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Assessment of knowledge, accessibility, and adherence to the use of personal protective equipment and standard preventive practices among healthcare workers during the COVID-19 pandemic

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Abstract

Background: Healthcare workers are at risk of acquiring infectious agents while providing services to patients. Thus, the need for evaluating and closely monitoring healthcare worker knowledge, perception, and adherence levels is critical. This study evaluates the knowledge, accessibility, and adherence regarding personal protective equipment (PPE) and preventive protocols among healthcare workers during the COVID-19 pandemic.

Design and methods: A web-based cross-sectional survey was conducted from March to September 2021. The study participants were 187 healthcare workers who replied to a 31-item questionnaire using an online tool.

Results: A total of 187 participants responded to the questionnaire. Most of the participants 102 (54.5%) were in the age group of 25–34 years. Of the 187 participants, 98 (52.4%) were medical doctors, and 92 (49.2%) had correct knowledge regarding donning and doffing of PPE. The vast majority (93.7%) had access to essential PPE. The average adherence level was 82.1%. Accessibility ($p = 0.003$) and adherence ($p < 0.01$) were found to be significantly high in older age participants.

Conclusion: The study showed most of the healthcare workers had appropriate knowledge and, they also adhered to the proper use of PPE and infection control protocols. However, few of them identified with poor knowledge about COVID-19, inappropriate doffing of PPE, non-adherence to the protocol, and unacceptable practices. We recommend the provision of adequate training that will lead to minimizing the risk of exposure to and transmission of COVID-19 among healthcare providers.

Keywords

COVID-19, healthcare workers, safety, personal protective equipment, infection prevention and control

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Background

The coronavirus (COVID-19) pandemic has profoundly changed the economy as well as the healthcare system.[1] Suppression of this disease has been a major hurdle despite the ongoing changes in the protocols and international guidelines.[2]

Based on published reports, it has been established that COVID-19 can be transmitted from human to human through respiratory droplets and aerosols.[3] Generally, people are at risk who are in close contact with confirmed

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COVID-19 cases. As healthcare workers are in contact with patients, they are at an increased risk of acquiring COVID-19 infection; consequently, the use of PPE in accordance with the procedure is essential to prevent transmission in the hospital setting. In addition, the basic preventive measures that should be followed to reduce the risk of infection with COVID-19 are to maintain contact distance, use face covers/masks, hand hygiene, self-monitoring of health, and report any illness at the earliest.[4] The protection of healthcare workers from transmission is possible only by complying with infection control and essential precautions.[5]

The unexpected outbreak of coronavirus (COVID-19) has initially led to confusion regarding the type and means of using PPE.[6] It is reported that as the infection widespread rapidly, there has been a rapid shortage in the availability of PPE, and a rapid increase in infection among healthcare workers.[7]

It was a serious challenge to the available infrastructure, trained manpower, hospital beds, drugs, and oxygen. The situation had an adverse impact on the quality of care and was reflected in the outcomes.[8]

We observed that many of our healthcare workers including medical doctors frequently infected by COVID-19 infection. Understanding the risk of transmission of infection is particularly important for guiding evidence-based protective measures. Although proper use of PPE is a basic step, it has a tremendous impact on reducing the risk of the spread of COVID-19 and keeping healthcare workers safe. Healthcare workers should get ready with adequate knowledge to protect themselves so that they can take care of others to face such problems even in the future. Keeping this in mind, in this study, we tried to evaluate the knowledge, accessibility, and adherence regarding the proper use of PPE as well as standard preventive protocols and practices among healthcare workers at BDF-RMS during the COVID-19 pandemic.

Design and methods

Ethical consideration

The study protocol was reviewed and approved by the research ethics committee of Bahrain Defense Force-Royal Medical Services (BDF-RMS) Military Hospital (Registration No. 2019-511) and the national COVID research committee of Bahrain. BDF-RMS is a tertiary care, 481-bedded hospital, that provides 19 different specialized medical services through 1500 healthcare providers to Bahrain people. All participants were anonymous, and their responses were confidential.

