Prevalence of anti-SARS-CoV-2 antibodies and associated factors in healthcare workers of a Mexican Covid-19 hospital

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Abstract

Objective. To determine the prevalence of SARS-CoV-2 antibodies among healthcare workers (HCW) and to identify factors associated with infection. **Materials and methods.** A cross-sectional study was conducted in a Covid-19 hospital in Morelos, Mexico. Antibodies against SARS-CoV-2 spike and nucleocapsid proteins were detected by ELISA. A bivariate and multivariable Poisson regression model were performed to identify factors associated with infection. **Results**. Among all participants, 31% had anti-SARS-CoV-2 antibodies, while only 13.1% had reported a history of positive RT-PCR. Individuals who reported cohabiting with someone with Covid-19, and those who had a previous RT-PCR test, were more likely to be seropositive. Laboratory personnel had the lowest seroprevalence (12.0%), while social workers had the highest (35.7%). **Conclusions.** The results of this study show the seroprevalence of SARS-CoV-2 antibodies among HCW in a hospital in Mexico, and underline the importance of serological tests for a better estimate of prevalence in health systems where only symptomatic cases are recorded.

Keywords: SARS-CoV-2; healthcare workers; antibodies; seroprevalence

Resumen

Objetivo. Determinar la prevalencia de anticuerpos contra SARS-CoV-2 entre trabajadores de la salud e identificar factores asociados con la infección. **Material y métodos.** Se realizó un estudio transversal en un hospital Covid-19 de Morelos. Se detectaron anticuerpos contra las proteínas spike y nucleocápside del SARS-CoV-2 por ELISA. Se realizó un análisis bivariado y multivarible mediante regresión de Poisson para identificar factores asociados con la infección. **Resultados.** El 31% de los participantes tenía anticuerpos anti-SARS-CoV-2 y sólo 13.1% reportó antecedentes de RT-PCR positiva. Cohabitar con una persona con Covid-19 y reportar una prueba RT-PCR fueron factores asociados con la seropositividad. El personal de laboratorios tuvo la prevalencia más baja (12.0%), mientras que trabajadores sociales la mayor (35.7%). **Conclusiones.** Se informa la seroprevalencia de anticuerpos contra SARS-CoV-2 entre personal de salud en un hospital de México y se subraya la importancia de las pruebas serológicas para una mejor estimación de la prevalencia en sistemas de salud que sólo registran casos sintomáticos.

Palabras clave: SARS-CoV-2: trabajadores de la salud; anticuerpos; seroprevalencia

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An outbreak of pneumonia of unknown etiology was identified in December 2019 in Wuhan, China. This emerging infection was attributed to a novel virus belonging to the *Coronaviridae* family, named "severe acute respiratory syndrome coronavirus 2" (SARS-CoV-2).[1] Despite the global containment efforts, the virus spread rapidly around the world causing a pandemic.

In Mexico, the first case of SARS-CoV-2 was officially reported on February 27, 2020, and by March 18 the first associated deaths occurred. Particularly, in the state of Morelos, the first case was detected on March 13, and the first death on March 28. SARS-CoV-2 infection is transmitted during the pre-symptomatic and symptomatic period. Viral load has been detected from three days before the onset of symptoms and up to 37 days later, and it is estimated that 30% of infections can occur before symptoms appear.[2-4] Transmission from asymptomatic individuals results in a greater spread of infection and leads to inaccurate estimates of the infection rate.[5]

The number of cases, hospitalizations, and fatality rates vary significantly between countries, and even in regions within them, due to the diverse health strategies that have been applied to reduce the pandemic impact. One of the consequences of implementing different approaches is having different risks of acquiring the infection both at the population level and in particular sectors, for instance, in healthcare personnel, and even more, among those who work in Covid-19 hospitals, and those who do not.[6]

Healthcare workers (HCW) play a leading role in the control of the pandemic. However, first-line healthcare personnel (those who directly treat Covid-19 patients) have a greater risk of contracting the disease. Compared to the rest of the population, first-line workers are occupationally exposed to infectious droplets of SARS-CoV-2 and other potentially infectious materials.[7] On September 2020, the World Health Organization (WHO) declared that, globally, approximately 14 to 35% of reported Covid-19 cases correspond to HCW.[8]

