American Journal of Laboratory Medicine
2023; 8(2): 21-26
http://www.sciencepublishinggroup.com/j/ajlm
doi: 10.11648/j.ajlm.20230802.12
ISSN: 2575-3878 (Print); ISSN: 2575-386X (Online)

Seroprevalence of SARS-CoV-2 IgG Among Medical Care Providers in Sana'a Capital, Yemen, 2021

Elham Zeehrah*, Mohammed Al-Amad

Yemen Field Epidemiology Training, Ministry of Public Health and Population, Sana'a, Yemen

Email address:
drelhamabdullah@gmail.com (Elham Zeehrah), mohdalemad@yahoo.com (Mohammed Al-Amad)

*Corresponding author

To cite this article:
Elham Zeehrah, Mohammed Al-Amad. Seroprevalence of SARS-CoV-2 IgG Among Medical Care Providers in Sana'a Capital, Yemen, 2021. *American Journal of Laboratory Medicine*. Vol. 8, No. 2, 2023, pp. 21-26. doi: 10.11648/j.ajlm.20230802.12

Received: March 20, 2023; **Accepted**: May 29, 2023; **Published**: August 4, 2023

Abstract: Medical care providers (MCPs) have a higher risk of contracting infection SARS-CoV-2 during medical care provision to infected patients. This study determined the seroprevalence of SARS-CoV-2 IgG and associated factors among MCPs in Sana'a Capital. A cross-sectional study among MCPs of six of the main Sana'a Capital hospitals was conducted. Data were collected by a self-administered questionnaire that was 288 distributed to MCPs, and blood samples were collected from participants, and tested for SARS-COV-2 IgG antibodies. Data entered and analyzed by Epi info 7.2.4. Univariate logistic regression to determine the association, and calculate crude and adjusted prevalence odds ratio. P-value < 0.05 were considered statistically significant. 288 of MCPs were enrolled, 72% were males, 52% were <30 years old, 65% were married, 84% were nurses, 53% working at ICUs and 58% were from public hospitals. SARS-COV-2 IgG was detected in 242 with 84% overall prevalence among MCPs. It was significantly higher among MCPs at private hospitals than public hospitals and no significant difference according to other sociodemographic factors. IgG seroprevalence of SARS-COV-2 was high. Implementation of effective standards for infection prevention and control (IPC) with sufficient personal protective equipment. Further studies to assess IPC practices and to identify risk factors among MCPs-related SARS-COV-2 infection are required.

Keywords: SARS-COV-2, IgG Seroprevalence, Medical Care Providers, Yemen

1. Introduction

Medical care providers (MCPs) stand at the frontline for fighting the SARS-COV-2 pandemic that placed them at high risk of being infected with SARS-COV-2. A recent meta-analysis with 11 studies found that 10.1% of MCPs were SARS-COV-2 positive. This proportion varied substantially between countries as follows, China, 4.2%, Italy, 9%, USA, 17.8%, UK 31.6%. Contributing factors to increased MCPs exposure may include patient-to-MCPs transmission, MCPs-to-MCPs transmission, or increased contact exposure during travel to work [1, 2]. Understanding SARS-COV-2 prevalence and characteristics among MCPs is important; as it can identify areas or personnel that are at increased risk because of the vulnerability of the patients, who are more susceptible to infection and at risk of more serious outcomes It can also inform infection control policy in the hospital setting to mitigate infection rates [3]. The Coronavirus Disease 2019 (SARS-COV-2) is recently identified as a serious respiratory problem caused by the Novel Coronavirus subtype SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) [4], which was first reported in Wuhan, China in late December 2019 [5]. The coronavirus that causes SARS-CoV-2 is a betacoronavirus, an RNA virus of the family coronaviridae which are human and animal pathogens [6, 7]. SARS-COV-2 is suggested to have animal origins (probably from the Huanan seafood market in Wuhan). It has a similar genome structure (96%) to bat coronavirus, supposing that, emerging as a bat-borne virus [8]. Also, an intermediate animal reservoir such as the pangolin was suggested to be involved in its transmission to humans, but efforts to determine an intermediate host seem to fail until now [9, 10]. The basic idea about SARS-COV-2 infection is that it spreads through direct mucus contact with the breath/ingestion/salivary abscess of an infected person that can live on hands, objects, or surfaces in the past nine days [11]. The disease is highly contagious and characterized by

