Original article

The Impact of health care worker's knowledge and attitude on their COVID-19 infection risk

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A R T I C L E I N F O

A B S T R A C T

Background: High number of losses may occur among health care workers (HCWs) who are the key contributors in the COVID-19 battle. **Objectives:** To explore the base-line knowledge and perception of HCWs who will join working in our isolation unit, correct the wrong believes and investigate their safety at the end of their quarantine period. **Method:** The study was implemented on 206 HCWs [133 nurses, 28 physicians, 8 pharmacists, and 37 technicians and housekeepers] by assessing HCW's knowledge and attitude via on-line questionnaire, improve misconceptions via health care program prior to start their work in the unit and inspect the COVID-19 infection by laboratory and radiological investigations. The inclusion criteria were being HCWs in the isolation unit of COVID-19, National Liver Institute, Menoufia University, Egypt for in the period from of June 10th to August 10th, 2020. **Results**: Base-line questionnaire results revealed good knowledge and positive attitude of HCWs towards 16-COVID-19 items in spite of ignoring the incubation period of the disease**.** There was significant positive attitude of the HCWs groups, and the total group attitude showed a significant good knowledge score. Health care workers had highly significant good knowledge score and positive attitude towards the importance of training on personal protective equipment (PPE) donning and doffing. Continuous health education on infection control practices and importance of social distancing during the isolation period was emphasized. At the end of the quarantine period, the infection rate was 5.8%. The HCWs with positive SARS-CoV-2 showed negative COVID-Ab results, significant changes in their C-T scan findings and lab findings. **Conclusion:** Health care workers with good knowledge, perception and who follow strict precautions in an isolation unit are the basis of success in winning the battle against SARS-CoV aiming at keeping HCWs safety with optimum patient care and less harm to the health facilities.

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), an enveloped RNA virus, belongs to the *Betacoronavirus* genus and the *Coronaviridae* family. It causes the coronavirus disease 2019 (COVID-19) disease pandemic all over the world [1]. The disease was first identified during 2019 in Wuhan, China's Hubei province's capital, and results in the ongoing 2019–2020 coronavirus pandemic. The first COVID -19 case was detected in Egypt on February 14th, 2020 [2]. Coronavirus

disease 2019 spread is rapid, and mostly occurs by close contact to infected individuals. Community-acquired cases may occur without a known source of infection. The challenges of social distancing, containment, isolation and protection of health care workers (HCWs) increase hospital's burden [1].

Healthcare workers (HCWs) are the front-line defense against COVID-19. Inadequate knowledge and incorrect attitudes among HCWs can directly influence their practices and consequently lead to inappropriate infection control practices, and thereby further spread of the disease [3]. During COVID-19 pandemic, a large number of patients with suspected infection swarm into the hospitals, the examination workload sharply increases, and the staff becomes overloaded. Transmission of SARS-CoV-2 mostly occurs through respiratory droplets and close contact transmission. Therefore, the possibility of aerosol transmission is increased due to high concentration of aerosol for a long time in a relatively closed hospital environment [4].

Because HCWs are at increased risk for infection, they need specific requirements for their protection to ensure the functioning of the basic healthcare system, including the availability of general practitioners (GPs). Understanding the transmission risk is important for determination of protective measures in healthcare setting [5]. It has been reported that both symptomatic and asymptomatic COVID-19 cases have the same transmission risk. A far greater portion of the population are exposed to the virus by contact with asymptomatic individuals and thus increases the late COVID-19 diagnosis and enhance the mortality [6]. Therefore, it is crucial to identify and isolate asymptomatic carriers and mild patients in order to contain the outbreak [7].

In this study, we aimed at investigating knowledge and attitude towards SARS-CoV-2 infection among HCWs who would join work in the Menoufia university workers COVID-19 isolation unit in the National Liver Institute, Menoufia University. Our findings may help to correct their wrong thoughts and to encourage them to respect infection control rules, which will have a good impact on COVID-19 infection rate.