Previous studies have shown great variability in the prevalence of SARS-CoV-2 infection among HCW, from 0.4% in Japan to 31.6% in the UK.[9-11] These variations can be the consequence of various factors, such as differences in the structure and organization of each health system, availability, and compliance with medical care protocols and personal protective equipment (PPE), as well as variation in the intensity of Covid-19 pandemic between and within countries.[6] In addition to the risk of contracting the infection, HCW bear a significant risk of transmitting the virus to patients, colleagues, and social contacts.[12] Therefore, monitoring HCW is very important to contain the transmission.

In most health systems, only symptomatic cases among healthcare personnel are registered and confirmed by molecular techniques. However, this process implies the disadvantage of ignoring asymptomatic cases that lead to underreporting. In this scenario, serological tests for the detection of past infections can be an alternative to estimate the prevalence of SARS-CoV-2 infection in this population. Epidemiological seroprevalence studies can be useful to monitor the dynamics of the epidemic and analyze the risk of infection in groups occupationally exposed to the virus, such as health personnel. Therefore, this study aimed to determine the seroprevalence of antibodies against SARS-CoV-2 among HCW in a Covid-19 hospital in the state of Morelos and to explore whether the seropositivity is associated with the profession and activities they perform.

Materials and methods

Study design

A cross-sectional study was conducted from January 14 to 21, 2021 at a Covid-19 hospital in the city of Cuernavaca, Morelos, Mexico. The General Hospital Dr. José G. Parres can attend 70 patients with Covid-19, 40 places designated for intermediate care, and 30 more for intensive care. Furthermore, the hospital has 1 050 HSW, and the medical team is integrated by 94 health professionals. All the personnel were invited to participate, regardless of their profession or major activity within the hospital. The inclusion criteria were people over 18 years of age working in the hospital, who agreed to sign the informed consent letter and answered a short questionnaire related to exposure and history of SARS-CoV-2 infection, and provided a venous blood sample. Participants were recruited from the four work shifts schedule (morning, afternoon, evening, and weekends). The protocol was approved by the ethics, biosafety, and research committees of the *Instituto Nacional de Salud Pública* (INSP) (project 1665).

Biological samples and antibody detection

A venous blood sample of approximately 6 ml was taken from the HCW. Samples were collected and transported every day to the *Laboratorio de Serología e Infecciones de Transmisión Sexual* at the INSP, where they were processed. Prior to any manipulation, the samples were inactivated at 56 °C for 30 min., then they were centrifuged to separate the plasma, which was aliquoted and stored at -20 °C until processing. The procedure was carried out in a level two biosafety cabinet with level three biosafety conditions. Given that vaccination in Mexico began on

December 24, 2020, and in Morelos one day before the start of this study, most of the participants had received one dose of the Pfizer-BioNTech vaccine between 1 and 7 days before blood sampling. However, the presence of vaccine-derived IgG antibodies is not expected during the first week post-vaccination.[13]

The detection of IgG antibodies was carried out using the commercial anti-SARS-CoV-2 IgG ELISA and anti-SARS-CoV-2 NCP ELISA kits (Euroimmun, Lübeck, Germany) which detect the spike (S) protein and the nucleocapsid protein (NCP), respectively. ELISAs were performed according to the manufacturer's instructions. All samples were evaluated for the detection of antibodies against S protein and NCP: those with an index ≥1.1 were considered positive and those with an index <1.1 were considered negative. Samples were considered positive when at least one of the antibodies was detected. Manufacturer reported a sensitivity of 94.4%, and a specificity of 99.6% for the detection of antibodies against S protein, whereas for NCP it was 94.6 and 99.8%, respectively.

Statistical analyses

The variable "Municipality" was coded into three categories: Cuernavaca, Metropolitan area (Jiutepec, Temixco, Emiliano Zapata, and Xochitepec) and Others. The variables of "nasopharyngeal sample" and "intubation" refer to activities carried out by health personnel. Variable about the SARS-CoV-2 test refers to whether individuals reported a previous diagnostic RT-PCR assay. "Cohabiting with someone with Covid-19" considers whether any person with whom they cohabit has been diagnosed with Covid-19.

