IJID Regions 3 (2022) 150–156

Contents lists available at ScienceDirect

IJID Regions

journal homepage: www.elsevier.com/locate/ijregi

Prevalence of SARS-CoV-2 infection and SARS-CoV-2-specific antibody detection among healthcare workers and hospital staff of a university hospital in Colombia

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A R T I C L E I N F O

Keywords:
COVID-19
SARS-CoV-2
COVID-19 serological testing
health personnel
seroepidemiological studies

A B S T R A C T

Objective: The aim of this study was to determine current and previous SARS-COV-2 infection, and describe risk factors associated with seropositivity, among HCWs and hospital staff between June and October of 2020.
Methodology: Data from the day of enrollment for a prospective cohort study were analyzed to determine point prevalence and seroprevalence of SARS-CoV-2 infection in HCWs and hospital staff of a university hospital in Colombia. Respiratory samples were collected to perform RT-PCR tests, along with blood samples to measure SARS-CoV-2 IgM and IgG antibodies. Data on nosocomial and community risk factors for infection were also collected and analyzed.
Findings: 420 HCWs and hospital staff members were included. The seroprevalence at baseline was 23.2%, of which 10.7% had only IgM antibodies, 0.7% had IgG, and 11.7% had IgM and IgG. The prevalence of acute SARS-CoV-2 infection was 1.9%. Being a nurse assistant was significantly associated with seropositivity when compared with all other job duties (PR 2.39, 95% CI 1.27–3.65, $p = 0.01$).
Conclusions: Overall SARS-CoV-2 prevalence was 1.9% and seroprevalence was 23.15%. Nurse assistants, medical doctors or students, and laboratory workers had a higher possibility of being SARS-CoV-2 seropositive.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic started as a cluster of pneumonia cases in Wuhan, China, in December 2019 (Salata et al., 2019). A few weeks later, severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), the virus that causes COVID-19, was identified, and China shared the genetic sequence on January 12, 2020 (WHO 2021). In March 2020, the World Health Organization (WHO) declared a global pandemic, and within a year, there were more than 147 million cases reported and more than 3 million deaths due to COVID-19 across the world (Google-News 2021). In Colombia, the first COVID-19 case was reported in March 2020. Since then, three waves have occurred (Vista de COVID-19 en Colombia: un año después de confirmar su primer caso 2021; World Health Organization (WHO) 2021). Up to July 24, 2021, 24 186 accumulated cases of confirmed COVID-19 had been reported among healthcare workers (HCWs) in Bogotá, corresponding to 1.7% of all COVID-19 cases in the city (COVID-19 Trabajadores salud 2021).

Evidence suggests that HCWs have a higher risk of infection with SARS-CoV-2 due to their direct contact with patients (Grant et al., 2021). They also might have a higher risk of severe infection, because it is presumed that the risk of mortality is higher among those who acquire

Abbreviations: HCWs, Healthcare workers; COVID-19, Coronavirus disease 2019; WHO, World Health Organization; SARS-CoV-2, Severe acute respiratory syndrome coronavirus-2; ICU, Intensive-care unit; ER, Emergency room.

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https://doi.org/10.1016/j.ijregi.2022.03.013
Received 16 February 2022; Received in revised form 16 March 2022; Accepted 17 March 2022

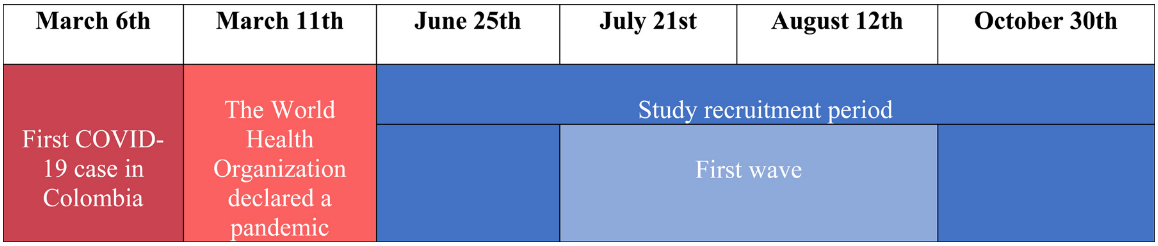

Figure 1. Study period in the setting of the COVID-19 pandemic, March–October 2020

the infection through nosocomial transmission than through community transmission (Wang et al., 2020). Multiple risk factors have been associated with COVID-19 infection among HCWs, including lack of personal protective equipment, workplace setting, profession, and increased exposure to the virus (Gholami et al., 2021). Epidemiological surveillance is fundamental to monitoring the pandemic and formulating immediate and long-term strategies to mitigate its burden. The screening of asymptomatic HCWs allows early detection of infection and aims to reduce the rate of transmission to patients and colleagues.

