Prevalence of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) among Health Care Workers—Zambia, July 2020

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Summary: SARS-CoV-2 prevalence among health care workers was similar to the prevalence in the general population during a period of community transmission in Zambia. Public health measures might have prevented increased SARS-CoV-2 transmission among HCWs in Zambia.

Accepted Manuscript

Abstract

Introduction: Healthcare workers (HCWs) in Zambia have become infected with SARS-CoV-2, the virus that causes coronavirus disease (COVID-19). However, SARS-CoV-2 prevalence among HCWs is not known in Zambia.

Methods: We conducted a cross-sectional SARS-CoV-2 prevalence survey among Zambian HCWs in twenty health facilities in six districts in July 2020. Participants were tested for SARS-CoV-2 infection using polymerase chain reaction (PCR) and for SARS-CoV-2 antibodies using enzyme-linked immunosorbent assay (ELISA). Prevalence estimates and 95% confidence intervals (CIs), adjusted for health facility clustering, were calculated for each test separately and a combined measure for those who had PCR and ELISA performed.

Results: In total, 660 HCWs participated in the study, with 450 (68.2%) providing nasopharyngeal swab for PCR and 575 (87.1%) providing a blood specimen for ELISA. Sixty-six percent of participants were females and the median age was 31.5 years (interquartile range 26.2–39.8 years). The overall prevalence of the combined measure was 9.3% (95% CI 3.8%–14.7%). PCR-positive prevalence of SARS-CoV-2 was 6.6% (95% CI 2.0%–11.1%) and ELISA-positive prevalence was 2.2% (95% CI 0.5%–3.9%).

Conclusions: SARS-CoV-2 prevalence among HCWs was similar to a population-based estimate (10.6%) during a period of community transmission in Zambia. Public health measures such as establishing COVID-19 treatment centers before the first cases, screening for COVID-19 symptoms among patients accessing health facilities, infection prevention and control trainings, and targeted distribution of personal protective equipment based on exposure risk might have prevented increased SARS-CoV-2 transmission among Zambian HCWs.

Introduction

As with other respiratory viruses, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19) is transmitted primarily through respiratory droplets from symptomatic and asymptomatic persons infected with the virus (1). Given the possibility of transmission of SARS-CoV-2 regardless of presence of symptoms, healthcare workers (HCWs) can be at elevated risk of acquiring the virus due to their role in patient care and treatment (2). Use of personal protective equipment (PPE) such as face masks and face shields, and other public health measures such as triage of patients accessing health facilities and immediate isolation of those with COVID-19 symptoms can limit the spread of COVID-19 among HCWs (3). However, shortages of PPE were commonplace in the early response to the SARS-CoV-2 outbreak in many countries, potentially placing healthcare workers at higher risk of infection with SARS-CoV-2 (4–6). Shortages of PPE have been particularly pronounced in resource-limited settings where PPE are generally imported. Determining the extent of spread and the prevalence of the virus among HCWs can be challenging in resource-limited settings because testing capacity is limited and many people with SARS-CoV-2 infection are asymptomatic or have only mild symptoms (1,7–10).

Some of the available data indicate that seroprevalence of SARS-CoV-2 among HCWs in resource-rich countries is dependent on the type of work performed and can range from lower to higher prevalence compared with what is observed among the general public (2,11–17). For instance, in the U.S., nurses had the highest risk of SARS-CoV-2 infection among HCWs (2). However, there are limited data about the prevalence of SARS-CoV-2 among HCWs in Africa where there have been severe shortages of PPE, testing for SARS-CoV-2 continues to be limited, and there tend to be shortages of HCWs in general (5,18). Small studies from Malawi and Nigeria found SARS-CoV-2 seroprevalence of 12.3%–45.1% among HCWs in urban settings (19–21), whereas, in Togo, there was a low prevalence of SARS-CoV-2 (1.6%) among high-risk populations including HCWs (22).

