

# A Cross-sectional Study on Adherence to Personal Protective Equipment among Healthcare Workers during COVID-19 Pandemic in a Tertiary Care Centre, Tamil Nadu, India

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## ABSTRACT

**Introduction:** Personal Protective Equipment (PPE) provides physical barrier against hazardous injury or infectious agents. With the outbreak of COVID-19 pandemic, PPE plays a vital role with face mask and gloves are being most essential. The frontline Healthcare Workers (HCW) utilises them to minimise the risk of contaminated contact or infected droplet exposure.

**Aim:** To evaluate the appropriate use of PPE among healthcare workers in tertiary care hospital.

**Materials and Methods:** This cross-sectional study was conducted in SRM Medical College Hospital and Research Centre, Potheri, Chengalpet district, Chennai, Tamil Nadu, India, from February 2021 to May 2021, on utility of PPE among the healthcare workers. There were a total of 273 participants including doctors, residents (postgraduate)/interns, nurses and laboratory technicians. A predesigned questionnaire was utilised to collect information, apart from observation of their PPE practice and 360 degree observation from peers were also used to evaluate. Statistical

analysis was done using Chi-square test, Fisher's-exact test and logistic regression model.

**Results:** Among 273 HCWs, there were 58 (21.24%) doctors, 163 (59.71%) residents and interns, 19 (6.96%) nurses and 33 (12.09%) technicians. There was no association in the frequency of mask with the type of HCW ( $p$ -value=0.217). However, the usage frequency of gloves ( $p$ -value=0.003), face shield/goggles ( $p$ -value=0.004), disposable gown ( $p$ -value=0.001) and doffing according to protocol ( $p$ -value=0.001) showed statistically significant difference between the category of HCWs.

**Conclusion:** In this study, PPE adherence was high among HCW; however, there was a subtle difference in compliance across the varied groups of healthcare professional and type of PPE used. The PPE compliance among HCW cannot be assumed to be good blindly; frequent official training programs, availability of PPE logistics along with scrutinisation regarding its appropriate usage and discarding at regular intervals minimises the non compliance and also helps in curtaining the COVID-19 transmission.

**Keywords:** Compliance, Coronavirus 2019 infection, Severe acute respiratory syndrome coronavirus-2, Transmission

## INTRODUCTION

The novel coronavirus, Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), the cause of Coronavirus Disease 2019 (COVID-19), could spread through aerosol, droplet and fomites [1]. The disease was transmissible from not only symptomatic but also through asymptomatic individuals, a significant contributor of pandemic, had affected the whole world, among which the healthcare population are at high risk of transmission due to their direct contact with COVID-19 patients [2,3]. Depending on the specific role of Healthcare Workers (HCW), the level of exposure varies. The healthcare professionals working in emergency department or operation room are at higher risk during surgical procedures, intubation or resuscitation as there would be an integral threat of close and long contact period with the patients [4].

In early 2000, during the SARS epidemic, studies showed that the rate of infection was less in HCW who defended with adequate Personal Protective Equipment (PPE) [5,6]. The PPE are to protect HCW from serious workplace biological accidents or illness by providing a physical barrier between microorganism and wearer [7,8]. The guidelines for PPE use, had been issued by the World Health Organisation (WHO) in February 2020, which includes gloves, medical masks, goggles or a face shield, and gown, as well as N95/Filtering Facepiece Respirators (FFR) or equivalent respirators, for those performing aerosol-generating procedure [9]. Though there

were established evidence on advantages, the utility of PPE is disorganised due to discomfort, handiness and individual's acumen [10,11]. Ineffectiveness in PPE adherence may facilitate nosocomial transmission of COVID-19 [12,13]. In China, it has been reported that 2055 HCW working in 476 different hospitals, mainly from Hubei (88%), have been infected with COVID-19 from December 18, 2019 to February 20, 2020. The reason for this high rate of infection among HCW was mentioned to be due to extended hours of duty (>10 hours) as there were large number of patients and serious shortages of staff [14,15]. Hence it is an irrefutable fact that the healthcare professionals play critical role during outbreaks despite of the fact that their life's are at increased risk. Therefore, it is needless to mention that personal protective equipment is the only effective armour against repeatedly mutating virus, wherein the effectiveness of vaccine is still repudiated.

