

Original Article

Personal Protective Equipment Associated Symptoms amongst Frontline Health Care Workers in COVID-19 Pandemic — A Cross Sectional Study

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Context : During COVID-19 Pandemic, frontline Health Care Worker (HCW) in hospitals were mandated to Personal Protective Equipment (PPE), while caring for suspected or confirmed COVID-19 patients, which involved the donning of close-fitting N95 Face Masks, Protective Eyewear, Gowns, Surgical Gloves and the use of Powered Air-Purifying Respirators (PAPR).

Aims : This study is to know the challenges faced during use of PPE among frontline HCW.

Methods and Material : This is a cross-sectional study among HCW at our Tertiary Institution who were working in high-risk hospital areas during COVID-19. All respondents completed a self-administered questionnaire

Statistical analysis used : Data were entered in Microsoft Excel and analyzed using SPSS version 23. Baseline characteristics were described using frequency and percentages. Association between predictors of PPE associated symptoms were assessed using Chi-square test with p-value of <0.05 considered as significant.

Results : Total of 190 Health Care Workers participated in the study. Doctors- contributed most [143/189 (75.2%)]. Majority of the respondents reported usage of Masks, Eyewear, Shield and Gown [126/189 (66.7%)], in which most of them donned N-95 mask [152/189(80.5%)], and Goggles [110/189 (58.2%)] average for 6.32 (2.40) hours a day and 18.15(8.65) days in a month. 83 respondents reported a new onset headache associated with usage of PPE. Majority of the respondents localized Headaches as frontal (69.9%) which was statistically significant. Other symptoms were Tiredness (73.5%), Excess Sweating (45.4%) and Giddiness (20.6%).

Conclusions : Prevalence and characteristics of PPE- associated symptoms in HCW working in high-risk areas in Tertiary Care Centers necessitates better measures and strategies for designing PPE and reducing the exposure time in HCW and also the impact on their work performance.

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Key words : Powered Air-Purifying Respirators (PAPR), Personal Protective Equipment (PPE), Health Care Worker (HCW).

Novel Coronavirus, SARS-CoV-2, named by World Health Organization (WHO) as COVID-19 is a highly transmissible virus causing unprecedented panic across the world¹. Health Care Workers (HCWs) providing care to patients need to ensure Infection Prevention and Control (IPC) measures as it is transmitted through respiratory droplets expelled during talking, coughing, sneezing, etc. Transmission is also likely to occur indirectly through surfaces, objects and fomites. The penetration is through mucous membranes of Upper Respiratory Tract, but also through Eyes and Mouth. WHO recommends the use of contact, droplet and air-borne transmission precautions by HCWs caring for patients with COVID-19 to prevent infection in Healthcare settings and the

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Editor's Comment :

■ Hence, to ensure workplace safety and productivity as well as improve overall occupational health, we recommend through better engineering, the next generation of PPE to have a better design to ensure tolerability and comfort, which can also ensure job satisfaction among the frontlines.

use of Personal Protective Equipment (PPE). The pandemic has forced the HCWs to wear PPE while caring for suspected or confirmed COVID-19 patients, which involves the donning of close-fitting N95 face Masks, protective Eyewear (mainly Goggles/Shields), Gowns, Surgical Gloves and at times, the use of powered Air-Purifying Respirators (PAPR)⁶. Use of Personal Protective Equipment (PPE) can markedly reduce the infection risk associated with caring for COVID-19 patients^{7,8}. SARS-CoV-2 infections among HCWs can occur due to lack of PPE improper use of PPE, or infection in the community⁷. There was increased risk of infection noted among HCW in all Healthcare settings as compared with the general community, with a higher risk in HCW working in

Inpatient and ICU settings. Face Masks were shown to be protective, and having worn one at all times decreased the risk of infection. Hence, PPE is critical for protection of front-line Health Care Workers. Unfortunately, PPE can also lead to considerable physical and mental distress to the users leading to Headaches, Skin changes and sub-optimal overall performance. Mental impact includes Somnolence, Anxiety and Depression¹⁰. In real world practice, donning of the PPE is often felt cumbersome and uncomfortable by the HCWs especially when used for a prolonged period. The objective of the present study is to understand the discomfort experienced by the HCWs with the use of PPE.

MATERIALS AND METHODS

This was a cross sectional study conducted at Yenepoya Medical College Hospital, a Tertiary Teaching Hospital in South India, Karnataka from October 2020 to March, 2021. Study settings included Isolation wards (designated as "COVID wards and ICU"), High Dependency Oxygen Units, and the Medical Intensive Care Unit (MICU), OPD, Fever Clinic, Operation Theatre, Emergency Care Rooms.