Subjects and Methods

Studied subjects

The study was implemented in the National Liver Institute Menoufia University COVID-19 infection isolation unit which was prepared to participate in combating the COVID-19 epidemic for all workers in the Menoufia University, Egypt. The inclusion criteria were being a HCW in the isolation unit of COVID-19. Health care workers who join work in the isolation unit were selected upon their work experience in Intensive Care Unit (ICU). Health care workers who joined work in the isolation unit were selected upon their work experience in ICU. They had experience on dealing with patients with respiratory infections and had good background on all infection control practices. They were previously monitored for application of all standard precautions.

They were divided into two groups:

- The COVID-19 front-line HCWs; physicians, nurses, radiology technicians and workers.

- The COVID-19 non-first line HCWs; laboratory workers and technicians, and employees.

Before joining the study, the participants were divided into groups; each group included 10 HCWs. Each group was asked to fill in the questionnaire in google forms electronic copy (the implementation phase).

Ethical considerations

The study procedures were approved by the Institutional Review Board of the National Liver Institute, Menoufia University. Ethical considerations were followed in the study regarding confidentiality and obtaining written consents from the study participants. Objectives of the study were explained to the involved HCWs, to obtain their acceptance to be recruited in the study and to gain their cooperation.

The study tools establishment

Data were collected using a well-constructed electronic questionnaire by google forms based on literature review that was developed by the researchers, and revised by jury of professors, then tested for validity and reliability (Cronbach's alpha 0.92). It included three parts:

Part I: Socio-demographic characteristics of the study participants as age, sex, job, and their medical history.

Part II: Questions to address participant's knowledge about COVID-19 infection as structure, mode of transmission, incubation period, symptoms, methods of diagnosis, treatment and prevention.

Part III: Questions to address participant's attitude about COVID-19 infection.

The constructed questionnaire was used to perform a pilot study on 15 participants of the HCWS to evaluate the questionnaire for applicability, clarity, and time to fill. Those participants were not included in the full-scale study. Based on the results of the pilot study, the questionnaire was modified and made ready for use based on the results of the pilot study.

Health care education on COVID-19

Education included the etiology, transmission, hand hygiene, personnel protective equipment (PPE) donning and doffing, social distancing importance in the isolation unit lounge, dealing and communication during caring of COVID-19 cases. This education was implemented at the Infection Control Training Unit for 3 weeks for each group. Each session included two hours per day for three days per week.

Laboratory investigations

Base-line laboratory work-up was done before starting the 15-day work shift in the Unit. It included drawing a sample (ten ml) of blood by aseptic venipuncture, after minimal venous stasis using sterile disposable syringes. Five mL of the blood were delivered to a vacutainer plain test tube. Serum was separated by centrifugation at 3000 rpm for 10 minutes and used for detection of the specific anti-COVID-19 antibody by chemiluminescence immunoassay using *Cobas 6000 (Roche, Germany)*, liver function tests, renal function tests, C-reactive protein (CRP). Three mL of blood were delivered to a vacutainer plastic tube containing EDTA and used for CBC using *Sysmex XT 1800i***** Automated Hematology Analyzer. ALL symptomatic HCWs during work period or positive COVID-19 PCR underwent testing for lactate dehydrogenase (LDH) using the *Cobas 6000 analyzer (C501 module) **. Serum ferritin was measured by chemiluminescence immunoassay using *Cobas 6000 (e 601 module) ****. Two mL of blood were delivered to a vacutainer plastic tube containing sodium citrate (3.2%) for D-dimer determination using the *Cobas 6000 analyzer (C501 module) **

At the end of the isolation unit work period, all HCWs were investigated for COVID-19 infection by nasopharyngeal swab PCR. Detection of SARS-CoV-2 was performed in the Department of Laboratory Medicine, National Liver Institute, Menoufia University using *QIAGEN Real-Time PCR system (QIAGEN, GmbH)*. This system uses *Genesig* kit (COVID-19) CE IVD Real-Time PCR detection kit which is an *in vitro* diagnostic test designed to detect all publicly available COVID-19 viral RNA sequence.

Respiratory tract specimens included nasopharyngeal and oropharyngeal swabs. These swabs were obtained under complete aseptic conditions with full protective PPE for lab personnel. Specimens were collected and stored in a collection tube with 5 mL viral transport media according to World Health Organization (WHO) recommendations (4°C for ≤ 5 days and minus 70°C for longer periods).

