COVID-19 among the Asymptomatic Healthcare Workers in the Tertiary Care Centers of the Southwestern Region of Saudi Arabia: Preventive and Protective Insights

Ahmed M. Al-Hakami, MD, Ph. D*,** Ali Al Bshabshe, MD*** Abdullah M. Alkahtani, Ph.D* Abdullah A. Alsabaani, MD**** Shehata F Shehata, Ph. D****,***** Hosam H Omar, MD****** Riyadh A Mousa, MSc* Mohammed A Dabaan, MD******* Ahmad M Alamri, Ph.D********,********, Abdullah Algarni, MD********** Abdelwahid Saeed Ali, Ph.D*

ABSTRACT

Background: COVID-19 pandemic has sent serious waves of medical emergency all over the world. Healthcare workers (HCWs) are vulnerable to the infection through various patient care processes. As the pandemic advances, it becomes necessary to screen the asymptomatic HCWs for COVID-19 as they constitute potential sources for the disease transmission.

Objectives: To screen for the incidence of COVID-19 among asymptomatic HCWs in the tertiary care centers in the Southern regions of Saudi Arabia using both RT-PCR and serology.

Methods: A cross-sectional, hospital-based study was conducted to determine the incidence of COVID-19 among the asymptomatic HCWs using RT-PCR and serological assays among 186 consented participants.

Results: The total number of COVID-19 cases among the participants using all tests was 34 (18.3%). Out of the total participants, 4.8%, 3.2%, 7%, 10.2%, and 11.8% positive COVID-19 cases were detected using RT-PCR, rapid ICT for IgG, rapid ICT for IgM, ELISA for IgG and ELISA for IgM respectively. Significantly higher cases were observed among HCWs in the ICU of Aseer Central Hospital. 100% of the medical students and administrative staff, 40% of respiratory therapists, 31.8% of laboratory specialists, 22.7% of cleaners, 13.5% of physicians, 12.2% of nurses participated were positive to COVID-19. Participants of 18-24 years old showed the highest level of cases. However, considering the total number of positive COVID-19, nurses showed the highest number of cases.

Conclusions: Considerable number of COVID-19 cases were detected among HCWs in the Southern region of KSA. Screening of HCWs should have the priority in the preventive interventions.

Keywords: COVID-19; HCWs; RT-PCR; serology; Saudi Arabi

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*	Department of Microbiology and Clinical Parasitology College of Medicine, King Khalid University Saudi Arabia. E-mail: abumalaz2002@gmail.com
**	Stem Cell Unit College of Medicine, King Khalid University
***	Department of Medicine College of Medicine King Khalid University
****	Department of Family and Community Medicine College of Medicine, King Khalid University
*****	High Institute of Public Health Alexandria University Alexandria Governorate, Egypt
******	Critical Care Fellow Ministry of Health Aseer Central Hospital, Saudi Arabia
*******	Serology Laboratory Ministry of Health Aseer Central Hospital, Saudi Arabia
********	Department of Clinical Laboratory Sciences College of Applied Medical Sciences King Khalid University, Saudi Arabia
*********	Cancer Research Unit King Khalid University Saudi Arabia
**********	Family and Community Medicine Department, Aseer Central Hospital

INTRODUCTION

COVID-19 is a viral respiratory infection caused by an emerging novel coronavirus named severe acute respiratory syndrome coronavirus virus 2 (SARS-CoV-2)[1]. This virus was first reported from Wuhan, the capital city of Hubei province of China, in late December of 2019, with speculation of an animal source[2]. Following genomic and biological studies, the virus was confirmed belonging to the genus *Betacoronavirus*[3]. COVID-19 was firstly impacted China with a massive epidemic, then rapidly spread to cause global pandemic with high infectivity rates among human populations worldwide[4-6]. The rapid virus spread associated with this pandemic was attributed to the human movements throughout the globe[7,8]. The clinical manifestations of COVID-19 included fever, dry cough, dyspnea, shortness of breath (SOB), myalgia, fatigue, and pneumonia with some variations among the affected individuals[7]. Other symptoms included dizziness, generalized weakness, vomiting, and diarrhea were also observed in some circumstances[8]. Deaths among COVID-19 patients were directly correlated with the occurrence of acute respiratory distress syndrome (ARDS)[9].

