General Original Article

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Mask-related skin changes among healthcare workers in a community-based hospital

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Abstract

Context: During the COVID-19 pandemic, dermatologists within the Beaumont Farmington Hills' Dermatology program noticed an increase in conditions associated with mask wearing, such as "maskne" (acne in a mask distribution, thought to be caused by mask wearing), as well as worsening of previously diagnosed dermatologic conditions.

Objectives: The goal of our study was to explore various factors that impacted mask-related skin changes and how these skin changes affected quality of life.

Methods: A cross-sectional study was performed. The primary 10-item survey instrument administered was the Dermatology Life Quality Index (DLQI). Respondents were asked a series of 10 additional questions concerning the degree to which abnormal mask-related skin conditions affect their skin symptoms, possible embarrassment/self-consciousness, and perceived impact of mask-related skin changes. A series of descriptive statistics, cross-tabulation charts, and graphical examinations of data was utilized to evaluate sample subgroup and outcome distributional patterns. Pearson r bivariate correlation coefficients between possible collinear predictive measures on the primary study outcome were calculated. A series of simple inferential chi-squared (X^2) tests of independence were also conducted.

Results: A total of 370 out of 430 (86.0%) Beaumont Health employees noticed some degree of skin changes since the work-hours face mask requirement was instituted, while 378 out of 430 (87.9%) felt that their skin was better when not wearing a mask. The majority of respondents, 283 (65.8%), reported having at least a little symptomatic skin (i.e., itchy, painful, sore, stinging) during the prior week. Furthermore, 72.3% reported that they were at least a little embarrassed or self-conscious of their skin. Chi-squared analysis of composite DLQI score categories by the number of types of masks utilized (Pearson X^2=19.0, df=8, p=0.015), and some degree of symptomatic skin (Pearson X^2=156.4, df=4, p<0.001) were found to be statistically significant.

Conclusions: A large number of healthcare workers are affected by mask-related skin changes. Further research should be directed at better understanding how skin changes associated with mask wearing impact one's quality of life and mental health.

The COVID-19 pandemic is one of the most devastating and unprecedented global health crises of the 21st century [1]. Healthcare workers are at the highest risk of contracting the virus and must take appropriate precautions to protect themselves [2]. Because the virus is thought to spread through respiratory droplets, masks are undoubtedly the most essential piece of personal protective equipment (PPE) [1].

Mask wearing is associated with dermatologic conditions including acne and contact dermatitis [3]. In a cross-sectional study of 20 healthcare workers by Han et al. [1], greater levels of sebum were identified in areas covered by PPE, which could not be explained by circadian changes in sebum levels. The authors also reported increased skin hydration, transepidermal water loss, erythema, and pH [1]. Excessive sebum may contribute to the development of "maskne," [1] which is

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acne in a mask distribution, thought to be caused by mask wearing. Increased skin pH leads to changes in the skin microflora, including compromised antimicrobial defenses that promote infection and irritation [1]. In a study of 21 healthy participants, Park et al. [4] similarly reported an increase in skin temperature, redness, hydration, and sebum production after both 1 h and 6 h of mask wearing. Skin redness and increased temperature may be markers for increased skin permeability and inflammation [1]. Changes in the aforementioned skin characteristics promote mask-related skin conditions.

Increased skin hydration increases chemical absorption and enhances susceptibility to allergens and irritants, leading to the development of allergic and irritant contact dermatitis [1]. The perioral area is most commonly affected due to its close approximation to the mouth [4]. Irritants such as friction and mechanical pressure [5] are exacerbated by humidity, leading to a breach in epidermal integrity [6]. Surgical masks and N95s contain formaldehyde and other preservatives that are known culprits of allergic contact dermatitis [2]. Other potential allergens include thiuram in elastic ear straps and dibromodicyanobutane in mask adhesive [5]. Unfortunately, potential allergens are difficult to identify, because chemicals utilized in mask manufacturing are often not disclosed [7].

During the COVID-19 pandemic, dermatologists at Beaumont Farmington Hills noticed an increase in conditions associated with mask wearing, such as maskne, as well as worsening of previously diagnosed dermatologic conditions. The goal of our study was to explore various factors that impacted mask-related skin changes and how these skin changes affected quality of life. We hypothesized that a majority of healthcare workers would report mask-related skin changes that negatively impacted their quality of life.