Study design and study duration

A prospective cross-sectional study was conducted with the enrollment of 187 participants at BDF-RMS Military Hospital from March to September 2021. The online link for the questionnaire was distributed to healthcare workers including doctors (physicians, surgeons, pathologists, radiologists, gynecologists, and anesthetists) and nurses workingatBDFRMS(https://forms.gle/VBm4C6fHS73xL8gn9).

Data collection procedure and techniques

This is a web-based cross-sectional survey study consisting of 31 questions. The questionnaire was constructed based on reviewing the previously published literature[9–11] and additional questions were integrated based on the set-up of our setting. A link for the questionnaire was provided to the medical doctors (physicians, surgeons, pathologists, radiologists, gynecologists, and anesthetists) and nurses at BDF-RMS by E-mail and on WhatsApp groups. The questionnaire started with a brief introductory passage about the objectives of the study.

Sampling technique and sample size calculation

In this study, non-probability sampling (voluntary sampling) procedures were used for gathering the primary data from the participants. A total of 187 responded to the questionnaire. Given that the population size is around 1500, margin of error should be 6.72% for 95% confidence level and 50% expected response distribution.

Instruments and variables

The questionnaire consisted of four parts with a total of 31 questions.

Part 1 consists of four demographic questions, including age, gender, medical practice, and the medical profession.

Part 2 consisted of nine questions related to the job description of the health care workers that includes whether or not they are working in a COVID-19 facility, vaccination status and whether they have been infected with COVID-19 or not, if infected then for how many occasions they tested positive and their disease was symptomatic or asymptomatic, if symptomatic then whether mild symptoms and did not hospitalized or severe symptoms and hospitalized, whether they had access to infection control protocols, and if so how familiar they were with the protocols.

Part 3 of the questionnaire consisted of six questions related to the accessibility of protective gear against COVID-19; the answers were 0 for No, 1 for Sometimes, and 2 for Yes. The sum of the scores was considered as the participant's perception of availability (presented as percentages; thus, a participant with 100% perception means he has answered that he has access to all PPE).

Finally, part 4 of the questionnaire consisted of 12 questions, 10 of which assessed adherence level by a Likert scale scored from 0 to 4, the sum of scores was considered as the participant's adherence level (presented as

percentages; thus, a participant with 100% adherence means he has answered that he always follows safety measures). The last two questions of part 4 assess the participant's knowledge of the correct sequences of donning and doffing; knowledge was summarized in one variable coded 0 for answering both questions wrong, 1 for answering one of them correctly, and 2 for answering both correctly. A common grading method that other papers have used to calculate the adherence, accessibility, and knowledge score.[10,12]

Face validity was established, by the prior discussion about the questionnaire with the in-house expertise associated with infection control committee. Reliability was tested by measuring internal consistency; Cronbach's alpha was 0.796, which is reliable.

Statistical analysis

Continuous variables were represented as mean ± standard deviation, whereas categorical variables were represented as frequencies and percentages. Depending on the data requirements, Mann-Whitney U test and Kruskal Wallis test were used to compare the total scores of respondents' characteristics regarding Accessibility and Adherence, while Chi-square and Fisher's exact tests were used for knowledge total scores. SPSS (version 26.0) software was used to conduct all analyses. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 187 respondents were included in the analysis. Of those, 54.5% were aged 25–34 years. Females were 50.8%, while males were 49.2%. Job descriptions, COVID infection-related questions, and participants' replies are summarized in Table 1.

In this study, 52.4% of the participants were doctors (physicians, surgeons, pathologists, radiologists, gynecologists, and anesthetists), and 47.6% were nurses. The majority, 72.2% ($N=135$), have worked in a COVID-19 facility. Only three participants were unvaccinated. Forty-nine participants (26.2%) have been positively tested for COVID-19 previously; out of those, 1.6% had been infected twice, while 23.0% were infected only once. In addition, 12.3% of them had mild symptoms, and 6.5% had severe symptoms.

The average perception of availability was 93.7%. Most participants answered that they have access to PPE, as illustrated in Figure 1(a).

The average adherence level was 82.1%. Participants' adherence to preventive and protective measures is summarized in Figure 1(b).

To assess the participants' knowledge of PPE, they were asked to choose the correct sequence of donning and doffing; a summary of their replies is displayed in Figure 1(c).

Table 1. Summary of general questions related to COVID-19, represented as *N* (%).

