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Attitude and practices of personal protective equipment, telemedicine, and social distance among health care workers during COVID-19 pandemic: An international study

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ABSTRACT

Background: Coronavirus disease 2019 **(**COVID-19) pandemic is a huge burden on health systems worldwide. Healthcare workers (HCWs) are at the frontline in this battle and personal protective equipment (PPE) is a crucial element for their safety. **Objectives:** to assess the attitude and practices of PPE among HCWs alongside its availability and toxicities as well as to assess the use of telemedicine, physical barriers, and practice of social distance among HCWs. **Methods:** A cross sectional online survey was conducted between July and November 2020. Healthcare workers from different countries were invited to participate via emails and social platforms. **Results:** Out of 384 requested to participate, 119 participants completed the survey. The mean age for the participants was 41.5± 10.4. Females accounted for (n=83, 69.8%). Although 67.2% said they received training for the correct use of PPE, a 69.7% and 79.8% failed to answer the correct order of donning and doffing PPE, respectively; (n=92, 77.3%) mentioned that N95/FFP2 respirators were the kind of masks routinely used for care of confirmed COVID-19 cases and (n=90, 75.6%) claimed that fit testing was done for N95/FFP2 respirators before use. Thirty-nine participants (n=39, 32.8%) said that they extended the use of PPE > 12 hours. Hazmat suit, overshoes, respirators, hair caps, and goggles were the most deficient PPE. The most frequently reported adverse events when working with PPEs were heat intolerance (47.1%), headache (43.7%), pressure areas (32.8%), and extreme exhaustion (31.1%). Regarding other protective measures, (n= 79, 66.4%) said they are maintaining adequate social distance; (n= 64, 53.8%) and (n=66, 55.5%) declared the use of physical barrier and telemedicine, respectively. As regard the attitude, a (n=79, 66.4%) said it is convenient to comply with the recommended PPE when examining COVID-19 cases. **Conclusion:** Donning and doffing were the most common PPE malpractices. There was a positive attitude towards PPE among the HCWs. There was limited access to telemedicine, physical barriers, and application of social distance inside the healthcare facilities.

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Introduction

Coronavirus Diseases 2019 (COVID-19) is an emerging viral illness caused by a novel coronavirus, termed Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Up till now, there are 267 million cases of SARS-CoV-2 and 5.2 million deaths worldwide [1]. Thus, COVID-19 pandemic has been pushing hospital systems and caregivers to the brink [2]. Maintaining healthy and efficient healthcare workers (HCWs) is an essential element to overcome the current pandemic [3].

A lesson learnt from SARS-CoV-1 outbreak in 2003 is that if personal protective equipment (PPE) is correctly worn, they can limit the transmission of infection in health care facilities [4]. Hence, the use of PPE including disposable long sleeved gowns, disposable gloves, fit tested N95 respirators in addition to eye protection in form of goggles or face shields are compulsory for HCWs' safety. Other protective measures include both hair and shoe covers [5].

Importantly, appropriate PPE should be always accessible and nor should there any shortage. Furthermore, HCWs must be appropriately trained [6]. It also must be considered that the usage of PPE for prolonged hours may be associated with unfavorable side effects discouraging HCWs from using them [7]. From other perspectives, practicing social distance, applying physical barriers, and implementing telemedicine may minimize the risk of infection among the HCWs [8-10].

Therefore, we carried out this study to evaluate the attitude and practices of PPE among HCWs in addition to its availability and toxicities, use of telemedicine, physical barriers and practice of social distance inside the medical facilities.

Methods

Study design and participants

This cross-sectional survey was carried out between July and November 2020.There are approximately 59 million HCWs worldwide including physicians, nurses, technicians, and other HCWs [11]. The calculated sample size at 95% confidence interval, margin of error 5%, and population proportion 50% was 385. Out of 385 invited participants, only 119 individual agreed to participate (response rate: 31%).

Questionnaire development and validation

The survey was designed by the principle investigator, reviewed for validity with the aid of biostatistics expert, and was pilot examined on 20 subjects from the target population who were not included in the study. The study survey consists of three sections. The first section included five items about the demographic characteristics of the participants. The second section comprised sixteen items about the PPE practices, availabilities, and toxicities alongside the application of telemedicine, physical barriers, and social distance. The third section comprised three items designed to evaluate attitude towards the PPE among the HCWs. Cronbach's alpha was calculated to be 0.7. Each participant was assigned one point for each correct practice or positive attitude answer and zero point for incorrect practice or negative attitude. If the participant achieved ≥ 60% correct answers in practices/attitude section, this was considered as good practice or positive attitude. The self-structured questionnaire is shown in the supplementary file.

