 HCWs who declined to participate, reasons given included pending approval from their hierarchy, organizational regulations restricting the release of information, and personal grounds. There were 153 HCWs classified as lost to follow up after repeated attempts to contact them were unsuccessful. HCWs were interviewed from 21/22 provinces across PNG with representation from 80.9% (72/89) of districts. The median age of respondents was 43.5 years (range 23–66 years), and 59% (n = 240) were male.

More than one-third, 37% (n = 150) of respondents were nurses, 31% (n = 126) were Community Health Workers (CHWs) and 19% (n = 78) were Health Extension Officers (HEOs). The remaining 13.0% (n = 53) included other health and non-health workers (Table 1). Approximately one-third, 33.4% (n = 136) of respondents worked at health centers, 27.8% (n = 113) at provincial hospitals, and 14.7% (n = 60) at district hospitals. Other facilities represented included aid posts, dedicated COVID-19 facilities, community health posts, urban day clinics, and health sub-centers (for definitions, refer to Box 1). The majority, 76.7% (n = 312) of respondents reported working for government-run health facilities, while nearly one-fifth, 19.2% (n = 78) were employed by church-run health facilities.

### Health care workers knowledge, practice

The majority, 89% (n = 364), of HCWs indicated that their current role included swabbing for COVID-19, although few swabs had been collected (median 3, IQR: 0–23). HCWs who had received training in donning and doffing PPE were 90.7% (n = 369) of respondents, 92.9% (n = 378) had received training in swabbing for COVID-19; however, only 83.3% (n = 339) reported receiving training on how to collect a nasopharyngeal swab. Of those trained in swabbing, 61.7% (209/339) reported having practiced collecting a nasopharyngeal swab during their training; some respondents stated that they had observed instructors but were not given the

**Table 1**  
Respondent characteristics (N = 407), Health Care Worker COVID-19 Survey, Papua New Guinea, 2020.

Characteristic	N (%)
Sex	
Male	240 (59%)
Female	167 (41 %)
Age: Median [Range]	43.5 (23-66)
Age category	
<20 years	0 (0%)
20–29 years	64 (15.7%)
30–39 years	139 (34.2%)
40–49 years	135 (33.2%)
50–59 years	57 (14.0%)
> = 60 years	11 (2.7%)
Unknown	1 (0.2%)
Qualification in Health Service	
Doctor	6 (1.5%)
Health Extension Officer	78 (19.2 %)
Nursing Officer	150 (36.9%)
Community Health Worker	126 (31.0%)
Lab Technician	28 (6.9%)
Surveillance Officer	2 (0.5 %)
Environmental Health Officer	6 (1.5%)
Others	11 (2.7%)
Medical Lab Assistant: 4 (1.0%)	
Anaesthetic officer: 1 (0.2%)	
Non - Health Care Workers <sup>a</sup> : 6 (1.5%)	
Position in Health Service	
Role includes swabbing for COVID-19	364 (89.4%)

<sup>a</sup> Includes volunteer's who's qualification was not specified.

opportunity to practice themselves. The median self-rated confidence score for donning and doffing PPE was 4/5 (IQR: 3–5), and collecting a nasopharyngeal swab 4/5 (IQR 3–5). The median self-rated fear score for contracting COVID-19 during the swabbing process was 4 (IQR: 3-5) and was 2 (IQR: 0-5).

Most respondents, 95.8% (n = 390), correctly indicated that swabs should be collected from individuals with fever, cough, shortness of breath, sore throat, loss of taste or smell or fatigue, as per the case definition. Approximately 78.4% (n = 319) also indicated that anyone with symptoms of respiratory illness, including those consistent with influenza-like illness, severe acute respiratory illness or pneumonia, should have swabs collected (Table 2).

#### Storage and transportation of COVID-19 specimens

The capacity to store and transport specimens varied across the type and level of facilities. Lack of access to specimen

**Table 2**  
Health Care Worker Knowledge, Attitudes and Practices related to COVID-19 swabbing (N = 407), Health Care Worker COVID-19 Survey, Papua New Guinea, 2020.