A descriptive analysis of the study population was performed. Qualitative variables were expressed as the percentage and 95% confidence intervals (95%CI), and quantitative variables, as the mean and 95%CI. Data from individuals with IgG antibodies (S or NCP) against SARS-CoV-2 and without antibodies were compared using a chi-square test, a value of p<0.05 was considered significant. A multivariable Poisson regression model with robust standard errors was performed to detect factors associated with the presence of anti-SARS-CoV-2 antibodies (S or NCP). Prevalence ratios (PR) with 95%CI were calculated, subsequently, a multivariable Poisson regression model was performed with gender, age, occupation, contact with Covid-19 patients, SARS-CoV-2 test, and cohabiting with someone with Covid-19. Statistical analysis was performed using the SPSS v 15.0 statistical program.*

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* IBM. Statistical Package for the Social Sciences 15. Chicago, IL: SPSS Inc., 2006.

Results

Characteristics of the study population

A total of 381 HCW participated in the study, which represents 36.2% of the hospital staff. As detailed in table I, 74% of participants were women and 26% were men. The mean age of the participants was 42.7 ± 10.9 years and most of them were residents of the municipality of Cuernavaca (47.8%). Regarding occupation, 43.8% were nurses, 19.7% were physicians, and 16.3% worked in the administrative area. Concerning SARS-CoV-2 infection, 13.1% reported a history of a positive result for SARS-CoV-2, and 19.7% mentioned cohabiting with someone with Covid-19. Regarding vaccination, 78.7% of participants were vaccinated between 1 and 7 days before blood sampling, 9.5% had been vaccinated eight or more days earlier, and only 11.8% had not received the first dose of the vaccine.

SARS-CoV-2 antibodies prevalence among HCW

From 381 participants, 108 samples were positive for antibodies against S protein, 76 samples were positive for antibodies against NCP, and 66 samples were positive for both antibodies. The rest of the samples tested negative for the presence of anti-SARS-CoV-2 antibodies. Overall, 118 HCW (31%; 95%CI: 26.5,35.8) were either positive for anti-S or anti-NCP.

Among HCW seropositive for SARS-CoV-2, 71.2% were women, and the mean age of the cases was 42.7 ± 11.3; the majority of the cases were in the age group of 40-49 (29.7%), while the smallest number of cases was found among the 60- 69 years (2.5%), and 31.4% had a positive RT-PCR (table II).

Factors associated with the presence of anti-SARS-CoV-2 antibodies

Individuals who reported living with someone ever diagnosed with Covid-19 had 1.5 times higher risk, and those who reported ever have being tested for the virus infection were 1.5 times more likely to have antibodies to SARS-CoV-2 (table III). Medicals, nurses, and social workers had 2.9, 3.6 and 4 times higher ratios against, respectively, of having antibodies SARS-CoV-2 compared to the people who work in laboratories, these had the lowest prevalence.

Discussion

The prevalence of anti-SARS-CoV-2 antibodies among HCW from the general hospital Dr. José G. Parres,

Table I
Demographic and clinical characteristics of healthcare workers, General Hospital Dr. José G. Parres. Morelos, Mexico, January 2021