General questions related to COVID-19:	*N* (%)
Worked in a COVID-19 facility?	
Yes	135 (72.2)
No	51 (27.3)
Not applicable	1 (0.5)
Taken the COVID-19 vaccine?	
Yes	184 (98.4)
No	3 (1.6)
Tested positive for COVID-19 at any time?	
Yes	49 (26.2)
No	138 (73.8)
■ If yes, were you tested positive on:	
One occasion	43 (23.0)
Two occasions	3 (1.6)
Not applicable	141 (75.4)
■ If yes, were you:	
Symptomatic	36 (19.3)
Asymptomatic	11 (5.9)
Not applicable	140 (74.8)
• If symptomatic, were they mild and didn't require hospitalization?	
Yes	23 (12.3)
No	13 (7.0)
Not applicable	151 (80.7)
• If symptomatic, were they severe and didn't require hospitalization?	
Yes	12 (6.5)
No	24 (12.8)
Not applicable	151 (80.7)
Have access to the infection control protocols and procedures?	
Yes	169 (90.4)
No	14 (7.5)
Not applicable	4 (2.1)
Familiar with your hospital infection control protocols and procedures?	
Yes	159 (85.0)
No	27 (14.5)
Not applicable	1 (0.5)

Frequencies of overall accessibility, adherence, and knowledge for all respondents are illustrated in Figure 1(a) –(c).

Differences between demographics in terms of accessibility and adherence are displayed in Table 2. Age was categorized into different groups and assessed for association in terms of accessibility ($p=0.003$) and adherence ($p<0.01$), with 18–24 years old respondents having the lowest scores in both accessibility and adherence, while 35–44 years old respondents had the highest scores of all. In terms of adherence, the medical profession differed significantly ($p<0.01$), with nurses scoring the highest as shown in Table 2.

Participants who have worked in COVID facilities were 72.2% while, those who have never worked in COVID

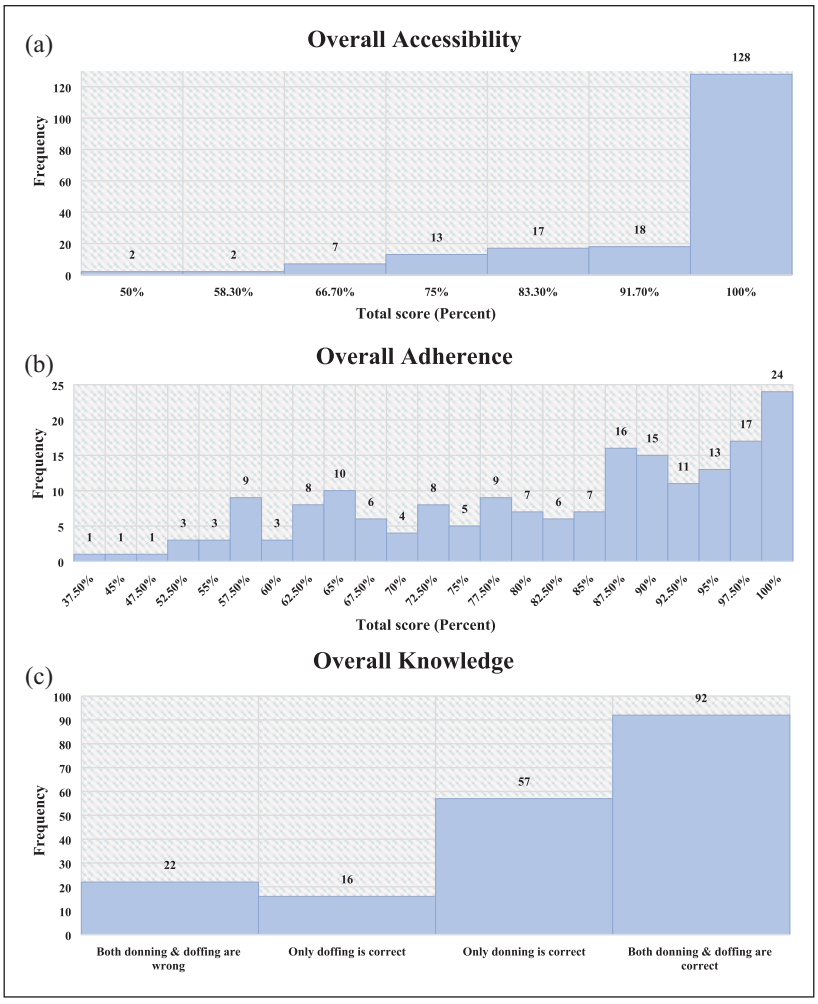

Figure 1. (a) Frequencies of overall accessibility for all respondents, (b) frequencies of overall adherence for all respondents, and (c) frequencies of overall knowledge for all respondents.