Prevention of COVID-19 infection is a herculean task, where, there is shortage of PPE on one hand and on the other hand in spite of availability there is low compliance to PPE due to various reasons like cost, comfort, lack of awareness, lack of training. Moreover, there are very few studies available addressing the knowledge and compliance to PPE measures from Southern India [11,16]. This information provides an opportunity to the administrators and decision makers to identify the deficiencies and bridge the gap. Therefore, this study was conducted to determine the adherence of

PPE among healthcare workers in the tertiary care hospital during the COVID-19 outbreak and to find the association between utility of PPE and incidence of COVID-19.

## MATERIALS AND METHODS

This cross-sectional study was conducted in SRM Medical College Hospital and Research Centre (tertiary care hospital), Potheri, Chengalpet district, Chennai, Tamil Nadu, India, from February 2021 to May 2021, on utility of PPE among the healthcare workers. The Institutional Ethics Committee approval was obtained (IEC No.:2166/IEC/2020).

**Inclusion criteria:** All healthcare professionals i.e, doctors (including residents and interns), nurses and technicians (N=1100), those providing complete information to the questionnaire and those given consent for participation were included in the study.

**Exclusion criteria:** All the non healthcare professionals, those providing questionnaires with incomplete information and those not willing to participate were excluded from the study.

**Sample size calculation:** In the pilot study conducted (n=50) there were about 65% of healthcare workers appropriately using the PPE. Minimum sample size (n) required to conduct the study was calculated by the following formula:

$$n = \frac{(Z_{1-\alpha})^2 \times PQ}{E^2}$$

where,

$Z_{(1-\alpha)}$  at 95% confidence level=1.96;

P=0.65;

Q=1-P=0.35 and

E=Margin of Error=6%=0.06.

In addition, 10% of attrition rate expected when collecting the data. Therefore,  $n=243+10\%$  of 243 (attrition rate). Hence, the minimum number of samples required to conduct the study was 267.

### Questionnaire

The questionnaire was prepared in English, based on World Health Organisation and Government of India, Ministry of Health and Family Welfare guidelines [17-20]. It was scrutinized, validated and approved by multidisciplinary experts ( $r=0.652$ ). Another pilot study was conducted with 30 HCWs of different designations and professions (Doctor/Nurses). Their feedback was also obtained, evaluated and modified accordingly for precise addressing of the objectives and clear understanding of questions. The questionnaire was distributed by E-mail and mobile based application (WhatsApp) to the HCW.

The questionnaire had three parts,

- Part 1 comprised of basic demographic characteristics of the professional and knowledge regarding use of PPE. On the basis of factor analysis, two latent variables such as utility of PPE and contact history of COVID-19 were extracted from the questionnaire items. The Cronbach's alpha values of the utility of PPE and contact history of COVID-19 were 0.873 and 0.655 respectively, which revealed that there was a good reliability within the items of these latent variables.
- Part 2 was pertaining to contact history of HCWs with COVID-19 patients.
- In Part 3 evaluated the use of PPE that was prepared with guidelines on safety checklist issued by WHO, with Likert responses: "always, as recommended", "most of the time", "occasionally" "rarely" and not applicable [14,15].

The questionnaire was sent by E-mail and mobile based application (WhatsApp) to the HCW. The HCW with responses of "Always" and "Most of time" was considered as compliant and those who responded as occasionally, rarely and not applicable were

considered as noncompliant with PPE adherence. Their responses once collected were statistically analysed [Annexure-1].

A total of 310 HCW responded to the questionnaire, however 37 were not considered due to incomplete information. So, the final sample considered for analysis was 273. The willingness of the participants to participate in the study was obtained through informed consent. The 273 participants, apart from the questionnaire, were assessed by 360 degree feedback (multisource evaluation technique) [21, 22] from peers - senior doctors, colleagues, staff nurse/laboratory technician to avoid ambiguous bias of respondents. The HCW was unaware, that he or she is been assessed during their work. All the responses once collected were statistically analysed.

