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ORIGINAL ARTICLE

Adverse Effects of Personal Protective Equipment Used on Healthcare Workers' Skin during COVID-19 Outbreak

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ABSTRACT

Objective: To investigate the adverse events on skin with continuous practice of personal protective equipment (PPE) in COVID-19 management among healthcare workers (HCWs).

Methods: This cross-sectional multicenter study was conducted at hospitals operating in Karachi, Pakistan from November 2020 to January 2021. The target population was HCWs including doctors, paramedical staff, postgraduate, and undergraduate students involved in the care of patients during COVID-19; and continuously wearing level 3 barrier protection personal protective equipment (L3PPE), such as masks, gloves, and protective clothing. Adverse effect was defined as presence of new onset obvious skin damages with continuous PPE used during used COVID-19 management.

Results: Of 383 HCWs, adverse effect was observed in 168 (43.9%) HCWs. The most common adverse effects because of facial mask were indentation and ear pin 200 (52.2%), by gloves was dry skin 186 (48.8%), by gown was wheals 19 (7.0%), and by goggles was pressure injury 40 (43.0%). A significantly higher association of adverse effect of using L3PPE was found with age >27 years (p-value <0.031), eczema and asthma as preexisting diseases (p-value <0.001), ≤10 times daily standard hand hygiene procedure (p-value 0.002), >6 hours of PPE worn per day (p-value <0.001), N-95 mask use (p-value 0.029), both OPD and isolation ward work setting (p-value <0.001), and systematic features like, headache (p-value 0.019), sneezing (p-value <0.001), feeling of intense heat (p-value <0.001), claustrophobia (p-value <0.001), and facial suffusion (p-value <0.001).

Conclusion: A higher number of HCWs reported adverse effects of L3PPE continuously usage during COVID-19 management.

Keywords: COVID-19, Face Masks, Healthcare Workers, Personal Protective Equipment, Skin Damage.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) pandemic has become a global health emergency. Though many studies have been conducted so far and more studies are still in progress.[1,2] Few of these studies have investigated the skin damage as a result of personal protective equipment (PPE) continuous usage for prolonged period of times.[2] In this scenario world health organization (WHO) has advices adequate use of PPE depending up on the situation and status of the patients.[3]

In general, cleaning of hand repeatedly and continuous wearing of level 3 barrier protection personal protective equipment (L3PPE) has aggressively exacerbated the incidence of adverse skin events in healthcare workers (HCWs).[4] This risk has become more frequent throughout severe acute respiratory syndrome (SARS) epidemic.[5] A study regarding skin damage and its preventive measures estimates 97% prevalence in Chinese HCWs. Study reported that usage of face masks and goggles more than six hours and washing the hands more than 10 times increase the risk of skin damage among HCWs.[6] Another study has reported excess use of antibacterial sanitizers because of the fear of getting COVID-19 infection.[7]

The rationale of this study is that though the importance of PPE cannot be denied for the HCWs working in an environment with highly transmissible infections but prolonged and continued use of these equipment in a hot and humid condition that specially prevail in regions like Pakistan could lead to various deleterious effects. These may interfere HCWs' physical and mental performance. Therefore, we aim to conduct

this study to investigate the adverse events on skin of HCWs with continuous practice of PPE during the management of COVID-19.

METHODS

This cross-sectional multicenter study included participants from Baqai Medical University Fatima Hospital, Jinnah Postgraduate Medical Centre and Indus Hospital Karachi, Pakistan from November 2020 to January 2021. The study was ethically approved from the Institutional Review Board of Baqai Medical University. All participants were explained about the study and were informed of their right of refusal at any point. All participants signed an informed consent form before giving the consent for participation in the study.

A sample size of 379 was calculated using an online sample size calculator with margin of error 0.05, confidence interval of 95%, population size 430000,[8] and percentage of skin problem in health worker as 56%.[9] However, 383 subjects were included to compensate missing and incomplete data. Healthcare staff working during COVID-19, and using PPE, who gave consent to participant in the study were included and HCW already having known skin condition and/or injuries were excluded from the study.

