

EFFECTS OF PERSONAL PROTECTIVE EQUIPMENT AND HAND WASHING /SANITIZERS ON THE SKIN OF HEALTHCARE WORKERS

By

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DOI: 10.21608/ejom.2022.122068.1266

Submit Date: 2022-02-22

Revise Date: 2022-03-30

Accept Date: 2022-04-09

Author's contribution: All authors contributed equally in this work.

Abstract

Introduction: Healthcare workers (HCWs) wear personal protective equipment (PPE) and use hand sanitizers in addition to frequent hand washing during work time which is one of the fundamental infection control guidelines to prevent different hospital infections. The outbreak of COVID-19 pandemic urged the use of PPE for longer periods and the more frequent hand washing/ or disinfectants use which attributed to the development of skin adverse effects as contact dermatitis. **Aim of Work:** To estimate the prevalence of adverse skin diseases due to the use PPE and sanitizers and their associated factors among HCWs in Mansoura University Hospital, Egypt. **Materials and Methods:** A cross sectional study was done in Mansoura University Hospital, Egypt; among HCWs who were subjected to personal interview to collect socio-demographic data, occupational history, medical history and the frequency of PPE, hand washing and sanitizers/alcohol use. Dermatological examination was done for the whole body; with using dermoscope (dermalite Hud) when needed. **Results:** The overall prevalence of dermatological disorders among the participants was 23.2%. Working >8 hours /day, wearing apron and Alcohol/antiseptic rubbing >10 times/day were independent significant predictors of PPE use and hand washing/sanitizers dermatoses { AOR(95% CI): 9.1(3.4-24.3), 5.9(2.5-13.6) & 19.3,(3.9-93.9); respectively}. **Conclusion and Recommendations:** The prevalence of adverse skin reactions related to PPE and disinfectants use, during the current COVID-19 pandemic, was relatively high. Further multicenter studies are recommended to express the magnitude of the problem on a larger scale. Measures should be considered to mitigate skin disorders resulted from frequent hand washing /or sanitizers use and the frequent use of PPE.

Keywords: Work- related skin lesions, Personal Protective Equipment, Hand washing, Disinfectants and Healthcare workers dermatoses .

Introduction

Healthcare workers (HCWs) who care for dangerous patients with communicable diseases are at great risk of contracting infections especially during a public health emergency and therefore personal protective equipment (PPE) such as face masks/covers, gloves, and gowns would be worn often for hours at work (Foo et al., 2006) . Also the use of hand sanitizers and frequent hand washing during work time is one of the fundamental infection control guidelines to prevent different hospital infections (Agrawal et al., 2020). This amplified hygiene practices and PPE wide use resulted in an increase of dermatological complications and diseases among HCWs, as contact dermatitis and pressure-related skin damage (Bhatia et al., 2020). The most common iatrogenic adverse skin reactions among HCWs using PPE are: nasal bridge scarring, acne, facial itching, skin damage, dry skin, rash, chapped skin and wheals (Hu et al., 2020).Retro-auricular dermatitis due to ear loop face masks were also reported (Bothra et al., 2020). However, efforts towards investigation of work related skin diseases among

HCWs in Egypt are very deficient, with under-reporting and under-diagnosis of occupational skin diseases. During COVID-19 pandemic, HCWs have had to use personal protective equipment for prolonged periods.

Aim of Work

To estimate the prevalence of adverse skin diseases due to the use PPE and sanitizers and their associated factors among HCWs in Mansoura University Hospital, Egypt.

Materials and methods

Study design: It is a cross-sectional study

Place and duration of the study: The study was done at Mansoura University Hospital, Egypt, during the period from November 2020 to January 2021.

Study sample:

Target population: HCWs who provide care and services to sick people either directly as doctors and nurses or indirectly as aides, helpers, laboratory technicians, or even medical waste handlers (Joseph and Joseph, 2016).

Inclusion criteria: Participants are on duty for at least one year, use

PPE and sanitizers at time of data collection (with minimum 4 h/day use of any kind of preventive PPE and/or more than 8 times/day use of any hand hygiene product) and not suffering from obsessive-compulsive disorders (as reported by the participants and the head of the department).