fever, cough, dyspnea, fatigue, myalgia, and anosmia [12]. Globally, the SARS-COV-2 pandemic is now a major health threat. Based on the WHO report on 21 October 2022, 623,893,894 confirmed cases have been reported in almost all countries and regions around the world, and case fatality rate was 1.05% [13]. In the Eastern Mediterranean Region, all countries in the region have been affected by the SARS-COV-2 pandemic. According to WHO by 17 October 2022, the total of confirmed cases of SARS-COV-2 was 23,124,739, case fatality rate was 1.5% [14].

In Yemen, the first confirmed case was on April 10th, 2020, and it was reported from the South of Hadramout governorate [15]. Up to 21 October 2022, a total of 11,939 cases were confirmed and the case fatality rate was 18.1% [16]. Many studies in different parts of the world have been conducted to determine the seroprevalence of SARS-COV-2 antibodies among MCPs. A study carried out in Oman, among 113 MCPs showed that 42 (37.2%) MCPs tested positive for SARS-COV-2 antibodies, with males and older ages were associated with a lower risk of acquiring SARS-COV-2 infection [17]. In Malaysia, showed zero seroprevalences among MCPs suggests a low incidence of undiagnosed SARS-COV-2 infection in our healthcare setting during the first local wave of SARS-CoV-2 infection [18]. In Saudi Arabia, a hospital-based study was conducted including 61 case hospitals and 24 control hospitals that had 9379 (74.3%) and 3242 (25.7%) MCPs respectively. The MCPs were from departments at high risk to get exposure to SARS-COV-2 cases: medicine, ICU, and emergency departments. It showed a 2.36% (299) overall positivity rate by immunoassay from the total 12621 MCPs with a significant difference between the case-hospital (2.9%) and the control group (0.8%) (P value <0.001) [19].

Various risk factors have been shown to position an increased transmission of SARS-COV-2 in various hospital settings. In Kuwait, being a nurse and prolonged glove use were associated with an increased likelihood of SARS-COV-2 infection [20].

In Yemen, however, the result of an outbreak investigation revealed a higher secondary attack rate for SARS-COV-2 among MCPs, seroprevalence studies for SARS-COV-2 among MCPs are limited [21]. It can also inform infection control policy in the hospital setting to mitigate infection rates [3]. Serological testing for MCPs in close contact with SARS-COV-2 patients will help to define the local transmission rate and infection-associated factors, especially asymptomatic or subclinical infections [22]. This study aimed to determine the seroprevalence of SARS-COV-2 IgG antibodies among medical care providers in the main Sana'a city hospitals, and to identify the demographics and occupational associated factors.

2. Materials and Methods

A cross-sectional study was conducted from July to October 2021 in Sana'a city, Yemen. The study was conducted at six of the main Sana'a city hospitals, Al-Gomhory, Palestine, and Al-Kuwait hospitals were the public hospitals. Al-Matukal, University of Science and technology hospital, and Yemen German hospital were private hospitals. The selection of those hospitals because these hospitals the main referral facility for all cases, and were they for quarantine and treatment of confirmed SARS-COV-2 patients, and have intensive care units for critical cases. Medical care providers (MCPs) were persons who receives SARS-COV-2 patients, and working in the departments of intensive care units and emergency departments, and where they considered as close contact with SARS-COV-2 patients and at high risk for getting an infection.

All MCPs who were working during the study period at intensive care units and emergency departments of the six hospitals were recruited. Inclusion criteria included MCPs who directly delivered care and services to SARS-COV-2 patients, as physicians or nurses, not receiving the vaccination against SARS-COV-2 and gave written consent for participation.

A predesigned self-administered questionnaire was distributed to be filled by MCPs. They were asked to answer questions on socio-demographic data (gender, age, occupation, education level, work experience, marital status), training on infection prevention and control (IPC), and their medical history of chronic diseases such as diabetes, heart disease, and hypertension. Blood collection, four ml of venous blood was collected from eligible participants by using vacuum containers. The specimens were kept at room temperature, allowed to clot, centrifugation at 3500 rpm for five minutes, isolation of serum was frozen at -20°C until analyses.