The target population was HCWs including doctors, paramedical staff and postgraduate and undergraduate students involved in the care of patients; and often-wearing PPE, such as masks, gloves, and protective clothing; and willing to participate in this study. HCWs already having known skin condition and/or injuries were excluded from the study. A self-structured questionnaire was developed for data collection. The reliability was tested through test re-test during pilot study prior to data collection. The questionnaire consisted of three sections, the first section consisted of questions relating to the demographic information and any pre- existing skin or allergic condition. The second section contained questions regarding the type and duration of L3PPE used and the final section included distinctive symptoms of skin reactions following use of L3PPE. Non-probability purposive sampling technique was used to collect data. The investigators interviewed the participants via face to face or telephonic communication and filled out the questionnaire to study skin damages such as acne, dry skin, edema, erosion/ ulcer, indentation and ear pain, itch, peeling skin, pigmentation, pressure injury, rash, scar at nose bridge, soaked with sweat (maceration), urticaria, wheals and xerosis.

Data entry and analysis were done using a Statistical Package for Social Sciences (SPSS) version 20.0. Mean ± SD were computed for quantitative variables like, age while frequency and percentages were computed for categorical variables like, gender, work setting, preexisting disease, daily standard hand hygiene procedure, average duration of PPE used per day, mask type and systematic features of HCWs. Inferential statistics were explored using Chi-square test to compare adverse effect of using N95 mask on HCWs skin and adverse effect of using L3PPE with demographic and clinical characteristics of HCWs. The p-value of ≤0.05 was considered statistically significant.

RESULTS

Of 383 HCWs, the mean age was 28.7 ± 6.9 years. There were 138 (36%) males and 245 (64%) females. Majority of the HCWs were doctors 245 (64.5%), followed by paramedic staff 103 (26.9%), and medical students 33 (8.6%). Most of the HCWs were working at OPD 163 (42.6%) as compared to isolation ward 105 (27.4%), others work setting 68 (17.8%), working in laboratory 26 (6.8%), and in both OPD and isolation ward 21 (5.5%).

Exacerbation of acne was found in 50 (13.1%) HCWs and eczema in 23 (6.0%) HCWs. More than half of the HCWs 202 (52.7%) reported that they did daily standard hand hygiene procedure for more than 10 times. Gloves was the most frequent used PPE component reported by 381 (99.5%), followed by gown 248 (64.8%), face shield 128 (33.4), and goggles 93 (24.3%). Half of HCWs used L3PPE for more than 6 hours a day i.e., 190 (49.6%).

The most common adverse effects observed in HCWs by using facial mask was indentation and ear pin 200 (52.2%), by using gloves was dry skin 186 (48.8%), by using gown was wheals 19 (7.0%), and by using goggles was pressure injury 40 (43.0%). (Table 1)

The most common skin damage observed in HCWs were on face 134 (35.0%) and nose 75 (19.6%). After used of L3PPE majority of the HCWs were faced headache 141 (36.8%), followed by feeling of intense heat 126 (32.9%), facial suffusion 71 (18.5%), sneezing 41 (10.7%), claustrophobia 34 (8.9%), and nausea 22 (5.7%). (Table 2)

Adverse effect of using N95 mask showed a significant association with rash (p-value 0.045) and scar at nose bridge (p-value <0.001). (Table 3) However, newly onset of obvious skin damage showed a significant association with age (p-value <0.031), exacerbation of any preexisting diseases (p-value <0.001), daily standard hand hygiene procedure (p-value 0.002), average duration of PPE worn per day (p-value <0.001), mask type (p-value 0.029), work setting (p-value

Table 1: Reported adverse events by HCWs (n = 383)

Parameters	Frequency	Percentage
Facial mask		
Acne	115	30
Pigmentation	24	6.3
Indentation and ear pain	200	52.2
Itch	170	44.4
Rash	87	22.7
Scar at nose bridge	110	28.7
Wheals	6	1.6
Dry skin	83	21.7
Peeling skin	27	7
Erosion/ ulcer	2	0.5
Gloves		
Itch	146	38.3
Dry skin	186	48.8
Edema	3	0.8
Rash	50	13.1
Wheals	3	0.8
Soaked with sweat (maceration)	96	25.2
Gown		
Itch	51	20.6
Rash	14	5.6
Wheals	19	7.7
Dry skin	14	5.6
Goggles		
Itch	16	17.2
Erosions	11	11.8
Pressure injury	40	43
Rash	22	23.7
xerosis	22	23.7
Urticaria	1	1.1