Who should be swabbed for COVID-19? [Response to this question enabled multiple answers]	N (%)
Someone who has any of these symptoms - fever, cough, shortness of breath, sore throat, loss of smell or taste, fatigue	390 (95.8 %)
Anyone with symptoms of a respiratory illness (ILI, SARI, Pneumonia)	319 (78.4 %)
People who require a clearance swab (e.g., quarantine, work, travel)	173 (42.5%)
People who have had contact with a confirmed case of COVID-19	113 (27.8%)
Everyone who asks / volunteers to be swabbed	44 (10.8%)
I don't know	2 (0.5%)
No-one, we don't have COVID-19 in this community	0 (0 %)
Others (listed below):	39 (9.6%)
Patients with other comorbidities	12 (2.9%)
Adults more than 40 years and elderlies	10 (2.5 %)
All health care workers	5 (1.2 %)
Illegal border and check point crossers	4 (1.0%)
Children	3 (0.7%)
Pregnant and breastfeeding mothers	2 (0.5 %)
Hotel guests and staff	1 (0.2 %)
Young people – socially active and mobile	1 (0.2 %)
Anyone with recent travel history	1 (0.2 %)

transportation was reported by 89 respondents (21.9%), and a further 82 (20.6%) stated that specimen transportation was irregular or ad hoc. Only 40.5% (n = 165) of respondents reporting having access to a refrigerator suitable to store COVID-19 specimens.

#### Barriers to COVID-19 swabbing

Four thematic areas were identified: human resources, logistics, HCW attitudes and community attitudes. The most reported barriers to COVID-19 swabbing were too few staff trained to swab, 74% (n = 301), and inadequate staffing at the facility, 64.9% (n = 264) (Figure 1).

We also face problems when health workers are absent due to patrol [mobile clinics], outreach activities and leave. We have no-one to cover their work. How can we get time for swabbing? HEO, Health Centre

Nearly two-thirds, 60.9% (n = 248) indicated that barriers associated with logistics included inadequate and irregular supply of equipment, including PPE and the lack of timely transport for specimen collection.

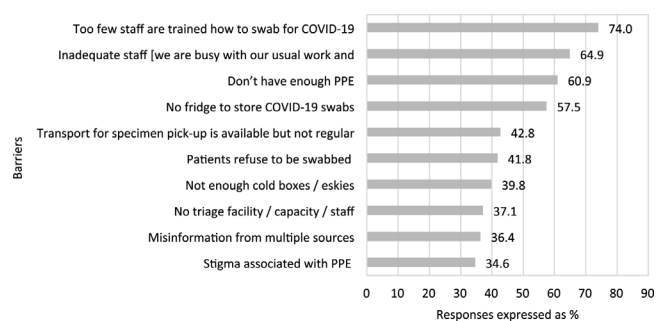
We have only one esky [cold box] that we use to store specimens to be transported to the labs and when the esky is delayed to be transported back to our facility we can't collect and store specimens for COVID. Nurse, Provincial Hospital

HCW and community attitudes were also highlighted as a barrier to swab collection for COVID-19. Two of the main challenges described were fear of contracting COVID-19 during swab collection, 31% (n = 126), and lack of interest in working with COVID-19, 24.3% (n = 99). Stigmatization associated with wearing PPE was reported by one-third of survey respondents, 34.6% (n = 141).

Stigmatization associated with PPE. When a member of the community sees someone talking to a health care worker in PPE, or collecting a swab from a patient, they assume the person has COVID-19. This results in stigmatization in the community that can have significant impact on an individual, their family and their community. Nurse, Health Centre

Concerning community attitudes, 41.8% (n = 170) of respondents reported that many patients refused to be swabbed for COVID-19, and 36.4% (n = 148) said misinformation circulating in the community had negative impacts on patients' willingness to be swabbed. Information from conflicting sources was considered the main issue and confusion about trusted sources of information.