Sample size: A pilot study was carried out among 75 healthcare workers at Mansoura University Hospital, 15 of them were diagnosed with dermatological disorders related to PPE and sanitizers with a prevalence of (20.0%). Sample size was calculated using the Open Epi program (<https://www.openepi.com/SampleSize/SSPropor.htm>). With 5% alpha error and 5% precision the sample size is 246 and by adding 5% attrition rate the total target is 258 HCWs.

Sampling method: The total number of HCWs in Mansoura University Hospital was 4164. About 20.0% (833) of these HCWs worked for less than 1 year and were excluded. A list of all the HCWs fulfilling the inclusion criteria (3331) was obtained. Systematic random sample of 258 HCWs were selected (every 13th). Sample size was distributed proportionally according to number of each job category, doctors

represented 10% (26 participants), the nursing staff represented 60% (155 participants) and each of the technicians group and the service workers 15% (39 participants each). Out of 258 participants, 250 completed the study with a response rate of 97%.

Study methods:

The authors developed a preliminary version of the questionnaire that was subjected to expert opinion of 3 professors of Occupational Medicine, and their recommendation and suggestions were considered.

A- Questionnaire :All the study population was subjected to personal interview by the first two authors and data was collected using a specially designed questionnaire covering:

1- Socio-demographic data (age, sex, marital status, educational level and residence)

2-Occupational history (job title, the working department , working years , daily working hours and shift work),

3-Medical history (history of the presence of chronic diseases as diabetes, hypertension ,etc...) and use of PPE (type , duration of use) and the frequency of hand washing and sanitizers/alcohol use.

B-Dermatological examination

was done by the third author (dermatologist) for the whole body and using Dermoscope (dermalite Hud), when needed, for examination which help to diagnose the skin lesion. Work-related skin diseases are defined as any disorder of the skin which is caused or worsened by work or workplace activity and /or exposures (Bepko and Mansalis, 2016). In the current study, using PPE /or frequent hand washing /using sanitizers are considered the workplace practice related to skin diseases (the lesions were absent outside work and on vacations and even may disappear after stopping PPE use or frequent hand washing).

Consent

Informed verbal consent was obtained from each participant sharing in the study after assuring confidentiality. The data collection and examinations were done in privacy.

Ethical Approval

Study proposal was approved by the Institutional Research Board in Mansoura University: IRB (R.20.12.1139).

Data Management

Data were analyzed using SPSS software (version 17.0 for Windows; SPSS Inc., Chicago, IL, USA). Descriptive statistics were calculated for all variables (qualitative) that were presented as frequencies and percentages. Chi-square test was used for categorical data to compare the variation of skin diseases according to different associated factors. Crude Odd's ratio (COR) and their 95% CI were calculated. Multivariate binary logistic regression was done to detect the independent predictors of skin diseases. Adjusted Odd's ratios (AOR) and their 95% CI were calculated. The statistical significance level was set at ≤ 0.05 .

Results

Table (1): Prevalence of dermatological disorders and its variation according to personal and occupational characteristics of the studied group.

Characteristics	Total No.	Dermatological disorders No.(%)	Significance test	COR(95% CI)
Overall	250	58(23.2)		
Age (years):				
21-40	189	44(23.2)	$\chi^2=0.003^*$ p=0.9	1.0(0.5-2.0)
>40 (r)	61	14(22.9)		1
Sex :				
Male	88	21(23.9)	$\chi^2=0.3$ p=0.9	1.1(0.6-1.9)
Female(r)	162	37(22.8)		1
Marital status:				
Married(r)	172	37(21.5)	$\chi^2=0.6$ p=0.4	1.3(0.7-2.5)
Unmarried	78	21(26.9)		1
Residence:				
Urban(r)	109	20(18.3)	$\chi^2=2.1$ p=0.1	1
Rural	141	38(27.0)		1.6(0.9-3.0)
Education:				
University& above	104	27(26.0)	$\chi^2=0.8$ p=0.4	1.3(0.7-2.3)
Below university(r)	146	31(21.2)		1
Job:				
Doctor(r)	45	7(15.6)	$\chi^2=1.9, p = 0.2$ $\chi^2=0.1, p = 0.7$ $\chi^2=1.3, p = 0.2$	1
Nurse	152	39(25.7)		1.8(0.8-4.5)
Technician	27	5(18.5)		1.2(0.4-4.3)
Service worker	26	7(27.0)		2.0(0.6-6.5)
Department :				
^Non-surgical departments (r)	209	47(22.5)	$\chi^2=0.4$ p=0.5	1
^^Surgical departments	41	11(26.8)		1.3(0.6-2.7)
Duration of work/ years:				
≤10 years (r)	123	27(21.9)	$\chi^2=0.2$ p=0.6	1
>10 years	127	31(24.4)		1.1(0.6-2.1)
Duration of work/ hours:				
≤8 (r)	148	50(33.7)	$\chi^2=22.8$ p≤0.001*	1
>8	102	8(7.8)		6.0(2.7-13.3)
Night shifts[§]:				
Yes	145	32(22.1)	$\chi^2=0.3$ p=0.6	0.8(0.5-1.5)
NO (r)	105	26(24.8)		1

