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# Personal protective equipment modification by health care workers owing to skin concerns during the COVID-19 pandemic: a multicenter cross-sectional study

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To the Editor:

Health care workers have reported skin concerns attributed to personal protective equipment (PPE) use during the COVID-19 pandemic, including acne, rash, discoloration, and bruising [1]. These skin symptoms have impacted health care workers' personal and professional lives, with reports of sleep disruption, missed work, and feelings of anxiety, embarrassment, and isolation [2,3]. Our previous work surveyed 390 health care workers during the COVID-19 pandemic, with nearly two-thirds reporting PPE modification to prevent or alleviate skin concerns [2]. The aim of this study was to further characterize such PPE modifications.

This study was approved by the Boston Medical Center and Mass General Brigham Institutional Review Boards. A secure, anonymous online questionnaire was distributed to health care workers at Boston Medical Center, Brigham and Women's Hospital, and Massachusetts General Hospital from 5/3/2021-6/28/2021. Additionally, flyers were placed in employee-only accessible areas throughout Boston Medical Center. Survey questions surrounded demographics, occupational characteristics, PPE use, and skin concerns. Descriptive statistics were tabulated using R, version 3.3.3 (R Development Core Team, 2017).

A total of 704 health care workers participated, of which 81.8% were female. The mean (standard deviation) age of participants was 38.4 (12.9) years. Participants included nurses (32.0%), physicians (14.3%), administrative staff (12.5%), and researchers (10.4%). Roughly one-third of participants (32.8%) worked directly with confirmed or suspected COVID-19 patients in the preceding two weeks. On average, workers utilized PPE 8.1 (3.7) hours per typical workday, 3.8 (1.5) days per week, and used 2.0 (2.0) surgical masks per workday.

Nearly all (94.0%) reported at least one PPE-related skin concern during the COVID-19 pandemic ([Table 1](#)). Of those surveyed, 89.2% of PPE users reported at least one skin concern with use of N95 masks, 88.6% with surgical masks, 31.0% with glasses or goggles, 27.6% with face shields, 26.5% with examination gloves, 18.0% with hospital-issued scrubs, and 6.7% with disposable or reusable gowns.

Nearly half (45.0%) reported modifying PPE to prevent or alleviate skin concerns. Of these, respondents modified surgical masks (83.9%), N95 masks (26.2%), glasses or goggles (21.5%), and face shields (10.7%). Of those who modified N95 masks, 48.2% received fit testing with the modified mask.

**Table 2.** Personal protective equipment modifications made by health care workers to prevent or alleviate skin concerns during the COVID-19 pandemic.

	PPE <sup>a</sup> Modifications N=317 N (% <sup>b</sup> )
Used clips, extenders, buttons, et cetera to keep mask loops off ears	235 (74.1)
Applied ointment, creams, or film on skin to prevent rubbing	145 (45.7)
Applied bandages, tape, or other barriers on skin to prevent rubbing	137 (43.2)
Wore headbands to prevent face shield rubbing forehead	90 (28.4)
Wore non-hospital issued scrubs	82 (25.9)
Wore non-hospital issued scrub caps	74 (23.3)
Wore multiple masks layered on top of each other	64 (20.2)
Wore non-hospital issued safety goggles or eye shields	63 (19.9)
Requested a different model of N95 mask due to skin symptoms	34 (10.7)
Wore non-hospital issued masks	26 (8.2)
Wore non-hospital issued face shields	12 (3.8)
Other	17 (5.4)

<sup>a</sup>PPE, personal protective equipment.

<sup>b</sup>Percentages do not sum to 100% because participants may have reported more than one type of PPE modification.

The most common modifications included using clips, extenders, buttons, and similar devices to reduce pressure from mask loops on ears (74.1%). In addition, applying ointment, creams, or films (45.7%), applying bandages, tape, or other barriers (43.2%), and wearing headbands (28.4%), (**Table 2**) were reported. **Figures 1, 2** illustrate examples of PPE modifications made by health care workers.



**Figure 1.** Examples of personal protective equipment modifications made by health care workers for skin concerns during the COVID-19 pandemic. **A)** Button sewn on to scrub cap for attachment to mask loops. **B)** Mask loops fastened to a hair clip secured to a headband. **C)** Mask loops connected to a plastic ear saver.



**Figure 2.** Examples of personal protective equipment modifications made by health care workers for skin concerns during the COVID-19 pandemic. **A)** Silicone mask bracket under surgical mask. **B)** Handknit hairpiece with buttons for mask loops fastened to the hair with bobby pins. **C)** Mask loops connected with a string fastened to paper clips. **D)** Eye protection with nose attachment. **E)** Mask loop connected to silicone ear saver. **F)** Surgical mask with paper tape fastened to the skin under face shield.