**Figure 1.** Identified barriers to swabbing (N = 407), Health Care Worker COVID-19 Survey, Papua New Guinea, 2020.

Misinformation and multiple sources of information was mentioned as leading to confusion in the community. This led to community members not believing the information provided by the health care worker, as they had heard conflicting information from a family member, or someone they trust in the community. Extract from interview notes

Additional barriers raised included the timeliness of results and leadership and management issues at health facilities and in government.

The community is cooperative but is very impatient with the prolonged delay in getting their results. CHW, Health Centre The top management team are not taking COVID-19 seriously. Most facilities here at [XX] province are not collecting swabs even though we have many presenting cases have COVID symptoms. CHW, Urban Day Clinic

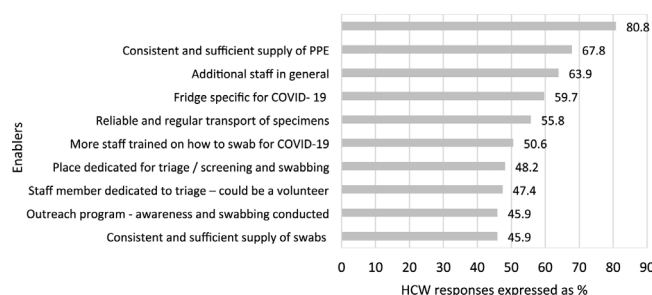
#### Enablers and local solutions to increasing COVID-19 swabbing

Enablers are presented according to the four key thematic areas. HCWs shared their experiences and recommendations for the local context that could be employed to increase swabbing for COVID-19. The most commonly reported enabling factor, mentioned by 80.8% (n = 329) of respondents, was focusing on community awareness and risk communication related to COVID-19. Successful approaches to increasing community awareness discussed by HCWs included: training volunteers to conduct ongoing health promotion messaging and risk communication in the outpatient and inpatient facilities; engagement with community leaders; ensuring COVID-19 risk communication and swab collection were integrated into all mobile clinics and outreach activities; and utilization of peer messaging by having a community member who has had a nasopharyngeal swab taken talk to the community about their experience.

It is important to integrate COVID into a normal health routine so that people will feel free to come and get tested without getting the feeling of being discriminated by their communities, families or others. HEO, Health Centre

Improved logistics was mentioned as a critical enabler to increase swabbing. The need for consistent and sufficient supplies of PPE was mentioned by 68% (n = 276) of respondents, 59.7% (n = 243) indicated availability of a fridge suitable for storing COVID-19 specimens, and 55.8% (n = 227) said they needed to have regular and reliable transport for specimen collection (Figure 2).

The need to strengthen the health workforce in PNG was identified as a priority if testing targets for COVID-19 were to be reached. Recommendations included increasing staff numbers in general 63.9% (n = 260), 50.6% (n = 206) mentioned increasing numbers of staff trained to swab for COVID-19, and 47.4% (n = 193) said having a dedicated staff member responsible for triage at



**Figure 2.** Identified enabling factors to swabbing (N = 407), Health Care Worker COVID-19 Survey, Papua New Guinea, 2020.

health facilities. Training of an alternate workforce was discussed, with reports that some facilities had engaged retired community health workers, newly graduated and retired nurses, and other underemployed health staff to conduct risk communication and health promotion activities at clinics.

Training of volunteers to triage, screen and provide health promotion messaging around COVID in the outpatient’s area. This removes the burden from the primary health care staff and ensures timely swabbing of symptomatic patients. Nurse, Provincial Hospital

Requests for applied and hands-on refresher training on PPE use, swabbing, triage, and risk communication were noted. The importance of post-training mentorship and supervision was discussed and other suggestions related to providing opportunities for cross-learning. One interviewee reported that after successfully implementing ongoing swabbing at their facility, they visited a nearby facility to assist them in establishing their triage, screening and health promotion messaging, increasing swabbing at this facility.

Improving information flows was also highlighted. Many participants mentioned the desire for regular communication with the health workforce on developments in the COVID-19 response.