Methods

Data collection

After IRB approval from the Beaumont Health IRB (IRB#2021-011), the study team observed an "opt in" recruitment method in which only those eligible Beaumont Farmington Hills healthcare workers who actively clicked on the SurveyMonkey [8] link provided to them through the health system's email system were allowed to enter any study survey responses. The SurveyMonkey [8] software was programmed with both secure socket layers (SSL) and internet protocol security (IPsec) encryption to systematically conceal the identities of all respondents to members of the study team. Each respondent was advised in initial survey instructions that they are asked to avoid providing any identifying information in all survey fields. The study date range was from April 21, 2021 to July 1, 2021.

A cross-sectional survey study was performed. The primary 10-item survey instrument that was administered is the Dermatology Life Quality Index (DLQI) [9], a well-validated Likert-scale survey tool utilized by the team analyst (WC) to generate a composite score of between 0 and 30 points [10]. The composite DLQI score can be utilized to categorize patients into one of five overall categories, ranging from "no effect at all on my life" (0–1 point) through "extremely large effect on my life" (21–30 points) [11]. Respondents were asked a series of 10 additional questions concerning the degree to which abnormal mask-related skin conditions affect their skin symptoms, possible embarrassment/self-consciousness, and perceived impact of mask-related skin changes (Figure 1).

The following eligibility criteria were observed: adults 21 years of age and older; Beaumont Health employees; and regular mask usage during work hours. Children less than 18 years of age and cognitively impaired individuals were excluded.

Minimal sample size calculations

Before data collection was begun for this IRB-approved project, the team analyst utilized G*Power 3.1.94 software [12] to generate *a priori* minimal sample size calculations for the hypothesized main effect influence of the predominant type of protective mask utilized (i.e., P100/N95/Kn95 vs. surgical/cloth mask) on variations in continuous DLQI composite scores. These calculations indicated that a minimal total sample size of at least 70 discrete respondents (i.e., at least 35 P100/N95/KN95 mask users vs. 35 surgical/cloth mask users) would afford the study team a 0.8005384 1 minus β level of statistical power to detect statistically significant variations between sample subgroups observing a two-tailed coefficient alpha of 0.05 to indicate statistical significance. This sample size was also based on a critical Z estimate for the hypothesized two-tailed influence of mask use subgroup on "moderate effect or higher" composite DLQI scores, as reported by Lan et al. [13] in 2020 (Critical Z=1.9599640).

Data analyses

After IRB approval, author WC conducted all analytic procedures. After cleaning the de-identified SurveyMonkey [8] data from string to numerical form, he created a "working" data set. For analytic procedures, the analyst examined the validity of the study teams' hypothesized relationships utilizing SPSS Version 27 analytic software [14].

First, a series of descriptive statistics, cross-tabulation charts, and graphical examinations of data were utilized to evaluate sample subgroup and outcome distributional patterns. For most analyses, continuous study measures (e.g., continuous DLQI scores, etc.) were conservatively categorized into sample subgroups as prescribed by the original DLQI designers. Next, a series of Pearson r bivariate correlation coefficients between possible collinear predictive measures on the primary study outcome (i.e., mask-related DLQI score variations of 6 or greater) were utilized [15]. A series of simple inferential chi-squared tests of independence were also conducted [15].

1. How many hours a day do you wear a mask during the work week - <20, 20-30, 31-40, >40?

2. What type of mask(s) do you wear? Please select all that apply: P100, N95, KN95, surgical mask, cloth mask, face shield only, other

3. How many consecutive days do you wear the same mask? (<1 day, 1 day, 2 days, 3 days, 4-5 days, >5 days)

4. Have you noticed changes in your skin since the work-hours face mask requirement was instituted? (yes/no)

5. Have you needed a prescription to manage a new or worsening mask-associated skin disorder (acne/skin break-outs in a mask distribution)? (yes/no)

6. If you had a pre-existing skin condition in the area the mask covers, has this condition worsened? (yes/no)

7. Have you noticed any bony-cartilage deformation of any skin covered by your mask? (yes/no)

8. Have you researched or searched for treatment options for mask-related skin changes? (yes/no)

9. Have you started any new medications (over-the-counter or prescription) to treat a new mask-related skin change? (yes/no)

10. Do you feel that your skin is better when you are not wearing a mask? (yes/no)

Figure 1: Survey questions. Participants were asked 10 questions regarding mask usage and their associated skin changes.

Finally, the predictive significance of each selected measure on the selected dichotomous and categorical outcomes of interest were modeled out during a series of nonparametric (i.e., not based on any normal distribution assumptions) two-tailed forward "stepwise" (i.e., one model term entered at a time, retained if initial p values are less than 0.10) "main effects" multinomial regression procedures [16]. For all analytic procedures, the analyst observed a two-tailed coefficient alpha p value of less than 0.05 to indicate statistical significance.

