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Original Research Article

Human factor issues in relation with personal protective equipment during COVID-19 pandemic: a survey

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ABSTRACT

Background: Personal protective equipment is used to reduce the danger that causes serious injuries and illnesses in the workplace. Alongside, continuously wearing PPE may also create some hazards. This study explores the human issues in relation to PPE among health care workers.
Methods: A cross-sectional survey was conducted with 283 health care workers who are wearing PPE for taking care of COVID-19 patients from October 2020 to January 2021. 283 valid responses were received. The structured questionnaire was developed in the google form and the link was shared among various groups. Data were organized and analysed by using IBM SPSS 20.0 software.
Results: Participants were uncomfortable in wearing with PPE, they reported safety glasses over spectacles (48.8%) safety goggles (32.9%) not comfortable, nearly half of them reported tough to read and operate equipment due to continuous wearing of safety glasses (46.3%). Around 77% of the participants have reported that they were facing communication problems and were using sign language also.
Conclusion: There are various issues with PPE including fit, comfort, communication & operating ability. This can cause significant discomfort which leads to fatigue, negatively impacting the user's physiological and psychological wellbeing. Poor fit PPE also puts HCWs at risk of exposure. Females face more issues than males so, we suggest to come up with the wider distribution of sizes like, small, medium and large to improve the fitness and comfort during working. Longer duration may further lead to physical and psychological stress.

Keywords: Personal protective equipment, Human issues in relation with PPE, Health care workers, COVID-19 pandemic

INTRODUCTION

The COVID-19 pandemic has become a serious challenge for spread, treatment, and prevention. It is spread through aerosolized droplets by way of coughing, sneezing or breathing as well as through airborne transmission.[1] It is a highly contagious virus that creates significant risk to healthcare workers yet is also largely preventable.[2] Health Care workers are affected with a significant risk of infection due to their care to suspected or confirmed cases and due to their engagement in laboratory for testing. For example, 15,000 health care workers have been affected by COVID-19 in Spain; in Italy out of which, 10% of the confirmed cases are of health care workers. As of 8 April 2020, 22,073 health workers have been infected by COVID-19 in 56 countries according to world health organization. More than 400 health care workers have been quarantined from various public and private healthcare centers based on either suspected or confirmed COVID-19 in India. Though it is a highly contagious virus that creates significant risk to health care workers

yet it is also largely preventable. since it is significantly risky to health care workers during this COVID-19 pandemic, Persons who involve in attending the patients/ suspects and in ICU and those working in laboratory are advised to wear the full cover PPE. Skill-based training and experience are needed to the health care workers for their efficient use of PPE.[3]

The well-designed Personal protective equipment protects the health care workers from serious injuries in the workplace, infections through the contacts of biological agents, or other workplace hazards.[4] In PPE, Gowns, gloves, eye shields act as the barriers; N95 or FFP2 are the standard respirators and aprons which protect the mucous membranes, airways, skin, and contacting with infectious agents.[5,6] A good-quality personal protective equipment (PPE) will keep the health care workers safe.[3]

Health Care Workers will frequently oppose wearing these devices because fitness and discomfort.[7] If the PPE fails that may put health care workers at high risk for causing diseases, thermic discomfort, limited fine motor skills, skin injury, and so on.[8] Hence compliance with PPE protocols is a significant concern in infection control practices.

COVID-19 poses many challenges to the health care workers. one of the major challenges is caring patients with PPE for long hours. Since wearing PPE for long duration, Health care workers are facing many problems-like physical discomforts, limited dexterity, psychological stress, not meeting basic personal needs (food, water, and elimination needs). hence, this study aims to focus the issues regarding human factors related to PPE and suggest ways to reduce the discomfort and improve the efficiency of the health was workers.

METHODS

A Cross sectional study was conducted from October 2020 to January 2021 to know the human factor issues related with PPE. General population are health care workers who are caring patients with PPE in the COVID area in various hospital in India (ICU, ward, emergency department, OT, lab, and other service areas). Therefore, subjects were invited to participate in this study through online mode. The sample size was calculated manually to be 235 by keeping 95% as confidence level, limit of 5%. Quality control of data achieved by daily checking the responses. By end of January 2021, totally 310 responses were received, and 27 responses were invalid so they were not considered for data analysis only 283 responses were considered for data analysis.

RESULTS

By end of January 2021, 310 responses were received, and 27 responses were invalid, so they were not considered for data analysis only 283 responses were considered for data analysis. Descriptive statistics was used for analyzing the data. Characteristics of participants included in the study is age and height.

Results parts divided into three categories; face cover PPE, hand cover PPE, body cover PPE.

Face cover PPE

Human factor issues in relation with Face cover PPE half of the participants reported that safety glasses (75.3%), safety goggles (62.2%) and surgical mask (47.7%) were acceptable fit while surgical hood (16.3%) full face shield (14.5%), safety goggles (14.8%) and safety glasses over spectacles (47%) are poor fit.

