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BRIEF REPORT

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Seroprevalence and Risk Factors Among Oligo/Asymptomatic Healthcare Workers: Estimating the Impact of Community Transmission

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We evaluated the seroprevalence of SARS-CoV-2 and risk factors among 4987 oligo/asymptomatic healthcare workers; seroprevalence was 14% and factors associated with SARS-CoV-2 infection were lower educational level (aOR, 1.93; 95% CI, 1.03–3.60), using public transport to work (aOR, 1.65; 95% CI, 1.07–2.62), and working in cleaning or security (aOR, 2.05; 95% CI, 1.04–4.03).

Keywords. SARS-CoV-2; seroprevalence; oligo/asymptomatic; health workers; community transmission.

The coronavirus disease 2019 (COVID-19) pandemic has become an increasing challenge for the Brazilian healthcare system, with over 100 000 deaths reported due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by 11 August 2020 [1, 2]. Healthcare workers (HCWs) providing frontline care for patients with COVID-19 are a highly vulnerable group for SARS-CoV-2 infection compared with the general population [3]. Outbreaks of COVID-19 have been described among HCWs in Asia, Europe, and the United States [3], suggesting that transmission of SARS-CoV-2 occurs in the hospital setting, aggravated by shortages of personal protective equipment (PPE). Few studies have evaluated SARS-CoV-2 seroprevalence and risk factors in HCWs [4, 5].

Hospital das Clínicas (HC) is the largest hospital in Latin America, situated in the center of the Greater Metropolitan Region of São Paulo, a densely populated megacity, and the epicenter of COVID-19 in Brazil. The aim of this study was to evaluate the seroprevalence of SARS-CoV-2 and risk factors for oligo/asymptomatic COVID-19 among HCWs at HC, and to estimate the impact of community transmission.

METHODS

This was a cross-sectional study conducted between 14 and 28 May 2020 evaluating the presence of anti–SARS-CoV-2 immunoglobulin (Ig) G/IgM antibodies (rapid chromatographic immunoassay; Wondfo-China) in HCWs in the Central and the Outpatient Institutes of HC.

A voluntary questionnaire comprising 52 questions (https://www.pdf.investintech.com/preview-frames.php?id=WGMxUkVjRVMxVTZqTTBFZ25yOFhwbEY0SWZDNmlCbERtZE1xVGRSWkdlYzdkTk9xRmg4Q3ZRTDk5VVZRc3pKeTdtZW0xa09HQjA2QVQwaG96OWFWOWRHN2MyQy8xeEtvNHdHWWZjZEtCOU5ZVFlFTnNyK2Z1UzhFdFJ5Y2tVVnA=) using the Survey Monkey platform was offered. This evaluated demographics, educational level, professional category, transportation to work, housing, household contacts, comorbidities, smoking status, medications, influenza vaccination status, PPE use, known prior COVID-19 infection, and respiratory symptoms. Healthcare workers answered a question about the type of PPE that they frequently wear. This question was multiple choice and the HCWs had to select which items of PPE they used.

Setting

Hospital das Clínicas is a 2200-bed public teaching hospital, spread over 7 buildings. The Central Institute was designated to receive COVID-19 cases and comprises an emergency department, 300 intensive care units (ICUs), and 300 ward beds, with 6000 HCWs. Between 30 March and 6 July 3483 patients with COVID-19 were hospitalized in the Central Institute. The Outpatient Institute was considered to be COVID-19 free, with 1000 HCWs. During the pandemic, HCWs did not move between buildings. Hospital das Clínicas contracts third-party cleaning, security, and laundry services.

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Personal protective equipment was made available to all HCWs. Healthcare workers providing direct patient care wore N95 masks and scrubs during their entire shifts. When examining or touching patients they added disposable gloves and a gown. During aerosol-generating procedures, they added a gown, gloves, and a face shield. Healthcare workers used the same N95 respirator between patients. The cleaning staff wore N95 respirators during their entire shifts. As of 4 May, universal surgical masks were implemented for all workers. Healthcare workers were trained to don and doff PPE in face-to-face sessions and with videos and posters.

Any symptomatic HCWs were evaluated clinically, and nasopharyngeal swabs were collected for SARS-CoV-2 reverse transcription–polymerase chain reaction (RT-PCR) [6]. PCR-positive HCWs received 14 days of paid leave.

Definitions

Healthcare workers were defined as any employee working within the hospital, including auxiliary services. An HCW was considered to have had oligo/asymptomatic COVID-19 if serology positive without previously being tested with RT-PCR.