facilities were 27.3%. Participants who tested COVID positive were 26.2% and those who have been negatively tested were 73.8%. Both these groups of participants were compared for accessibility and adherence which was found non-significant as displayed in Table 2.

Age had a statistically significant difference between groups in terms of accessibility and adherence, with 18–24 years old respondents having the lowest scores in both accessibility and adherence, while 35–44 years old respondents had the highest scores of all. In terms of adherence, the medical profession differed statistically, with nurses scoring the highest as shown in Table 2.

None of the demographics were found to be significantly associated with knowledge scores as shown in Table 3. Frequencies and percentage of accessibility of personal protective equipment and level of adherence to preventative measures are illustrated in Figures 2 and 3.

Discussion

In our observational study of donning and doffing of PPE in COVID facilities, we report the overall rate for full accessibility at 93.7%, adherence at 82.1%, and knowledge at 68.7%. A previous report by Lamhoot et al.,[24] has shown 50% of healthcare workers donned PPE correctly and 37% doffed correctly. While, another study related to PPE use in preventing Ebola virus infection has reported that 100% of Ebola Virus Disease healthcare workers committed at least one PPE protocol deviation during doffing and 27% while donning and important to note that even during the third training session, they found 7%–43% of an error frequency.[13] Casalino et al.[14] reported that errors while PPE doffing was found in healthcare workers even after a three-phase training program. This indicates that although PPE donning and doffing are generally considered a simple protocol, healthcare workers make errors while performing protocol to prevent contamination when taking off the possibly infected clothing.

There was an almost equal distribution of male to female workers. The majority range between the ages of 25 and 34 years, this age range is similar to other studies with a mean age of approximately 32 years and an almost equal male-to-female ratio.[15]

Comparable to other studies, more doctors than nurses responded to the questionnaire.[15] The majority, 72.2%, of

Table 2. Differences between demographics in terms of accessibility and adherence.

		N (%)	Accessibility (Out of 12)	*p*-Value	Adherence (Out of 40)	*p*-Value
Age	18–24	23 (12.3)	10.96 ± 1.331	0.003*	28.00 ± 4.134	<0.01*
	25–34	102 (54.5)	11.08 ± 1.460		32.19 ± 6.286	
	35–44	41 (21.9)	11.85 ± 0.478		36.59 ± 3.667	
	≥45	21 (11.2)	11.19 ± 1.537		33.90 ± 5.567	
Gender	Male	92 (49.2)	11.27 ± 1.268	0.961	32.16 ± 6.537	0.273
	Female	95 (50.8)	11.22 ± 1.400		33.47 ± 5.397	
Medical profession	Doctor	98 (52.4)	11.09 ± 1.493	0.154	31.43 ± 6.112	<0.01*
	Nurse	89 (47.6)	11.42 ± 1.116		34.37 ± 5.517	
COVID-19 ward	Yes	135 (72.2)	11.33 ± 1.239	0.128	32.84 ± 6.067	0.765
	No	51 (27.3)	11.02 ± 1.556		32.73 ± 5.926	
Tested positive	Yes	49 (26.2)	11.51 ± 0.960	0.234	34.06 ± 5.475	0.102
	No	138 (73.8)	11.15 ± 1.434		32.39 ± 6.141	

*Significant $p < 0.05$, *p*-value was calculated using Mann-Whitney U test and Kruskal Wallis test as appropriate.

Table 3. Frequencies and associations of demographics in terms of knowledge are represented as *N* (%).