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Radiological investigations

Noncontract chest Computed Tomography (CT) studies were performed for all patients on 16-slice, and 128-slice machines *(Siemens medical system, Siemens, Germany)*.

Scoring system and data management

Scoring of knowledge

A score for each answer on knowledge questions was given as follows: (2) for the correct answer, (1) for the wrong answer and (0) for the I don't know answer. Total knowledge score ranged from (0-32), knowledge of HCWS in the isolation unit about COVID-19 infection was considered good if it equals to or more than 30 and poor if it is less than 30.

Scoring of attitude

A score for each answer on attitude questions was given as follows: (2) for the correct feeling or intention, (1) for the wrong feeling or intention and (0) for the don't feel that answer. Attitude scores ranged from (0-12) points. Attitude score of HCWs in the isolation unit regarding COVID-19 infection was considered positive if it equals to or more than 10 and negative if it is less than 10.

Statistical analysis

Data was collected, coded, and transformed into specially designed form to be suitable for computer entry process. Data was entered and analyzed using SPSS (Statistical Package for Social Science) version 20. Quantitative data were presented as mean (X) and standard deviation (SD). Qualitative data were presented as frequency distribution tables and analyzed by chi-square ($\chi 2$) test. However, if an expected value of any cell in the table was less than 5, Fisher Exact test was used. Significance levels were considered at 5% level.

Results

This study was conducted in Menoufia university isolation unit during the period from June 10th - August 10th, 2020. The isolation unit had 100 bed inpatient capacity and served more than 1000 COVID-19 outpatient cases of Menoufia University employees. The studied population included 206 HCWs; 150 males (72.8%) and 56 females (27.2%). Their mean age was 26.89 years ± 6.241. According to occupation, they were distributed as follows: 133 (64.5%) nurses, 28 (13.6%) physicians, 8 (3.9%) pharmacists, and 37 (18%) technicians and housekeepers.

The infection rate among HCWs was 5.8% as shown in **figure (1)**. It was found that 12 of the studied 206 HCWs with COVID-19 were infected after the end of quarantine period. The infection was confirmed by laboratory and radiological findings and testing nasopharyngeal swabs by PCR.

In **table (1)**, the response of the studied HCWs to the 16 items knowledge of the on-line questionnaire is illustrated as follows: 99.5% of them had excellent knowledge about the mode of SARS-CoV-2 transmission, tools of its diagnosis and prevention, and importance of adherence to infection control measures. On the other hand, 11 (5.3) of them did not know the nature of SARS-CoV-2 (bacteria or virus) and 83% were ignorant of the incubation period of COVID-19.

Preliminary perceptions about HCWs isolation were explored **(Table 2)**. Of the studied participants, all of them felt being at risk of exposure to infection because of their job, 93.7% felt worry about their family because of their work nature, 96.6% felt having adequate training and want to participate in community awareness campaigns. On the other hand, 7.3% do not trust in the protection level of the available PPE and 17% don't feel safe against COVID-19 in their work environment.

Knowledge score of HCWs is shown in **table (3)**. Non-significant difference was detected between male and female (*P value 0.75*), age, and occupations of the studied HCWs while positive total groups of attitude shows significant good knowledge score. In **table (4)**, HCWs had a highly significant good knowledge score and positive attitude towards the importance of good training on PPE donning and doffing and off. Healthcare workers had significant positive attitude towards the importance of PPE availability when dealing with confirmed cases.

The level of the serum ferritin was significantly higher (*p<0.001*), while the percent of lymphocytes was significantly (*p<0.001*) lower among the PCR-positive compared to the PCR-negative patients **(Table 5)**. The good knowledge and positive attitude were significantly associated with negative serum antibodies to SARS-CoV-2 and significantly associated with normal findings on CT scan and negative PCR for SARS-CoV-2 in HCWs as shown in **table (6)**. Of the 12 infected HCWs, 50% were males; 9 of them were 21-30 years old, 8 were nurses, 3 were physicians, 91.7% were non-smokers and negative for HCV Ab and 100% were negative for serum antibodies to SARS-CoV-2 as shown in **table (7)**.