This study aimed to determine recent and previous SARS-COV-2 infection, and to describe the risk factors associated with SARS-CoV-2 infection, among active workers in a university hospital in Bogotá, Colombia, during the COVID-19 pandemic, between June and October of 2020. This time frame included the first wave of SARS-CoV-2 in the country, which occurred between July and August of 2020 (Figure 1).

Methods

Study setting

This study was conducted in a university hospital that provides highly complex, timely, and top-quality certified services to patients in Bogotá, Colombia with over 3000 employees. The hospital has specific COVID-19 emergency room, hospitalization, and intensive-care unit (ICU) beds, and is a referral hospital in the city for COVID-19 medical attention. Bogotá is the capital of Colombia, and has a population of 7 834 167 inhabitants. The city is divided into 20 localities, one of which is Usaquén, where the university hospital is located, and where the first case of COVID-19 in Colombia was detected.

Study design

A prospective cohort study was conducted as part of the CoVIDA project (Ruiz-Gómez and Carrasquilla-Barrera, 2021), an initiative for active epidemiological surveillance in Bogotá, Colombia (Amendola et al., 2020; Varela et al., 2021). Our study proposed a testing scheme for respiratory and blood sampling according to the RT-PCR results of participants at baseline (Supplementary Figure S2)

All active workers regardless of their risk of SARS-CoV-2 exposure were invited to voluntarily participate, via institutional email, in a 6-month study to assess the impact of SARS-CoV-2 infection in the hospital. Only data from the day of enrollment of each participant were analyzed to determine point prevalence and seroprevalence of SARS-CoV-2 infection. Individuals who wished to participate and met the eligibility criteria were assigned an appointment to join the study. The inclusion criteria included: 1) women and men older than 18 years; and 2) active hospital workers. Participants with contraindications for collecting nasopharyngeal and blood samples were excluded.

Participants were recruited between June 25 and October 30, 2020 (Figure 1). On the first visit, informed consent was obtained, followed by a medical evaluation, with weight, height, and vital signs recorded for all participants. Next, a risk factor questionnaire for nosocomial and community SARS-CoV-2 transmission was applied; this was created according to the recommended standard approach, based on the World Health Organization's 'Survey tool and guidance: rapid, simple, flexible behavioral insights on COVID-19' (World Health Organization, 2020). Lastly, a respiratory sample was collected via nasopharyngeal swaps to perform RT-PCR for SARS-CoV-2, along with a blood sample by phlebotomy to measure SARS-CoV-2 IgM and IgG antibodies. Blood samples were stored and processed in the Department of Pathology and Laboratory Medicine of the university hospital, while respiratory samples were transported to GenCore Laboratory of Universidad de los Andes for analysis.

Molecular and serological tests

RT-PCR molecular tests were performed to detect SARS-CoV-2 infection, using the U-TOP™ COVID-19 Detection Kit, according to the manufacturer's instructions. This kit detects: Gen N, gen ORF1ab, Rnasa P, and IPC, with a positive agreement of 100.0% (95% CI 83.89–100.00%) and a negative agreement of 100.0% (95% CI 86.68–100.00%) (Seasun Biomaterials, 2021).

To measure SARS-CoV-2 IgM and IgG antibodies, different serological kits based on immunochromatography were used, depending on their availability in our laboratory. One of the immunochromatographic assay kits employed was HighTop SARS-CoV-2 IgM/IgG Antibody Rapid Test (HIGHTOP Biotech), which uses a capture method for the qualitative detection of SARS-CoV-2 IgM/IgG antibody in human serum. One full drop of serum (10 μL) was added into the sample well, followed by two drops (80–100 μL) of sample buffer. The test results were observed within 15–20 minutes (no longer than 20 minutes, since abnormal results may occur). This kit reports a 94.15% sensitivity and 93.91% specificity for IgG and IgM. The second kit employed was the 2019-nCOV IgG/IgM Rapid Test (Dynamiker Biotechnology (Tianjin) Co., Ltd.), an immunochromatographic assay for the detection of SARS-CoV-2 IgG and IgM antibody in human whole blood/serum/plasma. For this, a 10 μL of serum sample was added to the sample pad, followed 60 μL of dissolution solution. The results were read after 10 minutes. This kit reports a 93.20% sensitivity and 95.30% specificity for IgG and IgM.