Nearly half of surveyed health care workers reported modifying PPE to address skin concerns. The most common modifications minimized friction or pressure on the skin. Nearly all reported that masks contributed to skin concerns, leading some participants to modify masks. The issue of masks causing skin concerns is widespread; a resolution presented at the June 2021 American Medical Association meeting urged for better fitting PPE, citing pressure ulcer development in health care workers from masks [4]. Similarly, in April 2021, the Department of Health and Human Services launched the *Mask Innovation Challenge* to develop masks that are effective and minimize contact dermatitis with extended wear [5]. Skin concerns related to masks are not limited to health care workers and efforts should be made to improve comfort and minimize skin consequences for all users. Personal protective equipment that offloads pressure to high-friction areas including the nasal bridge, ears, and forehead may address skin-related concerns and reduce the need for user modifications.

Research evaluating the efficacy of modified PPE is limited. Use of a sealed gown and glove

combination, a tight-fitting gown around the neck, wrists, and hands, or tabs to facilitate doffing of masks has been shown to reduce contamination risk [6]. In our study, some modifications were handmade, such as a handknit hair piece designed to keep mask loops off of ears (**Figure 2B**). Other PPE modifying devices were purchased as exemplified by a silicone mask bracket (**Figure 2A**). Of those who modified N95s, less than half received fit testing with the modified mask. Modified masks have varying fitted filtration efficiencies [7]. Further research is needed to investigate the impact of PPE modifications on PPE efficacy.

Limitations include the study's cross-sectional design and possible selection bias. Health care workers experiencing skin concerns may have been more motivated to participate. This survey was

primarily distributed through hospital Email distribution lists, making it difficult to estimate an accurate response rate.

In this study, nearly half of participating health care workers report modifying PPE to prevent or alleviate skin concerns, primarily utilizing methods to reduce friction on the nasal bridge, ears, and forehead. More dialogue is needed between health care workers, PPE manufacturers, and purchasers of PPE to provide PPE that is safe and minimizes skin concerns. Further research is needed to investigate the impact of PPE modification for skin concerns on PPE efficacy.

### Potential conflicts of interest

The authors declare no conflicts of interest.

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**Table 1.** Skin concerns reported by health care workers associated with personal protective equipment use during the COVID-19 pandemic.

Skin concern	PPE <sup>a</sup> N <sup>b</sup> (%)							
	Surgical mask N=699	N95 N=462	Glasses or goggles N=551	Face shield N=446	Exam gloves N=623	Hospital-issued scrubs N=361	Gowns N=523	Re-use of PPE <sup>a</sup> N=615
Any skin concern	619 (88.6)	412 (89.2)	171 (31.0)	123 (27.6)	165 (26.5)	65 (18.0)	35 (6.7)	245 (39.8)
Acne, pimples, or pus bumps	521 (74.5)	282 (61.0)	43 (7.8)	64 (14.3)	2 (0.3)	2 (0.6)	8 (1.5)	213 (34.6)
Redness	342 (48.9)	321 (69.5)	72 (13.1)	59 (13.2)	93 (14.9)	29 (8.0)	10 (1.9)	138 (22.4)
Itching	329 (47.1)	191 (41.3)	26 (4.7)	59 (13.2)	134 (21.5)	62 (17.2)	24 (4.6)	121 (19.7)
Pain	112 (16.0)	183 (39.6)	89 (16.2)	21 (4.7)	16 (2.6)	4 (1.1)	1 (0.2)	45 (7.3)
Persistent rash (>24 hours)	103 (14.7)	73 (15.8)	5 (0.9)	7 (1.6)	40 (6.4)	17 (4.7)	6 (1.1)	53 (8.6)
Discoloration	97 (13.9)	112 (24.2)	11 (2.0)	10 (2.2)	15 (2.4)	5 (1.4)	1 (0.2)	41 (6.7)
Blisters, erosions, or scabs	58 (8.3)	77 (16.7)	6 (1.1)	2 (0.4)	30 (4.8)	4 (1.1)	0 (0.0)	33 (5.4)
Bruising	16 (2.3)	110 (23.8)	22 (4.0)	4 (0.9)	2 (0.3)	0 (0.0)	1 (0.2)	18 (2.9)
None of these	77 (11.0)	47 (10.2)	373 (67.7)	316 (70.9)	452 (72.6)	288 (79.8)	482 (92.2)	2 (0.3)