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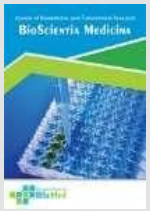

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Adverse Skin Reaction to Hand Hygiene and Personal Protective Equipment among Health-Care Workers during COVID-19 Pandemic in Dr. Mohammad Hoesin General Hospital Palembang

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A B S T R A C T

Background: Indonesian health-care workers (HCWs) are at the front liners battling against the Coronavirus-2019 disease (COVID-19) pandemic since March 2020 and must protect themselves by hand hygiene and using personal protective equipment (PPE). Hand hygiene and the use of PPE are associated with an adverse skin reactions. This study aimed to find out the prevalence, characteristics, and risk factors for adverse skin reactions to hand hygiene and PPE among HCWs in Indonesia during the COVID-19 pandemic. **Methods:** A cross-sectional online questionnaire-based survey among HCWs in Dr. Mohammad Hoesin General Hospital Palembang on April 1-30, 2022. The data were collected, including demographic characteristics, occupational-related characteristics, and adverse skin reactions. **Results:** The study included 134 respondents, the majority of the respondents were female (57,5%), with a mean age was 31,18 ± 4,89 years old. Adverse skin reactions were reported only on 16,4% of respondents. Hands (40,9%) were the most common site affected. The highest symptom and lesion were itch (54,5%), erythema (59,1%) and scales (59,1%). There was a significant association between adverse skin reactions to hand hygiene (p <0,001) and PPE (p = 0,001) before and during the pandemic. However, adverse skin reactions were not associated with increased frequency of hand hygiene and duration of PPE worn. History of pre-existing inflammatory skin condition is the risk factor for adverse skin reactions to hand hygiene and PPE. **Conclusion**: Adverse skin reactions to hand hygiene and PPE are increasing among Indonesian HCWs during the COVID-19 pandemic.

1. Introduction

The World Health Organization (WHO), on March 11, 2020, declared the novel coronavirus (COVID-19) outbreak a global pandemic caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2).[1] SARS-CoV-2 can be transmitted by droplets and contact.[2] In addition, SARS-CoV-2 remained viable and infectious in aerosols for 3 hours and on surfaces for up to 3 days, explaining the rapid spread of the disease.[3] As of February 28, 2022, more than 435 million COVID-19 cases have been confirmed, with up to 5,95 million death worldwide. Meanwhile, Indonesia reported a total case of COVID-19, approximately 6,1 million cases, with 156 thousand death nationwide.[4]

Frontline health-care workers (HCWs) fighting against COVID-19 infection with highly contagious and increased risk of infection due to occupational

exposure.[5,6] To fight against the pandemic and avoid virus transmission, HCWs must wear adequate personal protective equipment (PPE), including medical or N95 masks, goggles or face shields, coverall gowns, and gloves and perform frequent handwashing to prevent nosocomial infection as recommended by WHO.[7,8] However, performing hand hygiene frequently and prolonged application of PPE increased pressure, shear, friction, and moisture at the skin interface, leading to stratum corneum breakdown. Stratum corneum breakdown reduced the overall tolerance to mechanical loading and caused adverse skin reactions in 70-97% of HCWs.[9–11]

Several studies have reported adverse skin reactions to hand hygiene and PPE, including erythema, papules, urticaria, dry skin, scales, maceration, and itching. The most commonly affected site was the nose, hand, and cheeks.[9,12,13] History of pre-existing inflammatory skin conditions such as atopic dermatitis (AD) is associated with high rates of adverse skin reactions in HCWs to hand hygiene and PPE. In addition, frequency and composition of hand hygiene, as well as duration, type, and material of PPE, increased adverse skin reactions.[9,14,15]

Health-care workers' awareness may prevent and minimize adverse skin reactions, especially during the COVID-19 pandemic. In literature, there are few studies about adverse skin reactions caused by hand hygiene and PPE in Indonesia. This study aimed to determine the prevalence, characteristics, and possible risk factors for adverse skin reactions caused by hand hygiene and PPE among HCWs during the COVID-19 pandemic in Palembang, South Sumatra.