Data collection

Clinical data were obtained from the hospital's electronic medical records, including comorbidities, chronic medication use, flu vaccination, and previous viral infections. Meanwhile, the following data were extracted from the COVID-19 risk factors questionnaire: demographic characteristics (such as age, sex, socioeconomic status, and household location), hospital ward, type of job, aerosol exposure, community exposure (type of transportation used, rooms at home), and adherence to preventive strategies (such as frequency and duration of handwashing and use of masks). In addition, data on possible confounders, such as working in more than one hospital ward and handwashing frequency and duration, were collected via medical records. Vital signs and anthropometric measures were also measured. Cardiac frequency and oxygen saturation were measured using a pulse oximeter. Respiratory frequency was measured by counting the number of participant breaths in

Table 1
Level of exposure of HCWs to SARS-CoV-2 according to the hospital ward, aerosol-generating procedures, and type of occupation

	High exposure	Intermediate exposure	Low exposure
Hospital ward	ER, COVID-19 ICU, laboratory, COVID-19 hospitalization	Non-COVID-19 hospitalization, surgery, non-COVID-19 ICU, pediatric and neonatal ICU, oncology, specialty wards, external consultation, diagnostic imaging	Correspondence, public health, research, and administrative departments
Aerosol-generating procedures	Yes		No
Type of occupation	Healthcare and blended		Administrative

a minute, while in a sitting position. Blood pressure was measured using a digital monitor, with the cuff positioned on the upper arm. Weight was measured using a digital scale and height with a meter fixed on the wall.

Statistical analysis

Categorical data are presented as frequencies and percentages, and quantitative variables are presented as means, medians, IQRs, and standard deviations. Seroprevalence (seropositive for IgM and/or IgG against SARS-CoV-2) data and COVID-19 prevalence (detection of SARS-CoV-2 using RT-PCR) are expressed as proportions.

Baseline sociodemographic characteristics were summarized. Categorical variables were compared using Pearson's chi-squared test, and ordinal variables were compared using the Mann–Whitney U and Kruskal–Wallis tests. All p-values were two-sided, and $p < 0.05$ was considered to indicate significance.

The level of exposure to SARS-CoV-2 was categorized according to the hospital ward, participation in aerosol-generating procedures, and type of occupation (Table 1). Types of occupation were categorized as healthcare, blended, or administrative. Healthcare workers were all those who delivered care to patients directly (e.g. doctors and nurses) or indirectly (e.g. laboratory technicians). Blended workers were those who performed both administrative and patient-related tasks.

Bivariate and multivariate penalized logistic regression analyses were used to assess factors associated with seroprevalence of SARS-CoV-2, as well as for adjusting for confounders and detecting effect modification variables. Regression models were conducted using seropositivity status as the dependent variable, and all plausible independent variables (age, sex, previous COVID-19, socioeconomic stratification, type of occupation, profession, working in more than one hospital ward, aerosol exposure, handwashing frequency and duration, and number of cohabitants in the household). A reduced model with the minimum number of variables that best suited the data was performed. The best reduced regression model was selected based on the Akaike information criterion. Due to the high prevalence of seropositivity (> 10%), prevalence ratio was used as the association measure because odds ratios, in this case, may have overestimated the association. Penalized logistic regression model assumptions were tested. The observations were independent, because each came from an individual participant, without repetition. An absence of multicollinearity was confirmed using the variance inflation factor (VIF), with a 5.0 cut-off point. In total, 24 influential outliers were detected; regression models were conducted after dropping these observations, resulting in 393 observations for the multivariate model and 395 observations for the multivariate reduced model. Linearity was tested using the linktest for the multivariate and reduced model, which confirmed the assumption. Missing data corresponded to 4.78% of the sample size, so it was decided to drop them because they accounted for less than 5%. Systematic biases were reduced by obtaining data with previously calibrated digital devices. Questionnaires and medical record searches were conducted by trained personnel, reducing interviewer bias. Analysis was performed using Stata SE 17.0.