Zambia reported the first cases of COVID-19 in March 2020. By the end of July, over 13,000 Zambians were diagnosed with SARS-CoV-2, with most cases reported during July (Supplemental Figure). Like other countries in the region, Zambia relies on imported PPE, and the Ministry of Health (MOH) realized that supply chain disruptions could diminish COVID-19 control and prevention efforts among HCWs. To reduce transmission of SARS-CoV-2 in healthcare settings, Zambian MOH implemented mitigation measures aimed at limiting introduction and spread of SARS-CoV-2 in health facilities. Before the first confirmed COVID-19 cases, Zambia established COVID-19 isolation and treatment

facilities with the capacity to cohort patients with confirmed SARS-CoV-2 infection. At COVID-19 isolation and treatment facilities, clinicians trained in caring for COVID-19 patients worked for set periods of times (i.e., one month) after which they would quarantine for 14 days. In April, MOH introduced measures that required HFs to establish COVID-19 mitigation procedures including screening patients for symptoms of COVID-19 before patients could enter HFs (23); patients who screened positive for any COVID-19 symptoms were immediately isolated, given cloth masks, and were prioritized for COVID-19 testing. In addition, MOH officials conducted multiple infection prevention and control (IPC) trainings for HCWs using virtual platforms and distributed available PPE to HCWs based on risk of exposure to SARS-CoV-2. For example, HCWs who were directly managing COVID-19 patients were prioritized to receive face masks, goggles or face shields, gloves, and gowns. Moreover, MOH modified criteria for COVID-19 testing eligibility to include HCWs who managed COVID-19 patients, were exposed to patients with COVID-19, or worked in facilities with COVID-19 patients irrespective of symptoms (23). Additionally, health facilities increased outdoor waiting areas (given Zambia's favorable climate), and restricted visitors for inpatients. Furthermore, the Government of the Republic of Zambia introduced strict measures to limit the spread of SARS-CoV-2 in the community, including closing schools, bars and taverns, restaurants, and movie theatres; restricting large gatherings; prompt isolation of anyone who tested positive for SARS-CoV-2 and immediate contact tracing; mandated mask wearing or face covering in public; and mandatory quarantine of all travelers to Zambia for 14 days or pending a negative PCR-based test result.

SARS-CoV-2 prevalence was 10.6% during a cross-sectional, cluster sample, household survey conducted in six districts Zambia during July 2020, which was during the first wave in the country (Supplemental Figure) (24). With widespread community transmission of SARS-CoV-2 in July 2020, many HCWs were also diagnosed with COVID-19. However, the extent of spread of SARS-CoV-2 among HCWs in Zambia and the risk factors for acquisition of the virus remained unclear. We assessed the prevalence of SARS-CoV-2 infection among Zambian HCWs in selected districts with known widespread community transmission.

Methods

Study Design. A cross-sectional survey of SARS-CoV-2 prevalence among HCWs was conducted during July 2–31, 2020, at 20 health facilities in six districts across Zambia. The districts were purposefully selected based on high rates of confirmed COVID-19 cases, mixture of urban and rural setting, and being travel corridors to and from the neighboring countries. As of June 2020, these six

districts accounted for more than 90% of confirmed COVID-19 cases in Zambia and are home to one-quarter of the 18 million people in Zambia. The districts have a total of 2,056 health facilities (HFs) and 25,865 professional HCWs (e.g., doctors, nurses, etc.) (.[*]

Based on available resources, a total of 20 HFs were selected from the six districts (Supplemental Table). The proportion of HFs in each district out of the total HFs in the six districts were calculated and a proportional number of HFs from each district were selected for inclusion. Facilities were then purposefully selected to represent the different types of HFs in Zambia (hospitals and urban or rural health centers). Three of 20 selected facilities were also COVID-19 treatment centers. All but one HF were in areas designated as urban. A convenience sample of HCWs at the selected HFs who were present during the survey dates were recruited with the goal of reaching 600 participants. For smaller HFs (e.g., health centers), all HCWs were included; for larger HFs (e.g., hospitals), 50 HCWs were invited to participate. This HCW survey was conducted simultaneously to a population-based household survey in the same districts (24). The study was approved by the Zambia National Health Research Authority and the University of Zambia Biomedical Research Ethics Committee. The activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[†] The study methods were aligned with those of

the WHO Unity Studies (25).