Ethical approval and data collection

The study was performed in accordance with the Declaration of Helsinki guidelines and regulations. Ethical approval was received from Zagazig University- Faculty of Human Medicine's Review Board (ZU-IRB No. 6933). Consent was implied by the completion of the survey and participants were permitted to complete the survey only once. Introductory paragraph outlining the purpose of the study was posted along with the survey. The survey was openly distributed online to HCWs worldwide via e-mails and social media platforms and was delivered in English.

Statistical analysis

Data management was performed using the statistical Package and Service Solution version 25 (IBM SPSS, New York, United States). Continuous variables were expressed as mean and standard deviation. Categorical variables were expressed by reporting the number and the percentage. Two independent samples T test was used to compare continuous variables. Chi square test was used to compare categorical variables. *P* value was considered statistically significant if ≤ 0.05.

Results

a) Demographic criteria of the study participants

The baseline criteria for the study participants are shown in **table (1)**. The mean age± SD for the participants was 41.5± 10.4. Females constituted the majority of the participants (n=83, 69.8%). Physicians accounted for the majority of the HCWs participants (n=56, 47%). Most of the participants (n= 85, 71.4%) were working in either large tertiary or community urban hospitals. About sixty percent of the participants (n=71; 59.7%) had work experience more than 10 years. Fifty seven percent of the participants (n=68, 57.2%) were from North America (mainly the USA & one from Canada), whilst twenty eight participants (n=28, 23.5%) were from Africa (Egypt, South Africa, Ethiopia, Kenya, and Libya), fifteen participants (n=15,12.6%) were from Asia (Saudi Arabia, Iraq, India, Philippines, and China), and eight participants (n=8, 6.7%) were from Europe (UK, Italy, Romania, Croatia, Germany).

b) PPE practices among the HCWs

The PPE practices among the participants are shown in **table (2)**. High proportion (n=83, 69.7%) of the participants failed to answer the right order of donning the PPE. Along the same line, (n=95, 79.8%) could not answer the correct order of doffing the PPE. Additionally, (n=68, 57.1%) mentioned they never used the two person technique for donning and doffing PPE, although (n=80, 67.2%) stated that they had received training for the correct use of PPE.

Most of the participants (n=92, 77.3%) mentioned that N95or FFP2 respirators were the kind of the masks routinely used for care of confirmed COVID-19 cases and (n=90, 75.6%) claimed that fit testing was done for N95/FFP2 respirators before use. Only about one third of the participants (n=39, 32.8%) claimed that they extended the use of PPE for more than 12 hours.

The demographic factors associated with correct and wrong PPE practices are shown in **table (3)**.There was no statistically significant difference between both groups as regard age, sex, job, type of the affiliated hospital, or years of experience. The reasons for not applying the standard PPE during practice are shown in **figure (1)**.

c) PPE availability & toxicities

Almost 64% of the participants (n=76, 63.9%) declared that all the recommended PPE were available near the patients' rooms and the vast majority of the participants (n=94, 79%) stated that they were not forced to use homemade fabric or cotton masks, gowns, or face shields.

Regarding which PPE was not available, the answers are shown in **figure (2)**. Hazmat suit, overshoes, respirators, hair caps, and goggles were the most deficient PPE, respectively. The most frequently stated adverse events when working with PPE were heat intolerance (n=56, 47.1%), headache (n=52, 43.7%), pressure areas (n=39, 32.8%), and extreme exhaustion (n=37, 31.1%) as shown in **figure (3)**.

d) Practices of social distance, use of physical barriers, and telemedicine

Concerning other protective practices, (n= 79, 66.4%) said they were maintaining adequate social distance. About half of the participants (n= 64, 53.8%) declared the use of physical barrier and (n=66, 55.5%) participants used telemedicine as shown in **figure (4)**.

e) Attitude towards PPE among the HCWs

The participants' attitude towards the usage of PPE is shown in **table (4)**, a good percentage of the participants experienced positive attitude where (n=79, 66.4%) said it is convenient to comply with the recommended PPE when examining COVID-19 patients. Beside, about sixty nine percent (n=82, 68.9%) believed that they could improve the use of the recommended PPE. Only (n=33, 27.7%) said they had little or no confidence that the PPE have adequate standards to do their jobs safely. Demographic factors related to positive attitude towards PPE are shown in **table (5)** where sex and job type were the statistically significant factors between both groups.

Table 1. Baseline demographic criteria of the study participants.