Data Analysis

Univariable associations between possible risk factors and serostatus were tested within a logistic regression framework. A multivariable logistic regression using backward selections included professional category, socioeconomic level, number of contacts in the household, and type of transportation used. Age, sex, and professional category were included a priori. Other variables were evaluated if $P < .05$ in the univariate analysis.

Zip codes were used to geolocate HCWs' residential addresses and assign their census tract of residence. The per capita income in each census tract was extracted from the 2010 national census (www.ibge.gov.br) [7], and we calculated the distance from home to HC.

We calculated the cumulative number of reported confirmed COVID-19 cases and severe acute respiratory syndrome (SARS) of unknown cause in each of the 517 zones of the Greater Metropolitan Region using information from the state epidemiologic surveillance unit [8]. We compared both the absolute and per capita number of cumulative cases in the residential zones of seropositive and seronegative HCWs.

RESULTS

Serology was performed in 5645 HCWs. Of these, 658 had previously been tested with RT-PCR and were excluded (Supplementary Figure 1). Among the remaining 4987 HCWs, 701 were positive (14.1%; 95% confidence interval [CI], 13.1–15.0%). Seroprevalence was similar between men and women and hospital unit. Healthcare workers aged 61 years and older had low seroprevalence (Supplementary Table 1).

A total of 2415 of 4987 HCWs (48%) answered the questionnaire. Seroprevalence among nonresponders was higher than for responders (16.6% vs 11.3%). The univariable analysis of factors associated with SARS-CoV-2 serology can be seen in Table 1. Healthcare workers with a higher educational level had lower seroprevalence. Healthcare workers using public transportation had higher seroprevalence than those commuting by car. The professional categories with the highest seroprevalence were cleaners and security workers. We found no association between serostatus and the use of any particular item of PPE, comorbidities, or medications (Table 1).

In the multivariable analysis, HCWs with the lowest formal education had an adjusted odds ratio (aOR) of 1.93 (95% CI, 1.03–3.60) compared with those with a postgraduate qualification. Cleaning/security staff had an aOR of 10.1 (95% CI, 3.40–26.9) compared with doctors. Healthcare workers commuting to work on public transport carried an aOR of 2.03 (95% CI, 1.04–4.03) compared with those commuting by car (Table 1).

Many symptoms were associated with a positive serology—in particular, fever, loss of smell, and loss of taste (Supplementary Table 2). Truly asymptomatic HCWs (ie, those denying experiencing any symptoms) accounted for 48% (106/221) of seropositive cases but had a lower seropositivity than those experiencing at least 1 symptom (7.1% vs 13.5%).

The home addresses of 2239 (93% of respondents) were geocoded. The number of HCWs living in each of the 517 zones is shown according to serostatus (Supplementary Figure 2). Most seropositive cases lived far from the hospital. The median (interquartile range [IQR]) distance from work among seropositive HCWs was 11.5 km (4.2–18.9 km) compared with 9.3 km (3.4–17.2 km) among seronegative HCWs ($P = .005$) (Supplementary Figure 2).

Seropositive HCWs tended to live in census tracts with lower average per capita income (median, R$966/month; IQR, R$533–R$1713) compared with seronegative HCWs (R$1060/month; IQR, R$671–R$2802; $P < .001$) (US$1.00 = R$5.43). The income distribution among seronegative HCWs was bimodal: there was a high-income peak among seronegative HCWs not seen among seropositive HCW (Supplementary Figure 2).

DISCUSSION

Seroprevalence among oligo/asymptomatic HCWs was 14%, higher than in Europe (1.6–10.7%) and Asia (0–2%) [4, 5]. Seroprevalence did not vary by clinical area: HCWs from the building entirely dedicated to COVID-19 had the same prevalence as in the Outpatient Institute, a low-exposure setting. In addition, ICU and emergency department workers had the same prevalence as in other hospital wards. Factors associated with being infected with SARS-CoV-2 were lower educational level, using public transport or walking/cycling to work, and working in cleaning or security. Furthermore, the seroprevalence of 14% is similar to that in a household serosurvey (12%) in São Paulo at the time of our study [8].