## STATISTICAL ANALYSIS

Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) version 23.0 and Microsoft Excel software. The categorical variables were presented by frequency and percentage whereas the continuous variables were presented by mean and standard deviation. The association between two categorical variables was assessed either by Chi-square test ( $\chi^2$ ) or Fisher's-exact test. Interobserver reliability of 360 degree feedback and correlation with questionnaire responses was analysed with kappa statistics. The kappa statistics  $>0.7$  is acceptable level of agreement (reliability 50-60%) and  $>0.8$  is perfect level of agreement (reliability 65-80%) [23]. Multivariable statistical model like logistic regression model was used to extract the most predominant factors that need to be considered for avoiding COVID-19 infections among healthcare professionals. The statistical significance was considered when p-value  $<0.05$ .

## RESULTS

Among 273 HCW, there were 58 (21.24%) doctors, 163 (59.71%) residents and interns, 19 (6.9%) nurses and 33 (12.09%) laboratory technicians. The average age of doctors were  $32.25 \pm 7.58$  years followed by technicians were  $26.61 \pm 5.45$  years, residents and interns were  $24.90 \pm 3.79$  years and nurses were  $24.89 \pm 7.42$  years old. Overall, there were 110 male and 163 female HCW participated in the study. The demographic characteristics and knowledge pertaining to PPE among HCWs are presented in [Table/Fig-1]. The awareness of PPE and its indication was 100% across HCWs. The correct response for list of PPE was given by 100% of HCWs and correct response for levels of PPE was 80.95%. There was only 68.49% correct response for opting Level A as highest level of skin, eye and respiratory protection.

The mode of contact with COVID-19 patient among the healthcare professionals, showed that the direct care to confirmed COVID-19 patients provided by 140 (51.28%) HCW, face to face (within 1 metre) by 132 (48.35%), direct contact with the environment where the confirmed COVID-19 patient were cared by 128 (46.89%) and aerosol generating procedures were performed by 88 (32.23%) [Table/Fig-2]. The association between the type of HCW and utility of PPE showed that there was no significant difference in the usage frequency of mask (p-value=0.217). It infers that majority of healthcare professionals always wear masks. However, there was a significant difference among the HCW with respect to usage frequency of gloves (p-value=0.003), face shield/goggles (p-value=0.004), disposable gown (0.001) and doffing according to protocol (p-value=0.001) [Table/Fig-2].

There was no statistically significant difference (p-value=0.854) noted in the occurrence of COVID-19 infection 37 (13.55%) across HCW [Table/Fig-3] because of all HCW (100%) "Always /Mostly" wearing face mask. COVID-19 illness among healthcare workers is presented in [Table/Fig-4].

The 360 degree observation by peers was assessed for interobserver reliability and correlated with response to questionnaire from HCW

I. Demographic characteristics of healthcare professionals								
Variables		Healthcare professionals					Statistics test and p-value	
		Doctors	Interns/PG	Nurses	Technicians	Total		
Mean age (Mean±SD)		32.25±7.58	24.90±3.79	24.89±7.42	26.61±5.45	27.16±6.06	F-value=28.188 and p-value=0.001	
<b>Age (years)</b>								
<30 years	Total	27±1.47 (25)	24.06±3.19 (149)	23.22±1.43 (18)	23.63±2.79 (19)	24.47±2.22 (211,77.28%)		
	COVID-19 positive	26.66±1.03 (6)	23.7±3.54 (20)	23±1.41 (2)	23.5±3.31 (4)	24.21±2.32 (32, 86.48%)		
30-60 years	Total	35.33±6.83 (33)	31.71±1.97 (14)	55±0.0 (1)	34.64±7.13 (14)	39.17±3.98 (62, 22.72%)		
	COVID-19 positive	32.5±2.12 (2)	30±0.0 (1)	0	32.5±3.53 (2)	31.66±1.83 (5, 13.51%)		
<b>Gender</b>								
Male		30 (11.0%)	73 (26.7%)	0	7 (2.6%)	110 (40.29%)	Chi-square=22.334 and p-value=0.001	
Female		28 (10.3%)	90 (33%)	19 (7%)	26 (9.5%)	163 (59.71%)		
II. Knowledge pertaining to PPE among HCWs								
Knowledge about PPE				Response (n, %)				
Are u aware of PPE and its indication		Yes		273,100%				
		No		0				
PPE training was by		Social media		34,12.4%				
		Offline seminar/Lecture		85,31.1%				
		Hands on workshop		137,50.1%				
		Job training		17,6.22%				
Following are list of PPE except		Gown		100% correct response				
		Slippers (Uncovered)		100% correct response				
		Mask		100% correct response				
		Faceshield		100% correct response				
How many levels is the PPE classified?		a. 4		221, 80.95% correct response (Option A)				
		b. 3						
		c. 2						
		d. 1						
Highest level of skin, eye and respiratory protection is		a. Level A		187, 68.49% correct response (Option A)				
		b. Level B						
		c. Level C						
		d. Level D						