Parameter	**(N, %)**
Age (mean± SD)	41.5± 10.4
Sex	
Male	35 (29.4%)
Female	83 (69.8%)
Prefer not to say	1 (0.8%)
Job	
Physician	56 (47%)
Nurse	39 (32.8%)
Technician	5 (4.2%)
Other HCWs	19 (16%)
Level of hospital	
Large tertiary teaching hospital	42 (35.3%)
Community urban hospital	43 (36.1%)
Remote/ regional hospital	17 (14.3%)
Private hospital	17 (14.3%)
Years of experience	
< 5 years	23 (19.3%)
5-10 years	25 (21 %)
> 10 years	71 (59.7%)

Table 2. Perspnal protective equipments practices among the participants.

Question	**Answers (No, %)**
The correct order of putting on PPE.	
Correct	36 (30.3%)
Incorrect	83 (69.7%)
The correct order of PPE removal.	
Correct	24 (20.2%)
Incorrect	95 (79.8%)
Do you use a 2 person team for donning and doffing PPE?	
Always for donning and doffing	14 (11.8%)
Only for donning	9 (7.6%)
Only for doffing	6 (5%)
Sometimes	22 (18.5%)
Never	68 (57.1%)
Did you receive training for correct use of PPE?	
Yes	80 (67.2%)
No	39 (32.8%)
What is the type of your mask routinely used for care of confirmed COVID-19 cases?	
Surgical Mask	17 (14.3%)
N95 or FFP2	92 (77.3%)
Powdered air purifying respirators	6 (5%)
Others	4 (3.4%)
Fit testing is done for N95/FFP2 respirators before use?	
Yes	90 (75.6%)
No	29 (24.4%)
Do you extend the use of PPE for > 12 hours?	
Yes	39 (32.8%)
No	80 (67.2%)
All recommended PPE are available near patients' room?	
Yes	76 (63.9%)
No	43 (36.1%)
Are you using ''home made'' or '' creative'' PPE like homemade fabric or cotton masks, homemade gowns or face shields?	
Yes	25 (21%)
No	94 (79%)

Table 3. Demographic factors related to correct and wrong PPE practices among the studied participants.

Variable	Good practices (N=70)	Wrong practices (N=49)	*P* value
Age (mean±SD)	42.4±10.86	40.3±9.7	0.2
Sex (N, %)			
Females	48 (68.6%)	35 (71.4%)	0.68
Males	21 (30%)	14 (28.6%)	
Prefer not to say	1 (1.4%)	0 (0%)	
Job (N, %)			
Physician	29 (41.4%)	27 (55.1%)	
Nurse	25 (35.7%)	14 (28.6%)	0.2
Technician	5 (7.2%)	0 (0%)	
Other HCWs	11 (15.7%)	8 (16.3%)	
Hospital level (N, %)			
Large tertiary teaching hospital	24 (34.3%)	18 (36.7%)	
Community/Urban hospital	29 (41.4%)	14 (28.6%)	0.55
Remote regional hospital	9 (12.9%)	8 (16.3%)	
Private hospital	8 (11.4%)	9 (18.4%)	
Experience (N, %)			
<5 years	15 (21.4%)	8 (16.3%)	0.15
5-10 years	10 (14.3%)	15 (30.6%)	
>10 years	45 (64.3%)	26 (53.1%)	

Table 4. Personal protective equipment attitude among the participants.

Question	Answers (No, %)
It is convenient to comply with the recommended PPE when examining COVID-19 patients?	
Agree	79 (66.4%)
Disagree	26 (21.8%)
Not sure	14 (11.8%)
I believe I can improve my use of recommended PPE?	
Agree	82 (68.9%)
Disagree	21 (17.6%)
Not sure	16 (13.5%)
Are you confident that your PPE have adequate standards to do your job as safely as possible?	
Very confident	10 (8.4%)
Confident	32 (26.9%)
Somewhat confident	44 (37%)
Little confident	25 (21%)
Not confident at all	8 (6.7%)

Table 5. Demographic factors related to positive attitude towards PPE among the participants.

Variable	Positive attitude (N=89)	Negative attitude (N=30)	*P* value
Age (mean±SD)	40.67±10.5	44.2±6.7	0.08
Sex (N, %)			
Females	57 (64%)	26 (86.7%)	**0.01***
Males	32 (36%)	3 (10%)	
Prefer not to say	0 (0%)	1 (3.3%)	
Job (N, %)			
Physician	49 (55.1%)	7 (23.3%)	**0.02***
Nurse	23 (25.8%)	16 (53.4%)	
Technician	4 (4.5%)	1 (3.3%)	
Other HCWs	13 (14.6%)	6 (20%)	
Hospital Level (N, %)			
Large tertiary teaching hospital	35 (39.3%)	7 (23.3%)	0.3
Community/Urban hospital	29 (32.6%)	14 (46.7%)	
Remote regional hospital	11 (12.4%)	6 (20%)	
Private hospital	14 (15.7%)	3 (10%)	
Experience (N, %)			
<5 years	19 (21.3%)	4 (13.3%)	0.44
5-10 years	16 (18%)	9 (30%)	
>10 years	54 (60.7%)	17 (56.7%)	

p value is statistically significant.