Ethics

The study protocol was approved in June 2020 by the ethics committees of both Fundación Santa Fe de Bogotá and Universidad de los Andes (approval no. 1181). All participants provided written, informed consent before enrolment in the study. The study adhered to the international regulations stated in the Helsinki Declaration of 1975, Nuremberg's Code, and the Belmont Report.

Role of the funding source

This study received funding from Fundación Santa Fe de Bogotá to conduct research activities, including recruitment of study subjects, collection of nasopharyngeal samples, and collection and processing of blood samples, and from Universidad de los Andes to transport and process respiratory samples in order to perform RT-PCR.

Results

In total, 584 hospital workers were invited to participate in the study; 424 of these agreed to participate and met the eligibility criteria, of whom 420 attended the enrollment tests and were included in the analysis. During the study recruitment period (from June 25 to October 30, 2020), 982 552 new cases of COVID-19 were reported in Colombia, 30.0% (294 270) of them from Bogotá. The mean age of participants was 39.7 years (with a standard deviation of 9.8), and 75.7% were females. Nurses accounted for the largest proportion of roles (35.5%), followed by medical doctors (18.3%); both groups performed mainly healthcare activities. At least 30% of participants presented a comorbidity (Table 2).

The overall seroprevalence at baseline was 23.2%. Nearly 10.7% of participants had IgM antibodies only, 0.7% had IgG only, and 11.7% had both IgM and IgG. The prevalence of acute SARS-CoV-2 infection, determined by a positive RT-PCR test result at baseline, was 1.9% ($n = 8$). Some 7.4% ($n = 31$) of participants had a confirmed COVID-19 diagnosis before recruitment. Baseline tests were performed between June 25 and October 30, 2020, with a higher proportion of positive tests detected in early October (Supplementary Figure S1).

When comparing sociodemographic and clinical characteristics of participants by serostatus, most seropositive individuals were younger than 50 years (82.9%), with no significant differences between age groups. More than half (63.9%) of the seropositive participants performed healthcare activities and had a mid socioeconomic status (62.8%). Up to 30% of all HCWs reported at least one comorbidity, and there were no significant differences in comorbidities by serostatus (Table 2). Among all participants, 27.9% presented at least one symptom, but there were no significant differences in the reporting of COVID-19-related symptoms among seropositive and seronegative individuals (Table 2). The most reported symptoms were sore throat (12.2%), cough (5.3%), and fatigue (3.1%).

Among the PCR-positive participants, 75% ($n = 5$) presented at least one COVID-19 related symptom. Common symptoms reported were sore

Table 2
Sociodemographic and clinical characteristics of participants at enrollment according to COVID-19 serostatus

	Total		Seropositive		Seronegative		
	n	%	*n*	%	*n*	%	*p*-value
Total	420		97	23.10	322	76.67	
Gender							
Female	318	75.71	79	81.44	238	73.91	0.130[a]
Male	102	24.29	18	18.56	84	26..9	
Age in years							
Mean (SD) median (p25–p75)	39.7 (9.75)/39 (14)		39.8 (10.16)/39 (13)		39.6 (9.65)/39 (14)		0.878[b]
Previous COVID-19	31	7.38	27	87.10	4	12.90	< 0.01[a]
Socioeconomic stratum							0.539[a]
Low	63	15.0	18	28.57	45	71.43	
Mid	263	62.77	58	22.05	205	77.95	
High	93	22.20	21	22.58	72	77.42	
Household							
Bogotá	379	90.24	88	90.72	290	90.06	0.848[a]
Outside the city	41	9.76	9	9.28	32	9.94	
Type of occupation							
Administrative	91	21.67	26	26.80	64	19.88	0.113[a]
Blended	52	12.38	7	7.22	45	13.98	
Healthcare	260	61.90	62	63.92	197	61.18	
Missing	17	4.05					
Comorbidities							
Any	124	29.52	32	32.99	92	28.57	0.403[a]
Hypertension	36	8.57	12	12.37	24	7.45	
Obesity (BMI ≥ 30)	46	10.95	12	12.37	34	10.56	
Diabetes	6	1.43	1	1.03	5	1.55	
Asthma	14	3.33	5	5.15	9	2.80	
Cancer	9	2.14	4	4.12	5	1.55	
COPD	1	0.24	0	0.00	1	0.31	
Immunosuppression	9	2.14	3	3.09	6	1.86	
Current smoker	19	4.52	3	3.09	16	4.97	
Symptoms at enrollment							0.426[a]
Any	117	27.86	24	24.74	93	28.89	
Cough	22	5.25	8	8.25	14	4.35	
Sore throat	51	12.17	12	12.37	39	12.10	
Fatigue	13	3.10	4	4.12	9	2.80	
Fever	1	0.24	1	1.03	0	0.00	