HCWs: Healthcare workers

<0.001), and systematic features like, headache (p-value 0.019), sneezing (p-value <0.001), feeling of intense heat (p-value <0.001), claustrophobia (p-value <0.001), and facial suffusion (p-value <0.001). (Table 4)

DISCUSSION

The findings of this study showed a higher incidence of the adverse effect of wearing L3PPE in medical personnel during the pandemic of COVID-19. The most frequent affects after usage of mask were facial indentation and ear pain followed by itching, acne, scars at node bridge, rashes, and dry skin. With goggle usage, pressure injury was observed in most of the subjects, followed by rashes, xerosis, and itching. Adverse reactions observed after usage of gown were itching, wheals, rashes, and dry skin. The use of gloves for a long duration caused dry skin, maceration, itching and rashes among HCWs. The most common problems that were observed after using all above L3PPE are itching, rashes and dry skin. In accordance with our finding, the higher incidence of adverse reactions during the pandemic of COVID-19 was reported in previous studies.[9-12] These findings are in accordance

Table 2: Affected regions and systematic features of using PPE reported by HCWs (n = 383)

Parameters	Frequency	Percentage
Region effected		
Hand	64	16.7
Face	134	35
Nose	75	19.6
Cheeks	57	14.9
Forehead	14	3.7
Eyes	4	1
Ears	23	6
Systematic feature		
Nausea	22	5.7
Headache	141	36.8
Sneezing	41	10.7
Feeling of intense heat	126	32.9
Claustrophobia	34	8.9
Uffusion facial s	71	18.5

HCWs: Healthcare workers

with a similar study conducted in Indonesia.[13]

Skin of face and nose were most affected by the prolong use of PPE. Most subjects reported bruises, breakage, and dryness of skin in these areas. These finding are in accordance with the other studies conducted on this subject. [14,15] Similarly, symptoms like suffocation, nausea, inching, sneezing, claustrophobia were reportedly associated with the use of PPE.[14,15]

Demographic factors like age showed significant association with adverse effects of continuous use of PPE. Similarly, the duration of PPE used, type of mask, and work setting were also found associated with PPE adverse effects. Prior researches during COVID19 about PPE reported similar results.[9,16,17] According to the findings, subjects with preexisting skin condition are more susceptible to adverse effects of PPE.

Besides that, new onset skin problem observed with the usability of L3PPE, but then most of the affected subjects were healed by using emollient. According to previous review, comorbidities, such as obesity, smoking, and diabetes mellitus contributed on new-onset symptoms from the PPE use.[9]

As per WHO directive, HCWs during COVID-19 working should wear PPE in hospital settings specially working in areas such as isolation wards, intensive care units, emergency room, and general medical wards.[18,19] Studies have reported that HCWs working in these areas are more likely to develop adverse effect due to prolong use of PPEs.[20-22]

This study has tried to draw an attention towards improvement in the guidelines for PPE use and focus on the quality of materials for protective equipment to effectively minimize the adverse skin reactions. Hopefully, finding of this study will assist medical institutions to acknowledge the issue and take measure to eliminate or minimize the adverse effect of PPE use among HCWs. There is need to further investigation on this subject with a more broader sample size. Similarly, the PPE adverse effects also need to be studied in other part of Pakistan. As the COVID19 pandemic conclusion seen nowhere on the foreseeable future, there is need to take definite measure to eliminate or minimize these adverse effects. There is need of innovation in design of PPE to make it more comfortable in use. Other strategies also needed to be planned such as frequent breaks, hydration, rest, skin care. Few limitations were faced during the course of study such as data collection under lockdown condition hindered including more hospitals in the study. Other possible risk factors such as use of PPE after work can also contribute to the adverse effect but were not isolated in this study.