**[Table/Fig-1]:** Demographic characteristics and knowledge about PPE among Healthcare workers (N=273).  
p-value <0.05 was considered as statistically significant

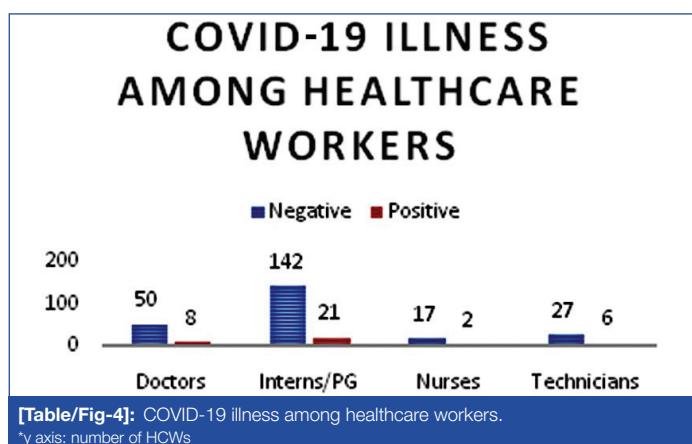
COVID-19 contact history of healthcare professionals	Healthcare professionals					Chi-square statistic and p-value
	Doctors (n, %)	Interns/PG (n, %)	Nurses (n, %)	Technicians (n, %)	Total (n, %)	
<b>Direct care to a confirmed COVID-19 patient</b>						
No	28 (10.3%)	69 (25.3%)	8 (2.9%)	28 (10.3%)	133 (48.72%)	$\chi^2=20.241$ and p-value=0.001
Yes	30 (11%)	94 (34.4%)	11 (4%)	5 (1.8%)	140 (51.28%)	
<b>Face-to-face contact (within 1 metre) with a confirmed COVID-19 patient</b>						
No	17 (6.2%)	59 (21.6%)	6 (2.2%)	26 (9.5%)	108 (39.56%)	Fishers' exact p-value=0.001
Yes	29 (10.6%)	89 (32.6%)	10 (3.7%)	4 (1.5%)	132 (48.35%)	
Unknown*	12 (4.4%)	15 (5.5%)	3 (1.1%)	3 (1.1%)	33 (12.09%)	
<b>Direct contact with the environment where the confirmed COVID-19 patient was cared</b>						
No	25 (9.2%)	78 (28.6%)	12 (4.4%)	30 (11%)	145 (53.11%)	$\chi^2=23.845$ and p-value=0.001
Yes	33 (12.1%)	85 (31.1%)	7 (2.6%)	3 (1.1%)	128 (46.89%)	
<b>Present when any aerosol-generating procedures were performed on the patient</b>						
No	35 (12.8%)	105 (38.5%)	13 (4.8%)	32 (11.7%)	185 (67.77%)	$\chi^2=15.187$ and p-value=0.002
Yes	23 (8.4%)	58 (21.2%)	6 (2.2%)	1 (0.4%)	88 (32.23%)	

**[Table/Fig-2]:** COVID-19 contact history of healthcare professionals.  
\*Unknown: HCW was not sure of face to face contact (within 1 metre) with confirmed COVID-19 patient  
p-value <0.05 was considered as statistically significant