Figure 1. Bar chart showing the factors for not applying the standard PPE.

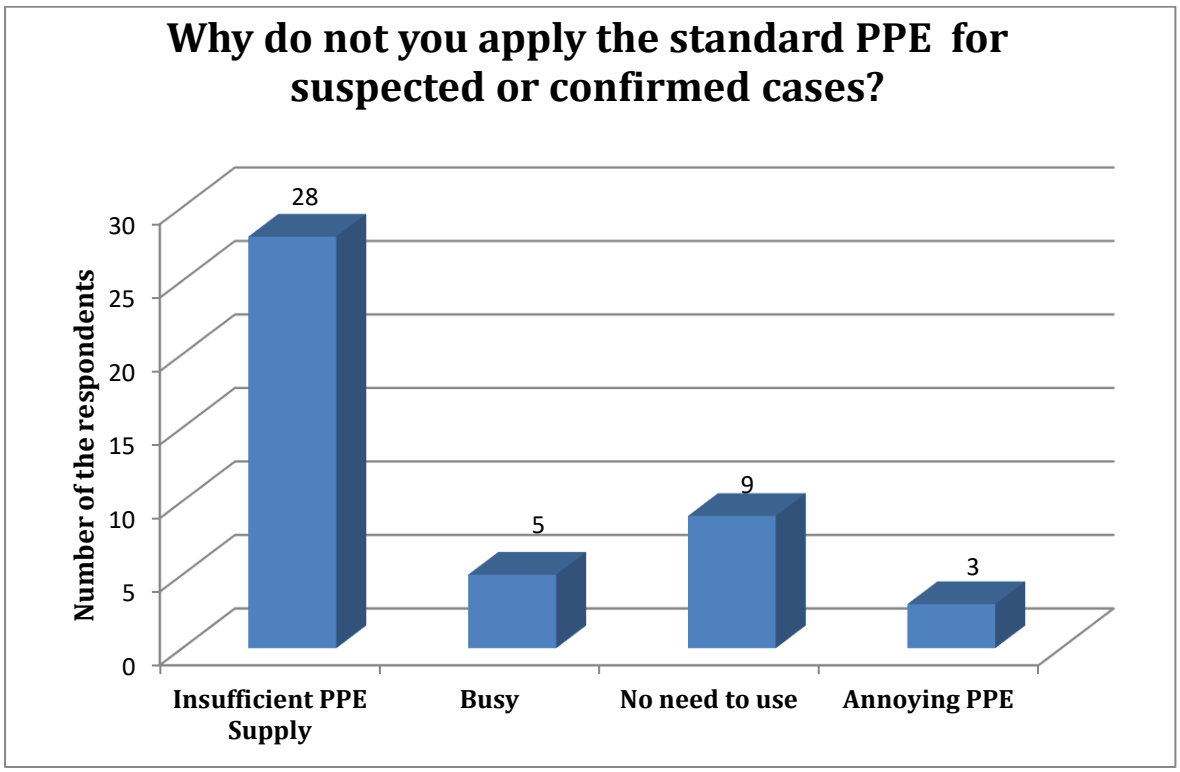


Figure 2. Bar chart showing which PPE is not available.