[a] Pearson's chi-squared test
[b] Difference between means *t*-test

throat (25%), cough (25%), fever (12.5%), and fatigue (12.5%). 87.5% of PCR-positive participants at baseline, worked in only one hospital ward. 62.5% had a healthcare occupation and 75% reported to wash their hands more than 10 times in a work shift. With regard to community transmission factors, 50% of PCR-positive participants occupied a high socioeconomic stratum and 50% lived with 0–1 person.

The overall seroprevalence was similar for all levels of risk exposure by work area (22.6% in high risk, 26.8% in intermediate-risk, and 18.9% in low risk). Most seropositive individuals had only IgM or both IgM and IgG antibodies. The prevalence of only IgG antibodies was insignificant, and similar among participants in the high- and intermediate-exposure wards (0.9% and 0.8%, respectively). No participants in the low-exposure wards had IgG antibodies (Figure 2C). Individuals not exposed to aerosol-generating procedures had a similar seroprevalence compared with those who performed aerosol procedures (23.71% vs 23.67%, respectively). The proportion of participants with only IgM antibodies was higher in the group exposed to aerosols compared with the non-exposed group (11.59% vs 10.82%) (Figure 2B). The proportion of seropositive participants was highest in administrative workers (28.9%), followed by healthcare (23.9%) and blended workers (13.5%). The prevalence of IgG antibodies was higher among administrative and healthcare workers (1.11% and 0.77%, respectively) (Figure 2A). However, none of the differences between groups was statistically significant.

Table 3 presents the results from the multivariate regression model. The proportion of seropositive participants was 4.84-fold greater among those who reported previous COVID-19, compared with those without previous infection (95% CI 3.89–5.22). SARS-CoV-2 seroprevalence was higher in females (PR 1.4, 95% CI 0.79–2.25); however, there was no significant association between sex and seropositivity. Participants from a high socioeconomic stratum were less likely to be seropositive than those from a low socioeconomic stratum, but there was no significant association between socioeconomic status and seroprevalence (PR 0.79, 95% CI 0.44–1.36). Healthcare and blended occupations were less likely to be seropositive compared with administrative occupations (PR 0.44, 95% CI 0.17–1.07), but these results had no statistical significance. The proportion of seropositive participants was higher among nursing assistants, medical doctors/medical students, and laboratory workers compared with professional nurses (PR 2.21 $p = 0.032$, 2.18 $p = 0.039$, and 2.21 $p = 0.049$, respectively). There were no statistically significant differences in seroprevalence between participants exposed and not exposed to aerosol-generating procedures (PR 1.63, 95% CI 0.91–2.60). Those who worked in more than one ward were less likely to be seropositive (PR 0.80, 95% CI 0.38–1.54). Finally, people

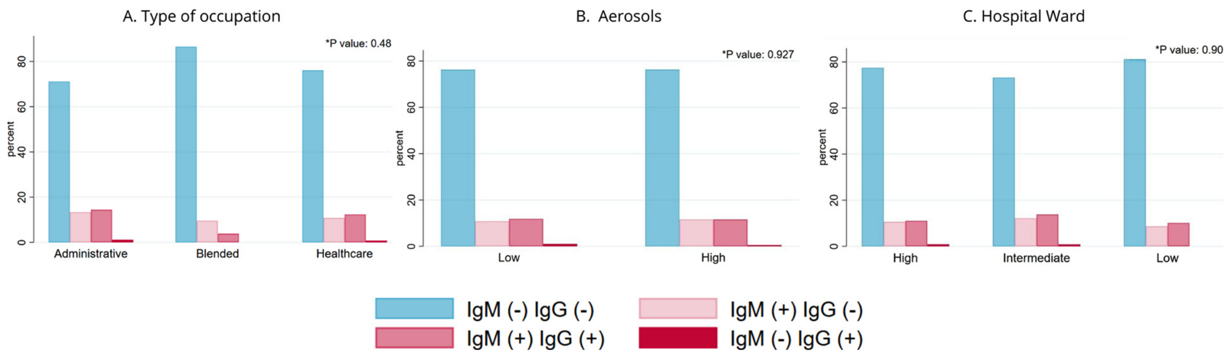

Figure 2. Serology test results according to exposure risk by A. type of occupation, B. aerosol-generating procedures, C. hospital ward