Variables. Participants were administered a standardized questionnaire by trained personnel that included information about demographics, past medical history, contact with a person with confirmed COVID-19, and history of recent illness on a tablet using REDCap (Research Electronic Data Capture, Nashville, Tennessee) hosted at the Zambia Ministry of Health. SARS-CoV-2 exposures included known contact with a laboratory-confirmed case, travel (domestic or international), typical means of transportation, past month health facility utilization, in-person attendance to work or school, and the number of visits to markets/grocery stores. Recent illness was assessed by asking if the participant had experienced any illnesses since February 2020 (before the first reported case in Zambia); if they responded affirmatively, symptomology was ascertained. HCWs were categorized as medical doctors, mid-level providers (clinical officers, nurse practitioners), nurses (registered/enrolled nurses and midwives), allied health (including physical therapists, nutritionists, psychosocial counselors, laboratory

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[*] Estimates that included all types of HCWs (as were included in this study) were not available.
[†] See e.g., 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.

technicians/workers, and pharmacists) and non-clinical staff (including clerks, cashiers, laundry staff, porters, drivers, and security).

Sample collection. Nasopharyngeal swabs (one per participant) were collected into a cryovial with viral transport medium for detection of SARS-CoV-2 Ribonucleic acid (RNA) using real-time reverse transcription polymerase chain reaction (PCR). Blood samples were collected by finger prick using the BD microtainer EDTA cryovial tube system for detection of SARS-CoV-2 antibodies using enzyme-linked immunosorbent assay (ELISA). The cryovial tubes were placed in vaccine-carrier type transport boxes with minus 20℃ frozen gel packs and all samples were transported to a district laboratory within 24 hours. Microtainers containing blood samples were centrifuged to separate plasma which was transferred into a separate cryovial. All samples were stored at or below minus 20℃ pending testing in Lusaka. Participants could participate in the survey, PCR testing, and/or serologic testing. Positive PCR results were communicated to district teams for notification and participant notification, case investigation, and contact tracing as per standard practice in Zambia. Negative PCR and all ELISA results were notified to participants by study staff.

Laboratory testing. RNA extraction for PCR was performed using the Qiagen Viral Mini procedure according to manufacturer's instructions. The Maccura COVID-19 PCR assay (Maccura Biotechnology, Chengdu, China) was used as the primary diagnostic on nasopharyngeal samples on the Quantstudio 3 platform (ThermoFisher, Waltham, Massachusetts) (Maccura percent positive agreement 100% and negative percent agreement 96.7%) (26). For antibody testing, the plasma specimens were tested using the Euroimmun ELISA for anti-Spike IgG (PerkinElmer, Waltham, Massachusetts) in single replicate according to manufacturer's instructions on blood samples (sensitivity of 90% and specificity of 100%) (27).

Data analysis: Demographic and clinical data were reported for all participants. SARS-CoV-2 prevalence and 95% confidence intervals (CIs) were calculated as the number of positive results divided by the total number of tests (for a given test modality), adjusting confidence intervals for clustering by health facility. PCR and ELISA prevalence estimates were reported separately. Additionally, a combined measure for any SARS-CoV-2 infection was reported for the subset of participants who had both PCR and ELISA tests performed to assess overall SARS-CoV-2 prevalence, with a positive result for either PCR or ELISA test considered positive for SARS-CoV-2 infection and a negative PCR and ELISA test considered negative. The combined measure reflects the estimated prevalence of persons who had a past or current SARS-CoV-2 infection. Logistic regression was performed on the combined

measure to assess for factors associated with SARS-CoV-2 prevalence. Analyses were performed using SAS v9.4 (Cary, North Carolina).

Results

A total 663 HCWs were approached for the study and 660 (99.5%) agreed to participate. Of the participants, 450 (68.2%) provided a nasopharyngeal swab for PCR and 575 (87.1%) provided a blood specimen for ELISA (383 [58.0%] provided both nasopharyngeal and blood specimens). Sixty-six percent of participants were females and the median age was 31.5 years (interquartile range 26.2–39.8 years) (Table 1). Most (84.4%) HCWs had post-secondary education, and 55.6% were direct patient care providers (doctors, mid-levels, and nurses), while the rest played supportive roles.

The prevalence of PCR-positive infection of SARS-CoV-2 was 6.6% (95% CI 2.0%−11.1%) and the prevalence of ELISA-positive infection was 2.2% (95% CI 0.5%−3.9%) (Table 2). The prevalence of the combined measure was 9.3% (95% CI 3.8%−14.7%).[‡] Allied health workers and non-clinical staff had higher combined prevalence of SARS-CoV-2 (15.2% [95% CI 6.7%−23.7%] and 18.5% [95% CI 2.2%−34.7%], respectively) than nurses (2.8% [95% CI 0.0%−6.0%]) (Table 3).