We included all Doctors (Postgraduates, House Surgeons) and Nurses working in these areas through random sampling. All participants gave a written and informed consent after understanding the study procedure and they completed a self-administered questionnaire in English. The questionnaire comprised of nine main sections with information on demography, any medical history, place of work, PPE use pattern in terms of duration and type. We also recorded information on any pre-existing Headache and Skin problem, any change in pattern noted by them and any other PPE associated symptoms. Finally, *information of location of Headache was collected from participants using visual options (Fig 1) by selecting the diagram below where pain, pressure or compression from wearing the respective PPE equipment is felt.*

At our Institution, two types of National Institute for Occupational Safety and Health (NIOSH) certified 3MR N95 face Masks are widely used, with the specification to filter out 95% of particles with a size greater than 0.3 microns. Protective Goggles that provide splash

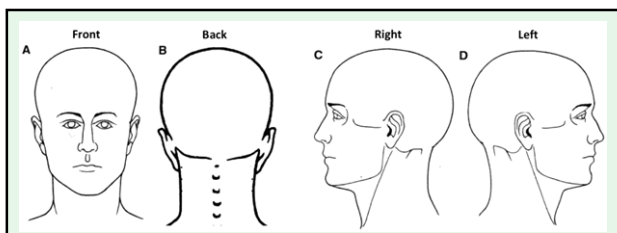


Fig 1 — Location of Headache

protection against biological materials are also widely available and are used commonly by the HCWs apart from Face-shields/Visors, while working in high-risk areas. Headcap and Gown are used with N95 Mask and Goggles in COVID ward and ICU, Fever Clinic. Other areas N95 Mask, Scrub, Shields and Headcap were used.

The study was approved by the Institutional Ethical Committee (YEC-1/2020/055).

Statistical Analysis :

Considering the prevalence of PPE associated symptoms as 60% with 7% margin of error and 5% significance, the required sample size was 185.

Data were entered in Microsoft Excel and analyzed using SPSS version 23. Baseline characteristics were described using frequency and percentages. Association between predictors of PPE associated symptoms was assessed using Chi-square test with p-value of <0.05 considered as significant.

RESULTS

To find association between PPE usage and other variables we used Chi-square test. From Table 1 we got significant association between Location of Headache and PPE usage ($p=0.008$), Likelihood of Headache associated with PPE usage ($p=0.004$) and PPE usage due to Facial Mask ($p=0.046$).

A total of 190 Health Care Workers were approached to participate in the study, with around 189 consenting to participate giving an overall response rate of 99.5%. Majority of study participants were male [91/189 (51.1%) aged 21-40 years [168/189 (88.4%)]. Doctors- contributed most [143/ 189 (75.2%)] followed by Interns [25/189 (13.2%)] then Nurses [17/189 (9%)]. Some respondents also reported concomitant non-headache comorbidities [50/189 (26.8%)].

Table 1 — Association between PPE usage and factors affecting		
Variables	Chi-square Value	P-value
Pre-existing Headache Disorder	6.577	0.087
Frequency of headache attack	7.218	0.843
Symptoms due to Face mask and Eye wear alone	12.322	0.420
Change due to protective eye wear	12.218	0.201
Change due to Facial mask and protective Eye wear	14.518	0.269
Change in acute medication	7.218	0.843
Other possible factors	2.644	0.450
Location of Headache	22.342	0.008
Quality of Headache	7.115	0.850
Likelihood of Headache due to PPE usage	28.545	0.004
Any pre-existing Skin Disorder	3.262	0.353
Likelihood of Skin disorder	5.159	0.820
Skin Disorder Due to Facial mask	76.472	0.046
New Skin Disorder	6.239	0.716

Out of 189 respondents, 40 respondents reported to be diagnosed with Pre-existing Headache Disorder.

PPE usage patterns: All health workers reported on increased frequency of usage of PPE due to pandemic. The Respondents donned PPE on average for 6.32 (2.40) hours a day and 18.15(8.65) days in a month. Majority of the Respondents reported usage of Masks, Eyewear, Shield and Gown [126/189 (66.7%)], in which most of them donned N-95 Mask [152/189(80.5%)], and Goggles [110/189 (58.2%)] Most of the respondents reported that their primary location of PPE usage as COVID ward (114/189 (60.3%)) followed by COVID ICU [109/189 (57.7%)] and In Patient Ward [82/189 (43.3%)].