Table 3
Factors associated with a positive serology for SARS-CoV-2 in healthcare workers

	Bivariate model[a]			Multivariate model[b]			Reduced model[c]		
Variable	PR	*p*-value	95% CI	PR	*p*-value	95% CI	PR	*p*-value	95% CI
Age	1.01	0.584	0.98–1.03	1.01	0.277	0.99–1.04	–	–	–
Previous COVID-19									
No	Ref	–	–	Ref	–	–	Ref	–	–
Yes	4.89	< 0.001	3.79–6.31	4.84	< 0.001	3.89–5.23	4.82	< 0.001	3.87–5.23
Sex									
Male	Ref	–	–	Ref	–	–	–	–	–
Female	1.41	0.130	0.89–2.24	1.40	0.259	0.79–2.25	–	–	–
Socioeconomic stratification									
High	0.75	0.108	0.52–1.07	0.79	0.114	0.44–1.36	–	–	–
Low	Ref			Ref			–	–	–
Type of occupation									
Administrative	Ref	–	–	Ref	–	–	Ref	–	–
Healthcare and blended	0.77	0.188	0.52–1.13	0.44	0.088	0.17–1.07	0.45	0.065	0.18–1.03
Profession									
Professional nurse	Ref	–	–	Ref	–	–	Ref	–	–
Nursing assistant	1.90	0.023	1.10–2.81	2.21	0.032	1.10–3.52	2.39	0.01	1.27–3.65
Medical doctors and students	1.30	0.339	0.74–2.05	2.18	0.039	1.07–3.52	1.70	0.109	0.89–2.80
Laboratory workers	1.58	0.126	0.86–2.50	2.21	0.049	1.02–3.62	2.02	0.056	0.98–3.34
Respiratory therapist and physiotherapist	0.67	0.464	0.23–1.60	0.50	0.321	0.13–1.63	0.56	0.404	0.15–1.72
Other non-healthcare professionals	1.43	0.154	0.87–2.14	1.58	0.259	0.70–2.89	1.26	0.535	0.58–2.37
Hospital ward									
Low-exposure ward	0.74	0.432	0.79–1.69	0.85	0.734	0.36–1.76	–	–	–
Intermediate-exposure ward	1.90	0.386	0.79–1.69	1.35	0.283	0.78–2.14	–	–	–
High-exposure ward	Ref			Ref			–	–	–
Number of wards									
One ward	Ref	–	–	Ref	–	–	–	–	–
More than one ward	0.82	0.445	0.50–1.37	0.80	0.565	0.38–1.55	–	–	–
Aerosol exposure									
High	1.00	0.993	0.70–1.42	1.63	0.114	0.91–2.60	–	–	–
Low				Ref			–	–	–
Hand-washing duration									
> 20 s	Ref	–	–	Ref	–	–	–	–	–
0–20 s	1.04	0.832	0.71–1.53	1.29	0.332	0.78–2.00	–	–	–
Hand-washing frequency									
0–4 times/day	Ref	–	–	Ref	–	–	–	–	–
5–10 times/day	0.91	0.735	0.45–1.65	1.24	0.653	0.53–2.43	–	–	–
> 10 times/day	0.78	0.409	0.39–1.42	1.03	0.991	0.42–2.14	–	–	–
Number of cohabitants									
0–1	Ref	–	–	Ref	–	–	–	–	–
2–3	1.17	0.448	0.78–1.67	1.11	0.700	0.66–1.74	–	–	–
4 or more	1.66	0.036	1.03–2.38	1.28	0.474	0.63–2.27	–	–	–

[a] Log-likelihood intercept only: −215.579
[b] Akaike information criterion: 385.851; Bayesian information criterion: 465.33; log likelihood of the model: −172.93
[c] Akaike information criterion: 374.436; Bayesian information criterion: 414.23; log likelihood of the model: −177.22

living with four cohabitants or more were more likely to be seropositive (PR 1.28, 95% CI 0.63–2.27) compared with those who lived with 0–1 person.