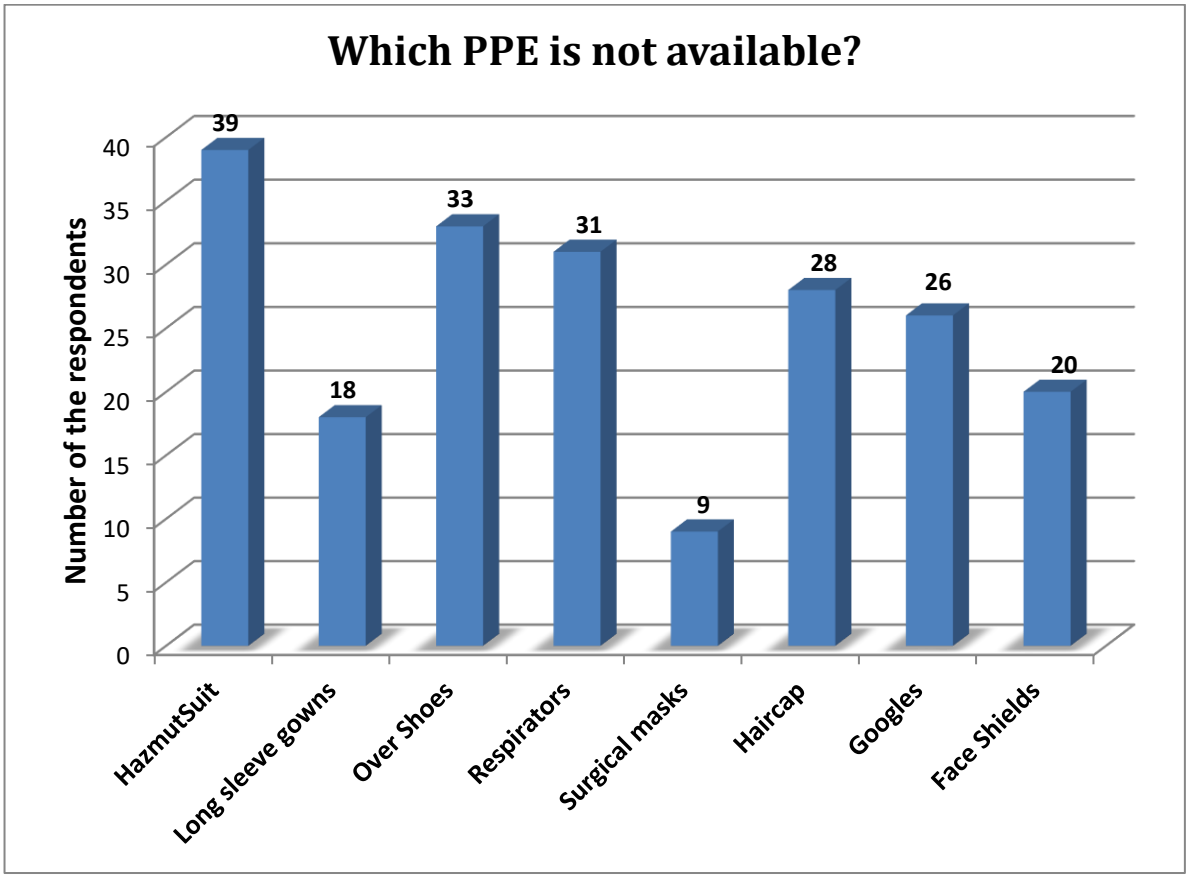


Figure 3. Bar chart showing the significant adverse effects when working with PPE.