Figure 1. Infection rate among HCWS. The infection rate was 5.8%. It was found that 12 of the studied 206 HCWs with COVID-19 were infected after the end of quarantine period. The infection was confirmed by laboratory and radiological findings and PCR.
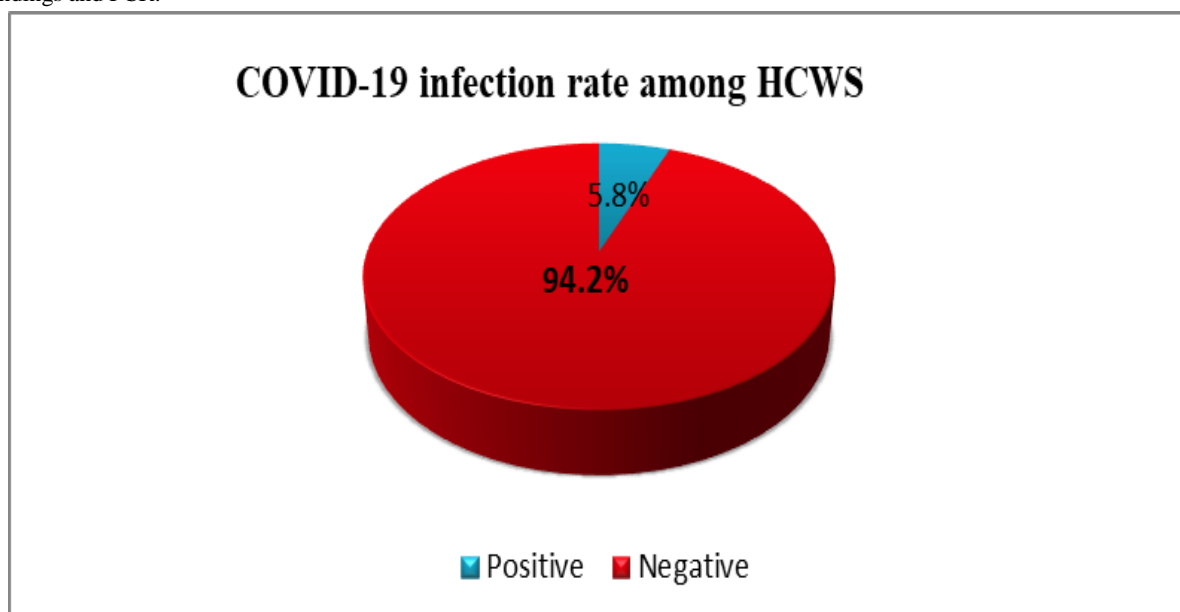
Table 1. Knowledge items about SARS-CoV-2 and COVID-19 among the studied cases.

The studied knowledge items (about SARS-COV-2)	Correct answer		Wrong answer		Don't know		Total	
	No	%	No	%	No	%	No	%
1. **SARS-COV-2 is a bacteria (no)**	194	94.2	1	0.5	11	5.3	206	100
2. **Incubation period is 7-14 days (yes)**	35	17	0	0.00	171	83	206	100
3. **Transmission among HCWs by contact (yes)**	205	99.5	1	0.5	0	0.00	206	100
4. **Transmission among HCWs by droplets (yes)**	205	99.5	1	0.5	0	0.00	206	100
5. **Transmission among HCWs by airborne route (yes)**	205	99.5	1	0.5	0	0.00	206	100
6. **Symptoms of COVID-19 include fever, cough, dyspnea and diarrhea (yes)**	203	98.5	1	0.5	3	1.5	206	100
7. **It can be asymptomatic (yes)**	199	96.6	1	0.5	6	2.9	206	100
8. **Diagnosis can be confirmed by chest X-ray, laboratory investigations & chest CT scan (yes)**	205	99.5	0	0.00	1	0.5	206	100
9. **Diagnosis is confirmed by nasopharyngeal swab (yes)**	205	99.5	0	0.00	1	0.5	206	100
10. **COVID-19 has specific lines of treatment (no)**	196	95.1	0	0.00	10	4.9	206	100
11. **COVID-19 has a specific vaccine (no)**	205	99.5	0	0.00	1	0.5	206	100
12. **Hand washing with soap and water for more than 20 seconds is protective (yes)**	205	99.5	1	0.5	0	0.00	206	100
13. **Wearing PPE can protect against infection (yes)**	199	96.6	1	0.5	6	2.9	206	100
14. **Infection can be prevented by Social distancing (yes)**	205	99.5	0	0.00	1	0.5	206	100
15. **Infection among HCWs is high due to absence of social distancing more than 1.5 meter (yes)**	205	99.5	0	0.00	1	0.5	206	100
16. **Infection among HCWs is high due to absence of adherence to infection control instructions (yes)**	205	99.5	0	0.00	1	0.5	206	100