Results

Mask-related skin changes

A total of 430 Beaumont Health employees completed the questionnaire and DLQI, out of which 62, or 12.6%, were excluded due to incomplete responses. A total of 370 out of 430 (86.0%) noticed skin changes since the work-hours face mask requirement was instituted at Beaumont, while 378 out of 430 (87.9%) felt that their skin was better when not wearing a mask. Among the participants, 167 (38.8%) reported worsening of a pre-existing skin condition in the area covered by the mask, 163 (37.9%) reported starting a new medication (over-the-counter or prescription), while 98 (22.8%) needed a prescription to manage a new or worsening mask-associated skin disorder. Further, 201 (46.7%) researched potential treatment options for mask-related skin changes. The majority, 267 (62.1%), of the respondents wore masks for greater than 31 h per week, with N95 (32.1%), cloth (30.0%), and surgical masks (23.5%) comprising the most reported mask types. The use of two or more total mask types was reported in 249 (57.9%). Many of the respondents, 272 (63.3%), wore the same mask for 1 day or less, whereas 83 (19.3%) wore the same mask for 2–3 days, and 63 (14.7%) wore the same mask for greater than 4 or more days. Responses to the questionnaire regarding mask-related skin changes are summarized in Table 1.

Dermatology life quality index (DLQI)

The majority of respondents, 283 (65.8%), reported having at least a little symptomatic skin (i.e., itchy, painful, sore, stinging) during the prior week. Furthermore, 311 (72.3%) reported that they were at least a little embarrassed or self-conscious of their skin. Problems caused by the treatment of their skin (i.e., taking up time) were reported in 178 (41.4%) of participants. Sample respondents' mean DLQI composite scores were 4.5 (SD 4.3), ranging from 0 to 24 on a possible scale from 0 to 30. A DLQI score of 4.5 is interpreted as a small effect on a patient's life. Due to the extremely nonparametric spread of composite scores with a lower mean DLQI score, our author group observed the DLQI designer's five categories. Responses to the DLQI are summarized in Table 2.

Chi-squared analysis

Chi-squared (X^2) analysis of composite DLQI tertile score (Table 3) by the number of different mask types utilized (Pearson X^2=19.0, df=8, p=0.015), and some degree of

Table 1: Ten-item survey of mask-related skin changes among beaumont health employees.

		Participants (N=430), No. (%)
1. How many hours a day do you wear a mask during the work week?	<20	81 (18.8)
	20–30	69 (16.0)
	31–40	136 (31.6)
	>40	131 (30.5)
	Missing data	13 (3.0)
2(a). What types of mask(s) do you wear?	P100	13 (3.0)
	N95	138 (32.1)
	KN95	33 (7.7)
	Surgical mask	101 (23.5)
	Cloth mask	129 (30.0)
	Face shield or other/ nothing	16 (3.7)
2(b). What is the total number of reported mask types utilized?	One	169 (39.3)
	Two	134 (31.2)
	Three/four	115 (26.7)
	Missing data	12 (2.8)
3. How many consecutive days do you wear the same mask?	<1 day	98 (22.8)
	1 day	174 (40.5)
	2 or 3 days	83 (19.3)
	4 or more days	63 (14.7)
	Missing data	12(2.8)
4. Have you noticed changes in your skin since the work-hours face mask requirement was instituted?	Yes	370 (86.0)
	No	48 (11.2)
	Missing data	12 (2.8)
5. Have you needed a prescription to manage a new or worsening mask-associated skin disorder?	Yes	98 (22.8)
	No	319 (74.2)
	Missing data	13 (3.0)
6. If you had a pre-existing skin condition in the area the mask covers, has this condition worsened?	Yes	167 (38.8)
	No	241 (56.0)
	Missing data	22 (5.1)
7. Have you noticed any bony-cartilage deformation of any skin covered by your mask?	Yes	32 (7.4)
	No	375 (87.2)
	Missing data	23 (5.3)
8. Have you researched or searched for treatment options for mask-related skin changes?	Yes	201 (46.7)
	No	214 (49.8)
	Missing data	15 (3.5)
9. Have you started any new medications (over-the-counter or prescription) to treat a new mask-related skin change?	Yes	163 (37.9)
	No	254 (59.1)
	Missing data	13 (3.0)
10. Do you feel that your skin is better when you are not wearing a mask?	Yes	378 (87.9)
	No	39 (9.1)
	Missing data	13 (3.0)

symptomatic skin (Pearson X^2=156.4, df 4, p<0.001), were found to be statistically significant. The number of mask types utilized and experiencing some degree of symptomatic skin were associated with a higher impact on the respondent's quality of life.

