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Coronavirus Pandemic

Face mask use and disposal behaviour of frontline young doctors during the COVID-19 pandemic: a two-year study

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Abstract

Introduction: The COVID-19 pandemic has severely affected India in spite of an ongoing vaccination campaign. The doctors are at greater risk of COVID-19 and face masks are a protective measure against this threat. We assessed the use and disposal of face masks among postgraduate trainees (PGTs) working on the COVID-19 frontline in an Indian medical college.

Methodology: Data was collected from all PGTs who agreed to participate during the first, second and third wave of the pandemic in India. A pre-tested questionnaire to assess and compare face mask use and disposal behaviour across the three phases was used.

Results: All participants used face masks regularly; a significant uptrend in N-95 mask users and double mask users was observed as the pandemic progressed. Use of face shields peaked during the second wave. Most participants preferred keeping the mask on always at work and avoided donning and doffing of masks in between usage. Many of them practiced 'extended use' of face masks and nearly a third re-used a mask for ≥ 6 days, which is against the standard recommendations; however, such behavior among participants showed a downward trend. Proper disposal practices were not followed by many participants, leaving scope for environmental contamination.

Conclusions: There is an imminent need to make the young frontline doctors aware regarding appropriate mask usage and disposal for better preparedness before any health exigencies of the future.

Key words: frontline worker; health worker; occupational risk; SARS-CoV-2; India.

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Introduction

COVID-19 is wreaking havoc globally for more than two years and there are currently more than 500 million cases [1,2]. In spite of the ongoing vaccination drive against the disease, India suffered a huge blow specially during the second wave of the pandemic, with 5 million new cases in one month during its peak [1,3,4]. West Bengal was one of the worst affected states in the country [5].

Health agencies like the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) stress upon prevention methods to curtail this pandemic [6,7]. Though vaccines are now available, emergence of new strains of coronavirus have raised concerns about the effectiveness of the vaccines against these strains [8]. Hence, personal protection continues to be an important safeguard against the disease. Face mask usage is a particularly important preventive measure in the fight against COVID-19. The risk of COVID-19 has been noted to be much higher in those who did not wear masks. Studies have concluded that proper use of face masks can reduce the daily growth of reported infections by 40% [6,7,9,10].

Health care workers (HCWs) like doctors are vulnerable to COVID-19 infection, given that they are in constant contact with patients with diagnosed or undiagnosed COVID-19 infection. Shortage of personal protective equipment (PPE) in general, and medical masks in particular, have contributed to the HCWs being infected [11]. Both medical masks and filtering facepiece respirators (FFRs) like N-95, act as barriers against droplets and aerosols but FFRs are also able to seal the user's face around the nose and mouth [12]. FFRs were developed to prevent HCWs from getting infected from patients [12]. However, in a crisis situation like the COVID-19 pandemic, use of triple-

layer masks may be an acceptable option during acute shortages of FFRs [12].

Proper protective behaviour cuts down the risk of infection transmission in HCWs including doctors and other health care staff. More than 700 doctors have lost their lives in the line of duty during the pandemic [13]. Safety of HCWs is thus an important concern, which, if overlooked, could mean a disaster for the country's health care sector. Additionally, the general public often look up to doctors to learn healthy practices. Therefore, we studied face mask use behaviour through the usage patterns and practices adopted by doctors during the COVID-19 pandemic. This might ultimately help in identifying gaps that make them vulnerable and lead to corrective measures.

This study was conducted on post graduate trainees (PGTs) of a medical college in West Bengal (India). PGTs are exposed to COVID-19 patients in indoor wards and emergencies. We assessed their face mask usage pattern and practice along with disposal behaviour through the consecutive waves of the COVID-19 pandemic.

Methodology

Data was collected in three phases - during first (May 2020), second (May 2021) and third (January 2022) wave of the pandemic in India. A pre-tested questionnaire with questions in English was developed for the purpose. The questionnaire assessed face-mask use pattern and disposal habits of participants during each of the three phases. Sociodemographic details of the respondents and information regarding face-mask hygiene were gathered during the first phase of data collection.