			Knowledge score			
		N (%)	Both donning & doffing are wrong (*N* = 22)	Either donning or doffing is correct (*N* = 73)	Both donning & doffing are correct (*N* = 92)	*p*-Value
Age	18–24	23 (12.3)	4 (17.4)	10 (43.5)	9 (39.1)	0.819
	25–34	102 (54.5)	12 (11.8)	41 (40.2)	49 (48.0)	
	35–44	41 (21.9)	4 (9.8)	13 (31.7)	24 (58.5)	
	≥45	21 (11.2)	2 (9.5)	9 (42.9)	10 (47.6)	
Gender	Male	92 (49.2)	9 (9.8)	38 (41.3)	45 (48.9)	0.685
	Female	95 (50.8)	13 (13.7)	35 (36.8)	47 (49.5)	
Medical profession	Doctor	98 (52.4)	10 (10.2)	42 (42.9)	46 (46.9)	0.489
	Nurse	89 (47.6)	12 (13.5)	31 (34.8)	46 (51.7)	
COVID-19 ward	Yes	135 (72.2)	15 (11.1)	53 (39.3)	67 (49.6)	>0.05
	No	51 (27.3)	6 (11.8)	20 (39.2)	25 (49.0)	
Tested positive	Yes	49 (26.2)	9 (18.4)	17 (34.7)	23 (46.9)	0.248
	No	138 (73.8)	13 (9.4)	56 (40.6)	69 (50.0)	

*Significant $p < 0.05$, *p*-value was calculated using Chi-square or Fisher exact test as appropriate.

healthcare workers in the study worked in a COVID-19 facility. About 98.4% of healthcare workers in this study received the COVID-19 vaccine, similar findings were reported in a survey conducted by the American Medical Association where 96% of doctors received the vaccine.[16]

Healthcare workers across the globe are at a higher risk of contracting COVID-19 infection.[17,18] The higher risk among healthcare workers could be attributed to various factors including their close contact with highly infectious patients as they are directly involved in the diagnosis, treatment, and care of patients,[19] and exposure to undiagnosed or subclinical infectious persons.[17,18] In addition to the infection risk, physical and mental exhaustion,[20] and poor access to PPE could be even more problematic from a personal protection point of view.[19]

In our study, 26.2% had tested positive for COVID-19. Healthcare workers aged 18–24 had the highest positive rates (43.5%), followed by healthcare workers aged 35–44 (31%). Healthcare workers aged 45 and older had the lowest positive rates. One of the possible reasons for the higher rate of COVID-19 positive in the 18–24 age group could be that young adults might expose more to the community as compared to the younger and older age groups of people. This might contribute to the transmission of infection from the outside community in addition to the exposure from infected patients in the COVID ward.

About 5.9% of healthcare workers who tested positive for COVID-19 were asymptomatic compared to a study by Gómez-Ochoa et al.[18] where 40% of those were asymptomatic at the time of diagnosis.

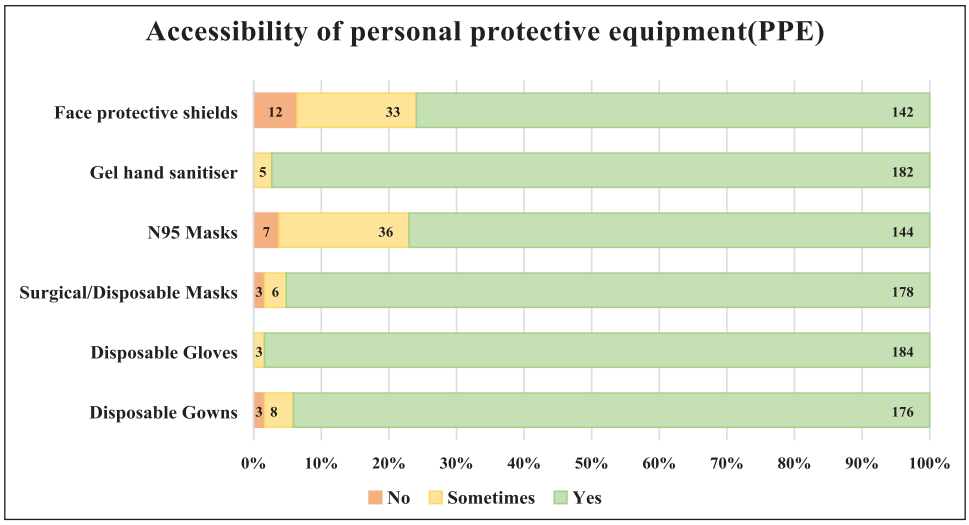

Figure 2. Frequencies and percentages of personal protective equipment (PPE) accessibility for all respondents.