Practices of PPE among healthcare professionals	Healthcare professionals					Fischers-exact (p-value)
	Doctors (n, %)	Interns/PG (n, %)	Nurses (n, %)	Technicians (n, %)	Total (n, %)	
<b>Frequency of usage of mask</b>						
Always	42 (15.4%)	131 (48%)	16 (5.9%)	31 (11.4%)	220 (80.59%)	0.217
Mostly	16 (5.9%)	31 (11.4%)	3 (1.1%)	2 (0.7%)	52 (19.05%)	
Occasionally	0	1 (0.4%)	0	0	1 (0.36%)	
<b>Single-use gloves</b>						
Always	35 (12.8%)	83 (30.4%)	13 (4.8%)	25 (9.2%)	156 (57.14%)	0.003
Mostly	14 (5.1%)	58 (21.2%)	5 (1.8%)	3 (1.1%)	80 (29.30%)	
Occasionally	5 (1.8%)	5 (1.8%)	0	5 (1.8%)	15 (5.40%)	
Rarely	3 (1.1%)	8 (2.9%)	1 (0.4%)	0	12 (4.39%)	
Not applicable <sup>‡</sup>	1 (0.4%)	9 (3.3%)	0	0	10 (3.66%)	
<b>Face shield or goggles/protective glasses</b>						
Always	17 (6.2%)	60 (22%)	11 (4.0%)	21 (7.7%)	109 (39.93%)	0.004
Mostly	25 (9.2%)	52 (19%)	7 (2.6%)	10 (3.7%)	94 (34.43%)	
Occasionally (20-50%)	12 (4.4%)	39 (14.3%)	1 (0.4%)	2 (0.7%)	54 (19.78%)	
Not applicable <sup>‡</sup>	4 (1.5%)	12 (4.4%)	0	0	16 (5.86%)	
<b>Disposable gown</b>						
Always	16 (5.9%)	59 (21.6%)	13 (4.8%)	22 (8.1%)	110 (40.29%)	0.001
Mostly	14 (5.1%)	27 (9.9%)	6 (2.2%)	4 (1.5%)	51 (18.68%)	
Occasionally	8 (2.9%)	46 (16.8%)	0	0	54 (19.78%)	
Rarely	14 (5.1%)	17 (6.2%)	0	1 (0.4%)	32 (11.72%)	
Not applicable <sup>‡</sup>	6 (2.2%)	14 (5.1%)	0	6 (2.2%)	26 (9.53%)	
<b>Remove and replace your PPE according to protocol</b>						
Always	25 (9.2%)	89 (32.6%)	16 (5.9%)	29 (10.6%)	159 (58.24%)	0.001
Mostly	9 (3.3%)	23 (8.4%)	3 (1.1%)	3 (1.1%)	38 (13.92%)	
Occasionally	0	2 (0.7%)	0	0	2 (0.73%)	
Rarely	7 (2.6%)	6 (2.2%)	0	0	13 (4.76%)	
Not applicable <sup>‡</sup>	17 (6.2%)	43 (15.75%)	0	1 (0.4%)	61 (22.35%)	
<b>Diagnosed with COVID-19 infection</b>						
No	50 (18.3%)	142 (52%)	17 (6.2%)	27 (9.9%)	236 (86.45%)	0.854
Yes	8 (2.9%)	21 (7.7%)	2 (0.7%)	6 (2.2%)	37 (13.55%)	

[Table/Fig-3]: Practices of PPE among healthcare professionals.

#: Few HCW who were not in direct contact, not performing aerosol generating procedures and performing desk work for documenting were not using certain PPE such as face shield, disposable gown and gloves. Hence, opted for Not applicable  
p-value <0.05 was considered as statistically significant



[Table/Fig-4]: COVID-19 illness among healthcare workers.  
\*y axis: number of HCWs

using Kappa statistics [Table/Fig-5] [23]. There was a perfect agreement among the peers observations and respondents' scores (Kappa Statistic >0.8) pertaining to the frequency of usage of mask, single-use gloves, disposable gown and removing and replacing PPE according to protocol whereas acceptable level of agreement exists pertaining to the question "Face shield or goggles/protective glasses" (Kappa Statistic >0.7).