The sample size (n) was calculated to be 384 using the formula $n = z^2pq/l^2$, considering the proportion of health workers properly using face mask as 50.0% (p), relative error (l) of 10.0% on p and q = 1-p. We added 20.0% for probable non-response and the sample size was finally calculated as 460.8, rounded to 461.

The medical college where the study was conducted has over 650 PGTs across departments. These PGTs have been on the frontline against COVID-19. Four hundred and sixty-one PGTs were randomly selected and the printed questionnaire was circulated to them. Responses from PGTs who participated in all the three phases were considered for analysis.

Statistical Packages for Social Science, SPSS® (SPSS Inc, Chicago, IL, USA) version 16.0 was used for data analysis. Face-mask use practice was compared across the three phases of data collection and changes in follow-up were checked for statistical significance using Chi Square test; $p < 0.05$ was considered significant.

The study obtained necessary permissions from the Institutional Ethics Committee of a Medical College of West Bengal (Ref. No.: MC/KOL/IEC/NON-SPON/866/01/2021). Anonymity of all participants was ensured and only participants who gave informed consent were included.

Table 1. Face mask hygiene among the study participants* (n = 422).

Variables	Number (%)
Frequency of touching outer surface of face mask	
Almost every 15 minutes	32 (7.6)
Almost every 30 minutes	57 (13.5)
Almost every 1-2 hours	44 (10.4)
Only when absolutely needed	289 (68.5)
Frequency of touching nose and mouth by inserting fingers inside mask	
Almost every 15 minutes	4 (0.9)
Almost every 30 minutes	14 (3.3)
Almost every 1-2 hours	16 (3.8)
Only when absolutely needed	388 (91.9)
Frequency of removal and re-wear of face mask	
Almost every 15 minutes	10 (2.4)
Almost every 30 minutes	36 (8.5)
Almost every 1-2 hours	88 (20.9)
Only when absolutely needed	288 (68.2)
Cleaning hands before donning and after doffing of face mask	
Always	258 (61.1)
Sometimes	148 (35.1)
Never	16 (3.8)

*: Multiple Options.

Results

Four hundred and twenty-two (422) eligible responses were obtained. Most of the participants were aged ≤ 30 years (56.2%, 237/422), followed by the 31–40-year-olds (42.9%; 181/422) and the remaining were > 40 years in age (0.9%, 4/422). Males comprised 58.3% (246/422) of the participants. Many participants or their families (41.2%, 174/422) had already suffered from COVID-19. With respect to face-mask related hygiene, 68.5% (289/422) avoided touching the outer surface of the mask while wearing it and 91.9% (388/422) rarely touched their mouth or nose while wearing a face-mask by inserting finger(s). In addition, 68.2% (288/422) participants avoided donning and doffing of masks unnecessarily; 61.1% (258/422) always cleaned their hands before putting on and after taking off a face-mask (Table 1). Most (46.9%; 198/422) participants said they faced breathing difficulties while wearing the mask, and 33.6% (142/422) said that face-masks did not cause any difficulty. Interestingly, 36.1% (152/422) and 13.0%

Table 2. Face-mask usage pattern among the study participants (n = 422).