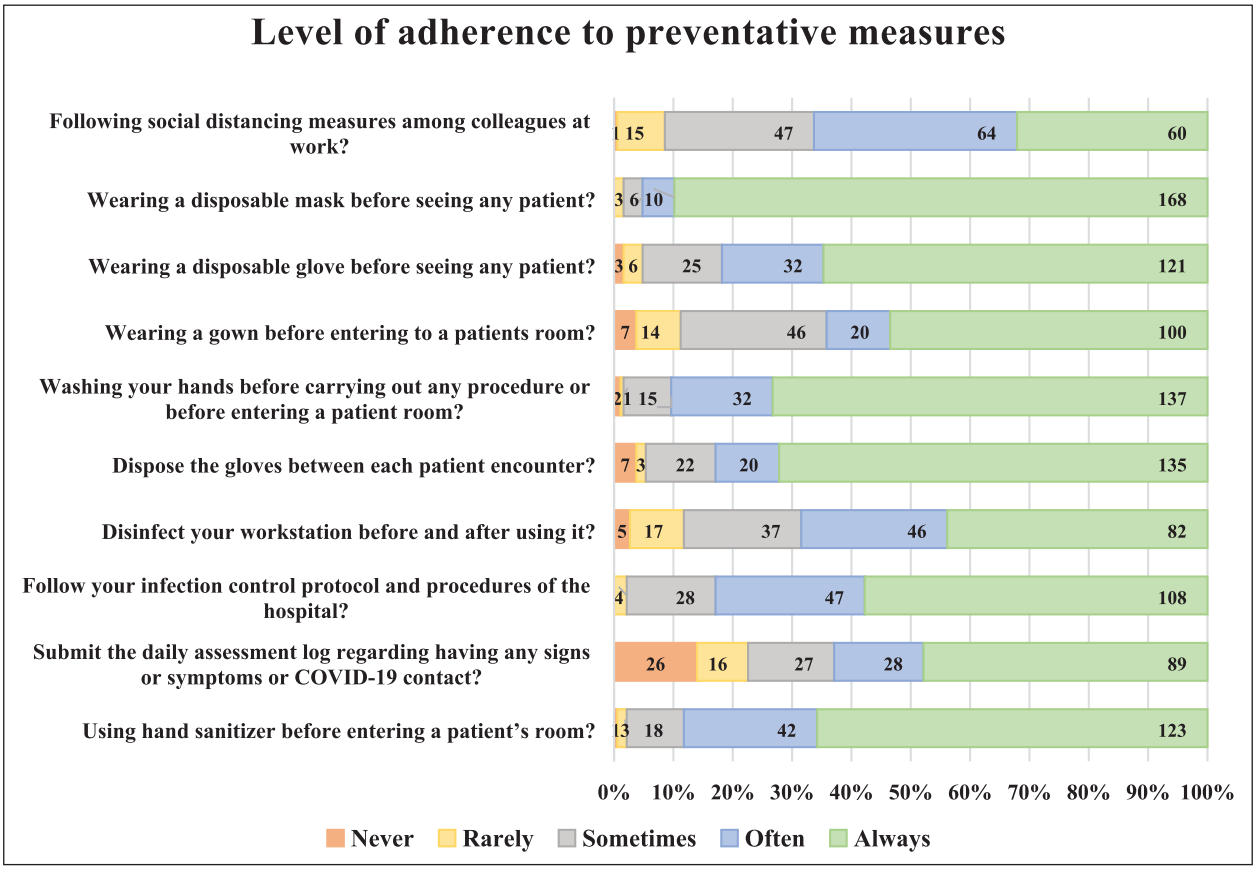

Figure 3. Frequencies and percentages of the level of adherence to preventative measures for all respondents (One respondent was not applicable for submitting the daily assessment question).

In our study, most of those who were symptomatic, 12.3%, had mild symptoms that did not require hospitalization, compared to 6.5% who had severe symptoms requiring hospitalization. In comparison, Gómez-Ochoa et al.[18] found 5% required hospitalization due to COVID-19 complications.