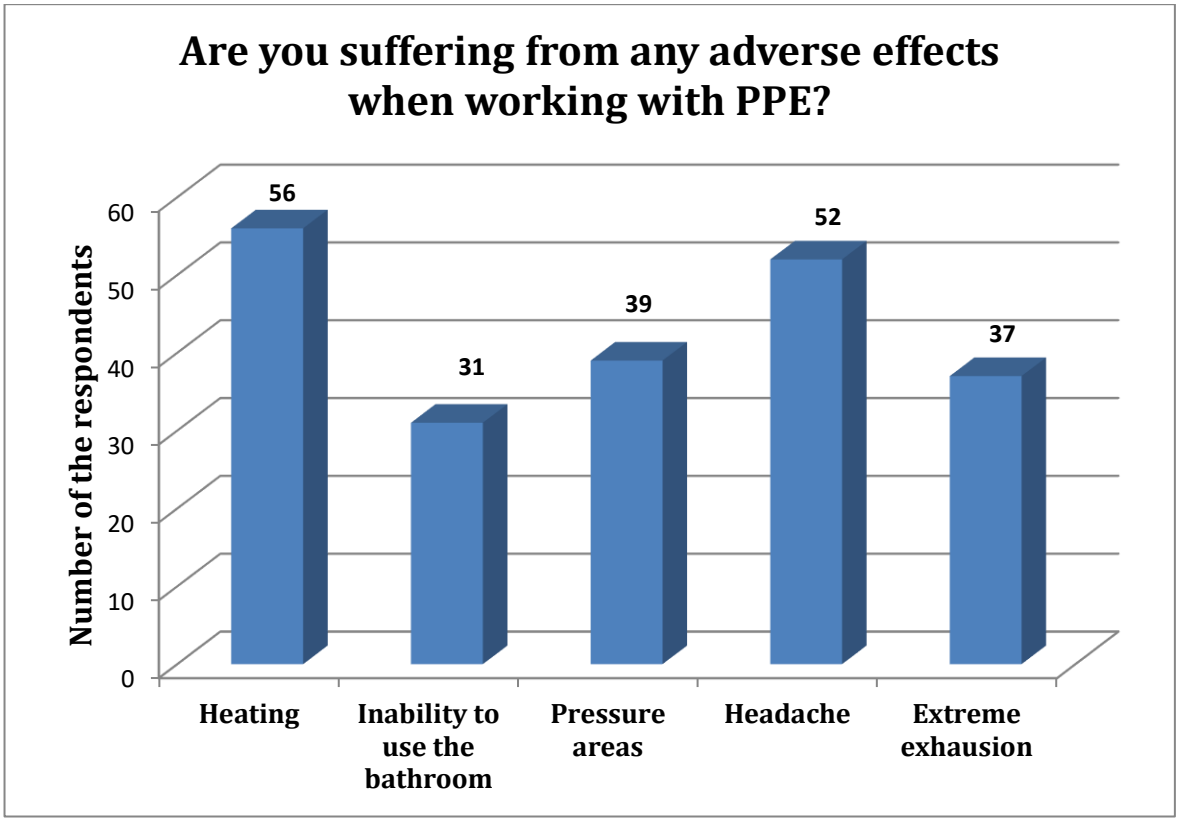
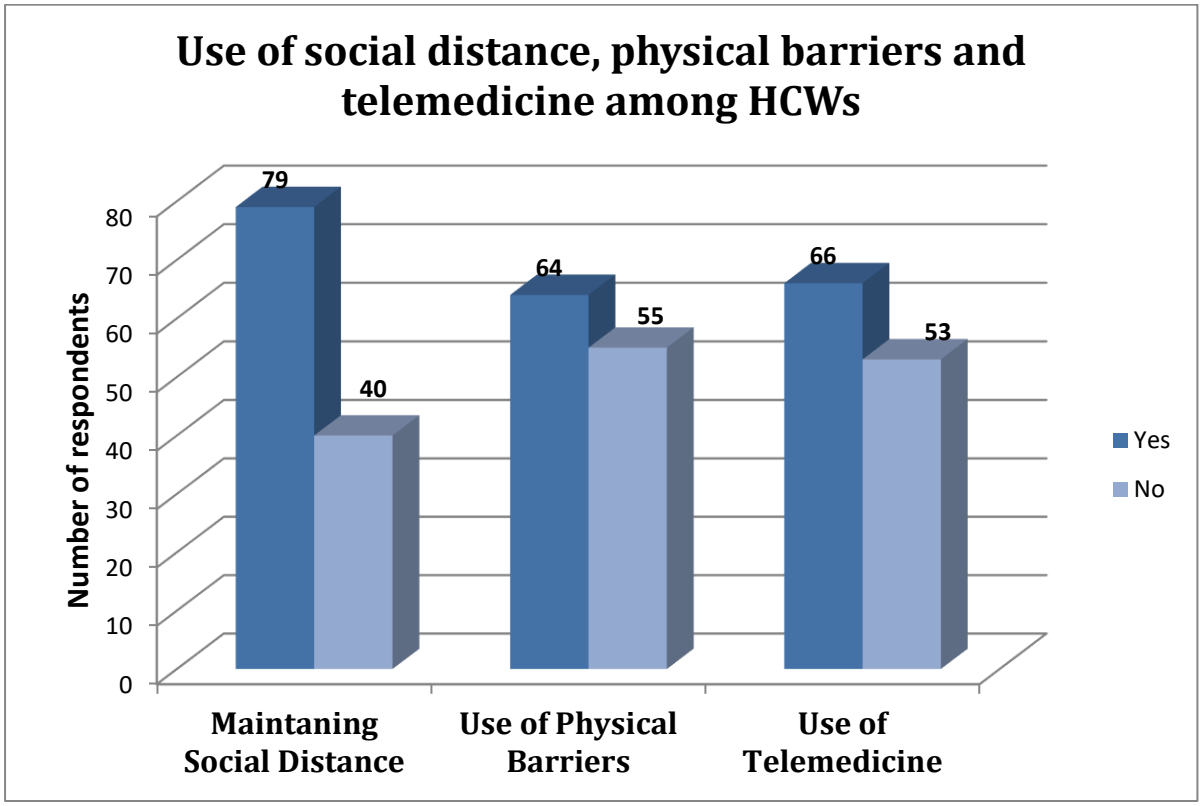


Figure 4. Bar chart showing other protective practices against COVID-19.



Discussion

Appropriate use of PPE is essential to prevent the acquisition and transmission of COVID-19, to maintain services, and to ensure HCWs are not afraid to provide patient care [12]. Thus, we conducted this study to assess the attitude and practices of PPE among HCWs alongside its availability and toxicities as well as, the practice of social distance, use of telemedicine, and physical barriers in medical facilities.