Variables	1st wave Number (%)	2nd wave Number (%)	3rd wave Number (%)
Type of face mask/respirator used*			
N-95	229 (54.3)	303 (71.8)	311 (73.7)
Surgical 3-ply	366 (86.7)	337 (79.8)	350 (82.9)
FFP-2	161 (38.2)	138 (32.7)	149 (35.3)
Cloth	184 (43.6)	132 (33.1)	119 (28.2)
Average daily usage of a single face mask			
≤ 3 hours	152 (36.0)	171 (40.5)	158 (37.4)
4-7 hours	168 (39.8)	147 (34.8)	165 (39.1)
≥ 8 hours	102 (24.2)	104 (24.6)	99 (23.5)
Face mask use while outdoors			
Wear the mask all time	163 (38.6)	201 (47.6)	209 (49.5)
Remove mask only when alone	245 (58.1)	213 (50.5)	204 (48.3)
Wear as and when preferred	14 (3.3)	8 (1.9)	9 (2.2)
Use of face shield			
Always	60 (14.2)	107 (25.4)	99 (23.5)
Sometimes	278 (65.9)	261 (61.8)	272 (64.4)
Never	84 (19.9)	54 (12.8)	51 (12.1)
Use of double face masks			
Always	69 (16.4)	99 (23.5)	113 (26.8)
Sometimes	271 (64.2)	244 (57.8)	241 (57.1)
Never	82 (19.4)	79 (18.7)	68 (16.1)

*: Multiple Options.

(55/422) said face-masks caused hindrance to communication and work respectively; 4.5% (19/422) felt that it restricts personal freedom.

When assessing usage pattern, a growing number of participants claimed to always use face-shields while encountering patients during the three data collection phases (p = 0.000); the same was true with usage of double face-masks (p = 0.001). Similarly, N-95 users also showed a significant rise (p = 0.000). An increased proportion of participants were found to use one face-mask at a stretch for 8 hours or more in a day during the second wave compared to the first and third (p = 0.921) (Tables 2 and 3; Figure 1).

The proportion of participating doctors who re-used their N-95 and/or surgical masks was minimum during the second wave. Among those who re-used these masks, most used the same mask for 2-3 days, with a gap of 2-4 days in between each use. The tendency to re-use a mask for 6 days or more showed a significant reduction through the pandemic (p = 0.005). Drying face-masks under the sun was the commonest practice in between re-use. None shared their mask with others. Most disposed a used mask into a bin by putting it in a plastic bag or putting a mask directly into a vat/bin without wrapping it up (Table 4).

Discussion

Hundreds of Indian doctors have died while serving during the pandemic. Therefore, personal protection among HCWs is a paramount factor for consideration.

Table 3. Comparison of face mask use across the three data collection phases (n = 422).

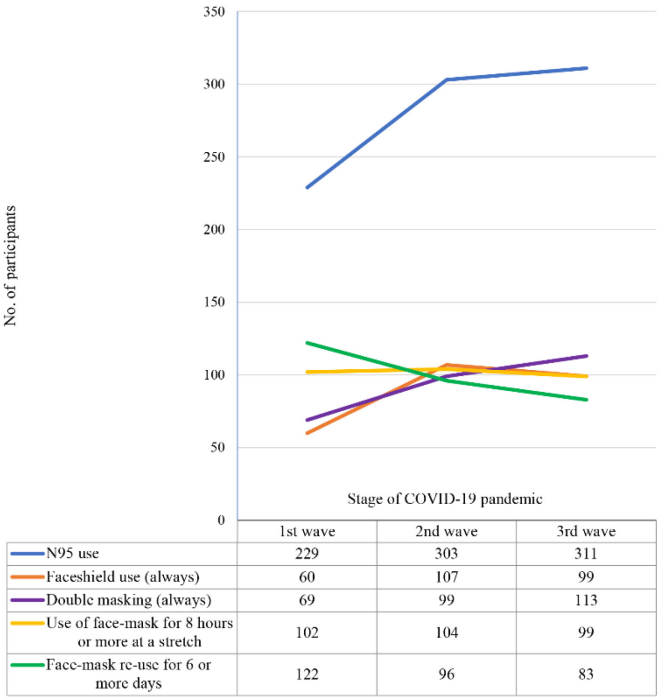
Variable	1st wave	2nd wave	3rd wave	X^2 (df = 2)	p
N95 use					
Used N95	229	303	311	43.54	0.000
Did not use	193	119	111		
Face shield use (always)					
Used face shield	60	107	99	18.06	0.000
Did not use	362	315	323		
Double face mask use (always)					
Yes	69	99	113	13.87	0.001
No	353	323	309		
Continuously used a face mask for ≥ 8 hours					
Yes	102	104	99	0.16	0.921
No	320	318	323		
Reused a face-mask for ≥ 6 days					
Yes	122	96	83	10.31	0.005
No	300	326	339		

Proper use of face-masks cuts down the risk of COVID-19 infection significantly and hence it is a vital measure that should be adopted [6,7,9,10]. This research studied the face-mask usage pattern and practices adopted by PGTs working at a medical college in West Bengal who are at the frontline in the management of COVID-19 patients in the institution during the different phases of the COVID-19 pandemic.