The reduced model (Table 3) included the following independent variables: previous COVID-19, type of occupation, and profession. The model showed that healthcare workers were less likely to be seropositive compared with administrative professionals (PR 0.45, 95% CI 0.18–1.03), but this association lacked statistical significance. Being a nursing assistant was significantly associated with a higher seroprevalence in comparison with being a professional nurse (PR 2.39, 95% CI 1.26–3.65), while medical doctors/students and laboratory workers did not show a statistically significant likelihood of being more seropositive than professional nurses (PR 1.7, 95% CI 0.89–2.80 and PR 2.02, 0.98–3.34, respectively).

Discussion

To our knowledge, this was the first study in Colombia to estimate the seroprevalence of SARS-CoV-2 and the prevalence of SARS-CoV-2 infection in hospital staff, including healthcare and administrative workers (SeroTracker 2021). The point prevalence of SARS-CoV-2 nasopharyngeal carriage was found to be 1.9%, with an overall seroprevalence estimate of 23.15%, which was similar to that reported among healthcare workers in Bogotá between October 26 and November 17, 2020, by the National Institute of Health (INS) (30%; 95% CI 0.26–0.34) (Instituto Nacional de Salud 2021). However, our study was conducted at a different time during the COVID-19 pandemic. The seroprevalence reported among healthcare workers by the INS was higher than that estimated for the general population in the city during the the same period (26%) (Instituto Nacional de Salud 2021). The enrollment period for our study coincided with the first COVID-19 wave (Supplementary Figure S1), when sectoral quarantines were among some of the different public health measures taken to reduce disease transmission. As a result, between June and October 2020, intensive care unit (ICU) occupancy fluctuated between 60% and 97% (Secretaría de Salud Bogotá, 2021).

The data from our study formed part of an epidemiological surveillance initiative of Universidad de Los Andes to assess SARS-CoV-2 carriage in high-risk professions. Hospital workers had the lowest SARS-CoV-2 infection rates among all professions screened (2.49%). In contrast, military personnel and security guards had the highest rates of SARS-CoV-2 infection (18.86% and 6.02%, respectively)(COVID-19 Vacunómetro 2021), which could be explained by the better understanding and higher adherence to measures to reduce infection risk displayed by hospital workers (Abeya et al., 2021; Colmenares-Mejía et al., 2021).

A similar study performed on healthcare workers and medical students between June 25 and July 4, 2020, in another hospital in Bogotá reported an IgG seroprevalence rate of 2.28% measured by chemiluminescent immunoassay (CLIA) (Ariza et al., 2021). This estimate was higher than our IgM−/IgG+ seroprevalence figure (0.72%) but lower than our IgM+/IgG+ rate (11.70%). The different techniques used for antibody detection may explain this distinction. Their study used both qualitative and quantitative methods for the detection of IgM (ELFA and LFA) and IgG (CLIA and LFA). In contrast, our study used a qualitative method (immunochromatography). These techniques have different diagnostic performances (Ariza et al., 2021). A meta-analysis on factors related to seroprevalence in healthcare workers showed that increased sensitivity of antibody tests was associated with increased seroprevalence (Galanis et al., 2021). Other reported factors associated with seropositivity have included male gender, ethnicity, working in COVID-19 units, patient-related work, frontline healthcare workers (HCWs), healthcare assistants, shortage of personal protective equipment, previous positive RT-PCR test, and household contact with a suspected or confirmed COVID-19 case (Galanis et al., 2021).

The overall seroprevalence of SARS-CoV-2 in the Bucaramanga Metropolitan Area reported during the last trimester of 2020 was 19.5% (95% CI 18.6–20.4), with a similar prevalence among healthcare workers. Our study reported a higher prevalence, which could be explained by the different contexts of the cities, with Bogotá being the capital of the country, with a higher population density. In addition, a cross-sectional study that assessed the prevalence of SARS-CoV-2 among healthcare workers in ten cities of Colombia, from September to November 2020, reported a seroprevalence of 35% (95% CI 33.0–37.0%) (Colmenares-Mejía et al., 2021). The seroprevalence estimated for healthcare workers in Bogotá was 34%. One of the highlights of this study was that small cities (fewer than 1.5 million inhabitants) presented a higher seroprevalence than the larger ones (Malagón-Rojas et al., 2022).

Our study demonstrated that nursing assistants in our hospital were at higher risk of having SARS-CoV-2 antibodies than professional nurses (PR 2.39; 95% CI 1.27–3.65). A similar study on healthcare workers at Oxford University Hospitals in the UK showed that most seropositive workers were nurses and healthcare assistants (47.2%) (Lumley et al., 2021). Our study also found that laboratory workers were 2.02 times more likely to be seropositive (95% CI 0.98–3.34), whereas previous studies have shown a low seroprevalence in this group (Amendola et al., 2020; Fukuda et al., 2021; Milazzo et al., 2021). Although this association was not statistically significant, those with administrative roles may have a lower self-perceived risk of infection and adherence to preventive measures.