Characteristic	n	%	95%CI
Sex	282	74.0	69.4,78.2
Women	99	26.0	21.8,30.6
Men			
Age (years)			
20-29	55	14.4	11.2,18.3
30-39	103	27.0	22.8,31.7
40-49	108	28.3	24.1,33.1
50-59	96	25.2	21.1,29.8
60-69	19	5.0	2.7,8.8
Municipality			
Cuernavaca	182	47.8	42.8,52.8
Metropolitan area	127	33.3	28.8,38.2
Others	72	18.9	15.3,23.1
Occupation			
Nursing	167	43.8	38.9,48.9
Medicine	75	19.7	16.0,24.0
Administration	62	16.3	12.9,20.3
Laboratory	24	6.3	4.2,9.2
Other*	39	10.2	7.6,13.7
Social work	14	3.7	2.2,6.1
Nasopharyngeal sample			
Yes	44	11.5	8.7,15.2
No	337	88.5	84.8,91.3
Intubation			
Yes	48	12.6	9.6,16.3
No	333	87.4	83.7,90.4
Contact with Covid-19 patients			
Yes	272	71.4	66.7,75.7
No	109	28.6	24.3,33.4
SARS-CoV-2 test			
Ever	171	44.9	40.0,49.9
Never	210	55.1	50.1,60.0
SARS-CoV-2 test result			
Positive	50	13.1	10.1,16.9
Negative	121	31.8	27.3,36.6
Never tested	210	55.1	50.1,60.0
Cohabiting with someone with Covid-19			
Yes	75	19.7	16.0,24.0
No	306	80.3	76.0,84.0
Vaccination against SARS-CoV-2 (days)			
No	45	11.8	8.9,15.5
1-4	159	41.7	36.9,46.7
5-7	141	37.0	32.3,42.0
≥8	36	9.5	6.2,14.1

* 8 stretcher-bearer, 7 maintenance, 4 pharmacists, 6 physiotherapists, 3 cleaning staff, 3 laundry, 1 nutritionist, 7 did not answer

Table II
Demographic, clinical characteristics and antibodies against SARS-CoV-2 of healthcare workers, General Hospital Dr. José G. Parres. Morelos, Mexico, January 2021

Characteristic	Positive %* n=118	Negative % n=263	p
Sex			
Men	28.8	24.7	0.399
Women	71.2	75.3	
Age (years)			
20-29	16.9	13.3	0.499
30-39	24.6	28.1	
40-49	29.7	27.8	
50-59	26.3	24.7	
60-69	2.5	6.1	
Municipality			
Cuernavaca	50.8	46.4	0.686
Metropolitan area	30.5	34.6	
Others	18.6	19.0	
Occupation			
Nursing	47.5	42.2	0.170
Medicine	22.0	18.6	
Administration	13.6	17.5	
Social work	4.2	3.4	
Other	11.0	9.9	
Laboratory	1.7	8.4	
Nasopharyngeal sample			
Yes	22.0	6.8	<0.001‡
No	78.0	93.2	
Intubation			
Yes	13.6	12.2	0.705
No	86.4	87.8	
Contact with Covid-19 patients			
Yes	77.1	68.8	0.098
No	22.9	31.2	
SARS-CoV-2 test			
Ever	55.1	40.3	0.007‡
Never	44.9	59.7	
SARS-CoV-2 test result			
Positive	31.4	4.9	<0.001‡
Negative	23.7	35.4	
Never tested	44.9	59.7	
Cohabiting with someone with Covid-19			
Yes	28.8	15.6	0.003‡
No	71.2	84.4	
Vaccination against SARS-CoV-2 (days)			
No	13.6	11.0	0.048‡
1-4	39.0	43.0	
5-7	32.2	39.2	
≥8	15.3	6.8	

* Antibodies against spike protein or nucleocapside protein
‡ Statistically significant

Table III
FACTORS ASSOCIATED WITH THE SEROPREVALENCE
OF SARS-CoV-2 AMONG HEALTHCARE
WORKERS OF THE GENERAL HOSPITAL
DR. JOSÉ G. PARRES.
MORELOS, MEXICO, JANUARY 2021