2. Methods

The study was a cross-sectional online questionnaire-based survey of HCWs in Dr. Mohammad Hoesin General Hospital Palembang conducted between April 1 and April 30, 2022. The study used a purposive sampling method to select qualified study participants. This study included the following criteria: HCWs in Dr. Mohammad Hoesin General Hospital Palembang; those who often performed hand hygiene and used PPE for the last 2 months. And those who were willing to take part in the study. Exclusion criteria were unable to communicate and refused to participate in the study. Electronic informed consent was obtained from all participants.

Data were obtained using a validated online survey questionnaire according to the relevant guides and literature and were further reviewed by consulting a board-certified dermatovenereologist. The questionnaire is composed of demographic characteristics (age, gender, and occupation), occupational-related characteristics (number of patients each day, main working department, duration of PPE worn since the pandemic, and working hours weekly), hand hygiene (washing hands with soap and alcohol-based hand rub before and during the pandemic, and frequency), PPE (duration wearing time of PPE before and during a pandemic), and adverse skin reaction (history of pre-existing inflammatory skin condition, anatomical site, symptoms, and skin lesion). Adverse skin reactions' choices had a definition, synonym, and picture to ensure a comprehensive understanding. The questionnaire provided multiple-choice responses as well as space for comments on the questions.

Data collected from the questionnaire were cleaned, edited, and coded. Statistical analyses were performed using Statistical Package for Social Sciences Statistics Version 22.0 (IBM Corp., Released 2015, Armonk, NY, USA). The association between demographic characteristics and history of pre-existing inflammatory skin conditions on adverse skin reactions to hand hygiene and PPE was assessed using the Chi-square test, Fisher test, and Mann-Whitney test. A *P*-value of <.05 was considered significant. The present study was approved by the Medical and Health Research Ethics Committee, Dr. Mohammad Hoesin General Hospital Palembang (No.53/kepkrsmh/2022).