Although the virus was proved to be pathogenic for all age groups of people, however, several epidemiological studies indicated the disease severity and fatalities are higher among the elderly[10], individuals with underlying health comorbidities[11,12], and lower among the children[13]. It had also been confirmed that immunosuppressed individuals and those suffering from chronic diseases, such as diabetes mellitus, hypertension, cardiovascular and pulmonary diseases, are more likely to develop serious and fatal COVID-19 infection[14]. COVID-19 was also confirmed to have an asymptomatic course in some infected individuals[5,15,16]. It had been known that the asymptomatic patients constituted about one fifth of those exposed to the virus[15]. The asymptomatic cases of COVID-19 were particularly noted and reported among the various specialties of healthcare workers (HCWs)[17,18]. Therefore, screening of HCWs for COVID-19 is critical for protecting those who had closed contacts with them from contracting the infection.

Although many studies were carried out in Saudi Arabia to investigate the epidemiological and clinical outcomes of the COVID-19, as well as to assess the therapeutics and preventive measures[19-21]. Although several studies regarding different scientific elements about COVID-19 among HCWs in Saudi Arabia were carried out[22-24], there was no assessment for the distribution and incidence of the disease among the HCWs was reported. It had been confirmed in many countries of the world that HCWs are among the groups of people who are at highest risk to COVID-19 as they have direct contacts with the patients[25,26]. Among the HCWs, medical staff, mainly physicians, considered in the first line of the communities to contract the infection from their patients and pass it to their families and others in their vicinities[27]. Laboratory technicians[28], nurses[29], pharmacists[30], biomedical engineers, and sanitary workers[31] were also known putting themselves under high risk to COVID-19.

In this scientific communication, we assessed the exposure of the asymptomatic HCWs to COVID-19 in the tertiary centers in the Southern regions of KSA. This is the first report about the occurrence of the disease among the asymptomatic HCWs in Saudi Arabia.

MATERIALS AND METHODS

Participants: A cross-sectional hospital-based study was conducted on randomly selected and consented 186 representative samples of asymptomatic HCWs working in Aseer Central Hospital (ACH), specialized health center and the regional laboratory in the Southern region of Saudi Arabia. The participants were randomly selected irrespective to the gender, age, specialization, place of residence, and place of work. They included physicians, residents, medical students, nurses, respiratory therapists, cleaners, cleaners' supervisors, medical engineers, administrators, housekeepers, laboratory radiology specialists and laboratory specialists. The baseline characteristics of the participants were demonstrated in Table 1. Aseer Central Hospital is located in Abha, the capital city of Aseer region, Southern of Saudi Arabia, is the main tertiary care hospital in the region. It is a 500-bed and JCI accredited. It serves around 1.8 million of the population.

Table 1: Gender distribution, N=54 children with nocturnal enuresis

Personal data	Number of the participants	Percentage of the specified item
Gender		
Male	80	43.0%
Female	106	57.0%
Age		
18-24	4	2.2%
25-34	94	50.5%
35-44	49	26.3%
45-54	31	16.7%
55-64	8	4.3%
Specialization		
Student/ resident	1	0.5%
Physician	37	19.9%
Nurse	82	44.1%
Cleaner/ porter/ supervisor	22	11.8%
Medical engineer	5	2.7%
Administrative/clerk	2	1.1%
Housekeeper	2	1.1%
Respiratory therapist	10	5.4%
Lab. radiology specialist	3	1.6%
Lab. specialist	22	11.8%
Place of work		
ACH- ICU	126	67.7%
PFKCC	34	18.3%
Regional laboratory	26	14.0%
Years of experience		
Trainee	19	10.2%
< 10 years	94	50.5%
11-20 years	66	35.5%
> 20 Years	7	3.8%
Residence city		
Abha	154	82.8%
Muhayel Aseer	1	0.5%
Khamis Mushait	30	16.1%
Jazan	1	0.5%

Abbreviations: ACH= Aseer Central Hospital; ICU= Intensive Care Unit; PFKCC= Prince Faisal bin Khalid Cardiac Centre

Participants' Selection and Sampling: The targeted participants in this study were first screened and tested for the suggestive COVID-19 symptoms from October 2020 through February 2021. An informed consent was given to the targeted participants. Those who were proven symptomless, at the time of the study, were requested to respond to a self- administered questionnaire. The factors related to COVID-19 infection among the participants given in the questionnaire is shown in Table (2). Blood samples and nasopharyngeal swabs were then collected from all the participants as described below.