Multinomial regression predictive modeling

A multivariate controlled two-tailed multinomial regression predictive modeling procedure was completed to examine for the significance of each respondent mask use characteristic on this categorical DLQI composite score outcome observing the DLQI designer parameters when controlling for respondent characteristics. The number of days the same mask was worn (Wald=22.3, df=12, p=0.035), and some degree of symptomatic skin (Wald=217.1, df=8, p<0.001), reached statistical significance on composite DLQI scores (Table 3). Thus, wearing a mask for a greater number of days and reporting some degree of symptomatic skin was associated with a higher impact on the respondent's quality of life.

Discussion

Healthcare workers are at an increased risk of developing mask-related dermatoses compared to the general population [17]. A cross-sectional study of 833 participants by Techasatian et al. [17] found longer duration of mask wearing in healthcare workers, more frequent use of surgical masks compared to other types of masks, and increased practice of not changing masks daily compared to non-healthcare workers to be associated with an increased risk of developing mask-related dermatoses. The prevalence of mask-related cutaneous reactions in this study was 454 (54.5%) [17].

In the present study, 86% of participants self-reported changes in their skin since the work-hours face mask requirement was instituted. These findings are similar to the high number of affected respondents reported in previous studies. Lan et al. [13] reported a 97% prevalence of skin damage in a study of 542 first-line healthcare workers. In a study of 322 healthcare workers by Foo et al. [18], 35.5% of medical staff utilizing masks reported adverse reactions. In a study of 43 healthcare workers by Singh et al. [6], 21% of respondents reported work absenteeism secondary to PPE-related dermatoses. These findings implicate that the significance of PPE-induced dermatoses on healthcare workers and healthcare systems cannot be ignored.

A majority of respondents (65.8%) reported at least a little symptomatic skin (i.e., itchy, painful, sore, stinging), and 87.9% of respondents felt that their skin was better when they were not wearing a mask. In the previously mentioned study by Singh et al. [6], pruritus was the most common symptom reported by healthcare worker respondents (67.4%) [6]. Sensitive skin and atopy are

Table 2: Dermatology life quality index (DLQI) questionnaire.

		Participants (N=430), No. (%)
1. Over the last week, how itchy, sore, painful, or stinging has your skin been?	Very much	29 (6.7)
	A lot	57 (13.3)
	A little	197 (45.8)
	Not at all or not relevant	146 (34.0)
	Missing data	1 (0.2)
2. Over the last week, how embarrassed or self-conscious have you been because of your skin?	Very much	57 (13.3)
	A lot	78 (18.1)
	A little	176 (40.9)
	Not at all or not relevant	119 (27.7)
3. Over the last week, how much has your skin interfered with you going shopping or looking after your home or garden?	Very much	6 (1.4)
	A lot	14 (3.3)
	A little	43 (10.0)
	Not at all or not relevant	367 (85.3)
4. Over the last week, how much has your skin influenced the clothes you wear?	Very much	7 (1.6)
	A lot	20 (4.7)
	A little	64 (14.9)
	Not at all or not relevant	338 (78.6)
	Missing data	1 (0.2)
5. Over the last week, how much has your skin affected any social or leisure activities?	Very much	11 (2.6)
	A lot	25 (5.8)
	A little	112 (26.0)
	Not at all or not relevant	282 (65.6)
6. Over the last week, how much has your skin made it difficult for you to do any sport?	Very much	4 (0.9)
	A lot	4 (0.9)
	A little	22 (5.1)
	Not at all or not relevant	399 (92.8)
	Missing data	1 (0.2)
7. Over the last week, has your skin prevented you from working or studying?	A lot	24 (5.6)
	A little	154 (35.8)
	Not relevant or not relevant	252 (58.6)
8. Over the last week, how much has your skin created problems with your partner or any of your close friends or relatives?	Very much	9 (2.1)
	A lot	5 (1.2)
	A little	70 (16.3)
	Not at all or not relevant	346 (80.5)
9. Over the last week, how much has your skin caused any sexual difficulties?	Very much	5 (1.2)
	A lot	4 (0.9)
	A little	36 (8.4)
	Not at all or not relevant	383 (89.1)
	Missing data	2 (0.5)
10. Over the last week, how much of a problem has the treatment for your skin been, for example, by making your home messy, or by taking up time?	Very much	7 (1.6)
	A lot	32 (7.4)
	A little	139 (32.3)
	Not at all or not relevant	252 (58.6)

Table 3: Composite DLQI impact score categories.