We would like regular feedback from the PDCO [Provincial Disease Control Officer] to keep the rural area updated and informed about COVID. HEO, Provincial Hospital

## Discussion

The ability to rapidly identify cases and institute appropriate control measures is at the foundation of any outbreak response, including a global pandemic. It often falls to frontline workers to identify suspect cases and collect and send specimens for laboratory confirmation. To our knowledge, this is the first national study focused on understanding the barriers and enablers HCWs face in swab collection for COVID-19. Findings from this study showed that HCWs face many challenges in meeting provincial testing targets for COVID-19, including insufficient workforce, logistics supply issues and HCW and community attitudes. A study by [Vindrola-Padros et al. \(2020\)](#) found similar issues reported by HCWs, including lack of training, insufficient supplies of PPE, and concerns related to the risk of contracting COVID-19. [Nanda et al. \(2020\)](#) also reported inadequate PPE supplies, disruption to routine work, and increased workloads of community HCWs responding to COVID-19 in India.

Testing for the SARS-CoV-2 RNA involves collecting a respiratory specimen through a nasopharyngeal and/or oropharyngeal swab; swabs are often taken from both sites to increase sensitivity ([Carver and Jones, 2020](#); [Loeffelholz and Tang, 2020](#); [Wang et al., 2020](#)). The swabbing process requires the donning and doffing of

PPE, which is time-consuming and requires specialized training (World Health Organization, 2020b, 2020, 2014). Considering the risk of infection and contamination during swabbing and recommended strict adherence to biosafety protocols (Karthik et al., 2020), it is of great concern that nearly two-thirds (60.9%) of HCWs surveyed reported an inadequate supply of PPE.

Findings from our study highlighted the many logistical challenges the health care workforce faces in receiving supplies to support COVID-19 swab collection and ensuring regular and reliable transport of specimens to the laboratory for testing. PNG is geographically diverse, with over 600 islands, rugged mountains, volcanoes, and swampy river deltas. This topography poses many challenges for access and transport. Only 3% of the nation's roads are paved and many villages are only reachable on foot (Grundy et al., 2019). Therefore, timely specimen transport is extremely challenging and expensive, often involving a combination of water, air and road transport.

In addition to transport issues, cold chain to support swab storage was highlighted as a significant issue. COVID-19 swabs are tested for the SARS-CoV-2 RNA via real-time reverse transcription PCR (RT-PCR). Maintaining the integrity of the specimen is essential for the RT-PCR to read the presence of viral RNA accurately. The lack of reliable storage for swabs, combined with issues related to timeliness of transportation to the laboratory, are significant challenges that need to be overcome if PNG is going to achieve testing targets.

Innovative strategies are needed to address the access and supply chain issue in PNG. Uncrewed aerial vehicles, more commonly known as drones, have been trialed in a number of countries to transport medical supplies (Eichleay et al., 2019; Knight, 2020; Walston et al., 2019). These drones may offer a solution for timely specimen transport in PNG, where there are significant challenges associated with infrastructure and accessibility. However, any approach would need to be considered in the context of health system integration and long-term sustainability.

The healthcare system is largely decentralized in PNG, and religious organizations play a significant role in health service delivery in rural areas (Grundy et al., 2019). Significant gaps in the number, diversity and distribution of the health workforce lead to staff taking on additional roles and responsibilities (Grundy et al., 2019; Tynan et al., 2017). Findings from our study showed that the number of staff trained in swabbing was not congruent with workforce needs in health centers. Staff reported high workloads during non-pandemic times and limited capacity to take on additional responsibilities associated with triage, screening, swabbing, health promotion and risk communication related to COVID-19.

Investment is needed in strengthening the workforce at the facility level. Recommendations from HCWs included increasing staff numbers in general, providing refresher training, training more staff to strengthen surge capacity, and ongoing supervision. It is essential to train and upskill additional staff to manage increasing demands as PNG continues to experience surges in COVID-19 cases. Training an alternate workforce was discussed by HCWs, and some facilities had trialed bringing in new graduates and retired HCWs as volunteers to assist with additional COVID-19 related activities. While this model effectively met needs during the initial response, HCWs questioned the sustainability of this approach, stating that these individuals should be compensated to ensure their continued involvement over the longer term.