Table 2: Factors related to COVID-19 infection among health care participants in the study areas

Factors related to COVID-19 infection	No of participants	Percentage of the specified item
How do you see your commitment to the safety precautions?		
Good commitment*	93	50.0%
Strict commitment	72	38.7%
Acceptable commitment	21	11.3%
Risk factors for COVID-19		
Travelled outside your work/residence area in the past two weeks?	42	22.6%
Contact with people who had COVID-19 during the past two weeks?	136	73.1%
Wear protective masks while working?	183	98.4%
Wear protective gloves while you work?	171	91.9%
Use hand sanitizers before and after dealing with patients?	178	95.7%
Wash hands before and after dealing with patients?	169	90.9%
Have chronic diseases such as hypertension/diabetes?	30	16.1%
Use immunosuppressive drugs?	6	3.2%
Have respiratory diseases?	10	5.4%
Smoking index		
Smoker	18	9.7%
Non-smoker	168	90.3%

* The commitment components targeted included; physical distancing, use of face masks and use of hands sanitizers.

Collection of Blood Samples: All the internationally registered safety measures for blood sampling were considered. From each participant, five ml of venous blood was aseptically collected into serum separator tubes (BD, New Jersy, USA). Blood samples were left for 30 minutes at room temperature to clot and centrifuged at 1000g for 10 minutes. Serum samples were aliquoted and kept at -80ºC. Before the test aliquots were thawed and put on ice until the time of the test.

Collection of Nasopharyngeal Secretions: Synthetic fiber swabs with plastic shafts (Citotest Labware Manufacturing Co, Haimen, China) were inserted into the nostril of the participant parallel to the palate and left in place for few seconds to absorb the secretions. The swab was then placed into a sterile tube containing 2-3 ml of viral transport media. The swabs were transported in cooled ice boxes to be tested for SARS-CoV-2. If cannot be tested immediately, swabs would be stored at -80ºC. As the nasopharyngeal swabs are considered hazardous at all times, the guidelines set by the WHO for collection and preservation of specimens for the diagnosis of avian influenza virus infection in 2006 were considered.

Laboratory Investigations:

Rapid ICT: The collected sera were tested for the presence of SARS-CoV-2- specific IgG and IgM antibodies using Onsite™ rapid test kit (CTK biotech Inc, CA, USA). Ten µl of the serum sample were added to the test device, followed by immediate addition of 2 drops of the detection buffer and the results were read after 15 minutes.

ELISA: An indirect ELISA commercially available kit (Vircell, Granada, Spain) was used for the detection of SARS-CoV-2- specific IgG and IgM antibodies. Hundred µl of the diluted (1:100) test sera and controls were added to the corresponding wells in the plates. The plates were sealed and incubated at 37°C for 45 minutes. Plates were removed from the incubator and washed five times before an amount of 100 µl of IgG and IgM conjugates were added and the plates were sealed again and incubated at 37°C for 30 minutes. The plates were then washed again and 100 µl of the substrate solution were added to all wells and left for 20 minutes at room temperature, followed by addition of 50 µl of stop solution and all wells were read at 450/620 nm using the ELISA reader (Humareader, Human company, Wiesbaden ,Germany).

RT-PCR: RNA was prepared according to the instructions provided by the manufacturer of the preparation system used (QIAamp® Viral RNA Mini Kit; Qiagen). Extraction of viral RNA from the collected nasopharyngeal secretions was made using MagNA Pure 96 system (Roche, CA, USA). Real-time RT-PCR for SARS-CoV-2 was employed using the commercially available kits (Altona diagnostics, Hamburg, Germany). Briefly, 20 µl of the master mix (5 µl mix A + 15

Table 3: RT-PCR and serological assays findings for COVID-19 among the total asymptomatic health care workers participants in the study areas

Test employed	No of cases	Percentage of cases
RT- PCR		
Positive	10*	5.4
Negative	176	94.6
Rapid ICT for IgG detection		
Positive	6	3.2
Negative	180	96.8
Rapid ICT for IgM detection		
Positive	13	7.0
Negative	173	93.0
ELISA for IgG detection		
Positive	19	10.2
Negative	167	89.8
ELISA for IgM detection		
Positive	22	11.8
Negative	164	88.2

* The number of the participants positive to COVID-19 infection among all tested by the specified test.