Although 67% of our participants (n=80) claimed they had received effective PPE training, only 30 % (n=36) and 20% (n=24) could answer the correct order of putting on and doffing PPE, respectively. Additionally, only 11.8% (n=14) mentioned they regularly used the 2 persons donning and doffing techniques. Thus, education and training cannot assume that they arrive with an understanding of appropriate PPE principles and practice. These finding aligns with that of **Peres et al.** who reported that 59% of advanced medical students and junior doctors who participated in his survey had insufficient knowledge about PPE [13].

Most of our participants (n=92, 77.3%) mentioned that they routinely used N95/FFP2 respirators for care of confirmed COVID-19 cases. While, only 17 participants (14.3%) used surgical masks. Our findings are in agreement with **Ippolito et al.** who assessed PPE use by HCWs during the early phase of COVID-19 pandemic in Italy. They declared that FFP2 and FFP3 respirators or equivalent were the most used masks for routine care. The median time of wearing PPE without taking a break was 5 hours [IQR: 4–6], compared to 6.8 hour in our survey [14].

Many studies documented the use of non-fit tested filtering respirators as well as incorrect donning and doffing of PPE as a possible causes of infection during SARS pandemic [15,16]. In the current study, 90 participants (75.6%) claimed that fit testing for N95/FFP2 respirators was done before use. However, **Ippolito et al.** mentioned that 249/380 (65%) of Italian HCWs had never performed a formal fit test for a N95 mask or equivalent [14].

Our findings showed that 68 participants (57.1%) never used the two person technique for donning and doffing PPE. However, **Ippolito et al.** reported that only 91/380 (24%) of the Italian HCWs never had a partner for donning and doffing procedures [14].

Our study showed that hazmat suits, over shoes, respirators, hair caps, and goggles were the

most deficient equipment, respectively. A cross sectional study from Latin America demonstrated that facial protective shields were the most deficient items of PPE followed by N95 respirators and disposable gowns [17]. Another survey from Japan showed that the N95, face shields, and goggles were out of stock [18].

The current study revealed that the most frequent PPE side effects was heating (47%).These findings coincide with data available from literature that overheating due to PPE is quite common [19]. The other most common side effects reported in our study were headache (43.7%), pressure areas (32.8%), extreme exhaustion (31.1%), and inability to use the bathroom (26%). Other two participants listed extreme thirst and inability to eat or drink as PPE drawbacks. These findings are in accordance with **Ippolito et al.** who mentioned that heat, thirst, and pressure areas were the most frequent adverse effects [14]. Other PPE side effects reported in the current study were inability to breathe, dizziness, and emotional exhaustion. Remarkably, one of the participants mentioned anger over patients as a side effect to PPE usage. Moreover, two participants complained of reticence and isolation when using PPE.

Hampton et al. studied the negative impact of wearing PPE on communication during COVID-19 pandemic and reported that HCWs were unable to communicate efficiently and properly with each other and with patients while wearing PPE. Given the muffled voices and hearing that results from multiple layers of PPE, communication may become difficult [20].

Two of our participants (1.7%) mentioned they had breaking out/ rashes and itching on the face. Our findings are along the same line with **Foo et al.** who reported four (1.6%) out of 258 cases developed adverse skin reactions related to the repetitive wearing of disposable gowns for average time of 6 hours during a mean period of 8.8 months in the SARS epidemic in Singapore. Itching and wrist rashes were the most frequent reactions, while pruritus without skin lesions was also observed in one case [21].

From other perspectives, the progressive spread of the COVID-19 pandemic exceeding the capacity of the health care systems worldwide and leading to struggle of the governments and HCWs alongside the urgent need to protect the medical personnel and the patients. **Sun et al.** showed that halving occupancy density can reduce the infection rate significantly by 20 to 40 % even under current ventilation practices [22].

Telemedicine is the use of communications technology to deliver health care to patients at a distance [23]. However, unfortunately, only half of our participants (n= 66, 55.5%) said they use telemedicine to initially evaluate suspected cases of COVID-19 when feasible. Explanations of these disappointing results may be attributed to that online consultations may require patients to have the knowledge and capacity to get online; some may have obstacles accessing tele-medical services. Furthermore, many older patients might be unable to do this because of disabilities or inexperience with technology [24]. In addition, **Hong et al.** found that the United States population interest in tele-health is high; however, this interest did not correlate with the proportion of hospitals providing tele-health services in the U.S.A, suggesting that increased population demand may not be met with the current tele-health capacity [25].