Table 1. Univariate and Multivariate Analysis of Factors Potentially Associated With SARS-CoV-2 Serostatus Among Healthcare Workers

Univariable associations	Seronegative (n = 2122), n (%)	Seropositive (n = 221), n (%)	OR (95% CI)	aOR (95% CI)
Educational level				
Postgraduate education	861 (92.8)	67 (7.2)	1.0	1.0
Higher education	995 (90.7)	102 (9.3)	1.32 (.96–1.82)	1.36 (.88–2.11)
High school or less	234 (83.3)	47 (16.7)	2.58 (1.72–3.84)	1.93 (1.03–3.60)
Type of transportation to hospital				
Car (own/taxi)	684 (94.6)	39 (5.4)	1.0	1.0
On foot/bicycle	254 (91.7)	23 (8.3)	1.59 (.92–2.69)	1.65 (1.07–2.62)
Public transport	1151 (88.3)	153 (11.7)	2.33 (1.64–3.40)	2.05 (1.04–4.03)
Motorcycle	25 (83.3)	5 (16.7)	3.51 (1.14–8.98)	2.31 (.60–7.11)
Type of housing				…
Apartment	1169 (91.8)	104 (8.2)	1.0	
House	946 (89.2)	115 (10.8)	1.37 (1.03–1.81)	
Number of contacts in the household				
1	310 (93.7)	21 (6.3)	1.0	1.0
2	649 (91.9)	57 (8.1)	1.30 (.78–2.22)	1.13 (.65–2.03)
3	509 (89.8)	58 (10.2)	1.68 (1.02–2.88)	1.52 (.86–2.76)
4+	634 (88.4)	83 (11.6)	1.93 (1.20–3.25)	1.50 (.86–2.70)
Number of bathrooms at the residence				…
1	958 (89.8)	109 (10.2)	1.0	
2	652 (90.2)	71 (9.8)	.96 (.70–1.31)	
3	284 (92.2)	24 (7.8)	.74 (.46–1.16)	
4+	196 (93.3)	14 (6.7)	.60 (.26–1.18)	
Sharing of face towels at home				…
Yes	991 (91.3)	95 (8.7)	1.0	
No	1081 (90.2)	118 (9.8)	.88 (.66–1.17)	
Professional category				
Doctors/medical students	614 (94.2)	38 (5.8)	1.0	1.0
Administrative job	103 (85.8)	17 (14.2)	2.67 (1.42–4.83)	2.45 (1.08–5.47)
Cleaning/security	24 (54.5)	20 (45.5)	13.5 (6.81–26.6)	10.1 (3.40–26.9)
Laboratory/radiology technician	64 (97.0)	2 (3.0)	.51 (.08–1.70)	.66 (.10–2.57)
Nurse	328 (88.6)	42 (11.4)	2.07 (1.31–3.28)	2.37 (1.22–4.70)
Nursing assistant	495 (89.5)	58 (10.5)	1.89 (1.24–2.92)	1.59 (0.81–3.19)
Other	243 (93.5)	17 (6.5)	1.13 (.61–2.01)	1.01 (.46–2.18)
Pharmacist/nutritionist/psychologist	103 (92.0)	9 (8.0)	1.41 (.63–2.88)	1.78 (.69–4.23)
Physiotherapist	142 (89.3)	17 (10.7)	1.93 (1.04–3.47)	2.18 (.96–4.80)
Use of tobacco				…
Never	1692 (90.6)	175 (9.4)	1.0	
Past	227 (90.4)	24 (9.6)	1.10 (.64–1.79)	
Current	158 (89.8)	18 (10.2)	1.02 (.64–1.57)	
Influenza vaccination	1912 (91.0)	188 (9.0)	.69 (.46–1.08)	…
Comorbidities				…
Heart disease	17 (94.4)	1 (5.6)	.56 (.03–2.76)	
Hypertension	178 (91.3)	17 (8.7)	.91 (.52–1.49)	
Diabetes	56 (94.9)	3 (5.1)	.51 (.12–1.39)	
Asthma	77 (93.9)	5 (6.1)	.62 (.214–1.39)	
COPD	19 (90.5)	2 (9.5)	1.01 (.16–3.51)	
Obesity	142 (90.7)	13 (9.3)	.87 (.46–1.51)	
Medications				…
ACE inhibitors	18 (90.0)	2 (10.0)	1.07 (.17–3.73)	
Angiotensin receptor blockers	10 (100)	0 (0.0)	NA	
Oral hypoglycemic agents	38(92.7)	3(7.3)	.76 (.18–2.11)	
Insulin	6 (85.7)	1 (14.3)	1.6 (.08–9.44)	
Nasal steroids	103 (90.5)	9 (9.5)	.832 (.39–1.58)	
Inhaled steroids	28 (100)	0 (0.0)	NA	
Oral steroid	14 (82.4)	3 (17.6)	2.07 (.48–6.41)	
IM steroid	5 (100)	0 (0.0)	NA	
Immunosuppression	3 (100)	0 (0.0)	NA	