There were no differences in the prevalence by sex, age group, presence of a medical comorbid condition, known contact with a COVID-19 case, travel, or typical means of transportation (Table 3). Compared with no attendance, reporting in-person attendance at work or school in the past month was associated with testing positive for SARS-CoV-2 (OR 4.8 [95% CI 1.6–14.0]). More frequent market visits (3–5 vs 1–2) was also associated with higher odds of SARS-CoV-2 (OR 3.0 [95% CI 1.3–7.0]).

Additionally, the SARS-CoV-2 prevalence varied by district such that HCWs in Livingstone District (32.7% [95% CI 21.9%−43.4%]) and Nakonde District (17.2% [95% CI 10.7%−23.7%]) had higher odds of infection than HCWs in referent Lusaka District (5.1% [95% CI 2.0%−8.7%]) (Table 2). Upon further investigation, the PCR-positive prevalence in Livingstone District health facilities (28.3% [95% CI 25.3%−31.3%]) was higher compared with Lusaka District (3.4% [95% CI 0.1%−6.7%])), whereas the ELISA prevalence (12.5% [95% CI 8.7%−16.3%]) in Nakonde District health facilities was higher compared with Lusaka District (2.0% [95% CI 0.0%−4.0%]).

[‡] The combined measure was reported for the subset of participants who had both PCR and ELISA test performed.

Discussion

During the month of July when confirmed cases of COVID-19 were rapidly increasing in Zambia, the overall prevalence of SARS-CoV-2 among Zambian HCWs was similar to what was being observed among the general Zambian public (24). The PCR prevalence was high in both populations, which was compatible with observed community-wide transmission during the study period. The similarity between the SARS-CoV-2 prevalence among HCWs and the general population was rather unexpected given HCWs are believed to be at higher risk of SARS-CoV-2 infections because of potential nosocomial exposures in HFs (28). Yet, a study of HCWs in the U.S. found equivalent and even lower seroprevalence estimates than comparable cumulative incidence estimated in some geographic areas, which could have results from greater access to PPE by HCWs early in the outbreak (2).

The finding of similar SARS-CoV-2 prevalence among HCWs as the general population might be attributed to measures that were implemented by MOH in healthcare settings, which might have resulted in reduced exposure to SARS-CoV-2 and ultimately fewer nosocomial infections among HCWs. Reports from Germany and China indicate that strict adherence to the use of PPE and other COVID-19 public health mitigation measures similar to ones implemented by MOH have resulted in keeping infection rates low among HCWs (3,8). Additionally, despite high percent positivity during the first epidemic peak in Zambia, health facilities were strained but never overwhelmed by persons with COVID-like symptoms. Thus, the actual exposure to SARS-CoV-2 at Zambian health facilities could have been lower than in some other countries. Finally, because hospitalizations lag confirmed cases, the study—which was conducted during the upslope of the first wave in Zambia—could have missed the period during which increased health care exposure occurred in Zambia, and subsequent prevalence studies among HCWs might show different findings. The first wave began to subside in late August 2020 and few cases were reported from mid-September to mid-December. However, beginning in mid-December 2020 cases began to climb again and, at the time of writing, Zambia is experiencing a second wave of COVID-19 that coincided with the detection of the B.1.351 variant in a majority of specimens (29).

SARS-CoV-2 prevalence was higher among allied health and non-clinical staff compared with nurses who provided direct patient care. This is in contrast to a study from Nigeria where there was no prevalence difference by HCW occupation, and another study from Scotland where patient-facing providers had elevated risk (19,30). It is possible that these non-clinical HCWs were less familiar with SARS-CoV-2 IPC best practices, as they were not included in the IPC trainings that were conducted by

MOH. Moreover, non-clinical staff who were perceived to be lower risk than patient-facing providers, might not have been prioritized to receive PPE even though many of them might have come into contact with COVID-19 patients within their HFs. Furthermore, the pattern of SARS-CoV-2 prevalence among different types of HCW in this study could indicate SARS-CoV-2 infections were occurring outside HFs given widespread community transmission in July in Zambia. Thus, both nosocomial and community SARS-CoV-2 transmission were likely both occurring among HCWs in Zambia in July. Providing IPC trainings, optimizing engineering and administrative controls, and ensuring adequate access to PPE for all HCWs—including those without direct clinical roles—can reduce the risk of nosocomial SARS-CoV-2 transmission (3,8). Furthermore, universal masking in health facilities is another strategy that can substantially reduce risk of nosocomial transmission (31).