Despite the worldwide strong emphasis on the importance of social distance to control COVID-19 pandemic especially in indoor places, only 66.4% (n=79) of our participants claimed they practice adequate social distance. This may be attributed to the inapplicability of practicing social distance in hospitals when dealing with patients of high physical needs.

Although physical barriers are inexpensive beneficial tool to protect HCWs, minimize the risk of exposure, and conserve PPE, only 53.8% (n=64) of our participants documented their use during routine practice. This may be attributed to reluctance of the medical facilities incorporating this new policy into the system.

The current study showed a positive attitude towards the usage of PPE. A study by **Ganczak et al.** evaluated the adherence to the usage of PPE among 601 surgical nurses. Their findings indicated that "compliance with PPE varies considerably. It was high for glove use (83%) but much lower for protective eyewear (9%). They also found that nurses with previous infection control training or experience caring for HIV patients had much higher compliance; the combined effect of training and experience exceeded that for either alone"[26]. However, in the current study we could not document these associations.

In our study, by asking the participants who stated they do not apply the standard PPE about their justifications, (n=28/119; 23.5%) said there is

insufficient PPE, (n=5/119; 4.2%) said they are busy, (n=9/119; 7.5%) said there is no need to use PPE, and (n=3/119; 2.5%) said PPE is annoying. Our findings are in harmony with **Ganczak et al.** who also found that "the lack of PPE (37%) was the most common reason for non-compliance followed by the persuasion that the source patient was not infected (33%), and staff concern that following locally recommended practices interfered with providing good patient care (32%)" [26].

Implications of the study

This survey provides data about the practices and the attitude towards PPE among HCWs alongside its availability and toxicities. It gives also insight into the practice of social distance, use of telemedicine, and physical barriers among the HCWs in medical facilities. These results could inform the medical authorities about the training needs for HCWs for proper use of PPE and the equipment in shortage to ensure adequate supply. Governments should encourage companies that might be able to shift manufacturing to this equipment to do so. Additionally, smaller companies can also play a key role in filling the gap.

Limitations

This study has several limitations. First of all, our data have to be put in context (July-November 2020) of the pandemic. Secondly, our survey was limited in scope. Participants were asked to answer very specific questions that might not have addressed the complex situation of the current pandemic. Thirdly, enrollment of the participants was based on their willingness to participate and access to social networking websites and applications; therefore, the study population does not include participants without those resources. Finally, the sample size of this study makes the generalization of our findings quite limited. Surveys directed to HCWs usually do not achieve high response rate due to their busy schedules, especially during the epidemic.

Conclusion

Donning and doffing were the most common PPE malpractices. There was a positive attitude of HCWs towards PPE use. There was modest use of telemedicine, physical barriers, or application of social distances inside the health care facilities. There was limited access to some PPE beside significant toxicities and side effects.

Recommendations

(1) HCWs must be periodically trained on how to correctly use full PPE (2) physical barriers should be applied wherever possible (3) Implementation of telemedicine in every medical facility is essential (4) Medical engineering teams should find novel solutions to create light PPE that allow easy communication between HCWs and perhaps eating and drinking during their shifts and should find creative remedies to apply social distance inside healthcare facilities.

Finally, we would like to share with the scientific community some comments mentioned by our participants in the comment section of our survey (1) Lack of terminal cleaning of the rooms after COVID-19 patients leave (2) We were not allowed to use our own PPE (3) I do not feel safe with my hospital providers for PPE (4) They surrounded our office with COVID-19 patients (5) N95 use for 12 hours then recycled and given back to us.

Future perspectives

(1) Future studies about implementation of social distance, physical barriers, and telemedicine inside the healthcare facilities are required. (2) Future studies about how to improve hospitals' ventilation systems during droplet or air-borne pandemic are required. (3) Future studies about the financial support or compensation of HCWs during these exceptional circumstances should be taken into consideration.

Abbreviations

COVID-19: Corona Virus Disease 2019.
FFP: Filtering Face Piece.
HCWs: Health Care Workers.
PPE: Personal Protective Equipment
SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus.

Authors' contributions

Dina M. Ali is the principal investigator and is responsible for the whole work including concept, study design, collection and analysis of data, writing and reviewing the draft, and critical revision of the final manuscript. Khaled Raafat & Rehab El- Sokkary are co-authors responsible for critical revision of the final manuscript for intellectual content.

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Competing interests

The authors have declared that no competing interests exist.

Availability of the data

The data that support the findings of this study are available from corresponding author upon reasonable request.

Supplementary materials: the studied questionnaire is attached.

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