*: Statistically significant (r):Reference group χ^2 :Chi-Square test

§: night shift: from 8 pm to 8 am. ^:Non surgical departments which include: inpatient , outpatient , ICU, emergency, laboratory , radiology , sterilization ,Covid-19 isolation & others.

^^: Surgical departments which include : operating theatre , surgery & anaesthesia.

Table 1 showed that the overall prevalence of dermatological disorders among the participants was 23.2%. The risk of dermatological disorders among the HCWs increased by being: aged from 21 to 40 years, unmarried, male and educated university or above {COR (95% CI): 1.0(0.5-2.0), 1.3(0.7-2.5), 1.1 (0.6-1.9) and 1.3(0.7-2.3), respectively}. Also being nurse or technician or service worker increased the risk of skin disorders {COR(95% CI): 1.8(0.8-4.5), 1.2(0.4-4.3) and 2(0.6-6.5), respectively}, as well as working in surgical departments and working > 10 years {COR(95% CI): 1.3(0.6-2.7) and 1.1(0.6-2.1), respectively}. Working >8 hours /day significantly increased the risk of work related skin lesions {COR(95% CI): 6.0(2.7-13.3), $p \leq 0.001$ }.

Table (2): Association between dermatological disorders and related exposure factors among the studied group.

Infection protective measures	Total No. (%)	Dermatological disorders No. (%)	Significance test	COR (95% CI)
Overall	250 (100.0)	58(23.2)		
Surgical mask#	247	57(23.1)	FET , $p=0.7$	0.6(0.05-6.70)
N95#	58	19(32.7)	$\chi^2=3.9, p=0.04^*$	1.9(0.9-3.6)
Overhead#	70	19(27.1)	$\chi^2=0.8, p=0.4$	1.3(0.7-2.5)
Overshoes #	51	10(19.6)	$\chi^2=0.5, p=0.5$	0.7(0.3-1.6)
Face-shield #	48	19(39.5)	$\chi^2=8.9, p=0.003^*$	2.7(1.4-5.4)
Gown#	95	29(30.5)	$\chi^2=4.6, p=0.03^*$	1.9(1.1-3.5)
Goggles#	18	8(44.4)	FET, $p=0.04^*$	2.9(1.1-7.7)
Apron #	40	21(52.5)	$\chi^2=30.1, p \leq 0.001^*$	6.2(3.1-12.8)
Gloves #	161	45(27.9)	$\chi^2=5.7, p=0.02^*$	2.3(1.1-4.5)
Hand washing with soap/Betadine				
≤10times(r)	249	58(23.3)	FET, $p=0.5$	-----
>10 times	1	0(0.0)		
Alcohol/antiseptic rubbing				
≤10times (r)	237	47(19.8)	FET, $p \leq 0.001^*$	1
>10 times	13	11(84.6)		4.2(1.8-10.1)

:Reference is NO.

χ^2 :Chi-Square test

FET: Fisher Exact Test

*: Statistically significant

(r): Reference group

Table 2 showed that the risks of dermatological disorders increased by wearing N95 mask , overhead , face-shield , gown , goggles , apron , gloves and using Alcohol/antiseptic rubbing >10 times: {COR(95% CI):1.9(0.9-3.6)p =0.04,2.7(1.4-5.4)p=0.003, 1.9(1.1-3.5)p=0.03,2.9(1.1-7.7)p=0.04, 6.2(3.1-12.8)p≤0.001, 2.3(1.1-4.5) p=0.02 and4.2(1.8-10.1)p≤0.001 respectively}.