HCWs in Livingstone District had higher PCR-positive prevalence than HCWs in other districts and, similarly, HCWs in Nakonde District had higher ELISA-positive prevalence than other HCWs in other districts. Moreover, the prevalence estimates in these districts were higher than in the general population (11.2% in Livingstone and 7.0% in Nakonde Districts) (24). This difference is suggestive of nosocomial outbreaks among HCWs in these districts—potentially ongoing at the time of the study in Livingstone District. In Nakonde District, a large outbreak was reported in early May 2020 (32), which could explain the higher ELISA-positive prevalence there.

There are several limitations to our study. The HFs included in our survey were purposefully selected and might not be representative of the HFs in Zambia. HFs were largely located in urban areas, and our findings do not reflect SARS-CoV-2 prevalence among rural HCWs; of note, persons residing in rural areas had lower SARS-CoV-2 prevalence in a population-based study in Zambia in July 2020 (24). Additionally, HCWs were conveniently sampled. Participants voluntarily participated in each aspect of the study (i.e., interview and nasopharyngeal and blood specimen collection), and the response rate for participants who had both PCR and ELISA tests was low (58% of all participants), which could have led to both less precise and biased estimates; therefore, PCR and ELISA prevalence estimates were also reported separately. Furthermore, the small sample size could have affected the ability to detect significant differences among age groups and other risk factors. The prevalence estimate for the combined measure was greater than the sum of the PCR and ELISA estimates, which was a result of how these estimates were calculated (i.e., the denominator was the number of participants who had data for the given measure). Next, we used Euroimmun ELISA for antibody testing, which is reported to have a sensitivity of about 90% (27). This would suggest an underestimation of previous infections in

our survey, which may be further compounded other factors like Ig isotype, waning levels, cross-reactivity, and other factors (33,34). Lack of access to antibody tests with higher sensitivity continues to be a challenge but future surveys might be able to use improved assays with higher sensitivity.

Despite the rapid increase in confirmed COVID-19 cases in Zambia in July, the SARS-CoV-2 prevalence among Zambia HCWs remained comparable with SARS-CoV-2 prevalence in the general public. Public health measures in health facilities might have prevented increased transmission of SARS-CoV-2 among Zambian HCWs. Continued vigilance and redoubling of efforts, including training non-patient-facing HCWs in IPC practices and ensuring adequate supply (and adherence) to PPE for all types of HCWs, might help to prevent SARS-CoV-2 infections among HCWs in Zambia.

Notes:

Conflicts of Interest: The authors declare no conflicts of interest with respect to this study

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Table 1: Demographic characteristics of health care workers from six districts—Zambia, July 2020 (N = 660)

Variable	Options	No. (%)	95% CI
Sex	Male	222 (33.6)	28.7%–38.6%
	Female	438 (66.4)	61.4%–71.3%
Age	10–19 years	3 (0.5)	0.0%–1.2%
	20–29 years	263 (40.0)	32.7%–47.3%
	30–39 years	220 (33.4)	29.2%–37.7%
	40–49 years	95 (14.4)	10.3%–18.6%
	50–59 years	58 (8.8)	6.1%–11.5%
	60–69 years	13 (2.0)	0.7%–3.2%
	≥70 years	6 (0.9)	0.2%–1.6%
District	Kabwe	84 (12.7)	0.0%–28.4%
	Livingstone	90 (13.6)	0.0%–29.7%
	Lusaka	281 (42.6)	16.3%–68.9%
	Nakonde	40 (6.1)	0.0%–15.6%
	Ndola	86 (13.0)	0.0%–28.9%
	Solwezi	79 (12.0)	0.0%–26.5%
Educational attainment	None	1 (0.2)	0.0%–0.5%
	Primary	14 (2.1)	1.0%–3.3%
	Secondary	87 (13.3)	9.3%–17.3%
	Higher	553 (84.4)	80.3%–88.5%
Health worker type	Medical doctor	59 (9.0)	3.3%–14.6%
	Mid-level provider	114 (17.3)	11.7%–23.0%
	Nurse	193 (29.3)	23.3%–35.4%
	Allied health	167 (25.4)	17.8%–33.0%
	Non-clinical staff	125 (19.0)	15.1%–22.9%
Health facility type	Hospital	401 (60.8)	36.9%–84.6%
	Health centre	259 (39.2)	15.4%–63.1%
Past medical history	Any history of a comorbid medical condition	161 (24.4)	19.3%–29.5%
	Diabetes	11 (1.7)	0.5%–2.9%
	Cardiac disease	5 (0.8)	0.1%–1.4%
	Hypertension	71 (10.8)	8.2%–13.4%
	Asthma	36 (5.5)	3.2%–7.7%
	Emphysema/COPD	0 (0.0)	0.0%–0.0%
	Chronic kidney disease	2 (0.3)	0.0%–0.7%