In the logistic model, usage of mask, single use gloves, face shield or goggles and disposable gown were included as independent variables and COVID-19 infection was included as dependent variable [Table/Fig-6]. The following factors such as usage of mask face shield and goggles were significantly associated with lower risk of developing COVID-19 infections among HCW [Table/Fig-7]. Though HCW who followed single use gloves had lesser risk of

Is the HCW adhering to PPE protocol as per guidelines	Questionnaire respondents (HCWs)	Observer 1	Observer 2	Observer 3	Observed (average)	Absolute difference=Reported-observed	Kappa statistics <sup>†</sup>
<b>Mask</b>							
Yes	272	267	267	268	267	5 (1.80%)	0.802
No	1	6	6	5	6		
<b>Single use gloves</b>							
Yes	236	233	228	227	229	7 (2.56%)	0.815
No	37	40	45	46	44		
<b>Face shield or goggles/protective glasses</b>							
Yes	203	153	156	153	154	49 (17.95%)	0.756
No	70	120	117	120	119		

Disposable gown							7 (2.56%)	0.878
Yes	161	152	153	157	154			
No	112	121	120	116	119			
Removing and replacing PPE according to protocol							5 (1.80%)	0.849
Yes	197	192	191	192	192			
No	76	81	76	81	81			

**[Table/Fig-5]:** Interobserver reliability of 360 degree feedback and its correlation with the questionnaire responses.  
 \*Yes- Adherence to PPE protocol as per guidelines in >50% (Always and Most of the time)  
 No- Adherence to PPE protocol as per guidelines in <50% (Occasionally and Rarely)  
 †Kappa statistics [23]  
 p-value <0.05 was considered as statistically significant

Healthcare workers	HCWs performing AGP	Mask (%)	Glove (%)	Face-shield (%)	Gown (%)	Overall compliance (Average %)
Doctors (n=58)	22	58 (100%)	49 (84.48%)	42 (72.41%)	30 (51.72%)	77.15%
Residents and Interns (n=163)	58	162 (99.38%)	141 (86.50%)	112 (68.71%)	86 (52.76%)	76.84%
Nurses (n=19)	6	19 (100%)	18 (94.73%)	18 (94.73%)	19 (100%)	97.36%
Technicians (n=33)	2	33 (100%)	28 (84.84%)	31 (93.94%)	26 (78.79%)	89.37%
Overall utility (%)	-	272 (99.63%)	236 (87.62%)	203 (74.35%)	161 (58.97%)	85.17%
Compliance among HCWs performing AGP	-	88 (100%)	87 (98.86%)	72 (81.81%)	71 (80.68%)	90.33%

**[Table/Fig-6]:** Compliance of utility of different PPE among Healthcare workers.

getting COVID-19 infections, it was statistically not significant ( $p$ -value=0.057). The adjusted odd ratios revealed that the odds of those who always wear a mask, gloves and face shield/goggles (OR <1) was less among COVID-19 infected persons compared with those who not always wear [Table/Fig-7].

Independent variables	Adjusted OR	p-value	95% CI for adjusted OR	
			Lower	Upper
Usage of mask (Always) Reference category: Not always	0.729	<b>0.042</b>	0.316	1.684
Single-use gloves (Always) Reference category: Not always	0.605	0.057	0.245	1.493
Face shield or goggles (Always) Reference category: Not always	0.489	<b>0.025</b>	0.144	1.655
Disposable gown (Always) Reference category: Not always	0.697	0.391	0.506	5.688
Constant	0.273	<0.001	-	-

**[Table/Fig-7]:** Factors that are influencing the COVID-19 infections among healthcare professionals using multivariate statistical model.  
 Dependent variable: COVID-19 infection (1-Yes, 0-No)  
 p-value <0.05 was considered as statistically significant

## DISCUSSION

Personal protective equipment (PPE), is a protective clothing prevents the physical chemical and microbial hazards at work place. It is not only helpful in assuring the safety and but also indirectly ensures their availability of HCWs to work throughout this pandemic, by protecting them from COVID-19 illness [24]. Infection prevention and control measures plays critical role in reducing HCW exposure to COVID-19 infection. Few studies had observed that inspite of availability of PPE, there was noncompliance, either it was not worn or incorrectly worn by HCWs [25]. Authors did the analysis of appropriate use of PPE among healthcare workers in tertiary care hospitals during the COVID19 outbreak.