Abbreviations: RT-PCR= Reverse transcription-polymerase chain reaction; ICT= Immunochromatography test; ELISA= Enzyme linked-immunosorbent assay

Table 4: Distribution of COVID-19 cases as detected by RT-PCR and for total cases (detected by RT-PCR and serology) according to the different correlates of HCWs participants

Factors	Items	Categories	RT-PCR positive cases			Total positive cases		
			No	*%*	*P-value*	*No*	*%*	*P-value*
Personal factors	Gender	Male	6	7.5%	*0.264*	19	23.8%	*0.094*
		Female	4	3.8%		15	14.2%	
	Age	18-24	0	0.0%	*0.161*	2	50%	*0.377*
		25-34	5	5.3%		15	16%	
		35-44	1	2.0%		10	20.4%	
		45-54	4	12.9%		6	19.4%	
		55-64	0	0.0%		1	12.5%	
	Specialty	Student/ resident	0	0.0%	*0.247*	1	100%	*0.004**
		Physician	3	8.1%		5	13.5%	
		Nurse	2	2.4%		10	12.2%	
		Cleaner/ porter/ supervisor	2	9.1%		5	22.7%	
		Medical engineer	0	0.0%		0	0.0%	
		Administrative/clerk	1	50%		2	100%	
		Housekeeper	0	0.0%		0	0.0%	
		Respiratory therapist	1	10%		4	40%	
		Lab radiology specialist	0	0.0%		0	0.0%	
		Lab specialist	1	4.5%		7	31.8%	
Work related factors	Place of work	ACH	8	6.3%	*0.295*	25	19.8%	*0.016**
		PFKCC	0	0.0%		1	2.9%	
		Regional laboratory	2	7.7%		8	30.8%	
	Years of experience	Trainee	0	0.0%	*0.631*	0	0.0%	*0.029**
		<10 years	6	6.4%		15	16%	
		11-20 years	4	6.1%		16	24.2%	
		>20 years	0	0.0%		3	42.9%	
	How do you see your commitment to the safety precautions?	Good commitment	7	7.5%	*0.046**	15	16.1%	*0.411*
		Strict commitment	0	0.0%		13	18.1%	
		Acceptable commitment	0	0.0%		0	0.0%	
		No commitment	3	14.3%		6	28.6%	
Infection control factors	Have you travelled outside your work/ residence area in the past two weeks?	Yes	4	9.5%	*0.167*	22	15.3%	*0.049**
		No	6	4.2%		12	28.6%	
	Do you had contact with people who had COVID-19 during the past two weeks?	Yes	7	5.1%	*0.819*	24	17.6%	*0.713*
		No	3	6%		10	20%	
	Do you wear protective masks while working?	Yes	10	5.5%	*0.677*	34	18.6%	*0.409*
		No	0	0.0%		0	0.0%	
	Do you wear protective gloves while you work?	Yes	8	4.7%	*0.154*	31	18.1%	*0.857*
		No	2	13.3%		3	20%	
	Do you use hand sanitizers before and after dealing with patients?	Yes	9	5.1%	*0.361*	32	18%	*0.615*
		No	1	12.5%		2	25%	
	Do you wash hands before and after dealing with patients?	Yes	9	5.3%	*0.923*	30	17.8%	*0.557*
		No	1	5.9%		4	23.5%	
Other factors	Do you have chronic diseases such as hypertension/diabetes?	Yes	0	0.0%	*0.154*	7	23.3%	*0.434*
		No	10	6.4%		27	17.3%	
	Do you use immunosuppressive drugs?	Yes	0	0.0%	*0.553*	1	16.7%	*0.917*
		No	10	5.6%		33	18.3	
	Do you have respiratory diseases?	Yes	0	0.0%	*0.650*	4	40%	*0.173*
		No	10	5.8%		30	17%	
	Smoking index	Non-smoker	7	4.2%	*0.025**	30	17.9%	*0.649*
		Mild	3	16.7%		4	22.2%	