Other studies have demonstrated an association between poor adherence to hand washing and the use of personal protective equipment (PPE) and COVID-19. A systematic review of the literature found that unqualified handwashing (OR 2.64, 95% CI 1.04–6.71), suboptimal hand hygiene before patient contact (OR 3.10, 95% CI 1.43–6.73), and inadequate use of PPE (OR 2.82, 95% CI 1.11–7.18) were risk factors for SARS-CoV-2 infection (Gómez-ochoa et al., 2020). However, our results did not show this association, which could be explained by our hospital's high adherence to these practices. Our results suggest that SARS-CoV-2 infection can be an occupational disease, affecting more healthcare professionals than other hospital workers in specific scenarios (Carlsten et al., 2021; Sandal and Yildiz, 2021). These findings could be used to enhance biosafety protocols in order to reduce SARS-CoV-2 transmission in hospital environments.

Our study had some limitations. It only reflected the seroprevalence among healthcare workers and hospital staff over a 4-month period; these results may have varied over time according to the dynamics of the COVID-19 pandemic in Bogotá. Participants self-presented to enroll, which may have introduced selection bias in the study cohort. Additionally, qualitative serology tests can introduce measurement bias due to interobserver variability. Our study used two different serology kits, with similar performances, according to their availability in the laboratory. Finally, obsequiousness bias may have been present because participants self-reported hand hygiene practices and details of face coverings, including type and duration of wearing. Sample selection was non-probabilistic through consecutive sampling.

It is crucial to monitor seroprevalence among healthcare workers, especially in the context of COVID-19 vaccination, as we can now assess both previous COVID-19 infection and antibody presence due to COVID-19 vaccination. Studies on the immunogenicity of vaccines among healthcare workers have shown that women, non-obese individuals, and young people have a superior humoral immune response (Lustig et al., 2021). In addition, people with previous COVID-19 infection who have received one dose of an mRNA vaccine have a similar humoral and cellular response to those without previous infection who have received two doses of the vaccine (Angyal et al., 2021; (Ebinger et al., 2021)). However, additional longitudinal studies addressing the duration of natural and artificially induced immune responses need to be performed.

This study was part of a prospective cohort study. The follow-up period has now been completed, and the data are currently being analyzed to report findings of incidence, seroconversion, and factors of SARS-CoV-2 infection. Additionally, the natural, artificial, and hybrid humoral immune responses against SARS-CoV-2 in participants infected and/or vaccinated against COVID-19 during the study's follow-up period are being assessed.

Conclusion

The overall SARS-CoV-2 prevalence of healthcare workers and hospital staff at a university hospital in Colombia was 1.9%, and the seroprevalence was 23.15%. Being a nurse assistant, medical doctor, or student and laboratory personnel was associated with a higher chance of having antibodies against SARS-CoV-2.

Contributors

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Declaration of Competing Interest

The authors declare no conflicts of interest.

Acknowledgments

The authors would like to express their great appreciation to all health workers who participated in this study. They would also like to acknowledge various people and institutions for their contributions to this study: Dr Henry Gallardo, director of Fundación Santa Fe de Bogotá, for supporting the conduction and funding of the study; Dr Dario Londoño, director of the Population Health division at Fundación Santa Fe de Bogotá for supporting the conduction and funding of the study; Ángela Ortiz, Dr Lilian Peñuela, and Dr Jose de la Hoz from the Division of Clinical Research at Fundación Santa Fe de Bogotá, for their initial support in participant inclusion and study procedures; Yubelly Malaver, Dallana Melo, and all technicians (Department of Pathology and Laboratory Medicine of Fundación Santa Fe de Bogotá) for their assistance in all laboratory procedures (sample collection, sample processing, and data curation); and Pilar Castro and Leonardo Valdez (Division of Population Health) and the CoVIDA team (Universidad de los Andes) for logistic support.

Data sharing

Data collected from the study, including individual participant data that underlie the results reported in this article (after de-identification), the data dictionary, and other related study documents (protocol, questionnaires) are available upon reasonable request from the corresponding author.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijregi.2022.03.013.

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