In this study, the mean age of the participants is 27.16. The participants age less than 30 years were 211 (77.29%) and 62 (22.71%) were between 30-60 years. In a study conducted by Ashinyo ME et al., had 124 (37.80%) study participants in the age group of less than 30 years and 204 (62.20%) between 30-50 years. The difference is due to the elderly HCWs, with co-morbidities were exempted and younger age HCWs were deployed for the COVID-19 duty. There were slightly higher enthusiastic participants of female gender 163 (59.71%) than males 110 (40.29%) [26].

In the present study, 100% (n=273) HCWs were aware of PPE, its indication and knew what it constituted. However, correct response regarding the details of classification of PPE levels were given only by 80.95% which is comparable with studies of Hossain MA et al., [27] and Tien TQ et al., [28] [Table/Fig-8] [27-29]. The studies by Alao MA et al., had observed only 14% of respondents knew about standard PPE [29]. Similarly, Wang J et al., had also reported low knowledge about PPE, in Hubei province of China [30] and by Aguwa EN et al., in Southeast Nigeria during Ebola infection [7]. The possible reasons for poor knowledge was mentioned to be due to less expertise to conduct training, less training, further repeated trainings and negligence or lack of involvement in acquiring knowledge about rare disease [29].

Variables	Present study	Hossain MA et al., [27]	Tien TQ et al., [28]	Alao MA et al., [29]	
Place of study and year	India (2021)	Bangladesh (2021)	Vietnam (2021)	Nigeria (2020)	
Number of participants	273	393	963	272	
Mean age (years)	27.16±6.06	28.9±5.2	34.5±7.6	32.3±9.9	
Gender	Male	110 (40.2%)	197 (50.2%)	310 (32.3%)	116 (42.6%)
	Female	163 (59.8%)	196 (49.8%)	650 (67.7%)	156 (57.4%)
Type of healthcare personnel	Doctors, Interns/ Postgraduates, Nurses, Laboratory technicians	Doctors, Nurses, Pharmacists, Laboratory technicians	Doctors and Assistant doctors, Nurses and Midwives, Pharmacists, Technicians, Administrative officers	Doctors, Nurses, Clinical students	
Overall knowledge of respondent on PPE	87.3%	99.5%	91.3%	14%	
Overall PPE utility	85.1%	51.7%	83.1%	10%	

**[Table/Fig-8]:** Comparison of overall knowledge and PPE utility with other studies [27-29].

The PPE adherence was high among residents/interns (76.84%) and doctors (77.15%) followed by nurses (97.36%) and technicians (89.37%). High compliance of PPE usage (90.33%) was noted while performing aerosol generating procedures which was similar to previous studies [31-32].

The overall compliance among HCW in the present study is 85.17%, which is slightly higher than study by Mulkalwar S et al., (84.4%),

Gulilat K et al., (84%) [33] and Desta M et al., (84.7%) [32-34]. However, the compliance was slightly less than the study conducted by Ashinyo ME et al., (90.6%) [26] and Russell D et al., [35]. Among HCW in a Tanzanian outpatient facilities, Powell-Jackson T et al., had observed a low compliance [36]. The difference is due to the reason that the study was conducted by observation during non COVID-19 times as against, in the present study and also study by Ashinyo ME et al., the research was conducted during the COVID-19 outbreak and by self reporting by HCW [26].

Lai X et al, observed that the improvement in infection prevention and control behaviours of healthcare workers during the COVID-19 outbreak [37]. On an average 100% compliance for mask was observed among doctors and nurses followed by residents/interns and laboratory personnel. Compliance for gloves, face shield and disposable gown were high among nurses and lab personnel. This is in contrast with previous study wherein the compliance among ancillary staff was low [26].

Low compliance among subpopulation (always use face shield=74.35%) was noted with faceshield in the present study. In spite of studies had shown that faceshield prevent transmission by reducing the ocular exposure or contamination of masks or hands or by diversion of movement of air around the face, there is limited utility because of poor visibility due to glaring and fogging [38-39].

In this study, low compliance (always use disposable gown=58.97%) was noted with use of disposable gown which is comparable with study conducted in Ghana [26]. Manian FA and Ponzillo JJ, also observed low compliance (73%) during non covid times, especially among male HCWs has mentioned, to improve the compliance with gown use, more intensive educational efforts have to be made [40].