Analysis of the studied HCWs' response to the 16 items knowledge of the on-line questionnaire was performed.

Table 2. Attitude of HCWs towards SARS-CoV-2 and COVID-19.

The studied attitude items (about SARS-COV-2)	Correct feeling (intention)		Wrong feeling (intention)		Don't feel that		Total	
	No	%	No	%	No	%	No	%
1. **Do you feel safe in your work environment against COVID-19? (yes)**	189	91.7	0	0.00	17	8.3	206	100
2. **Do you trust in your PPE protection level? (yes)**	190	92.2	1	0.5	15	7.3	206	100
3. **Do you feel that you had adequate training on infection control practices? (yes)**	199	96.6	6	2.9	1	0.5	206	100
4. **Do you feel that there is a possible danger on your family due to your work nature? (yes)**	10	4.9	193	93.7	3	1.5	206	100
5. **Do you want to participate in any community activity to raise awareness on COVID-19 as health education? (yes)**	199	96.6	1	0.5	6	2.9	206	100
6. **Do you feel having exposure risk for COVID-19 infection? (no)**	206	100	0	0.00	0	0.00	206	100

The various feelings of the Quarantine HCWs were explored.

Table 3. The studied sociodemographic data of the studied HCWs in relation to their knowledge and attitude scores.

The studied score	The studied variables	Negative		Positive		χ^2	p value
		No	%	No	%		
Knowledge score	**Gender:** Male	19	70.4	131	73.2	0. 094	0.75
	Female	8	29.6	48	26.8		
	Age groups: ≤ 20 y	0	0.0	5	2.8	1.467*	0.4
	21-30	19	70.4	135	75.4		
	≥31 y	8	29.6	39	21.8		
	Occupation of HCWS: Physicians	6	22.2	22	12.3	5.742*	125
	Nurses	12	44.4	121	67.6		
	pharmacists	2	7.4	6	3.4		
	Others	7	25.9	30	16.8		
	Total groups attitude: Negative	10	37	31	17.3	5.722	0.01
	Positive	17	63	148	82.7		
	Total	27	100	179	100		
Attitude score	**Gender:** Male	32	78	118	71.5	0.708	0.400
	Female	9	22	47	28.5		
	Age groups: ≤20 y	2	4.9	3	1.8	1.517*	0.46
	21-30 y	31	75.6	123	74.5		
	≥31 y	8	19.5	39	23.6		
	Occupation of HCWS: Physicians	0	0.0	28	17	10.841	0.013
	Nurses	32	78	101	61.2		
	Pharmacists	0	0.0	8	4.8		
	Others	9	22	28	17		
	Total	41	100	165	100		

* Fischer - exact testKnowledge of HCWs shows non-significant good score in relation to gender, age and occupations of the studied HCWs while positive total groups of attitudes show significant good knowledge score. There was significant positive attitude of different occupational groups of the studied population while no significant attitude differences were detected among age and gender subgroups of the studied population.

Table 4. Health care workers knowledge and attitude in relation to training on donning and doffing PPE, and availability of PPE when dealing with confirmed cases.