Characteristic	% Anti-SARS-CoV-2*	cPR (95%CI)	aPR (95%CI)
Sex			
Men	34.3	1.15 (0.82,1.54)	1.34 (0.90,1.83)
Women	29.8	1.0	1.0
Age (years)			
20-29	36.4	2.30 (0.82,4.35)	2.07 (0.66,4.22)
30-39	28.2	1.78 (0.61,3.74)	1.72 (0.55,3.76)
40-49	32.4	2.05 (0.73,4.03)	2.02 (0.69,4.07)
50-59	32.3	2.04 (0.73,4.04)	2.06 (0.71,4.12)
≥ 60	15.8	1.0	1.0
Municipality			
Cuernavaca	33.0	1.16 (0.81,1.58)	
Others	30.6	1.08 (0.67,1.60)	
Metropolitan area	28.3	1.0	
Occupation			
Nursing	33.5	2.79 (1.05,5.31)‡	3.56 (1.39,6.12)‡
Medicine	34.7	2.89 (1.06,5.50)‡	2.93 (1.05,5.59)‡
Administration	25.8	2.15 (0.70,4.74)	2.86 (0.95,5.66)
Social work	35.7	2.98 (0.82,6.16)	4.03 (1.18,7.01)‡
Other	31.6	2.63 (0.86,5.41)‡	3.02 (0.99,5.88)
Laboratory	12.0	1.0	1.0
Nasopharyngeal sample			
Yes	57.5	2.06 (1.47,2.60)‡	
No	27.9	1.0	
Intubation			
Yes	33.3	1.09 (0.68,1.59)	
No	30.6	1.0	
Contact with Covid-19 patients			
Yes	33.5	1.35 (0.94,1.83)	1.26 (0.82,1.81)
No	24.8	1.0	1.0
SARS-CoV-2 test			
Ever	38.0	1.51 (1.12,1.93)‡	1.53 (1.11,2.00)‡
Never	25.2	1.0	

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	% Anti-SARS-CoV-2*	cPR (95%CI)	aPR (95%CI)
SARS-CoV-2 test result			
Positive	74.0	2.93 (2.32,3.38)	
Negative	23.1	0.92 (0.60,1.34)	
Never tested	25.2	1.0	
Cohabiting with someone with Covid-19			
Yes	45.3	1.65 (1.20,2.12)‡	1.53 (1.08,2.03)‡
No	27.5	1.0	1.0
Vaccination against SARS-CoV-2 (days)			
≥8	50.0	1.41 (0.82,1.99)	
5-7	27.0	0.76 (0.43,1.21)	
1-4	28.9	0.81 (0.47,1.27)	
No	35.6		

*Antibodies against spike protein or nucleocapsid protein
‡ Statistically significant
cPR: crude Prevalence Ratio; aPR: Prevalence Ratio adjusted for age, sex, occupation, contact with Covid-19 patients, SARS-CoV-2 test, and cohabiting with someone with Covid-19

Cuernavaca, Morelos was 31%, which is similar to reports from different countries. Worldwide, the seroprevalence of antibodies against SARS-CoV-2 has been estimated at 8.7%, varying between countries from 0 to 45.3%, being North America (12.7%) the region with the highest seroprevalence, compared to Europe (8.5%), Africa (8.2%) and Asia (4%).[14]

Among the studies conducted in America, the Centers for Disease Control (CDC) reported that seroprevalence among HCW in the United States ranges from 0.8 to 31.2% according to a study that involved 12 states.[15] Another study performed in New York found 27% seropositivity among HCW, while in San Diego, California, the seroprevalence was 2.2%.[16,17] In Brazil, Colombia, and Argentina, the seroprevalences in HCW were 17, 5.98, and 0.75 % respectively.[18-20] However, the highest prevalence of antibodies against SARS-CoV-2 among HCW in America has been reported in Peru, where a seroprevalence of more than 50% was found.[21]

As with the estimated cases of Covid-19 in HCW, the large variation observed in seroprevalence between studies may be due to different factors, including the selection criteria of HCW, the type of work activities, the different laboratory tests used to detect antibodies, etc. A very important factor is the time of data collection since seroprevalence represents the accumulated cases during the development of the pandemic. The present study was conducted in January 2021, 10 months after

the first case was presented in Mexico (February 28, 2020) and during the peak of the second wave of the pandemic, when the highest number of cases was reported in Mexico, with a cumulative incidence of 12 730 cases per million inhabitants.[22] Most of the studies reported so far were carried out between March and September 2020, thus, this study implies that HCW had a longer exposure time, and probably a higher risk of infection.