New Onset Headaches : Out of 189 Respondents, 83 Respondents reported a new onset Headache associated with usage of PPE. Headaches were described as bilateral (77.1%) by most of the Respondents. Majority of the Respondents localized Headaches as frontal (69.9%), the location of the Headache corresponds to the area of contact of face Mask or Goggles and their corresponding head straps. Majority described the Headache as pressure heaviness [48/83(57.8%)] and some also described it as throbbing [19/83(22.9%)] with moderate intensity (50.6%).

PPE- associated Headache attack lasted for an average of 5-9 days (38.9%) in a month and on average resolved after 45 minutes after removal of PPE (mask, protective Eye wear) in majority of the respondents. Most of the Respondents did not experience any associated symptoms during each attack (38.6%), while some reported to have neck discomfort (33.7%) and nausea/vomiting (21.7%). During a Headache attack majority of the Respondents used Paracetamol/ NSAIDS (56.6%) as Acute Analgesic Treatment while the remaining population did not require any acute treatment. Headaches deemed as "likely" by 37 respondents due to PPE- usage. The majority [45(54.2%)] opined a "slight decrease" in work performance due to PPE-associated Headaches.

Course of Pre-existing Headaches during COVID-19 : Out of 189 Respondents, 40 reported to be diagnosed with a Pre-existing Headache Disorder, out of which most of them were diagnosed with Migraines [30 (75%)], Unilateral [24(60%), throbbing (57.5%), Moderate Intensity (65%). Majority of the Respondents "agree" [19(47.5%)] an increase in average duration of Headache following usage of PPE. Factors that might've aggravated Pre-existing Headaches include irregular meal times (25%), sleep deprivation(15%), insufficient hydration(15%). Most of the respondents opined "maybe" [19(47.5%)] there was a change in usage of acute treatment following usage of PPE.

Results are shown in Table 1.

PPE-associated New skin reactions : 54 out of 189(28.6%) Respondents reported a new skin reaction following usage of PPE.

Due to Facial Mask : Majority of the Respondents [30/54(55.6%)] reported new onset acne following usage of PPE, followed by scar at nose bridge [23 (42.6%)] Due to Gloves: Most of the Respondents reported no skin reactions while others reported Dry skin [21(38.9%)]. Due to Gowns: Majority reported no skin reactions due to gowns.

Majority of the respondents "strongly agree" (51.9%) the new skin reaction was due to the usage of PPE.

Course of Pre-existing Skin Disorder: 13 out of 189 Respondents reported to have a Pre-existing Skin Disorder, out of which majority were diagnosed with Acne (12.5%), Eczema (12.5%), Contact Dermatitis (12.5%). Majority of Respondents "agree" (38.5%) that the increased usage of PPE has affected the control of the Pre-existing Skin Disorder.

Other associated symptoms: Apart from the above-mentioned symptoms most of the Respondents also experienced Tiredness [139/189 (73.5%)], Excess sweating [86/189(45.4%)], and Giddiness [39/189(20.6%)].

The most experienced symptom is Tiredness (73.5%), whereas half of the population experienced excess sweating as well (45.4%) (Table 2).

DISCUSSION

It is indeed very important that we highlight the origin of Personal Protective Equipment so we can deliberate on the reason why was it first donned or worn The first "vulcanized" rubber Gloves was patented in 1840s by Charles Goodyear following which Surgical Masks made from cotton gauze to prevent contamination of surgical wounds in 1900s. The use of Goggles evolved from using polished tortoise shells in the early 15th century to the Goggles we use now, considering the dire need of protection and risk of infection through spread of body fluids. The use of PPE was mainly to protect the Health Care Workers, emphasizing on the occupational health as well as protecting the patients pertaining to the infection control protocols.

Our study elucidates the PPE-associated

Table 2 — Other PPE associated symptoms as reported by study participants

Breathlessness	10/189(0.05%)
Excess sweating	86/189(45.5%)
Palpitation	23/189(12.2%)
Giddiness	39/189(20.6%)
Tiredness	139/189(73.5%)

symptoms among frontline Health Workers at a Tertiary Care Hospital in South India state during the current COVID outbreak. About 43.9% of the cohort reported new-onset Headaches, 28.6% reported new onset skin disorders and other symptoms. The combined usage of N-95 Mask, Goggle, Gowns for more than 4 hours per day, and in Respondents with Pre-existing Headache and Skin Disorders had more chances of developing such symptoms due to increased PPE usage.