The studied variables	The studied score	Yes		No		Don't know		Fischer exact test	p value
		No	%	No	%	No	%		
Training on donning and doffing PPE	*Knowledge* Poor	24	12.5	3	50.0	0	0.00	8.43	*0.015*
	Good	168	87.5	3	50.0	8	100		
	Attitude Negative	27	14.1	6	100	8	100	60.45	*0.00*
	Positive	165	85.9	0	0.00	0	0.00		
Availability of full PPE on dealing with confirmed cases	*Knowledge* Poor	21	14.7	6	10.3	0	0.00	1.45	*0.48*
	Good	122	85.3	52	89.7	5	100		
	Attitude Negative	20	14	16	27.6	5	100	25.41	*0.00*
	Positive	123	86	42	72.4	0	0.00		
Total		143	100	58	100	5	100		

HCWs has highly significant good knowledge score and positive attitude towards the importance of good training on PPE donning and doffing. HCWs have significant positive attitude towards importance of PPE availability when dealing with confirmed cases.

Table 5. Laboratory findings of the studied participants.

	PCR for SARS-CoV-2		Total	Mann-Whitney U test	p value
	Positive (n=12)	Negative (n=194)			
D-dimer	3.574167±5.0131272	0.443969±1.5815419	0.626311±2.0599792	784.000	*0.057*
Ferritin	282.25±292.252	39.58±81.954	53.72±118.964	352.000	*0.000*
Total Leucocytic count (TLC)	6000.00±1815.589	5632.47±1479.542	5653.88±498.409	980.000	*0.358*
Percent of Lymphocytes	21.17±9.084	63.38±341.390	60.92± 331.402	515.000	*0.001*

There were non-significant elevations of total leucocytic count and D-dimer in COVID-19 infected HCWs. The serum ferritin was significantly elevated while lymphocytic count was significantly decreased.

Table 6. The knowledge and attitude scores in relation to the PCR, CT findings and the SARS-CoV-2-specific serum total antibodies.

The studied variables			Knowledge score		Attitude score		Total
			Good	Poor	Positive	Negative	
SARS-CoV-specific serum total antibodies	Positive	No	13	5	10	8	18
		%	72.2	27.8	55.6	44.4	100
	Negative	No	166	22	155	33	188
		%	88.3	11.7	82.4	17.6	100
Fischer exact test			3.72		7.45		-
p value			0.05		0.006		-
PCR for SARS-CoV-2	Positive	No	9	3	7	5	12
		%	75	25	58.3	41.7	100
	Negative	No	170	24	158	36	194
		%	87.6	12.4	81.4	18.6	100
Fischer exact test			1.583		3.78		---
P value			0.19		0.06		----
CT signs	Yes	No	8	3	5	6	11
		%	72.7	27.3	17.9	45.5	100
	NO	No	171	24	160	36	196
		%	87.7	12.3	82.1	17.9	100
Fischer exact test			2.048		8.74		--
p value			0.15		0.003		---

The studied HCWs with negative SARS-CoV-specific serum total antibodies had significant knowledge score and high positive attitude.

Table 7. The distribution of the studied HCWs in relation to SARS-CoV PCR results.

The studied variables	SARS-CoV PCR				Fischer exact test	p value
	Positive (n=12)		Negative (n=194)			
	No	%	No	%		
Gender Male	6	50.0	144	74.2	3.351	0.06
Female	6	50.0	50	25.8		
Age groups ≤20 y	0	0.00	5	2.6	0.336	0.845
21-30 y	9	75	145	74.7		
≥31 y	3	25	44	22.7		
Occupation of HCWS Nurse	8	66.7	125	64.4	1.114	0.77
Physicians	1	8.3	27	13.9		
pharmacist	0	0.0	8	4.1		
others	3	25	34	17.5		
CRP Positive	8	66.7	4	2.1	85.98	0.000
Negative	4	33.3	190	97.9		
COVID-Ab Positive IgG	0	0.00	18	9.3	1.22	0.26
Negative	12	100	176	90.7		
CT signs Yes	8	66.7	0	0	94.81	0.000
No	4	33.3	194	100		
Smoking Smoking	1	8.3	29	14.9	0.39	0.52
Nonsmokers	11	91.7	165	85.1		
Past HCV infection Yes	1	8.3	6	3.1	0.94	0.33
No	11	91.7	188	96.9		
Total	12	100	194	100		

The HCWs with positive SARS-CoV showed significant difference in CT scan findings and CRP results, 100% of them were SARS-CoV negative, 91.7% were non-smokers with no past exposure.