HCW and community attitudes were highlighted as a significant barrier to COVID-19 swabbing in PNG. While respondents reported a low self-rated fear of contracting COVID-19 while conducting swabbing overall (median = 2, IQR:0–5), the IQR range indicates that over 25% perceived high risk of transmission. There is a need

for ongoing training and risk communication among HCWs in PNG to ensure they understand COVID-19, reduce fear and anxiety, and ensure they feel comfortable and confident in safe swabbing practice. Training and communication need to occur alongside improvements in the supply of PPE and other necessary supplies (Karthik et al., 2020).

In response to fear among frontline workers during the Ebola virus disease outbreak in West Africa in 2014–16, national governments collaborated with mobile network providers to facilitate the provision of low-cost, high-impact mobile health (mHealth) solutions, providing education interventions to promote changes in knowledge, attitudes and practice (O'Donovan and Bersin, 2014; Out et al., 2016). The use of mHealth technology as a means of information dissemination, knowledge exchange, and dissemination of resources and training materials has been shown to be acceptable to frontline workers in multiple settings (Abou El Fadl and Hassan, 2020; Agarwal et al., 2015; Braun et al., 2013). Implementing this technology in PNG could also meet other needs mentioned in our study, such as improving information flows from the national and provincial levels to the district health centers and regular communication on developments in the COVID-19 response. HCWs in our study reported feeling disconnected from the COVID-19 response; mHealth technology could be used to improve staff morale by enabling them to feel part of the national response efforts.

Our study highlighted that community awareness, education and risk communication were considered the most critical interventions for increasing swabbing in PNG. Risk perception among the community had resulted in stigmatization of HCWs, which had sometimes resulted in violent attacks against HCWs and their families. Studies conducted with HCWs in other settings have found that HCWs directly involved in the care of COVID-19 patients experienced a high level of stigma from their neighbors and community owing to false beliefs and misinformation about COVID-19 (Devi, 2020; Mostafa et al., 2020; Nanda et al., 2020). Stigmatization in the context of the COVID-19 pandemic is defined by Bhanot et al. (2021) as 'a social process set to exclude those who are perceived to be a potential source of disease and may pose threat to the effective social living in the society' (p.2). Bhanot et al. (2021) discuss strategies implemented in India to reduce stigmatization of frontline workers, including a public health communication strategy promoting frontline workers as corona warriors, calling on the public to recognize the contribution of frontline workers. Collective clapping, lighting candles, and Indian fighter jets releasing flowers over hospitals with COVID-19 patients were recognized as important mitigation strategies against stigmatization.

Communication plays an essential role in providing communities with a framework for explaining and understanding a new disease. In our study, misinformation and multiple sources of information were reported to have propagated negative perceptions in the community and decreased trust in information provided by HCWs. Following the Ebola virus disease outbreak in West Africa, there was a surge in literature on risk communication and community engagement (RCCE) during outbreaks and pandemics (Toppenberg-Pejcic et al., 2019) and specific guidance has now been developed for COVID-19 (World Health Organization, 2020a). Despite this, community engagement remains one of the last strategies employed in a response, often only conducted after noncompliance with response efforts. Tambo et al. (2021) emphasize that RCCE is integral to the success of public health emergency response efforts. However, the authors stress the importance of the involvement of the community in the design and implementation of RCCE, recognizing that a top-down approach has limited impact on addressing uncertainty and managing misinformation.

In our study, HCWs discussed successful approaches to increasing community awareness. Approaches included training volunteers to conduct ongoing health promotion messaging and risk communication in the outpatient and inpatient facilities and ensuring COVID-19 risk communication and mobile swab collection were integrated into all patrol/outreach activities. Other strategies included engagement with community leaders and utilizing peer messaging by having a community member who has had a nasopharyngeal swab talk to the community about their experience. While such strategies were recognized as a priority, the workforce issues discussed above limited capacity on the ground to carry out the activities.