CONCLUSION

The prolong use of PPE such as N95, surgical masks, face shield, gloves, goggles, and gown by HCWs during COVID19 has significant adverse effects such as, facial indentation, ear pin, dry skin, wheals, and pressure injuries. Moreover, dermatological manifestation specifically rashes, itching, and dry skin could develop

Table 3: adverse effects of using N95 mask on HCWs skin (n = 383)

Symptoms	Total	Mask Type		p-value
		N95 (n= 171)	Surgical (n= 212)	
Acne				
Yes	115	51 (44.3)	64 (55.7)	0.938
No	268	120 (44.8)	148 (55.2)	
Pigmentation				
Yes	24	12 (50.0)	12 (50.0)	0.586
No	359	159 (44.3)	200 (55.7)	
Indentation and ear pain				
Yes	200	90 (45.0)	110 (55.0)	0.885
No	183	81 (44.3)	102 (55.7)	
Itch				
Yes	170	77 (45.3)	93 (54.7)	0.820
No	213	94 (44.1)	119 (55.9)	
Rash				
Yes	87	47 (54.0)	40 (46.0)	0.045*
No	296	124 (41.9)	172 (58.1)	
Scar at nose bridge				
Yes	110	66 (60.0)	44 (40.0)	<0.001*
No	273	105 (38.5)	168 (61.5)	
Dry skin				
Yes	83	33 (39.8)	50 (60.2)	0.311
No	300	138 (46.0)	162 (76.4%)	
Peeling skin				
Yes	27	16 (59.3)	11 (40.7)	0.113
No	356	155 (43.5)	201 (94.8%)	

HCWs: Healthcare workers

Chi-Square test applied, *p-value ≤ 0.05

on long-term usage of L3PPE. Increased age and duration of PPE worn per day along with the pre-existing diseases like eczema, asthma, and acne has significant risk of adverse effects. In addition, people with systematic features like headache, feeling of intense heat, and claustrophobia may also develop adverse effect after continuous usage of L3PPE.

ETHICAL AAPROVAL: This study was approved by Ethical Committee of Baqai Medical University Karachi, Pakistan [BMU-EC/2020-06(OL)].

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Table 4: Comparison of Adverse Effect of Using L3PPE with Demographic and Clinical Characteristics of HCWs (n = 383)

		Adverse Effects[$]		
	Total	**Yes (n = 168)**	**No (n = 215)**	**p- value**
Age, year				
≤ 27	200	77 (38.5)	43 (70.5)	0.031^*
> 27	183	91 (49.7)	40 (60.6)	
Gender				
Male	138	57 (41.3)	81 (58.7)	0.455
Female	245	111 (45.3)	134 (54.7)	
Health care role				
Doctor	245	116 (47.0)	131 (53.0)	0.268
Medical student	33	13 (39.4)	20 (60.6)	
Paramedic	103	39 (37.9)	64 (62.1)	
Exacerbation of any Preexisting diseases				
Eczema	23	16 (69.6)	7 (30.4)	<0.001*
Asthma	15	10 (66.7)	5 (33.3)	
Acne	50	29 (58.0)	21 (42.0)	
Others	12	6 (50.0)	6 (50.0)	
None	283	107 (37.8)	176 (62.2)	
Daily standard hand hygiene procedure				
≤ 10 times	181	64 (35.4)	117 (64.6)	0.002*
> 10 times	202	104 (51.5)	98 (48.5)	
Average duration of PPE worn per day				
≤ 6 hours	193	64 (33.2)	129 (66.8)	<0.001*
>6 hours	190	104 (54.7)	86 (45.3)	
Mask type				
N95	171	86 (50.3)	85 (49.7)	0.029*
Surgical	212	82 (38.7)	130 (61.3)	
Systematic features				
Nausea	22	9 (40.9)	13 (59.1)	0.828
Headache	141	73 (51.8)	68 (48.2)	0.019*
Sneezing	41	31 (75.6)	10 (24.4)	<0.001*
Feeling of intense heat	126	70 (55.6)	56 (44.4)	<0.001*
Claustrophobia	34	26 (76.5)	8 (23.5)	<0.001*
Facial suffusion	71	45 (63.4)	26 (36.6)	<0.001*
Work setting				
Isolation ward	105	62 (59.0)	43 (41.0)	<0.001*
OPD	163	53 (32.5)	110 (67.5)	
Laboratory	26	11 (42.3)	15 (57.7)	
OPD and isolation ward both	21	16 (76.2)	5 (23.8)	
Other	68	26 (38.2)	42 (61.8)	

OPD: Outpatient department, [$]New onset of obvious skin damage during the duration of PPE used
Chi-Square test applied, *p-value ≤ 0.05

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