Table 1. Continued

Univariable associations	Seronegative (n = 2122), n (%)	Seropositive (n = 221), n (%)	OR (95% CI)	aOR (95% CI)
Personal protective equipment				…
Surgical mask	1205 (91.6)	111 (8.4)	.77 (.58–1.01)	
Filter mask (N95, N99, R95, PFF2)	1636 (90.4)	173 (9.6)	1.07 (.77–1.51)	
Other type of mask	146 (88.5)	19 (11.5)	1.27 (.75–2.05)	
Gloves	1668 (90.6)	173 (9.4)	.98 (.71–1.39)	
Facial shield	1236 (90.2)	134 (9.8)	1.10 (.83–1.47)	
Eye protection	1434 (90.4)	153 (9.6)	1.08 (.80–1.46)	
Gown	1412 (90.2)	153 (9.8)	1.13 (.84–1.53)	
Cap	1396 (90.5)	146 (9.5)	1.01 (.76–1.36)	

Abbreviations: ACE, angiotensin-converting enzyme; aOR, adjusted odds ratio; CI, confidence interval; COPD, chronic obstructive pulmonary disease; IM, intramuscular; OR, odds ratio; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

Taken together, this suggests that HCWs may have acquired the infection predominantly in the community. Our findings are consistent with results from the Netherlands, where whole-genome sequencing of clinical samples from HCWs and patients suggested there were multiple introductions into the hospitals through community-acquired infections and local amplification [9].

We found that the distance from home to work, use of public transportation, and residing in poorer neighbourhoods were associated with infection. Brazil is a country with great social inequality, and São Paulo—a megacity with 12 252 023 inhabitants and a population density of 7 398.26 inhabitants/km^2 [7]—has severe urban mobility problems and inefficient public transportation. Data from the national census show that the low-income population can spend more than 2 hours commuting to work [7]. Public transportation during the peak hours is usually crowded, facilitating the transmission of respiratory viruses.

The number of people at home was not associated with seropositivity, suggesting that contagion may not have primarily occurred there. The number of inhabitants per household is a cultural aspect of Brazilian society and probably does not differ much between the HCWs [9]. Interestingly, working in cleaning/security carried an OR of 10.1 compared with doctors. These are outsourced third-party workers and with a lower income than other hospital workers and the lowest educational level. During this troubled period in which good information and fake news are spread equally, with mixed messages even at the government level, education may be crucial to understanding the measures necessary to avoid infection [10].

Healthcare workers who denied respiratory symptoms during the epidemic were more likely to be negative than those with respiratory symptoms. Symptoms presented by seropositive HCWs were those frequently described by patients with PCR-diagnosed COVID-19, such as fever, cough, and anosmia. Our findings suggest that, among HCWs, very slight symptoms may predict SARS-CoV-2 infection.

Our study has limitations. The questionnaire was not answered by all participants. We could not evaluate the usage of masks outside the workplace or social distancing.

In conclusion, our findings point to the possibility of an important role of community SARS-CoV-2 transmission among HCWs.

Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

Author Contributions. S. F. C., P. G. B., A. J. S. D., A. C. S., V. A. d. S., and A. S. L. contributed equally to this paper. Conceptualization: A. P. M. P., E. P. S. E., J. K., E. S. Formal analysis: L. B., P. G. B., R. P. Funding acquisition: E. S. D. O. B., A. J. P. Patient samples: L. G. N. d. S., A. A. B., M. C. P. B. F., F. M. S., M. A. J. M., L. Q., G. d. F. P. Laboratory: M. M. R., C. L. Questionnaire data: C. M. P., D. M. R. C., A. B. d. O., M. F. L. d. F., A. S. d. A. P., M. C. P. B. F., F. M. S., M. A. J. M., L. Q. Methodology: L. B., R. P., J. K., M. C. M.-C., I. O. M. d. S., E. S. Resources: M. B. d. M. P., E. S. D. O. B., A. J. P. Writing–original draft: L. B., E. S., S. F. C., A. S. L. Writing–review and editing: L. B., E. S., S. F. C., A. S. L. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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