### Limitations of the study

There were some limitations to this study. First, we could not determine if the lists of HCWs submitted by the provincial health authorities were complete, which may have led to an incomplete sampling frame. We had a high proportion of respondents from hospital settings, so our study may not reflect the challenges of rural health facilities, noting that training for COVID-19 swabbing has focused on larger health facilities. Second, the nature of our sampling frame meant that we might have included responses from multiple HCWs at the same facility. As responses were based on individual perspectives, there may have been differing responses for the same facility. However, we felt that a rapid, cross-sectional overview of HCWs' individual experiences and opinions would provide an adequate understanding of the major issues affecting COVID-19 swab collection. Third, due to communication issues with telecommunication network providers in some provincial locations, we were unable to reach some participants, which may have introduced non-response bias in our study, which we could not measure.

While considering these limitations, we also recognize that a strength of this study was the use of multiple methods, which enabled the exploration of concepts in greater depth and the contextualization of survey findings. Triangulation of survey findings with findings from the scoping exercise demonstrated congruent themes, reinforcing the reliability and validity of findings. To our knowledge, this was the first national telephone survey conducted in PNG, and the response rate was encouraging, indicating that this methodology could be employed for future surveys.

### Conclusions and recommendations

Our study highlighted the importance of HCWs' perspectives on the challenges they face in swabbing patients for COVID-19. HCWs in PNG face a multiplicity of complex challenges in collecting and transporting specimens for COVID-19 involving human resources, logistics, and HCW and community attitudes. Even with such challenges, HCWs identified local solutions they have trialed and/or recommended in addressing some of these challenges.

Policymakers and incident management teams must take on board the perspectives of frontline workers as they roll out strategies to improve COVID-19 testing rates across PNG. Targeted community and HCW engagement strategies on the importance of COVID-19 testing are needed. With the imminent roll-out of COVID-19 vaccinations, messaging should also be targeted at mitigating vaccine hesitancy. Ongoing support of HCWs should include refresher training, workforce expansion, supervision, and regular communication, including updated COVID-19 information. Improving logistics and ensuring an efficient supply chain is also vital to support HCWs to carry out COVID-19 testing.

Innovation and a willingness to try novel approaches to address identified challenges are needed for PNG to access testing and

rapid turnaround results. Follow-up studies are required to assess and evaluate the impact of interventions designed to improve testing coverage and to continue to inform the national COVID-19 response plan.

### Author contribution

BS contributed to the study implementation, data analysis, interpretation of findings, construction of the final report and dissemination of findings. TH, JC contributed to the study design, implementation, data analysis, interpretation of findings and construction of the final report. RD contributed to the study design, implementation, interpretation of findings. GH contributed to the study design, interpretation of findings. JF contributed to data analysis and interpretation of findings. All authors contributed to the construction and review of this manuscript.

### Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Funding

This study was funded by the World Health Organization country office in Papua New Guinea. Logistical support was provided by St John's Ambulance Papua New Guinea.

### Ethical approval

This study was approved by the PNG Medical Research Advisory Committee (MRAC # 20.24). Informed consent was sought prior to interview. This study was developed by Papua New Guinean health staff and therefore was sensitive to Papua New Guinean culture and social values.

### Acknowledgements

We would like to acknowledge the contribution from the Provincial Health Authorities, who provided the lists of trained health care workers when they had many competing priorities related to the COVID-19 response. We would like to acknowledge the support from St John Ambulance PNG, the Joint Agency Taskforce National Control Centre for COVID-19, the WHO Country Office in PNG, the Indo-Pacific Centre for Health Security, and the Global Outbreak Alert and Response Network. We would like to thank Associate Professor Alice Richardson for her assistance with the sampling strategy. We would also like to thank Getinet Shewaseged Adenager at the WHO Country Office in PNG for his assistance in building the electronic survey form in ODK. We express our gratitude to the many health care workers who gave their time to answer our questions and helped contribute to an understanding of the barriers and enablers health care workers face in conducting swabbing for COVID-19. Finally, we would like to express our thanks to the students who conducted the interviews and the team at the National Control Centre for their support during interviewer training, pre-testing and piloting.