The findings of our study are in agreement with the report by Jonathan, *et al*⁶, which was for PPE associated Headaches only, which reported 82% of the study population developed new-onset Headaches compared to 43.9% reported in this study. Most of the Health Workers who developed symptoms had their primary work location in COVID ward. While more than half of our study participants didn't require analgesics suggesting use of PPE was not associated with severe Headaches

Nearly half of the study population (54.4%) did not require acute analgesic treatment for Headaches probably due to Moderate intensity and reduced frequency of Headache attacks. PPE associated symptoms also has an impact on occupational health due to "slight decrease in work performance" as reported by the Respondents. The results of this study lead us to postulate that the overall Tiredness, Excessive Sweating caused by PPE could lead to decrease in work performance of Health Care Workers especially if the pandemic prolongs. Hence, reduced work shifts which results in shorter duration of PPE usage can help down the adverse events.

Our results are in agreement with the study by Hoernke K, *et al*²⁰ which delineated the persistence of HCWs in taking care of the patients despite the challenges faced being shortage of PPE, inadequate training and guidance regarding its usage also considering the prevalence of adverse events amongst PPE workers was very high (78%) as per the study by Galanis P, *et al*²¹.

The pathogenesis of new onset Headaches can be due to multiple etiologies which include hypoxia, hypercarbia, mechanical stress and other factors. Forces of tractions or applied pressure due to tight fitting straps may cause local tissue damage and exert effect on the underlying superficial sensory Nerves (trigeminal or occipital nerve branches) innervating the Face, Head and Cervical region. It is important to acknowledge that previous studies also reported Headache due external compression of peri cranial tissues due to tight fitting straps while wearing Helmets, swimming gear or frontal lux devices⁹⁻¹⁵.

However, the scientific literature on PPE-associated Headaches and the combined usage of N-95 Mask and Goggles including their effect on work performance is scarce. A previous study among health care providers wearing the N95 Face Mask during the 2003 Severe Acute Respiratory Distress Syndrome (SARS) epidemic in Singapore reported new onset face mask-associated headaches with a prevalence rate of 37.3%.

Another study among Nurses Working in a Medical Intensive Care unit reported Headache as one of the main factors accounting for sub-optimal N95 Face Mask compliance. Previous reports highlighted that pain or discomfort (headache, facial pain, and/or ear lobe discomfort) arising from tight-fitting Face Masks as well as elastic head straps resulted in limited tolerability when the N95 Face Mask was used for a prolonged period. The peripheral sensitization may activate the trigeminocervical complex through nociceptive information transmitted via different branches of the trigeminal nerve through the trigeminal ganglia and brainstem to the higher cortical areas thereby triggering the Headache attacks. The etiological factors may be responsible for the development of new onset Headaches as well as exacerbation of pre-existing Headaches.

Majority of Respondents reported acne as the common skin reaction due to Masks, this can be due to the reasons reported in the article by Foo CC, *et al*¹⁹ which explains the acne is due to the hot and humid climate microclimate created in certain regions of face which causes acne flare up and also may do to blockage of pilosebaceous ducts due to local pressure. Skin reactions, like dry skin, itch, rash maybe due Type 1 hypersensitivity reactions to rubber latex, which is one plausible explanation or this could even be due to increased frequency of hand washing and exposure to harsh antimicrobial chemicals and soaps. Unfortunately, the pandemic has brought about or mandated increased use of PPE much more than prior PPE usage patterns under infection control protocols. Considering the additional symptoms like Tiredness, Giddiness as reported by the respondents, it is evident that Health Care Workers especially the front lines have to endure varying degrees of pain despite the discomfort.

We also need to consider that the PPE available does not take into account regarding the overall fit and level of tolerability and comfort when worn, these factors also contribute to the development of the symptoms. Hence, to ensure workplace safety and productivity as well as improve overall occupational health, we recommend through better engineering, the next generation of PPE to have a better design to ensure

tolerability and comfort, which can also ensure job satisfaction among the frontlines.

We also do acknowledge, certain limitations of our study. First, since the study was conducted through a self-administered online questionnaire, the participants did not respond to all the mentioned questions which might have affected the statistical analysis through recall bias. Second, the initial sample size was considered small which may have been due to the infection control protocols and restrictions imposed due to COVID-19 outbreak. Third, other factors such as anthropometric variables, psychological and sleep patterns and ambient climate and humid environmental condition as the study was set up in a coastal region weren't taken into consideration in contributing towards the development of the symptoms.

CONCLUSION

Based on discussed results we conclude the prevalence and characteristics of PPE- associated symptoms in HCW working in high-risk areas in Tertiary Care Centers. The impact of increased usage of PPE is clinically significant and might worsen the consequences if the pandemic lasts for a longer time. Better measures and strategies required for designing PPE and reducing the exposure time in HCW and also the impact on their work performance.

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