Discussion

The novel coronavirus disease-2019 (COVID-19) started in December 2019 in the city of Wuhan, the Chinese province of Hubei city. Its occurrence has frozen the world's activities and endangered every country [8]. Healthcare workers are susceptible to direct or indirect exposure hazards to patients or their infectious materials [9]. It is essential to ensure safety of HCWs, both at work and in the community because they have a vital role in this pandemic [10]. They are at increased risk of contracting droplet-spread respiratory viruses, including COVID-19, because of their high level of work exposure [11]. In this study, we aimed to decrease the infection among isolation unit workers through increasing their awareness and improving their attitude towards COVID-19 infection control instructions *via* health educational program based on the online assessment questionnaire.

In this study, COVID-19 infection rate among HCWS was 5.8% (12 out of 206 HCWs was infected). This infection rate was low in comparison to other studies. In some European countries, 10% or more of all those infected with COVID-19 were HCWs [12]. In Italy, HCWs experienced high rates of infection and death [12]. In France; the National French Public Health Agency, Santé Publique reported that more than 30 000 HCWs were infected since March 2020 [13]. In Wuhan alone, 1080 HCWs were infected [14]. In China, more than 3300 HCWs were infected as of early March 13. On the

other hand, infection of 30 cases among 1180 HCWs (2.5%) was reported by **Rizza et al.** [15]. The high infection rates among HCWs, in some countries, may be attributed to their limited knowledge, low attitude and poor practice [16].

To decrease COVID-19 infection rate among HCWs, an initial essential step is estimating their knowledge, awareness, and practice towards the COVID-19 infections [16]. In this study, a base-line evaluation questionnaire about knowledge and attitude to COVID-19 was constructed and HCWs were asked to fill in it on google forms. Their answers showed that about 99.5% had good knowledge about mode of transmission, symptoms, tools of diagnosis and absence of specific treatment or vaccine. On the other hand, only 17% of HCWs were aware of incubation period of COVID-19. These findings agree with that reported by **Naseer et al**. [16] who demonstrated that the vast majority of the health care professionals had adequate knowledge and awareness. However, some aspects of practice of health care professionals were found to be deficient including CDC guidelines during patient care, disinfection protocol and the use of N-95 mask. Continued professional development programs including lectures and workshops on COVID-19 are mandatory for all health care professionals to contain the pandemic and to limit its morbidity and mortality [16]. **Hussain et al**. [17] illustrated that the knowledge, attitude and practice scores were 12.7 ± 0.89, 8.9 ± 4.1 and 7.3 ± 1.2 respectively. Most of the participants knew the term COVID-19 and its mode of transmission (90%), signs and symptoms (84%) and risk factors (72%). About 74.3% and 84.6% of the participants knew that transmission of COVID-19 can occur by coughing and sneezing and that its prevention can be accomplished by preventive measures respectively [17].

The various feelings of HCWs in the isolation unit were explored in this study. Our results revealed that 100% of them were worried about transmitting COVID-19 to their families, 96.5% had adequate training on infection control practices and decided to participate in community awareness campaign about COVID-19, 92.2% trusted their available PPE protection level and 91.7% felt safety in their working environment and only 10% felt worried about possibility of transmitting infection to their families. These findings agree with that reported by **Zheng et al.** [18] who found that 85% of their studied HCWs were afraid of becoming infected at work.

In the current study, knowledge score among the studied HCWs was non-significantly good in 73.3% of males who were 21-30 years old, in 86.89% of those who were first-line health care occupations although positive attitude of total groups showed significant good knowledge score. **Abdel Wahed et al.** [19] reported that the HCWs risk perception could affect their mental health and their exhibition to infection risk. Despite their high knowledge score, most HCWs were afraid (83.1%) and felt high susceptibility to have COVID-19 infection (89.2%). Therefore, it was emphasized that HCWs were afraid of being infected with SARS-CoV-2 and transmitting the virus to their families. This stress may indirectly weaken the immune system and increase the risk of disease [20]. In accordance with our study, The level of knowledge and awareness among the participants in our study were higher than that demonstrated in an Indian study although most of the Indian respondents were aware about basic elements of the disease [21]. **Xu et al.** [22] showed that medical workers had more advanced knowledge about professional questions than the other two non-medical groups. Most of Chinese participants were knowledgeable about COVID-19 [22,23]. The correct knowledge response rate was 40% in Jordan [24] and 82.4% in Uganda [25].