Percentages were calculated as the positive cases out from the total participant with the specified factor as in Tables 1 & 2; ACH= Aseer Central Hospital; PFKCC= Prince Faisal bin Khalid Cardiac Centre

*P value= Exact probability test; * P < 0.05 (significant)*

Table 5: Summary for the individual COVID-19 positive cases among the health care workers participated in the study

ELISA results		Rapid ICT results		PCR results	Contact with COVID-19 patients	Age group	Sex	Participant code	Place of work
IgM	IgG	IgM	IgG						
+	+	+		+	•	25-34	F	C 002	ICU- ACH
	+				•	25-34	F	C 004	
+					•	25-34	F	C 008	
+					•	35-44	F	C 009	
+				+	•	25-34	M	C 010	
+					•	35-44	F	C 020	
	+	+	+		•	35-44	M	C 021	
				+	•	45-54	F	C 025	
+	+	+				25-34	M	C 034	
	+	+			•	25-34	F	C 035	
				+	•	45-54	M	C 040	
	+			+	•	45-54	F	C 053	
+	+	+	+			55-64	F	C 057	
+	+	+			•	35-44	F	C 065	
	+			+	•	25-34	M	C 067	
+	+	+	+		•	45-54	F	C 072	
	+				•	35-44	M	C 074	
	+	+			•	25-34	M	C 088	
+	+	+	+		•	45-54	F	C 089	
+					•	18-24	M	C 145	
	+				•	35-44	M	C 146	
+					•	35-44	F	C 151	
+	+		+	+	•	25-34	F	C 158	
+					•	25-34	M	C 159	
				+		25-34	M	C 160	
+	+	+			•	35-44	M	C 161	
		+				25-34	M	21	Regional laboratory
+						25-34	M	94	
+	+			+		35-44	M	95	
+	+	+	+			25-34	M	96	
+						35-44	M	97	
+						25-34	M	98	
+				+		45-54	M	99	
+	+	+			•	18-24	F	C 125	PFKCC

Abbreviations: ICU-ACH = Intensive care unit of Aseer Central Hospital; PFKCC= Prince Faisal bin Khalid Cardiac Centre. The regional laboratory is located at Abha city which is the capital city of Aseer region (Souther region of KSA)
+= Participants positive to COVID-19 using the specified test; •= Participants had previous contacts with COVID-19 patients.

µl mix B) were mixed by multiple inversion (without vortex) and added to 10 µl of the samples. This mixture was thoroughly pipetted up and down for several times. Positive and negative controls were also included in the reaction plate and centrifuged for 30 seconds at 1000g. The reaction plate was then sealed and incubated in the LightCycler® instrument II (Roche, CA, USA) and programmed according to the kit instructions.

Data Analysis: All data were extracted, revised, coded, and fed to the statistical software IBM SPSS version 22 (SPSS, Inc. Chicago, IL, USA). Statistical analysis was done using the two-tailed tests. P value less than 0.05 was considered significant. Descriptive analysis based on the frequency of occurrence and percent distribution was done for all variables including HCWs personal data, RT-PCR, serology findings and clinical manifestations. Cross-tabulation was used to assess the distribution of HCWs serological findings by their personal and work-related data.

Ethical Approval: The research issues related to human use complied with all the relevant national regulations and institutional policies, and in accordance with the tenets of the Helsinki Declaration. They were approved by the Regional Committee for Research Ethics, Directorate Health Affairs, Aseer Region, Saudi Arabia (Number: REC-02-06-2020).

RESULTS

COVID-19 Cases as Detected by RT-PCR, Rapid ICT and ELISA: The number of SARS-CoV-2 positive cases using different tests are shown in Table 3. Out of the 186 participants, 5.4%, 3.2%, 7%, 10.2%, and 11.8% of positive cases were detected using RT-PCR, rapid ICT for IgG, rapid ICT for IgM, ELISA for IgG and ELISA for IgM detection respectively. The ELISA test for detection of IgM revealed the highest number of cases (11.8%) while the rapid ICT for detection of IgG revealed the lowest number of cases among the HCWs participants (3.2%).