The report of the *Encuesta Nacional de Salud Pública 2020 sobre Covid-19* carried out between September and October 2020 in Mexico, showed that 24.9% of the population had antibodies against SARS-CoV-2.[23] Therefore,

the seroprevalence found among HCW in Cuernavaca, Morelos is slightly higher than the general population. A similar result was found in a study conducted in South Africa and seven European countries, where the seroprevalence among pediatric hospital HCW was comparable to their national population and was related to the national burden of Covid-19.[24]

Among the circumstances associated with seropositivity, two main factors were found: having a contact at home with Covid-19 (1.5 times more risk) and having a positive RT-PCR test (1.5 times more risk). These factors coincide with those found in other

Table IV
COMPARATIVE TABLE OF DIFFERENT STUDIES ON SEROPREVALENCE. MEXICO, 2022

Place	Study type (n of HCW)	Temporality	Seroprevalence (%)	Factors associated with seropositivity	Reference
Cuernavaca, Morelos, Mexico: General Hospital	Cross-sectional (381)	January 2021	31	Cohabiting with someone with Covid-19 or having ever had RT-PCR to detect Covid-19 were more likely to have antibodies against SARS-CoV-2. Social workers had four times the risk of having antibodies against SARS-CoV-2, while laboratory workers had the lowest prevalence.	This study
Brazil	Cross-sectional (5 645)	May 14-28, 2020	14	Lowest educational level (OR: 1.93; 95%IC: 1.03,3.60), use of public transportation to go to work (OR: 1.65; 95%IC: 1.07,2.62), and working in cleaning or security (OR: 10.1; 95%IC: 3.40,26.9).	18
Peru: Regional Hospital Loreto	Cross-sectional (1 147)	May 19-June 6, 2020	58.3,	Administrative staff had the highest prevalence (98%), while physicians had the lowest (24.7%)	20
San Diego, EUA: California Sharp HealthCare system	Cross-sectional (1 770)	May 20-June 8, 2020.	2.20	Known community exposure to Covid-19, and Hispanic/Latino participants were associated with seropositivity. Percentage of time working with Covid-19 patients, unintentional exposure to Covid-19 without PPE, geographic location, type of work, and unit were not associated with higher odds of being antibody or PCR positive.	16
Buenos Aires, Argentina: Sanitary region VIII	Cross-sectional (738)	June 3-July 6, 2020	0.75,	No associations with risk factors for infection were identified.	18
Colombia: Covid-19 hospital staff	Cross-sectional and prospective (351)	June, July and August, 2020	2.8-5.98	No associations with risk factors for infection were identified.	19
Finland: Hospital of Helsinki	Cross-sectional (1 095)	March-April, 2020	3.00	Contact with a known case of Covid-19 work in the Covid-19 area or in an area with cases among staff. No significant differences were found by profession.	24
Switzerland: a hospital	Prospective (4 726)	April 16-30, 2020	9.6	Work in Covid-19 units (14.1%; 95%IC: 11.9,16.5) compared to other hospital areas with medium (10.7%; 95%IC: 7.6,14.6) or low risk exposure (7.3%; 95%IC: 6.4, 8.3). Home contact to Covid-19 cases (OR: 2.80; 95%IC: 2.14,3.67).	6
Madrid, Spain: University Hospital	Cross-sectional (2 590)	April 14-27, 2020	31.60	Physicians were the most infected professional category (39.6%) followed by nursing assistants (33.7%), and nurses (31.2%). The seropositivity rate among those who said they did not use PPE properly was 42.0% compared to 27.6% in the cases with referred appropriate use of PPE; p<0.001.	25

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Denmark	Observatio-nal cohort (28 792)	April 15 - 23, 2020	4.04	IgG seroprevalence was highest in medical students (13.66%) and the lowest was observed among laboratory personnel (1.16%).	27
Barcelona, North metropolitan area	Cross-sectio-nal (7 563)	May 4 - 22, 2020	10.30	Administrative workers showed the lowest prevalence (6.52%). No significant differences were observed between those working in primary care or in the referral hospital.	26
India: Institute of Medical Sciences	Cross-sectio-nal (919)	September, 2020	13.3	Seropositivity was almost double in men (17.6%) compared to women (8.7%). Intensive care unit personnel were less likely to be IgG seropositive (5.2%) and laboratory personnel were the most likely (28.6%).	22

PPE: personal protection equipment

studies (table IV). According to the meta-analysis carried out by Galanis and collaborators, some factors such as male gender; Black, Asian and Hispanic HCW; work in a Covid-19 unit; performing patient-related work; first-line HCW; healthcare assistants; insufficiency of PPE; the self-reported belief of a previous SARS-CoV-2 infection; and a prior positive PCR test have been related to seropositivity.[14] In contrast to a study in India where seropositivity was almost double in men (17.6%) compared to women (8.7%), the present study found no association with gender or age. Similarly, in a study conducted in an Egyptian hospital, neither gender nor age were risk factors for SARS-CoV-2 seropositivity.[25,26] Finally, the variable nasopharyngeal sample was negatively correlated with some occupation strata, which give rise to collinearity in the multivariable model.