In laboratory procedures, an Enzyme Immuno-serpent assay was used for detecting IgG antibodies. The examination was carried out at the reference (General Al-Thawra hospital laboratory) by using Snibe instrument. MAGLUMI anti-SARS-CoV-2 S-RBD IgG (Snibe Diagnostics, New Industries Biomedical Engineering Co., Ltd [Snibe], Shenzhen, China) was used following the manufacturer's instructions. SARS-CoV-2 S-RBD IgG is a chemiluminescent immunoassay (CLIA) that determines IgG Ab against the RBD of the Spike (S) protein of the virus, in human serum or plasma. The manufacturer's index value of ≥ 1.00 AU/mL is interpreted as reactive, or non-reactive (index value <1.00AU/mL) based on the index values reported by the instrument.

Data was entered and analyzed using Epi info (Center for Disease Control and Prevention Atlanta, GA) version 7.2.4. The completeness and consistency of data were checked by running the frequencies of each variable. The dependent variable is the presence of antibodies to SARS-CoV-2 and the independent variables include demographic-related variables such as gender, age, marital status, education level, work experience, training on IPC, smoking behavior, and chronic diseases such as diabetes, heart disease, hypertension or other.

The proportion was used for categorical variables, mean with standard deviation in cases of normal distribution,

median and interquartile for continuous variables for no normally distributed variables. Univariate logistic regression was used to measure the association between SARS-CoV-2 seropositivity and categorical variables. While multivariate logistic regression was used to calculate crude, and adjusted prevalence odds ratio was conducted to determine factors associated with SARS-CoV-2 seropositivity. P-value <0.05 was considered as a cut-off point for statistical significance.

Clearance was granted from the ethical committee at Ministry of Public Health and Population. Approval was also obtained from each hospital director. Verbal assent was obtained from all participants before the initiation of data collection. All MCPs' information was coded and kept confidential (personal identifiers were used during data collection). MCPs were informed of their right to withdraw from the study at any time and assured that this will not affect the standard of health care provided to them. Feedback from the results of the study was given to MCPs.

3. Results

3.1. Demographic and Clinical Characteristics of Study Participants

Table 1 near to three-quarters (72%) were males, the median age was 29 the interquartile range from 18 to 60 years old and 65% were married. About Half (53%) were working in ICU departments and 58% were from public hospitals. Most of the participants (84%) were nurses, 47% had a diploma, a median of 5 (1-30) years of working experience, 68% received IPC training, 23% were smokers, and 7% had chronic diseases.

3.2. SARS-CoV-2 IgG Seroprevalence

Table 2 out of all tested 288 participants, 84% (242) were positive for SARS-COV-2 IgG. Of them, 72% were males, 55% were < 30 years old, 54% were from public hospitals, 52% worked in ICU, and 65% received training on IPC (table 2).

3.3. Factors Associated with Health Care Workers' Infection Status

Table 3 the result of univariate logistic regression in table 3 showed the prevalence odds of SARS-CoV-2 among MCPs were higher (POR 2.6, 95% CL; 1.3-5.5, p 0.005) in private hospitals compares to public hospitals, among non-smokers (POR 1.9, 95%CL; 1.0-3.9, p 0.04). Lower prevalence odds among workers who have received IPC training (POR*0.4* 95% CL; 0.2-0.9, P value 0.04) In multivariate analysis only the prevalence of SARS-COV-2 remained associated with private hospitals (POR 2.6 CI 95%: 1.2-5.8, P value 0.01).

Table 1. *Characteristics of study participants in the prevalence of SARS-COV-2 IgG, Sana'a city hospitals, Yemen, 2021 (n=288).*

	Characteristics	N	%
Gender	Male	208	72
	Female	80	28
Age, year	<30	150	52
	≥30	138	48
Marital Status	Married	186	65
	Single	102	35
Type of Hospital	Public	166	58
	Private	122	42
Ward	ICU	153	53
	ER	135	47
Occupation	Nurse	243	84
	Physician	45	16
Educational level	Primary/Secondary	25	9
	Diploma	134	47
	Bachelor's	102	35
	Master's / Doctoral degree	27	9
Work Experience	<5	141	49
	≥5	147	51
IPC Training	Yes	195	68
	No	93	32
Smoker	Yes	67	23
	No	221	77
Chronic disease	Yes	19	7
	No	269	93