All the participants wore face masks regularly. Most preferred wearing face masks all the time while outdoors or at work, also ensuring avoidance of frequent donning and doffing of the mask. This was in line with the mask mandates issued at the time of the COVID-19 pandemic by the Indian Government [14]. Regarding face mask hygiene, compliance with the national protocols in place for infection control among HCWs were: 68.5% with respect to touching outer surface of mask, 92% for not inserting fingers inside the mask, 0% in the case of removal and re-wear of mask and 61% in the case of handwashing before the donning or doffing of the masks [14–16].

A few comparable studies were found in the public domain. A hospital-based study from Pakistan found 90.4% compliance with face mask use [17]. A Saudi Arabian study found that 86.5% of its participants were compliant with face-mask use [18]. A survey conducted

Figure 1. Face mask use patterns among study participants during the three phases of data collection (n = 422).



	1st wave	2nd wave	3rd wave
N95 use	229	303	311
Faceshield use (always)	60	107	99
Double masking (always)	69	99	113
Use of face-mask for 8 hours or more at a stretch	102	104	99
Face-mask re-use for 6 or more days	122	96	83

Table 4. Re-use of face mask by the study participants.

Variables	1st wave (n = 354) N (%)	2nd wave (n = 322) N (%)	3rd wave (n = 362) N (%)
Number of days a face mask is used			
2-3 days	142 (40.1)	169 (52.5)	181 (50.0)
4-5 days	90 (25.4)	57 (17.7)	98 (27.1)
≥ 6 days	122 (34.5)	96 (29.8)	83 (22.9)
Gap in between re-use of same face mask			
Wear on consecutive days	82 (23.2)	86 (26.7)	89 (24.6)
Gap of 1 day	91 (25.7)	77 (23.9)	93 (25.7)
Gap of 2-4 days	93 (26.3)	92 (28.6)	103 (28.4)
Gap of 5 days or more	88 (24.8)	67 (20.8)	77 (21.3)
Face mask preservation in between re-use*			
Hang it in the sun	177 (50.0)	183 (56.8)	194 (53.6)
Hang it indoors	103 (29.1)	92 (26.6)	103 (28.4)
Keep in a paper bag	36 (10.1)	54 (16.8)	55 (15.2)
Spray disinfectant solution	60 (16.9)	72 (22.4)	48 (13.3)
Autoclave	2 (0.6)	3 (0.9)	3 (0.9)
Use Ultraviolet ray sterilization	0 (0.0)	4 (1.2)	6 (1.6)
Wash it with water/soap solution	73 (20.6)	43 (13.4)	32 (8.8)
Method of face mask disposal*			
Throw it in a bin	133 (37.6)	100 (31.5)	106 (29.3)
Shred and throw it in a bin	40 (11.3)	48 (14.9)	64 (17.7)
Put in a plastic bag and throw it in a bin	91 (25.7)	94 (29.2)	112 (30.9)
Shred it, put in a plastic bag and throw it in a bin	56 (15.8)	57 (17.7)	66 (18.2)
Throw it on the road side or in water bodies	10 (2.8)	2 (0.6)	2 (0.6)
Burn it	10 (2.8)	8 (2.5)	5 (1.4)
Keep it in a bin or bag	26 (7.3)	16 (5.0)	15 (4.1)

*: Multiple Options.

on the general public as well as health care providers in India found that there was no significant difference between mask usage in the two groups [19]. In another Saudi Arabian study, about 47% HCWs were always compliant with wearing masks in public places and HCWs from larger cities were more compliant [20]. Unfortunately, such possibilities were not explored in the current study.