In our study, our front-line HCWs had good experience in dealing with respiratory infections and in infection control practices. They showed a highly significant good knowledge score and positive attitude towards the good training on PPE donning and doffing. HCWs had significant positive attitude towards the significance of PPE availability when dealing with confirmed cases. Similar findings were reported by other investigators, who demonstrated that the majority of HCWs had positive attitude towards COVID-19 [19,20]. Among front-line HCWs, reuse of PPE due to inadequate supply, increased the risk of occurrence of COVID-19 [26]. Although HCWs caring for COVID-19 patients who reported inadequate PPE had the highest risk, an increased vulnerability to infection was also reported among those having adequate PPE. This may raise the attention to the importance of appropriate usage, including correct donning and doffing and clinical situation (practice location) in addition to ensuring PPE quality and availability [26]. Front-line HCWs who worked in inpatient settings were reported to have greater risk associated with reuse of PPE. This finding may be attributed to self-contamination

during repeated donning and doffing or breakdown of materials due to extended wear [27]. Because HCWs are the front-line defense against COVID-19, it is imperative to protect them against infection. Personal protective equipment availability for HCWs in an isolation unit represents one of the main defense ways to protect against infection of HCW by SARS-CoV-2 [27].

In this study, nasopharyngeal swab results of HCWs at the end of their work period revealed that 12 out of 206 were COVID-19 positive; 6 were males aged 21-30 years, 8 were nurses and one physician. In spite of the good knowledge and positive attitude, and adequacy of full PPE; the infection rate was 5.8%. Lack of deep knowledge on the nature of the disease, presence of asymptomatic carriers, overcrowding, lack of social distancing, anxiety and psychological distress of HCWs may be contributing factors [28]. Therefore, HCWs who have good knowledge, experience and confidence in addition to availability of good quality PPEs are important to prevent infection [29]. It has been suggested that the major factors for COVID -19 infection among HCWs included lack of understanding the infection, inadequate use and availability of PPE, uncertain diagnostic criteria and unavailability of diagnostic tests and psychological stress [29]. It was reported that HCWs on front-line, who are directly involved in the diagnosis and treatment of COVID-19 patients, were at high risk of getting an infection [30]. The ever-increasing number of COVID-19 cases, overwhelming workload, the depletion of PPE, physical fatigue, and psychological stress during the early outbreak has resulted in at least 22073 cases of COVID-19 among HCWs [31].

The current study showed that the studied HCWs with negative SARS-CoV-specific PCR, serum total antibodies and normal CT scan had significant knowledge score and high positive attitude. It has been reported that good knowledge, positive attitude and good practice regarding precautionary measures such as wearing gloves, protective clothing, goggles and face masks are imperative to deal with infected patients [32]. The ongoing pandemic nature of the disease made it necessary for HCWs to adopt increased precautions in accordance with the critical situation, and to put effort into implementing appropriate hygienic conditions and follow recommendation to minimize risk [32]. It has been reported that HCWs had positive attitude but moderate-to-poor level of knowledge and practice regarding the use of face mask [33]. Therefore, awareness campaigns regarding the proper use of PPE utilizing all available social media resources are mandatory [33]. Although the overall COVID-19-related HCWs were satisfactory, some misperceptions and malpractices must be addressed to effectively combat COVID-19 [34]. The interest of the participants to be oriented with the virus and their confidence in their government's efforts are elements of positive attitude [35].

Conclusion

Health care workers in the isolation unit may be the most exposed personnel to infection by SARS-CoV-2. They should have adequate knowledge, motivation and positive perception about COVID-19. They must follow strict precautions and infection control practices in addition to supplying them with adequate PPEs to overcome the COVID-19 epidemic. Further studies are important to investigate causes of COVID-19 occurrence among HCWs in spite of adequate health practices.

Conflict of Interest: There is no conflict of interest.

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