Cirrhosis or fatty liver	1 (0.2)	0.0%–0.5%
Immunocompromised	11 (1.7)	0.2%–3.2%
Cancer	0 (0.0)	0.0%–0.0%
Pregnant*	24 (6.4)	4.0%–8.9%
HIV	42 (6.4)	3.4%–9.4%
Tuberculosis	6 (0.9)	0.0%–2.5%
Malaria	12 (1.8)	0.0%–3.7%
Other chronic medical condition	29 (4.6)	2.1%–7.2%
Don't know if comorbid medical condition	108 (16.4)	2.0%–30.8%

* Analysis of pregnancy status restricted to women aged 15-49 years
CI: confidence interval; COPD: chronic obstructive pulmonary disease

Table 2. SARS-CoV-2 prevalence by district and test type among health care workers in six districts — Zambia, July 2020

District	Combination measure* (n = 383)		PCR (n = 450)		ELISA (n = 575)	
	% (95% CI)	Crude OR (95% CI)	% (95% CI)	Crude OR (95% CI)	% (95% CI)	Crude OR (95% CI)
Kabwe	5.1 (1.4 – 8.8)	0.9 (0.3–2.6)	3.1 (0.0 – 6.9)	0.9 (0.2 – 4.7)	1.3 (0.0 – 3.8)	0.6 (0.1 – 6.3)
Livingstone	32.7 (21.9–43.4)	8.6 (3.7–19.7)	28.3 (25.3–31.3)	11.2 (4.0 – 31.5)	1.3 (0.0–3.8)	0.6 (0.1 – 5.6)
Lusaka	5.4 (2.0–8.7)	Referent	3.4 (0.1–6.7)	Referent	2.0 (0.0 – 4.0)2.0 (0.0–4.0)	Referent
Nakonde	17.2 (10.7–23.7)	3.7 (1.6–8.3)	3.3 (0.0–10.4)	1.0 (0.1 – 11.2)	12.5 (8.7–16.3)	6.9 (2.4 – 20.2)
Ndola	3.0 (0.0 – 6.4)	0.5 (0.1–2.1)	2.9 (0.5 – 5.3)	0.8 (0.2 – 3.2)	1.1 (0.0 – 2.7)	0.5 (0.1 – 3.4)
Solwezi	3.4 (0.0–8.7)	0.6 (0.1–3.6)	2.8 (0.0–6.2)	0.8 (0.2 – 4.1)	0.0 (0.0–0.0)	Not calculated
Pooled	9.3 (3.8–14.7)	Not calculated	6.6 (2.0–11.1)	Not calculated	2.2 (0.5–3.9)	Not calculated

* Refers to the subset of participants who had both PCR and ELISA tests performed

SARS-CoV-2 prevalence and 95% CIs were calculated as the proportion of positive results divided by the total number of tests (for a given test modality), adjusting confidence intervals for clustering by health facility. Participants with facility information missing (PCR=8; ELISA=21; combined measure=6) were excluded from the calculations. The sum of the PCR and ELISA prevalence estimates does not equal the combined measure prevalence estimate because each estimate was independently derived from the subset of study participants who had data for a given modality.