	Participants (N=430), No. (%)
"No effect at all on patient's life" (score 0–1)	121 (28.1)
"Small effect on patient's life" (score 2–5)	171 (39.8)
"Moderate effect on patient's life" (score 6–10)	90 (20.9)
"Very large effect on patient's life" (score 11–20)	41 (9.5)
"Extremely large effect on patient's life" (score 21–30)	3 (0.7)
Missing data	4 (0.9)

significantly associated with increased risk of itch [19]. The risk of mask-induced itch is also related to the presence of pre-existing dermatologic conditions such as atopic dermatitis, seborrheic dermatitis, and acne [19]. Gomolin et al. [20] recommend placing two to three pieces of gauze inside the mask to alleviate mask-induced pruritus. The importance of treating itch cannot be overstated because pruritus negatively impacts psychosocial status [19].

In the present study, 86.0% of our respondents reported skin changes, and almost half (46.7%) of the respondents explored treatment options for these skin changes. Over a third (37.9%) started a new medication to address a facial skin concern, and 22.8% needed a prescription for their maskne. The large proportion of respondents who required treatment highlights the severity of their mask-induced skin changes. In a cross-sectional study of 4,306 healthcare workers by Jiang et al. [21], only 17.7% of respondents utilized preventative measures to protect their skin. Of those who developed skin injuries in the study (42.8% of respondents), 45% utilized hydrocolloid dressing, oil, or cream for treatment [21]. This emphasizes the deficiency in prevention and treatment, and further supports the need for additional education and resources.

Despite the number of publications exploring the factors that contribute to mask-related skin changes, there is a paucity of research investigating how these skin changes impact healthcare workers' quality of life. As osteopathic-trained dermatologists, we recognize the impact that dermatologic conditions can have on patients' mental and emotional well-being. It is important that one treats the whole patient when addressing dermatologic complaints, such as acne and atopic dermatitis. Even mild acne can have a negative impact on patients' quality of life [22].

Sample respondents' mean DLQI composite score was 4.5 (SD 4.3), reflecting an overall "small effect" ranging from 0 to 24 on a possible scale from 0 through 30. However, the majority of the respondents in our study

(72.3%) reported that they were at least a little embarrassed or self-conscious of their skin. In a controlled predictive regression model, the total number of reported mask types was the only statistically significant mask use characteristic on the DLQI. The number of mask types utilized and experiencing some degree of symptomatic skin were associated with a higher impact on the respondent's quality of life.

We suspect that the total number of mask types is reflective of a respondent's proximity to combating the COVID-19 virus. A respondent wearing multiple masks may be working long shifts in an environment that is not conducive to removing the mask while at work. Those who wear a mask for greater than 6 h are at the highest risk of developing mask-related skin changes [7]. N95 masks are also associated with more discomfort and mask-induced skin changes compared to surgical masks [2]. Thus, those who wear multiple masks may be at a higher risk of developing mask-related skin changes that impact quality of life. However, this is only inferred, and further research should be directed at this possible association.

Limitations

This study is not without limitations. The data was only collected from one healthcare organization. The cross-sectional design of the study is also a limitation. The lack of demographic data introduces potential confounding factors, including age, gender, and healthcare roles. We recognize that the question "How many hours a day do you wear your mask during the work week?" with options "Less than 20, 20–30, 31–40, and over 40" is poorly worded because there are only 24 h in a day. Our results likely underestimate the effect that mask wearing has on skin conditions among healthcare workers because the survey was distributed to both frontline healthcare workers and those who work in a corporate office setting.

The lack of significant associations between some of the selected study measures on selected study outcomes could be partially attributed to (A) the lack of a sufficient-sized sample to detect meaningful sample subgroup differences; (B) an inadequately heterogeneous sample (e.g., more variation needed among selected measures or outcomes); (C) missing data patterns; and/or (D) perhaps the lack of any possible association to detect in the first place. The study team acknowledges that their results may have been skewed by "preferred response" or self-selection respondent biases. We also recognize that dermatologic conditions and symptoms were self-diagnosed and self-perceived.

Conclusions

In conclusion, our study demonstrated that a large number of healthcare workers at Beaumont Health were affected by mask-related skin changes at the onset of the COVID-19 pandemic. Further research should be directed at better understanding how skin changes associated with mask wearing impact one's quality of life and mental health. As new variants of the COVID-19 virus emerge, healthcare workers will likely be wearing masks for the foreseeable future. Education is also needed regarding the best practices and prevention strategies of mask wearing to prevent mask-related dermatoses.

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Informed consent: All study participants provided written informed consent prior to participation.
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