Table 1: Fitness of face cover PPE

Variables	Face cover PPE					
	Excellent fit		Acceptable fit		Poor fit	
	N	%	N	%	N	%
Safety glasses	36	12.7	213	75.3	34	12
Safety glasses over spectacles	39	13.8	111	39.2	133	47
Safety goggles	65	23	176	62.2	42	14.8
Surgical mask	123	43.5	135	47.7	25	8.8
Surgical hood	67	23.7	170	60.1	46	16.3
Ffp3/n95 face mask	101	35.7	155	54.8	27	9.5
Full face shield (visor)	95	33.6	147	51.9	41	14.5

Comfortable of face cover PPE

Participants reported that safety glasses (29%), safety glasses over spectacles (48.8%), Full face shield (25.8%) and safety goggles (32.9%) are not comfortable. half of the participants reported that safety glasses (38.5%), safety goggles (45.9%) , Full face shield (38.5%) FFP3/N95 face mask (37.5) are comfortable for up to 2 hours only. Additionally There was a significant association between gender and the comfortableness of face cover PPE while using surgical mask ($\chi 2$ (4)=48.77, $p<0.01$), surgical hood ($\chi 2$ (4) =17.63, $p<0.01$), FFP3/N96 mask ($\chi 2$ (5)= 30.01, $p <0.01$), full face shield ($\chi 2$ (4) = 24.27, $p<0.01$). Women are more likely to be comfortable for up to 2 hours, and less likely to be

moving and adjusting in all the time and feeling not comfortable at all than men.

Operating equipment with face cover PPE

One third of participants reported that its very difficult to read and operating the equipment due to glasses /mask/visor with safety glasses (46.3%), and also it got affecting due to sweating in safety goggles (37.8%), safety glasses over spectacles (33.9%) and full-face shield (31.4%) and test of independence Chi-square showed that there was significant association between gender and the face cover PPE in in reading and operate equipment while using safety goggles ($\chi 2$ (3) = 10.70, $p<0.05$) and surgical mask ($\chi 2$ (3) = 12.59, $p<0.01$) and also women are more likely to feel difficult due to glasses, mask, visor, sweating, misting and find harder than men.

Communication issues with face cove

Participants (28.3%) reported that they are facing problem for communication, hearing colleagues voice , alarms due to mask/visor with full face shield and followed by there was statistically significant association between gender and the face cover PPE in communicating and hearing colleagues' alarms etc. while wearing surgical mask ($\chi 2$ (2) = 29.07, $p<0.01$) & FFP3 face mask ($\chi 2$ (2) = 6.05, $p <0.05$) Women are more likely to feel harder and less likely to feel difficult due to mask and visor in communicating and hearing colleagues' alarms etc. while using the surgical mask and FFP3 facemask than men respectively.

Body cover PPE fitness

One-third of participants reported that plastic apron (20.5%), one-piece PPE suit (20.5%) are a poor fit. There was significant association between gender and the body cover PPE fit while wearing plastic apron ($\chi 2$ (2) = 8.15, $p<0.05$) and one-piece PPE suit ($\chi 2$ (2) = 7.30, $p<0.05$). Women are more likely to feel acceptable fit and poor fit and less likely to feel excellent fit while wearing plastic apron PPE than men.

Operating equipment with body cover PPE

It was very difficult to reach the object with one piece PPE suit (40.3%) and surgical gown with sleeves (49.8%) due to sweating during the working time and there was a significant association between gender and plastic apron in reaching and moving to operate equipment ($\chi 2$ (5) = 13.24, $p<0.05$) and women are more likely to find difficult due to fit, suffocation and harder and less likely to feel difficult due to sweating and accepting plastic apron than men. The results of the study showed that there was significant association between gender and One-piece PPE suit in reaching and moving to operate equipment ($\chi 2$ (5)=16.56, $p<0.01$). Men are more likely to find difficult due to fit and suffocation and less likely to feel harder, difficult due to sweating and accepting the one-piece suit than women.

Hand cover PPE fitness

Hand cover PPE gloves assessed in terms of disposable gloves and nitrile gloves, study reported that both gloves are poor fit among participants respectively 18.4% and 55.1%. Statistical results showed that there was significant association between gender and the PPE Gloves fit while wearing disposable gloves ($\chi 2(2) = 6.61$, $p<0.05$) and Nitrite gloves ($\chi 2$ (2)=8.48, $p<0.05$). Women are more likely to feel acceptable fit and poor fit and less likely to feel excellent fit while wearing disposable gloves than men.

Table 2: Operating equipment with body cover PPE

Variables	Body cover PPE									
	Fitness		Suffocation		Sweating		Harder but Ok		No difficulty	
	N	%	N	%	N	%	N	%	N	%
Plastic apron	48	17	5	1.7	37	13.1	95	33.6	98	34.6
Surgical gowns with sleeves	20	7.1	4	1.5	141	49.8	36	12.7	82	29
One piece suit	22	7.8	29	10.3	114	40.3	85	30	33	11.7

Table 3: Fitness of hand cover PPE

Variables	Hand cover PPE							
	Difficult due to fitness		Difficult due to sweating		Harder but ok		No changes with PPE	
	N	%	N	%	N	%	N	%
Gloves disposable	147	51.9	28	9.9	69	24.4	39	13.8
Nit rite gloves	37	13.1	39	13.8	122	43.1	85	30

Dexterity changing with hand cover PPE

Half of the participants reported that Dexterity is affected with disposable gloves (51.9%) due to fitness of gloves and there was significant association between gender and dexterity in using touch screens, pressing buttons, turning knobs, opening vials/taps, using syringes etc while wearing disposable gloves ($\chi 2$ (3) = 18.39, $p<0.01$). Women are more likely to find difficult due to fit of gloves and harder and less to feel difficult due to sweating and accepting the disposable gloves than men.