Table 2. *Seroprevalence of SARS-COV-2 among medical care providers by participant's characteristics, Sana'a capital hospitals, Yemen, 2021.*

Characteristics		Positive 242 (84%)	Negative 46 (16%)
		N (%)	N (%)
Gender	Male	175 (72%)	33 (72%)
	Female	67 (28%)	13 (28%)
Age, year	<30	132 (55%)	27 (59%)
	≥30	119 (49%)	19 (41%)
Type of Hospital	Public	111 (46%)	11 (24%)
	Private	131 (54%)	35 (76%)
Ward	ICU	125 (52%)	28 (61%)
	ER	117 (48%)	18 (39%)
Occupation	Nurse	203 (84%)	40 (87%)
	Physician	39 (16%)	6 (13%)
Educational level	Primary/Secondary	21 (9%)	4 (9%)
	Diploma	111 (46%)	23 (50%)
	Bachelor's	89 (37%)	13 (28%)
	Master's/Doctoral degree	21 (9%)	6 (13%)
Work Experience	<5	121 (50%)	20 (43%)
	≥5	121 (50%)	26 (57%)

Characteristics		Positive 242 (84%)	Negative 46 (16%)
		N (%)	N (%)
IPC Training	Yes	158 (65%)	37 (80%)
	No	84 (35%)	9 (20%)
Smoker	Yes	191 (79%)	30 (65%)
	No	51 (21%)	10 (22%)
Chronic disease	Yes	226 (93%)	43 (93%)
	No	16 (7%)	3 (7%)

Table 3. *Univariate and Multivariate logistic regression for prevalence associated factors of SARS-COV-2 among medical care providers, Sana'a capital hospitals, Yemen, 2021.*

Characteristics	CPOR[1]		APOR[2]	
	OR (95% CI)	P value	OR (95% CI)	P value
Gender (male/female)	1.0 (0.5-2.0)	0.93	1.7 (0.7-3.7)	0.18
Age (<30/≥30)	0.7 (0.3-1.3)	0.32	2.0 (0.8-1.5)	0.09
Hospital (Private/Public)	2.6 (1.3-5.5)	0.005	2.6 (1.2-5.8)	0.01
Ward (ICU/ER)	0.68 (0.3-1.3)	0.25	0.7 (0.4-1.5)	0.51
Occupation (Nurse/Physician)	0.7 (0.3-1.9)	0.59	1.0 (0.3-2.7)	0.92
Work Experience (<5/≥5)	1.3 (0.6-2.4)	0.41	0.5 (0.2-1.2)	0.17
Diploma/ primary or secondary	1.2 (0.6-2.2)	0.6	0.9 (0.2-3.3)	0.98
Bachelors/ primary or secondary	0.6 (0.3-1.3)	0.3	0.8 (0.2-3.3)	0.86
Master/ primary or secondary	1.6 (0.6-4.2)	0.4	0.2 (0.03-1.6)	0.1
IPC Training (Yes/No)	0.4 (0.2-0.9)	0.04	0.5 (0.2-1.3)	0.18
Smoker (Yes/No)	1.9 (1.0-3.9)	0.04	2.1 (1.0-4.7)	0.05
Chronic Disease (Yes/No)	0.9 (0.2-3.5)	0.98	0.7 (0.1-2.8)	0.62

1. CPOR=Crude Prevalence Odd Ratio. 2. APOR= Adjusted Prevalence Odd Ratio

4. Discussion

Medical care providers may have a higher risk of exposure to SARS-COV-2 than the general population [23]. Seroprevalence studies on MCPs make it possible to assess the level of exposure, and indirectly, the effectiveness of the implemented protective measures [24].

This study was carried out in one of the Eastern Mediterranean Crisis countries, Yemen, particularly in the main Sana'a city hospitals to measure the seroprevalence of SARS-COV-2 and provide information on the exposure of MCPs to SARS-COV-2.

Our study included 288 MCPs who were working in six public and private hospitals in Sana'a city, 58% were from public hospitals, 72% were males, 52% were <30 years old, 84% were nurses and 53% were working in ICUs.