The state of compliance with infection control protocol stressing upon personal protection, in line with nationally available guidelines, before and after the COVID-19 pandemic has been studied by some researchers, [15]. A Chinese study conducted in 2011 found that 70% HCWs were compliant with face mask usage, and in 2016, a study in Vietnam found 77% compliance for masks [21,22].

With regard to public perception on wearing masks and other protective equipment in the recent times, 77.8% participants in a large Saudi Arabian study agreed that masks were an effective method of preventing COVID-19 transmission [20]. In another study conducted in Pakistan, 31.6% physicians and 36.7% HCWs believed that not wearing a mask and not washing hands were not plausible ways of getting infected with COVID-19 [23]. In an Indian study on PPE use among HCWs in surgical settings during the pandemic, the overall compliance for PPE, including masks, was 96% [24].

The present study found that N-95 masks and surgical 3-ply masks were commonly used by the respondents, with a growing proportion of N-95 users through the pandemic. FFP-2 and cloth masks were used as well. FFRs like N-95 face-masks work to prevent HCWs from getting infected from their patients. The Government guidelines for rational use of PPE in India specify that doctors and nurses working in close contact with patients should wear N-95 masks [14]. However, the use of triple-layer masks is an acceptable option for personal protection of HCWs during acute shortages of FFRs in situations of crisis [12]. There were some mixed findings when N-95 was compared to surgical/medical masks. Six studies reported that both forms provided similar levels of protection, whereas four studies reported that N-95 masks offered superior protection [9]. A randomized control trial concluded that there was no significant difference in incidence of lab-confirmed influenza when both were compared [25]. However, a recent systematic review and meta-analyses about the efficacy of cloth masks in prevention of the novel coronavirus transmission concluded that cloth masks have minimum efficacy in source control compared to the medical grade masks [26].

Most of our participants faced breathing difficulties, and hindrance to communication and work as a result of face mask usage. Discomfort, poor visibility, fogging of spectacles, ache, itchy nose, difficulty in breathing and local pain were often reported as difficulty by respondents in other similar studies [24,27]. In our study, around 25% doctors wore a mask for a stretch of more than 8 hours, indicating extended use, as per the National Institute for Occupational Safety and Health (NIOSH) criteria [28]. However, such use is not recommended in the guidelines issued by the Indian Government [14–16]. The use of face shields was also not in absolute conformity with the National Guidelines on Infection Control. Around 20% doctors never used a face shield during the first wave.. This number reduced to around 12% in later phases of the study [14–16]. Additionally, around 16% doctors always wore double masks, and this usage increased to 23.5% and 26.8% during the second and third wave, respectively. This is again not supported by Government documents pertaining to coronavirus control in India [14–16]. Many participants re-used their N-95 masks and/or surgical masks; sometimes using a face-mask for 6 days or more. The reason for re- and extended use could have been shortage of supply, as well as lack of knowledge or stringent application of national guidelines. However, though extended use and re-use of these masks are not recommended, it is acknowledged that in times of crisis, a rotation and use strategy can be adopted, allowing re-use of a mask for up to 5 times, provided contamination of the masks are minimized ensuring safe donning and doffing practices [28,29]. Majority of our participants said they cleaned their hands before donning and after doffing face-masks and avoided touching the surfaces of the mask while wearing it.