Details of COVID-19 Cases Among the HCWs Participants: The distribution of the COVID-19 cases detected by RT-PCR and the total

number of cases are demonstrated in Table 4. Considering RT-PCR results, there are no significant variations observed among participants with reference to their gender, age groups, specialties, place of work, years of experience, infection control factors, or among those suffering either from chronic or respiratory diseases and those who use immunosuppressive drugs. However, significant differences among the positive participants were observed as per the factors of commitment to the safety precautions and smoking ($P < 0.05$). Considering the total cases of results (detected by both PCR and serology), the significant differences were observed among the HCWs with the different specialties, place of work, years of experiences and those who travelled outside the residence and work areas during the pandemic ($P < 0.05$) (Table 4). Participants of 18-24 years old showed the highest level of COVID-19 cases while those of 55-64 years old showed the lowest level. The laboratory specialists and the cleaners showed significantly higher level of positive cases ($P < 0.05$) in contrast to the other HCWs participated in the study. However, the highest number of the total positive cases were observed among the nurse group of the HCWs. The significantly ($P < 0.05$) higher number of positive cases were also noted among the participants working in the ICU of ACH as compared to those working in the regional laboratory and the PFKCC.

The detailed summary for the individual COVID-19 cases among the HCWs participated in the study is shown in Table 5. A total of 34 (18.4%) of COVID-19 cases was detected among the HCWs participants using the three tests. Out of these positive cases, 26 (76.5%), 7 (20.6%) and 1 (2.9%) were detected among those working in the intensive care unit of Aseer Central Hospital (ICU- ACH) in Abha city, regional laboratory and Prince Faisal bin Khalid Cardiac Center (PFKCC) respectively. Based on the participant's specialization, 10 (29.4%), 7 (20.6%), 4 (11.8%), 4 (11.8%), 4 (11.8%), 2 (5.9%), 2 (5.9%) and 1 (2.9%) of the total positive cases were nurses, laboratory specialists, physicians, respiratory therapists, cleaners, cleaner supervisors, administrators and resident respectively. A number of 19 (55.9%) male and 15 (44.1%) female cases were noted. A 24 (70.6%) of the positive participants had previous contacts with COVID-19 patients while 10 (29.4%) of them had no previous contacts.

Factors Affecting COVID-19 Infection Among the HCWs: The factors related to COVID-19 among the HCWs participants and their effects in the disease occurrence are summarized in Table 4. Before the tests, 50% of the total number of the participants were reported having good commitments to the safety precautions (Table 2). However, after using the RT-PCR, significant number of the cases were observed among those who had no commitments to the safety precautions and among the smoking HCWs ($P < 0.05$) (Table 4). The participants who travelled outside their work/residence areas in the past two weeks also showed significantly higher cases compared to those who didn't travel ($P < 0.05$). Other risk factors to COVID-19 were seen without significant differences among the participants to these factors ($P < 0.05$) as shown in Table 4.

The complains mentioned by the participants that they had before two weeks of the study phase are summarized in Figure (1). They included general fatigue, dry cough, arthralgia, and shortness of breath (SOB), fever and loss of smell or taste. These complaints had different levels of occurrence among the participants. A 31.2% of total HCWs participants had general fatigue as major complain while 8.1% of them had loss of smell and taste as minor complain.

DISCUSSION

Nowadays, COVID-19 constitutes global public health concerns among all professionals worldwide. Health care workers (HCWs) and the subordinates considered in the front-line of exposure to the infection as compared to the general communities. The issues of these groups of people in the community having the priority in contracting the infection, through direct and indirect contacts with the patients and infectious materials, and the measures for the protection of them were addressed and discussed in several previous studies[20,25,32]. On the contrary, HCWs were also known posing great threats to the other populations in the communities as they were seen manifesting an asymptomatic form of the disease[32,33]. In this communication, we investigated the incidence of COVID-19 among HCWs in the Southern region of KSA as first report. The detection of the infection was employed using the global