CI: confidence interval; OR = odds ratio; ELISA: enzyme-linked immunosorbent assay; PCR: real-time polymerase chain reaction

Table 3. Basic demographic and clinical characteristics and risk factors for SARS-CoV-2 by SARS-CoV-2 testing status (combined measure*) among health care works in six districts — Zambia, July 2020 (N=383[†])

		Positive		Negative		OR (95% CI)
		n (%)	95% CI	n (%)	95% CI	
Sex	Male	15 (12.1)	4.2 – 20.0	109 (87.9)	80.0 – 95.8	Referent
	Female	19 (7.9)	3.1 – 12.6	223 (92.2)	87.4 – 96.9	0.6 (0.3 – 1.1)
Age	10-19	0 (0.0)	0.0 – 0.0	3 (100.0)	100.0 – 100.0	Not calculated
	20-29	15 (11.4)	3.2 – 19.5	117 (88.6)	80.5 – 96.8	Referent
	30-39	9 (7.1)	0.0 – 14.5	118 (92.9)	85.5 – 100.0	0.6 (0.2 – 2.3)
	40-49	8 (13.6)	2.6 – 24.5	51 (86.4)	75.5 – 97.4	1.2 (0.5 – 3.0)
	50-59	2 (5.4)	0.0 – 13.3	35 (94.6)	86.7 – 100.0	0.4 (0.1 – 2.6)
	60-69	0 (0.0)	0.0 – 0.0	3 (100.0)	100.0 – 100.0	Not calculated
	≥70	0 (0.0)	0.0 – 0.0	5 (100.0)	100.0 – 100.0	Not calculated
District	Kabwe	3 (5.1)	1.4 – 8.8	56 (94.9)	91.2 – 98.6	0.9 (0.3 – 2.6)
	Livingstone	17 (32.7)	22.0 – 43.4	35 (67.3)	56.6 – 78.1	8.6 (3.7 – 19.7)
	Lusaka	6 (5.4)	2.0 – 8.7	106 (94.6)	91.3 – 98.0	Referent
	Nakonde	5 (17.2)	10.7 – 23.7	24 (82.8)	76.3 – 89.3	3.7 (1.6 – 8.3)
	Ndola	2 (3.0)	0.0 – 6.4	65 (97.0)	93.6 – 100.0	0.5 (0.1 – 2.1)
	Solwezi	2 (3.4)	0.0 – 8.7	56 (96.6)	91.3 – 100.0	0.6 (0.1 – 3.6)
Health worker type	Medical doctor	1 (2.9)	0.0 – 9.5	33 (97.1)	90.5 – 100.0	1.0 (0.1 – 12.9)
	Mid-level provider	4 (6.0)	0.4 – 11.5	63 (94.0)	88.5 – 99.6	2.2 (0.4 – 11.0)
	Nurse	3 (2.8)	0.0 – 6.0	103 (97.2)	94.0 – 100.0	Referent
	Allied health	14 (15.2)	6.7 – 23.7	78 (84.8)	76.3 – 93.3	6.2 (1.7 – 22.4)
	Non-clinical staff	12 (18.5)	2.2 – 34.7	53 (81.5)	65.3 – 97.8	7.8 (1.7 – 34.9)
Health facility type	Hospital	17 (9.1)	0.3 – 17.8	170 (90.9)	82.2 – 99.7	Referent
	Health centre	17 (9.5)	3.8 – 15.2	162 (90.5)	84.8 – 96.2	1.0 (0.3 – 3.5)
Any comorbid condition[‡]	No	26 (8.8)	3.2 – 14.4	269 (91.2)	85.6 – 96.8	Referent
	Yes	9 (11.0)	2.3 – 19.7	73 (89.0)	80.3 – 97.7	1.3 (0.5 – 3.0)
Hypertension	Negative	30 (9.3)	3.1 – 15.5	293 (90.7)	84.5 – 96.9	Referent