The result showed a prevalence of SARS-COV-2 among 84% MCPs who have worked in intensive care units and emergency departments. It was higher than many studies conducted in Egypt [25], Saudi Arabic [19], Boston [3], Spain [26], and London [2] have reported 40.2%, 2.36%, 5.5%, 10.3%, and 31.6% respectively. This might be explained by good adherence to infection prevention and control measures and appropriate use of personal protective equipment among MCPs in these countries. So the higher prevalence in our study could be due to unprepared healthcare facilities to cope with the SARS-COV-2 outbreak, as a result of war, and lacking the most basic resources and capabilities to face SARS-COV-2 [27]. As well as the asymptomatic transmission of SARS-COV-2 in which several asymptomatic patients can infect MCPs [22].

The findings in the univariate analysis showed a higher prevalence among workers at private hospitals than workers in public hospitals. It might be due to an overload in private hospitals because people prefer private hospitals for getting medical services, as they are well equipped and have qualified staff more than public hospitals.

Optimal personal protective equipment is still unknown, but the rigorous application of personal protective equipment measures and absolute adherence to all infection prevention and control measures are crucial to reducing nosocomial transmission of SARS-COV-2 [28-31]. Our result comes with this fact and showed lower seroprevalence among workers who received IPCs training. It was similar to the result of many studies conducted in Tokyo [32] and Malaysia [18].

However, a protective effect of smoking on the risk of infection is unlikely, our study showed significantly lower seroprevalence among smokers. This might reflect the influence of smoking on major components of both innate and adaptive immune cells [33]. Particularly, a decreased production of IgA, IgG, and IgM has been observed in smokers if compared with non-smokers [34].

Our findings showed no significant difference in seroprevalence of SARS-COV-2 IgG according to gender, age, occupation, and working ward. This result was similar to many studies conducted elsewhere in Egypt [25], Boston [3], Nepal [35], and New York City [36].

In multivariate analysis, the higher prevalence was among MCPs working in private hospitals compared to public hospitals. This might be providing an excellent ICU with modern equipment for SARS-COV-2 disease, but there are not available in public hospitals.

Strength and Limitations of the Current Study

Some limitations in our study include: the result of our study was limited by not calculating sample sizes. The study

was facility-based and cannot be generalized to the community. Since the time between exposure and antibody testing was unknown, the seropositivity may have been missed in the case of earlier testing.

5. Conclusions

The seroprevalence of SARS-COV-2 antibodies among MCPs was high, indicating that MCPs represent a population at considerable risk of contracting SARS-COV-2. Our study proved that serological testing is useful for the identification of asymptomatic SARS-COV-2 infection among MCPs who have close contact with SARS-COV-2 patients. Medical care providers in private hospitals were at higher risk to more than others. There was no statistically significant association between seropositivity and gender, age, or occupation. Medical care providers have a high risk of contracting SARS-COV-2, therefore, implementation of effective standards for infection prevention and control (IPCs) including sufficient personal protective equipment, early identification of asymptomatic carriers through IgA or IgM immunoglobulin isotypes, and isolation of infected MCPs with SARS-CoV-2 is imperative to decrease the risk of SARS-COV-2 infection. Further studies to assess infection control practices and to identify risk factors among MCPs-related SARS-COV-2 infection are required.

Author Contributions

Elham Zeehrah, MSc, Yemen Field Epidemiology Training Program, Ministry of Public Health and Population, Sana'a-Yemen. Mohammed Al-Amed; supervision. All authors have read and agreed to the published version of the manuscript."

Institutional Review Board Statement

The study has been: approved by the National Ethical Committee at the Ministry of Public Health and Population, Yemen The study has been conducted in accordance with the Declaration of Helsinki, and approved by the Eithics Committee of Ministry of Public Health and Population (protocol code 5151 and August 31 202.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Data are available upon reasonable request. We encourage those interested to contact the corresponding author.

Conflicts of Interest

Declare no conflict of interest.

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Acknowledgements

The authors would like to acknowledge the EMPHNET as well as the General Directorate of Surveillance and Disease Control at the Ministry of Public Health and Population for their support of the Y-FETP. Also, we thank the study participants who donated their blood samples for this project, and the healthcare workers who care for SARS-COV-2 patients.

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