Community transmission of SARS-CoV-2 among HCW has been reported in several studies, in a San Diego hospital, where seropositivity was associated with exposure to a Covid-19 contact (family member or friend).[17] Similarly, a report from Switzerland, stands that seropositivity was higher among HCW who were exposed to Covid-19 cases at home compared to those who were not (18.7 vs. 7.7%, *p*<0.001).[7] Furthermore, a study conducted in Sao Paulo, Brazil, suggested that the transmission of SARS-CoV-2 among HCW is primarily community-based. In that study, the associated risk factors were low educational level, use of public transportation, and work in security or cleaning, but was not associated with working in a Covid-19 hospital versus a non-Covid-19 hospital.[18]

In the present study, being a nurse, medical or social worker was related to higher ratios of having antibodies against Covid-19 than other occupations. Globally, it is not clear whether belonging to a specific professional group is a determining risk factor for the presence of antibodies against SARS-CoV-2. Following this line, in a study carried out in Finland the authors found no significant differences by profession, while in a Hospital in Madrid, Spain, it was observed that doctors were the most infected professional category (39.6%), followed by nursing assistants (33.7%), and nurses (31.2%).[27,28] In another study in Barcelona, they found that administrative workers had the lowest prevalence (6.5%), contrasting with what was reported for Peru, where administrative staff had the highest prevalence (98%).[21,29] In the present study, that people who worked in the laboratory were found to have the lowest prevalence, a result similar to that reported in Denmark, but in contrast with the results found in a hospital in India, where the laboratory personnel were more likely to be seropositive.[25,30]

Some risk factors that were not considered in this study were training in biosafety measures, and the proper use of PPE. It has been documented that proper use of PPE is essential to preventing transmission. For example, in a study from a university hospital in Madrid, Spain, they observed that the seropositivity rate among those who referred not having used the PPE properly was 42.0% compared to 27.6% among the cases that reported adequate use of PPE.[28] Therefore, evaluation of knowledge about good biosafety practices and appropriate use of PPE among HCW to prevent or minimize the transmission risk should be considered in further studies.

When estimating the prevalence of SARS-CoV-2 infection by detecting antibodies, there are some aspects that can influence the results, such as the seroconversion rate, the duration or permanence of the antibodies, and the type of test used. It has been observed that between 10 to 20% of people with a positive PCR test did not generate antibodies.[31,32] People with severe disease are more likely to have antibodies than those with mild or asymptomatic disease.[33,34] Moreover, seronegativiza-

tion is also usually higher among those with mild or asymptomatic infection.[35] Another important factor is the permanence of antibodies; a great variability has been documented in the rate of antibodies loss over time.[35-37] Likewise, regarding antibody detection, it is important to consider the viral protein that was used for the analysis. Seroprevalence studies have shown that not all those exposed to SARS-CoV-2 generate anti-S and anti-NCP antibodies simultaneously.[32] The tendency to seronegativization is greater for anti-NCP, while anti-S IgG antibodies remain more stable.[36]

Limitations of this study include the sample size, which did not allow an analysis stratified by occupation; selection bias: although all hospital workers were invited to participate, we do not know the characteristics of non-participants; and the lack of information on deaths among hospital health workers, which may lead to underestimation of seroprevalence.

In conclusion, epidemiological studies of seroprevalence can be useful to monitor the dynamics of the epidemic, as well as to analyze the risk of infection in groups occupationally exposed to the virus, such as health personnel. Physicians and nurses presented the highest seroprevalence and, in contrast, laboratory personnel the lowest. The seroprevalence found in the present study could be a combination of high-risk work activities and community exposure.

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