The mean age of COVID-19 positive HCW was 24.21±2.32 years in the present study. Study conducted in Bangladesh observed 32.7±5.4 years and 42 years in a United States of America based study. During the study period, there were small proportions of HCWs (doctors (n=8/58, 13.79%), Interns/postgraduates (n=21/163, 12.88%), nurses (n=2/19, 10.52%) and technicians (n=6/33, 18.18%)) affected by COVID-19 in each group which could be reduced by stringent PPE measures and repeated training at monthly intervals [41,42].

Overall compliance with PPE was high among nurses (97.36%) followed by the rest of HCW. Similar findings were shown by earlier studies that nurses generally tend adhere to the universal precautions than the other HCW [43-46]. Though the reasons are not very clear, it was possible that a relatively experienced well trained staff nurse and specialist nurses who work in the theatre and intensive care unit participated in the survey.

### Limitation(s)

The limitations of the study include recall bias could have occurred while responding the questionnaire. Also the increased work load/stress level on HCW, overt lack of interest, or multiple survey fatigue at the time of the study which could have excluded some of the HCWs from participating. The sample size was small and factors affecting compliance was not evaluated.

### CONCLUSION(S)

In the present study, high PPE compliance was observed but varied with healthcare personnel characteristic. There was no statistically significant difference noted in the occurrence of COVID-19 infection across HCW because of all HCW "Always/Mostly" wearing face mask. There was a perfect agreement among the peers observations and respondent's scores (Kappa Statistic >0.8) for frequency of usage of mask, single-use gloves, disposable gown and removing and replacing PPE. The protective measures are to be practised universal, assuming that everyone is potentially infected or is colonised with a pathogen that can be transmitted in a healthcare environment. Strong PPE compliance can be achieved with repeated training programme, frequent supervision, effective communication

of its importance, mock drill, support from management and administration for uninterrupted supply of PPE. Furthermore, large scale, multicentric study with proportionate sampling in each group would exploit ways to increase the PPE adherence.

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## ANNEXURE 1

### Questionnaire

#### Personal Protective Equipments (PPE) adherence among healthcare workers

##### Part 1: Basic details

1. Name
2. Email id
3. I am willing to take part in the survey of PPE adherence among healthcare workers:  
a Yes b. No
4. Date of birth
5. Age
6. Gender: a. Female b. Male
7. Type of Health care personnel: a. Doctor b. Nurse c. Others
8. Designation
9. Contact number
10. Diagnosed with COVID19 infection: a. No b. Yes

##### Knowledge pertaining to PPE among HCWs

1. Are u aware of PPE and its indication: a. Yes b. No
2. PPE training was by: a. Social media b. Offline seminar/lecture c. Hands on workshop d. Job training
3. Following are list of PPE except: a. Gown, b. Slippers (Uncovered), c. Mask, d. Faceshield
4. How many levels is the PPE classified? a. 4, b. 3, c. 2, d. 1
5. Highest level of skin, eye and respiratory protection is: a. Level A, b. Level B, c. Level C, d. Level D

**Part 2: COVID-19 contact history of Healthcare Professionals**

1. Direct care to a confirmed COVID-19 patient: a. No b. Yes
2. Face-to-face contact (within 1 metre) with a confirmed COVID-19 patient: a. No b. Yes
3. Direct contact with the environment where the confirmed COVID-19 patient was cared:  
a. No b. Yes
4. Present when any aerosol-generating procedures were performed on the patient: a. No b. Yes

**Part 3: Practices of PPE among healthcare professionals**

1. Frequency of usage of mask: a. Always b. Mostly c. Occasionally d. Rarely e. Not applicable
2. Single-use gloves: a. Always b. Mostly c. Occasionally d. Rarely e. Not applicable
3. Face shield or goggles/protective glasses:  
a. Always b. Mostly c. Occasionally d. Rarely e. Not applicable
4. Disposable gown: a. Always b. Mostly c. Occasionally d. Rarely e. Not applicable
5. Remove and replace your PPE according to protocol:  
a. Always b. Mostly c. Occasionally d. Rarely e. Not applicable