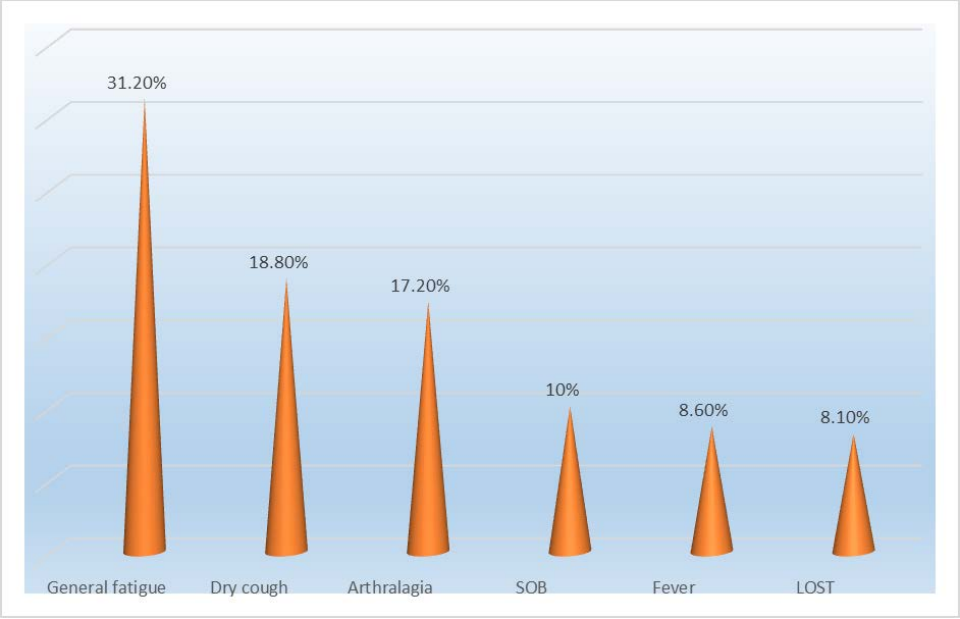

Figure 1: Complaints of the HCWs participants they had before two weeks of the study phase

** They expressed that they experienced the symptoms since two weeks before the study phase.*

** Percentages were calculated out of the total participants who informed had symptoms before the study phase (as registered in the questionnaire).*

** **Abbreviations:** SOB= Shortness of breath; LOST= Loss of smell and/ or taste*

standard test of RT-PCR and some serological assays with the purpose of evaluating the efficiency of these tests to detect the asymptomatic and past infections among the participants.

Primarily, the commitments of the HCWs to the safety precautions and other risks factors related to COVID-19 were targeted and evaluated. Generally, before testing them a significant number ($p< 0.05$) of participants were known having good commitments and adherence to the safety precautions. Additionally, the other risk factors associated with COVID-19 acquisition and complications were all extracted (Table 2). That is extremely important as it had been recommended that HCWs should be adequately acquainted with these factors and their role in the disease occurrence[34]. Furthermore, the complaints and symptoms of the participants from which they are suffering before the last 15 days of the study phase were also recorded in the questionnaire designed for the purpose of this study. Although all the participants are asymptomatic at the time of the study, we requested them to inform about the symptoms they may had experienced in the past. The recorded symptoms included fever, dry cough, SOB, fatigue, arthralgia, and loss of smell and taste. These symptoms were totally or partially recognized and considered as indication of COVID-19 infection[7,8]. Nasopharyngeal swabs sampling for the virus detection using RT-PCR was then carried out for the asymptomatic HCWs participated in the study. If these asymptomatic participants had previously suffered from symptoms suggestive for the disease, this may be an indication of their exposure to the virus in the past. Because of this possible previous exposure to the virus, we also subjected all of the participants to blood sampling for serological analysis.

The results obtained in this study also showed that the ELISA used for the detection of the virus-specific IgG and IgM picked out the highest number of positive cases among the tested HCWs as compared to the RT-PCR and ICT. This may partly be attributed to the false negative results obtained by the PCR[32] or it may also be attributed to the complete clinical recovery of these individuals and they are no longer shedding the virus in their secretions. These findings look necessary for ELISA being proposed for the test of the infection for the apparently healthy individuals like these asymptomatic HCWs. Similar conclusion about the use of ELISA to screen the medical staff and people who had contacts with the COVID-19 patients was previously reported[35]. The rapid ICT also detected some cases but lower than those detected by ELISA. This looks conformable with similar previous studies findings where the sensitivity of the rapid ICT to diagnose COVID-19 among the clinically ill patients was much lower than required, with reference to the standard PCR[36]. That should be pretty true for the recently infected individuals. However, we still believe this test can be used for the asymptomatic HCWs as it is characterized by a potential of rapid diagnosis for COVID-19.