### Transparency declaration

This article is published as part of a supplement titled, "Field Epidemiology: The Complex Science Behind Battling Acute Health Threats," which was supported by Cooperative Agreement number NU2HGH000044, managed by TEPHINET (a program of The Task Force for Global Health) and funded by the Centers for Disease



Control and Prevention (CDC). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention, the Department of Health and Human Services, The Task Force for Global Health, Inc., or TEPHINET.

## References

- Abou El Fadl R, Hassan H. Unpacking readiness for m-health in emergency settings. Online: Social Research Center of the American University in Cairo. 2020 Unpacking readiness for mHealth in emergency settings (emrdsdgslearn.net). [Accessed 12 January 2021].
- Agarwal S, Perry H, Long L, Labrique AI. Evidence on feasibility and effective use of mHealth strategies by frontline health workers in developing countries: systematic review. *Trop Med Int Health* 2015;20:1003–14.
- Bhanot D, Singh T, Verma S, Sharad S. Stigma and Discrimination During COVID-19 Pandemic. *Frontiers in public health* 2021;8:577018, doi:<http://dx.doi.org/10.3389/fpubh.2020.577018>.
- Braun R, Catalani C, Wimbush J, Israelski D. Community health workers and mobile technology: a systematic review of the literature. *PLoS One* 2013;8:e65772.
- Carver C, Jones N. Comparative accuracy of oropharyngeal and nasopharyngeal swabs for diagnosis of COVID-19. Oxford COVID-19 evidence service team centre for evidence based medicine. The Center for Evidence Based Medicine. 2020 Comparative accuracy of oropharyngeal and nasopharyngeal swabs for diagnosis of COVID-19 - The Centre for Evidence-Based Medicine (ceb.m.net). [Accessed 28 February 2021].
- Cucinotta D, Vanelli M. WHO Declares COVID-19 a Pandemic. *Acta Biomed* 2020;19(91):157–60.
- Devi S. COVID-19 exacerbates violence against health workers. *The Lancet* 2020;369:658.
- Eichleay M, Evens E, Stankevitz K, Parker C. Using the unmanned aerial vehicle delivery decision tool to consider transporting medical supplies via Drone. *Global Health Sci Pract* 2019;7:500–6.
- Grundy J, Dakulala P, Wai K, Maalsen A, Whittaker M. Health systems in transition: independent state of Papua New Guinea health systems review. Port Moresby: World Health Organization, Regional Office for South East Asia; 2019 9789290226741-eng.pdf (who.int). [Accessed 5 November 2020].
- Halcomb E, Davidson P. Is verbatim transcription of interview data always necessary?. *Appl Nurs Res* 2006;19:38–42.
- Johnson G, Vindrola-Padros C. Rapid qualitative research methods during complex health emergencies: a systematic review of the literature. *Soc Sci Med* 2017;189:63–75.
- Karthik K, Babu R, Dhama K, Chitra M, Kalaiselvi G, Senthilkumar T, et al. Biosafety concerns during the collection, transportation, and processing of COVID-19 samples for diagnosis. *Arch Med Res* 2020;51:623–30.
- Knight R. Drones deliver health care. Online: [insideunmannedsystems.com](http://insideunmannedsystems.com). Drones in HealthCare; 2020 [Accessed 2 February 2021].
- Loeffelholz M, Tang Y. Laboratory diagnosis of emerging human coronavirus infections—the state of the art. *Emerg Microbes Infect* 2020;9:747–56.
- Mostafa A, Sabry W, Mostafa N. COVID-19-related stigmatization among a sample of Egyptian healthcare workers. COVID-19-related stigmatization among a sample of Egyptian healthcare workers. 2020 15: e0244172.
- Nanda P, Lewis TN, Das P, Krishnan S. From the frontlines to centre stage: resilience of frontline health workers in the context of COVID-19. *Sex Reprod Health Matters* 2020;28:85–9.