In addition, to the practice of drying the masks in the sun and using paper envelopes for safe-keeping, some of our participants autoclaved their masks or used ultraviolet (UV) sterilization; some washed their masks as well. The CDC lists steam and liquid hydrogen peroxide as potentially viable methods for mask sterilization; hanging masks in a safe place or placing them in paper envelopes in between re-use is also recommended [28,29]. However, UV sterilization at home is not recommended [29]. Among the various decontamination methods, ultraviolet germicidal irradiation (UVGI), ethylene oxide (EtO) and VHP (vaporized hydrogen peroxide) are useful with respect to filter aerosol penetration and filter airflow resistance;

however the CDC does not recommend EtO due to its probable toxicity to the wearer [29,30]. When surgical face-masks were dried in shade for 14 hours before re-use, changes in pore size over time were noted to be statistically non-significant; pore structure did not change significantly even after prolonged use or after being treated with UV light, ethanol, steam or washing machine [31]. In another study, steam-sterilizing a mask at 121 °C in a laminated bag was not found to affect the mask's function and therefore can be a useful re-use method [32]. There are conflicting views with regard to boiling a mask. One study showed N95 and other brands of medical masks to be able to block more than 99% viruses even after being put in boiling water for two hours. However, the CDC does not approve boiling and use of soap water for mask decontamination [29,33].

Used face-masks are considered biomedical wastes [14–16,34]. Therefore, proper disposal of used face-masks is essential to avoid further environmental contamination. At the individual level, cutting up the masks (to prevent re-use) and putting them in plastic bags before disposal (to avoid contamination) is recommended. In the hospital setup, face-masks need to be disposed in yellow coloured bags/bins before they are processed further by processes such as incineration, based on the disposal facilities available with the health institution, including its linkage with a Common Bio-medical Waste Treatment and Disposal Facility (CBWTF) [34–36]. Most (38% in the first phase, 32% in the second phase, and 29% in the third phase) of our participants disposed a used mask into a bin by putting it in a plastic bag or disposed it directly into a vat or bin without wrapping it up, which is in compliance with the relevant national protocols in place at the time of this study [14–16].

Strength and Limitation

Surveys about mask use pattern among health professionals have rarely been conducted before. Hence, we believe, vital and new information on mask use behaviour among health practitioners has been obtained. Being a longitudinal study, it could also capture the changing trends in face mask usage before and during the second wave of the COVID-19 pandemic. As a limitation, we could not assess the burden of counterfeit masks, which are commonly available in the Indian market. Additionally, in the absence of mandatory education on face masks in India, we could not compare the correlation of compliance of appropriate face mask behaviour by HCWs with their having received that mandatory training.

Conclusions

A large proportion of our participating doctors were re-using masks; many wore the same mask for 8 hours or more, indicating extended use, which was outside the purview of existing guidelines in India. Many of the participating doctors re-used masks on consecutive days, contrary to standard recommendations. Additionally, re-use of face masks was found to be significantly associated with extended use, which could result in diminished efficiency of the masks, making the users vulnerable to infection. Some participants used cloth masks which have a questionable role in preventing COVID-19 infection. With an increasing number of doctors dying during the pandemic, it is vital to take every step to ensure that health practitioners are protected to the maximum extent. There is an imminent need to ensure an adequate supply of good quality face masks for these frontline workers. Price of face masks will need to be strongly regulated to ascertain that they remain affordable. Medical councils like the West Bengal Medical Council and the National Medical Commission that maintain the registration and contact details of practicing health professionals, can actively take steps to ensure that all HCWs receive proper training on mask use. Working shifts of doctors may also be reorganized to ensure that doctors work in shifts that are not longer than 6-8 hours, as this could help decrease the tendency of extended use of masks. Stricter rules towards proper disposal of masks should be urgently implemented, to guarantee safe disposal and prevention of environmental contamination. Mandatory education and periodic re-training of HCWs in appropriate mask use can improve adherence to national guidelines.

Authors' Contributions

Shibaji Gupta: concept, design, definition of intellectual content, literature search, data acquisition, data analysis, statistical analysis, manuscript preparation; Arup Chakraborty: concept, design, data acquisition, data analysis, manuscript editing and manuscript review; Rudradeep Banerjee: definition of intellectual content, literature search, data acquisition, manuscript preparation; Abhishek De: data analysis, statistical analysis, manuscript editing and manuscript review; Sohini Halder: definition of intellectual content, literature search, manuscript preparation; Debasis Das: concept, design, manuscript editing and manuscript review.

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