Our study also showed that out of the total number of HCWs participants, 18.3% are exposed to the virus through their contacts with the patients or infectious materials. This result is almost comparable to the findings obtained in previous similar studies. In some European countries, it had been estimated that about 10% of all those infected with COVID-19 are belonging to the HCWs[37]. It had also known that HCWs are experiencing high levels of morbidities and mortalities due to COVID-19 in Italy during the heavy blow of the pandemic[38]. In another comprehensive study, included large number of people in UK and USA, it had been reported that at least three-fold increased risk of COVID-19 among the frontline HCWs was estimated as compared with the general community[25]. This suggests HWCs should always be given priorities of attention for protection. Many studies had also been carried out to screen for the transmission of the COVID-19 to HCWs. None of them described the sources of infection (e.g. ICUs, laboratories, health centers). We assume this is the first study targeted the incidence of the disease among HCWs with reference to the source within the health systems. The proportions of the participants infected with COVID-19 and related to ICU is significantly higher ($p< 0.05$) than those serving in the regional laboratory and PFKCC in the study area. Again, this is the first study highlighted the ICU as a potential source of infection to the health practitioners in the study area and in the region at large. It is much acceptable idea having the highest number of COVID-19 cases originated from the ICU as they deal with the most critically ill patients. This finding necessitates that the ICU practitioners must receive an utmost attention in terms of infrastructure and staff management to avoid the nosocomial infection with the disease. Similarly, the ICUs have also been known to constitute a great risk of infection for the HCWs during the epidemics of human coronavirus-SARS-1[39] and human coronavirus-MERS[40].

The results obtained also showed that nurses constitute the group of HCWs who had the highest number of COVID-19 cases among all clinical staff and the other groups of specialties. Previous studies indicated almost similar findings[26,41]. Nurses are working in close contacts with the patients thus expected to have high vulnerability to COVID-19 infectivity. The safety of these workforce seems of utmost necessity and the establishment of hospital-based protocols to reduce the risk of their infections, and interactions with the patients, for their protection is extremely important. Beside the nurses, medical students and physicians had also showed significantly high number ($p< 0.05$) of COVID-19 cases in this study. This might be due to the low number of participants with these specialties involved in the study. On another note, the acquisition of these HCWs to the virus is more likely to occur as they may had direct contact with the infected individuals. Additional important note indicated that the administrative staff participated in the study showed 100% infection with COVID-19. They may had low commitment to the health precautions and awareness. It is also logical to see most of them acquiring the infection as they do not have an adequate medical background and knowledge like the physicians and nurses. It is, therefore, special attention for such group of people as per awareness and education seems of an utmost importance also. The results obtained in this study also revealed that participants of 18-24 years old showed the highest level of positive cases, as compared to the other age groups of participants, while those of 55-64 years old showed a relatively low level. Although different number for the different age groups of HCWs were participated in the study, but the findings indicated that the more senior health care providers are less likely to contract the infection. An almost comparable results were previously observed and published[42].

Although it is difficult to draw a valid conclusion form this hospital based cross-sectional study as to the association between the risk factor and health outcome, we still believe that our attempt to screen for the incidence of COVID-19 among the asymptomatic HCWs in the study area can shed some light on the subclinical transmission of the disease. It may also become beneficial for evaluating the protective measures and decisions made regarding the staffing and protection of HCWs during the pandemic.

CONCLUSION

Considerable number of COVID-19 cases among the asymptomatic HCWs volunteers participated in the study were observed; particularly among those serving in the ICU of ACH in Abha city, Southern region of Saudi Arabia. Nurses constituted the highest group of HCWs who contacted the infection. Serological tests, including ELISA and ICT, were used and succeeded to pick out some positive cases. To reduce the risk of infection for these groups

of people, we propose regular testing of them using both RT-PCR and serology.

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