Table (3): Binary logistic regression of independent predictors of dermatological disorders among the studied group.

Predictors	β	p	Adjusted OR (95% CI)
Duration of work/ hours:			
≤8(r)	---	p≤0.001*	1
>8	2.2		9.1(3.4-24.3)
Apron			
Yes	1.8	p≤0.001*	5.9(2.5-13.6)
NO (r)	---		1
Alcohol/antiseptic rubbing			
≤10times (r)	---	p≤0.001*	1
>10 times	3.0		19.3(3.9-93.9)
Constant= 1.8 Model Chi-Square test= 67.7 , p≤0.001*			
Percent predicted=83.2%			

* : Statistically significant

(r): Reference group

Table 3 showed that the significant independent predictors of dermatological disorders among participants were working >8 hours /day (AOR:9.1,95% CI: 3.4-24.3), wearing apron (AOR:5.9,95% CI: 2.5-13.6) and Alcohol/antiseptic rubbing >10 times (AOR:19.3,95% CI: 3.9-93.9).

Table (4) : Adverse skin lesions due to the use of hand sanitizers and PPE.

Type of dermatoses	HCWs with dermatological disorders (No. =58) No. (%)
Hand Xerosis	20(34.5)
Hand eczema	18(31.0)
Fingers Onychomycosis	11(19.0)
Acne vulgaris(face)	5(8.6)
Hand Contact dermatitis	2(3.4)
Tinea manum	2(3.4)

Table 4 showed that hand xerosis was the most prevalent dermatological disorder (34.5%) followed by hand eczema (31.0%) while the least prevalent disorders were hand contact dermatitis and tinea manum (3.4% each).

**Figure 1: Onychomycosis of finger nail****Figure 2: Hand eczema****Figure 4: Exacerbation of acne at site of facial mask****Figure 3: Hand xerosis**

Discussion

Making the workplace safe, HCWs should use PPE for a certain period of time when the exposure to hazard is difficult to be avoided or controlled. Also, they should use disinfectants to follow infection prevention and control (IPC) guidelines (WHO, 2021). Dermatological lesions caused or aggravated by PPE or the use of disinfectants become a prominent complaint among HCWs especially during the COVID-19 pandemic requiring continuous disinfectants use and wearing PPE for extended periods of time due to heavy prolonged workload (Goyal et al., 2020).

About 23% of the studied HCWs had dermatological disorders (Table 1) that could be related to the frequent use of PPE and/or disinfectants concomitant with the COVID-19 pandemic at the time of the study.

A lower prevalence (3.6%) was reported among HCWs in Portugal by França et al., (2019). However, a higher prevalence was reported among HCWs in Indonesia by Christopher et al., (2020) and in China by Jiang et al., (2020) (66.5% and 42.8%; respectively). Furthermore, Lan et al., (2020) in China recorded a much higher prevalence

(97.0%) of skin lesions among HCWs related to enhanced personal protection against Covid -19 infection through using PPE and hand disinfectants.

The highest prevalence of work related skin diseases was detected among service workers and nursing staff (27.0% and 25.7%; respectively) while the least prevalence was among doctors (15.6%) (Table 1). This variation in prevalence can be attributed to that service workers and nursing staff are more exposed to wet work environment, irritants and sensitizing agents compared to other occupational groups. This finding was in accordance with Higgins et al., (2016) in Australia and França et al., (2019) in Portugal who found that nursing staff showed the highest prevalence of dermatoses related to occupational exposure to PPE and hand sanitizers. Also, Smith et al., (2005) in China reported that doctors as a profession showed lower prevalence of skin diseases of occupational origin than other HCWs. However, Christopher et al., (2020) in Indonesia found that doctors had the highest prevalence of work related skin diseases (82.7%) among their studied HCWs.