In this study, most healthcare workers 90.4%, had access to infection control protocols and procedures of

their healthcare facility, and 85.0% were familiar with the protocols and procedures compared to Delgado et al.,[11] where 75.5% had access to hospital safety rules and regulations. In addition, the majority had access to PPE items such as facial protective shields (76.2%), gel hand sanitizer (97.4%), N95 masks (76.7%), disposable surgical masks (94.8%), gloves (98.4%), and disposable gowns (93.8%). In comparison, Delgado et al.[11] reported healthcare workers had access to the following items: facial protective shields 32.6%, gel hand sanitizer 95%, N95 masks 56.1%, disposable surgical masks 83.9%, disposable gloves 91.1%, had access to disposable gowns 67.3%. However, Houghton et al. found significant apprehension among healthcare workers and hospital managers due to low standard equipment and scarcity of PPE.[21]

Most healthcare workers, 82.1%, followed preventive measures such as always wearing masks, wearing surgical gloves before checking a patient, changing gloves between patients, and washing their hands before carrying out procedures or entering a patient's room. In addition, the majority strictly followed hand sanitizing infection control protocols and procedures of their hospital. A study conducted among nurses in Saudi Arabia reported that the majority of nurses (96.85%), had excellent knowledge of COVID-19 awareness, while 83.2% of nurses had knowledge of preventive measures.[22]

Only 31.6% of workers followed social distancing measures at the workplace; social distancing could be challenging to adhere to in a hospital or primary healthcare setting due to overcrowding.[23] About 48.2% of healthcare workers submitted a daily assessment log on having any signs or symptoms of COVID-19, 57.5% strictly followed hospital infection control protocols and procedures, and 44% disinfected their workstations before and after use. The given percentile indicates that many healthcare workers are not strictly following recommended infection prevention and control practices, suggesting the need for further strictly following routine protocol in our in-house setup to control the spread of Coronavirus. When asked about doffing and donning, 49.2% of healthcare workers got both correct, 39.0% got either one correct of those, 30.4% got only donning correct, and 8.6% got only doffing correct. However, 11.8% got both wrong. In a study conducted by Lamhoot et al.,[24] 50% of healthcare workers performed donning correctly, whereas 37% performed doffing correctly.

Our study provides an overview of the current state of practice in terms of adherence and accessibility to the use of preventative and protective personal equipment. However, one of the limitations of this research is that the practice of the use of preventative and protective measures is single-centered rather than multi-centered. Discrepancies can be observed as policies and protocols differ among different centers, hence in the future multi-centered study is recommended.

Conclusion

Study findings revealed that most healthcare workers at BDF-RMS had appropriate knowledge, and, they also adhered to the proper use of PPE and infection control protocols and practices. However; there were areas where poor knowledge, non-adherence to the protocol, inappropriate doffing of PPE, and unacceptable practices were observed. We recommend providing continuous health education to healthcare workers regarding the prevention and control of SARS-COV-2 infection and transmission.

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Author contributions

KAY and SMI: Study concept, questionnaire sharing with healthcare workers on social media, data collection, data analysis, interpretation, and manuscript writing. KAY, SMI, AFA, HAA: Data interpretation, read, and approved the final manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical approval and consent to participate

This study was conducted in accordance with Institutional Research Ethics. Approval from the ethics committee at Bahrain Defense Force Hospital was obtained at the end of March 2021. The reference number for ethics committee approval is BDF/R&REC/2021-554. Participation in the study was completely voluntary with the anonymity of the participants guaranteed. At the beginning of the questionnaire, there was written informed consent that must be approved by healthcare workers to be able to complete the questionnaire. The confidentiality of the collected data was strictly maintained.

Consent for publication

Not applicable.

Significance for public health

One of the public health priorities is protecting healthcare workers. Hence, evaluating the deficiencies either in terms of supplementing healthcare facilities with resources or training healthcare workers regarding the proper use of personal protective equipment and preventative measure would ultimately limit the spread of infection among healthcare workers. Thus, the role of the

public health ministry is to provide occupational safety for healthcare workers by supplying the necessary equipment.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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