	Positive	4 (9.3)	0.0 – 20.8	39 (90.7)	79.2 – 100.0	1.0 (0.2 – 5.2)
Pregnant	No	16 (8.3)	3.3 – 13.3	176 (91.7)	86.7 – 96.7	Referent
	Yes	2 (15.4)	0.0 – 37.8	11 (84.6)	62.2 – 100.0	2.0 (0.4 – 10.6)
HIV	Negative	29 (8.5)	3.9 – 13.1	313 (91.5)	86.9 – 96.2	Referent
	Positive	3 (16.7)	0.0 – 36.4	15 (83.3)	63.7 – 100.0	2.2 (0.7 – 7.0)
	Don't know	2 (33.3)	4.1 – 62.6	4 (66.7)	37.4 – 95.9	5.4 (1.6 – 18.0)
Contact with a person with a confirmed case of COVID-19	No	22 (8.4)	3.1 – 13.7	240 (91.6)	86.3 – 96.9	Referent
	Yes	6 (12.8)	3.8 – 21.8	41 (87.2)	78.2 – 96.2	1.6 (0.6 – 4.2)
	Don't know	6 (10.5)	0.0 – 22.0	51 (89.5)	78.1 – 100.0	1.3 (0.5 – 3.3)
Provided direct patient care	No	16 (9.4)	2.9 – 15.8	155 (90.6)	84.2 – 97.1	Referent
	Yes	9 (8.4)	0.5 – 16.4	98 (91.6)	83.6 – 99.6	0.9 (0.3 – 2.5)
	Don't know	3 (23.1)	0.0 – 46.2	10 (76.9)	53.8 – 100.0	2.9 (0.5 – 16.3)
Provided care to a patient with confirmed COVID-19	No	22 (8.8)	2.6 – 15.0	228 (91.2)	85.0 – 97.4	Referent
	Yes	3 (12.5)	0.0 – 26.9	21 (87.5)	73.1 – 100.0	1.5 (0.3 – 6.3)
	Don't know	3 (18.8)	2.1 – 35.4	13 (81.3)	64.6 – 97.9	2.4 (0.5 – 11.3)
Travel	None	19 (7.5)	2.2 – 12.8	234 (92.5)	87.2 – 97.8	Referent
	International	0 (0.0)	0.0 – 0.0	2 (100.0)	100.0 – 100.0	Not calculated
	Domestic	14 (13.3)	5.1 – 21.6	91 (86.7)	78.4 – 94.9	1.9 (0.9 – 3.8)
Visited a health facility in the past month	No	20 (11.6)	2.0 – 21.3	152 (88.4)	78.7 – 98.1	Referent
	Yes	13 (6.9)	2.5 – 11.3	176 (93.1)	88.8 – 97.5	0.6 (0.2 – 1.7)
In-person attendance to work or school in the past month	No	4 (2.9)	0.4 – 5.4	133 (97.1)	94.6 – 99.6	Referent
	Yes	28 (12.6)	4.8 – 20.3	195 (87.4)	79.7 – 95.2	4.8 (1.6 – 13.9)
Number of visits to the market/grocer in the past month	0	0 (0.0)	0.0 – 0.0	10 (100.0)	100.0 – 100.0	Not calculated
	1-2	4 (5.1)	0.0 – 10.6	75 (94.9)	89.5 – 100.0	Referent
	3-5	16 (13.9)	6.1 – 21.7	99 (86.1)	78.3 – 93.9	3.0 (1.3 – 7.0)
	5-10	7 (13.0)	0.0 – 26.6	47 (87.0)	73.5 – 100.0	2.8 (0.6 – 12.4)
	≥10	7 (7.4)	2.3 – 12.5	88 (92.6)	87.5 – 97.7	1.5 (0.5 – 4.1)
Usual means of transportation	Car	7 (6.9)	0.0 – 13.9	94 (93.1)	86.1 – 100.0	Referent
	Taxi	8 (13.1)	0.7 – 25.5	53 (86.9)	74.5 – 99.3	2.0 (0.5 – 8.1)

	Bike	3 (27.3)	0.0 – 55.5	8 (72.7)	44.6 – 100.0	5.0 (0.7 – 34.8)
	Minibus	8 (7.2)	2.7 – 11.7	103 (92.8)	88.3 – 97.3	1.0 (0.4 – 2.9)
	Walking	8 (10.1)	1.8 – 18.5	71 (89.9)	81.6 – 98.2	1.5 (0.7 – 3.4)

* Refers to the subset of participants who had both PCR and ELISA tests performed

† Total sample size of participants who provided specimen for PCR and ELISA tests was 383, of whom 35 were SARS-CoV-2 positive according to the combined measure. Data were missing for participants for variables where the sum of the frequency shown is <35 participants.

‡ Co-existing medical conditions with reported prevalence of ≥6.0% are disaggregated in table.

SARS-CoV-2 prevalence and 95% CIs were calculated as the proportion of positive results divided by the total number of tests (for a given test modality), adjusting confidence intervals for clustering by health facility

CI: confidence interval; OR: odds ratio