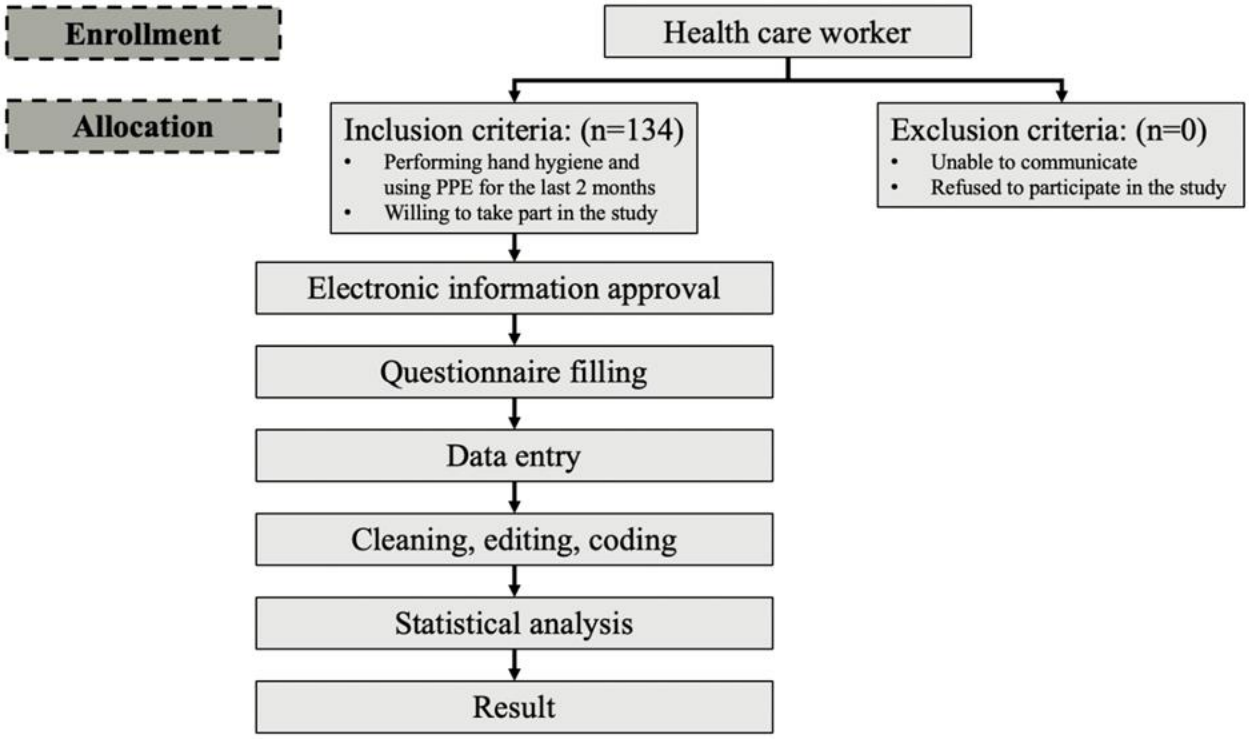

Figure 1. Operational framework

3. Results

Demographic characteristics

A total of 134 HCWs were included in this study. Among them, there were 77 females (57,5%) and 57 males (42,5%), with a mean age ± SD of 31,18 ± 4,89 years old. The majority of the respondents were medical doctors (general practitioners, medical specialists, and resident doctors) (80,6%) (Table 1).

Occupational-related characteristics

The majority of the respondents treated 6-10 patients each day (35,1%). A total of 69 respondents (51,5%) work in the non-COVID-19 department. Mean ± SD duration of PPE worn regularly since the pandemic, and working hours weekly of 12,73 ± 5,47 months, and 47,78 ± 25,34 hours/week, respectively (Table 1).

Hand hygiene and PPE

Hand hygiene was divided into washing hands with soap and alcohol-based hand rub. The frequency of hand washing with soap was found to increase before the pandemic from 0-5 times/day (61,9%) to 6-10 times/day (35,1%) during a pandemic, also found in hand hygiene with alcohol-based hand rub. Daily wearing time of PPE also increased from less than 1 hour (34,4%) before the pandemic to 4-6 hours/day (29,9%) during the pandemic (Table 2).

Adverse skin reaction characteristics

The history of pre-existing inflammatory skin conditions in this study was atopic dermatitis (50%), irritant contact dermatitis (11,2%), and allergic contact dermatitis (8,2%). During the study period, Adverse skin reactions were reported only on 16,4% of respondents. The most commonly affected side was handed (40,9%), with itch (54,5%), erythema (59,1%), and scale (59,1%) were symptoms and lesions of adverse skin reactions. The most reported symptoms and lesions of adverse skin reactions are due to hand hygiene and PPE (Table 3).

Table 1. Demographics and occupational-related characteristics.

Characteristics	Total (%)
Gender	
Male	57 (42,5)
Female	77 (57,5)
Age (years)	
Mean ± SD	31,18 ± 4,89
Occupation	
Medical doctor	108 (80,8)
Clinical clerkship	3 (2,2)
Nurse	22 (16,4)
Laboratory staff	1 (0,7)
Number of patients each day	
1-5	40 (29,9)
6-10	47 (35,1)
11-15	14 (10,4)
16-20	11 (8,2)
> 20	22 (16,4)
Main working department	
Non-COVID-19 department	69 (51,5)
COVID-19 department	65 (48,5)
Duration of PPE worn (month)	
Mean ± SD	11,78 ± 4,96
Working hours each week (hours)	
Mean ± SD	47,78 ± 25,34

Table 2. Hand hygiene and PPE before and during the pandemic.

Category	Time	Frequency	Total (%)
Hand hygiene with soap	Before pandemic	0-5 times/day	83 (61,9)
		6-10 times/day	47 (35,1)
		11-20 times/day	3 (2,2)
		> 20 times/day	1 (0,7)
	During pandemic	0-5 times/day	43 (32,1)
		6-10 times/day	47 (35,1)
		11-20 times/day	31 (23,1)
		> 20 times/day	13 (9,7)
Hand hygiene with alcohol-based hand rub	Before pandemic	0-5 times/day	99 (73,9)
		6-10 times/day	30 (22,4)
		11-20 times/day	4 (3)
		> 20 times/day	1 (0,7)
	During pandemic	0-5 times/day	37 (27,6)
		6-10 times/day	53 (39,6)
		11-20 times/day	40 (29,9)
		> 20 times/day	4 (3)
PPE	Before pandemic	< 1 hours	46 (34,3)
		1-2 hours	42 (31,3)
		2-4 hours	29 (21,6)
		4-6 hours	14 (10,4)
		> 6 hours	3 (2,2)
	During pandemic	< 1 hours	29 (21,6)
		1-2 hours	21 (15,7)
		2-4 hours	23 (17,2)
		4-6 hours	40 (29,9)
		> 6 hours	21 (15,7)

Table 3. Adverse skin reaction characteristics.