- National Department of Health. COVID-19 Testing Strategy. Unpublished. Papua New Guinea National Department of Health; 2020.
- National Department of Health. National situation report December 31st 2020. Port Moresby: COVID-19 Task Force National Control Centre; 2020.
- National Department of Health. Standard operating procedure for COVID-19 specimen collection. Port Moresby: National Department of Health; 2020.
- O'Donovan J, Bersin Amalia. Controlling Ebola through mHealth strategies. *Lancet Global Health* 2014;3:e22.
- Out A, Ebenso B, Okuzu O, Osifo-Dawodu E. Using a mHealth tutorial application to change knowledge and attitudes of frontline health workers to Ebola virus disease in Nigeria: a before-and-after study. 2016 14: 1–9.
- Tambo E, Djuikoue I, Tazemda G, Fotsing M, Zhou X-N. Early stage risk communication and community engagement (RCCE) strategies and measures against the coronavirus disease 2019 (COVID-19) pandemic crisis. *Global Health Journal* 2021;5(1):44–50, doi:<http://dx.doi.org/10.1016/j.glohj.2021.02.009>.
- Taylor B, Henshall C, Kenyon S, Litchfield I, Greenfield S. Can rapid approaches to qualitative analysis deliver timely, valid findings to clinical leaders? A mixed methods study comparing rapid and thematic analysis. *BMJ Open* 2018;8:e019993.
- Toppenberg-Pejcic D, Noyes JTA, Alexander N, Vanderford M, Gamhewage G. Emergency Risk Communication: lessons learned from a rapid review of recent gray literature on Ebola, Zika, and Yellow Fever. *Health Commun* 2019;34:437–55.
- Tynan A, Valley L, Kupul M, Neo R, Fiya V, Worth H, et al. Programmes for the prevention of parent-to-child transmission of HIV in Papua New Guinea: health system challenges and opportunities. *Int J Health Plann Manage* 2017;33:e377.
- Vindrola-Padros C, Andrews L, Dowrick A, Djellouli N, Fillmore H, Gonzalez E, et al. Perceptions and experiences of healthcare workers during the COVID-19 pandemic in the UK. *BMJ open* 2020;10:e040503.
- Walston B, Peterson K, Graves D, Russo J. UPS Partners With Matternet To Transport Medical Samples Via Drone Across Hospital System In Raleigh, N.C. online: [GlobeNewswire](http://GlobeNewswire.com). UPS Partners With Matternet To Transport Medical Samples Via Drone Across Hospital System In Raleigh; 2019 N.C. NYSE:UPS (globe-newswire.com). [Accessed 21 February 2021].
- Wang W, Xu Y, Gao R, Roujian L, Han K, Guizhen W, et al. Detection of SARS-CoV-2 in different types of clinical specimens. *JAMA* 2020;12:1843–4.
- World Health Organization. Infection prevention and control of epidemic and pandemic prone acute respiratory infections in health care. Geneva: World Health Organization; 2014 9789241507134\_eng.pdf (who.int). [Accessed 14 January 2021].
- World Health Organization. Laboratory Guidelines for the Detection and Diagnosis of COVID-19 Virus Infection World Health Organization, Pan American Health Organization. 2020 PAHOIMSPHECOVID-19-19200038\_eng.pdf. [Accessed 13 February 2021].
- World Health Organization. Rational use of personal protective equipment (PPE) for coronavirus disease (COVID-19). Geneva: World Health Organization; 2020 Rational use of personal protective equipment for coronavirus disease (COVID-19-19) and considerations during severe shortages (who.int). [Accessed 26 February 2021].
- World Health Organization. International Federation of the Red Cross, United Nations International Childrens Fund. RCCE action plan guidance: COVID-19 preparedness and response. Geneva: World Health Organization; 2020 Preparedness for and response to coronavirus 2019 (COVID-19-19).pdf (unicef.org). [Accessed 14 February 2021].