Sign language after donning

Total 77% of people are using sign language with PPE suit. it's hard to communicate things especially during an emergency time.

DISCUSSION

There have been many reviews of literature and studies related to COVID-19 Epidemiology, management, and prevention. but limited studies which are related to PPE related problem faced during donning, doffing, and during patient care awareness about donning and doffing of personal protective equipment among HCW but very limited studies were done in issues regarding PPE in India.[9,10]

The present study showed that there was significant association between gender and the face cover PPE (surgical mask) in terms of hurt and irritation of skin, ears, nose and mouth etc.5 x2 (4) =48.77, $p<0.01$. Hignett et al they found that safety glasses and over spectacles are significantly associated with fit and gender at the level of $p=0.022$.[11] Among the common problem associated with face cover PPE. Reading and operating equipment is difficult with safety glasses (46.3%), safety goggles (37.8%) & safety glasses over spectacles (33.9%) which was similar to the previous study where 23% participants reported that facing visual difficulties with safety glasses during working time.[11] Nearly one-third of the participants (28.3%) were having difficulties in communication, hearing colleague's voices, and alarms. Communication can be difficult for people who rely on lipreading or visual cues and unmuffled speech to understand what is being said and the results indicate that there was significant association between gender and the face cover PPE in communicating and hearing colleagues' alarms.[12] while wearing surgical mask $\chi 2$ (2) = 29.07, $p<0.01$. Women are more likely to feel discomfort due to mask and visor in communicating and hearing colleagues' alarms. while using the surgical mask than men. Hignett et al has also got similar findings and women reported more problems with communication and hearing alarms with surgical mask (49%), ($p= 0.038$).[11] In Body cover, PPE (surgical gown with sleeves (49.8%) & one-piece suit (40.3%) participants report that it's difficult due to fit in moving, reaching and operating equipment with PPE. which was similar to Hignett et al.[11] They found that Health care worker faced additional problems for non-clinical activities and clinical activities including typing, changing monitor button and using electronic interfaces. Reaching (gross motor) activities were restricted by both surgical gowns with sleeves (44%, N=116/265) and one-piece coveralls (66%, N=39/59). On hand cover PPE half of the participants reported that dexterity was changing because of the fitness of gloves especially in disposable gloves (51.9%), and also it was statistically significant association between gender and dexterity in using touch screens, pressing buttons, turning knobs, opening vials/taps, using syringes etc. while wearing disposable gloves $\chi 2$ (3) = 18.39, $p<0.01$. Women are more likely to find difficult due to fit of gloves and harder and less to feel difficult due to sweating and accepting the disposable gloves than males. working with hand gloves inward and ICU Setting will create many issues like skin problem for HCW and if the size of the gloves is not proper then they may face some other issues during the emergency like dexterity will be affected that will give some false incident. Apart from this majority of the HCW are using sign language (77%) to communicate what they want. Additionally, participants reported that they are suffering from breathing problem and dehydration, developed UTI, can't work freely, restricted movement, it's very hot inside, creating stressful environment and fear. This finding was supported with study conducted, by a team of researchers working in a government-owned super-specialty institute in North India in July 2020 (49%) reported forced removal of PPE kit due to extreme heat or thirst on one or more occasions and (26%) participants reported that forced removal of PPE kit due to the urge to void the bladder.[13,14] This study quoted that mainly women are facing more problem than men When PPE does not fit properly this impacts the user's performance, comfort and safety. PPE that is too big can hinder the user's ability to move freely and they risk the PPE damaging their work, this can cause significant discomfort which leads to fatigue, negatively impacting on the user's physiological and psychological wellbeing. Perhaps most importantly, PPE that does not fit the user correctly puts them at risk of exposure to the hazards in the environment.[15]

Relevance to clinical practices

Adherence to protective measures and use of PPE is almost importance for HCW to prevent infection (specially COVID-19) in this pandemic. It is also considered that various practical issues with use of PPE in patient care. Comparatively female nurses are facing more problem due to the fitness and discomfort of PPE. Hence this study findings revealed that Health care workers are facing many issues with PPE during clinical practice.

Limitations

Limitations of current study were that further qualitative study is required to be conducted to identify the in-depth

problem and study can be conducted with large sample to generalize the findings.

CONCLUSION

Everyone believes that during this pandemic personal protective equipment would provide sufficient protection to healthcare professionals when caring for patients with COVID-19. But No one thought that caring patients with PPE for more than 6 hours is a big task for each health care workers who are facing many issues physically and psychologically during the working period. Hence this study concluded that wearing the PPE itself additional stress to the health care workers physically and mentally.

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