The present study showed that most of the HCWs with skin disorders

(84.6%), practiced Alcohol/antiseptic rubbing >10 times during work time and about half of them reported wearing PPE {aprons (52.5%) and goggles (44.4%)}, (Table 2). These findings can be explained by the fear and anxiety which would be present among HCWs especially during COVID-19 pandemic thus leading to unnecessary overuse of some items as Alcohol/antiseptic rubbing. On the other hand the shortage in PPE supplies or feeling uncomfortable while working wearing PPE caused the reduced compliance to PPE use. Keng et al., (2021), agreed with these finding and reported in their systematic review that hand hygiene practices were the most widely implicated rather than PPE use among HCWs. Also El-Sokkary et al., (2021), in Egypt detected in their study that high percentage of HCWs were not compliant to PPE use.

The risk of work related skin diseases was higher among those working >8 hours daily, wearing apron and using Alcohol/antiseptic rubbing >10 times during work time (AOR: 9.1, 5.9 & 19.3; respectively) (Table 3). This can be explained that prolonged working hours with frequent hand washing and disinfectants use can induce skin peeling, bleeding and cracking that contribute to changes

in the skin microclimate and reduced skin tolerance enhancing adverse skin reactions (Lin et al., 2020). Aprons can cause excess moisture accumulation in the skin through enhancing and exacerbating factors for sweat-induced dermatitis (profuse sweating, occlusive synthetic non-absorbent clothing and friction) which is helped by ambient high temperature and humidity leading to epidermal barrier disruption, inflammation and infections (Gopinath et al., 2019). Also their accompanying straps can cause contact or delayed pressure urticaria (Yan et al., 2020).

Similarly, Telksniene and Januskevicius, (2003) and Christopher et al., (2020) reported that working > 7 hours/day and 9 hours/day, respectively, raised the risk of skin diseases especially during the current COVID-19 pandemic necessitating high intensity work with wearing airtight PPE for long periods.

Smith et al., (2005) and França et al., (2019) reported that regular surgical hand rubbing and use of alcohol hand disinfectants increased the risk of work related hand dermatitis. On the contrary, Hamnerius et al., (2018) from Sweden found that there was no association between using alcoholic disinfectants and occupational hand dermatoses and

even Higgins et al., (2016) encouraged the use of alcoholic disinfectants among HCWs in Australia.

The hands were the commonest site of skin diseases among the studied population: xerosis (34.5%) and eczema (31.0%) followed by onychomycosis (19.0%) (Table 4).

These findings were in agreement with (Suneja and Belsito, 2008) in the USA who found that occupational dermatoses among HCWs affected the hands most frequently because of the routine use of PPE, detergents, disinfectants and hand washing causing disruption of the skin barrier.

Conclusion : The current study showed that the prevalence of adverse skin reactions related to PPE and disinfectants use, during the current COVID-19 pandemic, was 23.2% among the studied HCWs in Mansoura University Hospital. Working >8 hours /day, wearing apron and Alcohol/antiseptic rubbing >10 times were independent significant predictors of work related dermatoses.

Recommendations: Health education sessions should be regularly offered to HCWs about proper donning and doffing of protective equipments, as well as encouraging protective

measures that may help to preserve the workforce vital for caring for patients as:

- Hospital uniforms and non-woven fabric in disposable gowns and masks should not contain formaldehyde textile resins (FTR), to avoid contact dermatitis.
- Frequent breaks in cool well ventilated places for HCWs.
- HCWs should wear moisture-wicking and thin garments beneath the gowns.
- For male HCWs the scalp hair should be kept short and regular facial shaving is advised for the integrity of masks.
- To protect the skin barrier, HCWs should use adhesive barrier films / or paraffin-based emollients before donning protective gear. Use gentle soap-free cleansers, and regular frequent application of moisturizers especially before and after shifts and at home.
- Adequate counseling and treatment for HCWs with skin lesions through occupational skin health clinics.
- Regular dermatological examination is advisable for HCWs for early detection of any skin disease.

Further multicenter studies are recommended to express the magnitude of the problem on a larger scale.

Funding

All authors didn't receive any fund or research grants.

Conflict of interest

None.

Acknowledgement

The authors would like to acknowledge Mansoura University Hospital administration for their help and support. Also we thank the HCWs for their participation in the study.

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