Characteristics	Total (%)
History of atopic dermatitis	
Yes	67 (50)
No	67 (50)
History of irritant contact dermatitis	
Yes	15 (11,2)
No	119 (89,8)
History of allergic contact dermatitis	
Yes	11 (8,2)
No	123 (91,8)
Adverse skin reaction	22 (16,4)
Location	
Forehead	1 (4,5)
Nose	3 (13,6)
Ears	1 (4,5)
Cheek	2 (9,1)
Chin	3 (13,6)
Arms	1 (4,5)
Hands	9 (40,9)
Symptoms	
Itch	12 (54,5)
Burning sensation	6 (27,3)
Pain	6 (27,3)
Skin lesion	
Erythema	13 (59,1)
Vesicle	6 (27,3)
Papule	10 (45,4)
Wheal	7 (31,8)
Scale	13 (59,1)
Fissure	8 (36,3)
Crust	5 (22,7)

Adverse skin reaction due to hand hygiene and PPE

Adverse skin reactions due to hand hygiene and PPR before and during pandemics were asked by the respondent. Adverse skin reactions due to hand hygiene were found before the pandemic (6%) and increased during the pandemic (9,7%). Adverse skin reactions due to PPE were also shown before the pandemic (3%) and increased during the pandemic (6,7%). Statistical analysis found a significant association between adverse skin reactions due to hand hygiene ($p<0,001$) and PPE ($p=0,001$) before and during the pandemic (Table 4).

Table 4. Adverse skin reaction before and during pandemic due to hand hygiene and PPE.

Time	Category	Adverse skin reaction	Before pandemic		Total (%)	P-value
			Yes	No		
During pandemic	**Hand hygiene**	Yes	8	5	13 (9,7)	**<0,001***
		No	0	121	121 (90,3)	
	PPE	Yes	3	6	9 (6,7)	**0,001***
		No	1	124	125 (93,9)	

* Fisher test

Association between demographic, occupational-related, and adverse skin reaction characteristics

An analysis was conducted to determine the risk factors of adverse skin reaction due to hand hygiene and PPE during the COVID-19 pandemic. Analysis showed demographic and occupational-related characteristics, frequency of hand hygiene more than 10 times, and duration of PPE worn during pandemic were not significantly associated with the adverse skin reaction. History of pre-existing inflammatory skin condition, including atopic dermatitis, irritant contact dermatitis, and allergic contact dermatitis significantly

increased risk of adverse skin reaction due to hand hygiene (OR (95% CI) 14,40 (1,81-114,25); p=0,002, 10,67 (2,95-38,54); p=0,001, and 7,24 (1,78-29,45); p=0,012, respectively). However, only a history of allergic contact dermatitis was found significantly increased the risk of adverse skin reactions due to PPE wore (OR (95% CI) 7,31 (1,54-34,80); p=0,027) (Table 5).

Table 5. Association between demographic, occupational-related, and adverse skin reaction characteristics during a pandemic.

Characteristics	Adverse skin reaction due to hand hygiene during a pandemic				Adverse skin reaction due to PPE during a pandemic			
	Yes	No	P-value	OR (95% CI)	Yes	No	P-value	OR (95% CI)
Gender								
Male Female	3 10	54 67	0,135*	0,37 (0,10-1,42)	4 5	63 72	1,000**	0,91 (0,24-3,55)
Age (years)								
Mean ± SD	31,46 ± 5,21	31,15 ± 4,87	0,724***		29,67 ± 3,61	31,29 ± 4,96	0,660***	
Occupation								
Medical doctors Non-medical Doctors	8 5	100 21	0,131**	0,34 (0,10-1,13)	5 4	103 22	0,071**	0,27 (0,07-1,08)
Number of patients each day								
1-10 patients > 10 patients	9 4	78 43	0,496**	1,24 (0,36-4,27)	7 2	80 45	0,328**	1,97 (0,39-9,88)
Duration of PPE worn (month)								
Mean ± SD	9,77 ± 5,4	11,99 ± 4,88	0,149***		11,44 ± 3,85	11,8 ± 5,05	0,961***	
Working hours each week (hours)								
Mean ± SD	55,15 ± 27,53	46,98 ± 25,08	0,759**		45,89 ± 13,49	47,31 ± 26,01	0,814***	
History of atopic dermatitis								
Yes No	12 1	55 66	**0,002***	**14,40 (1,81-114,25)**	7 2	60 65	0,165**	3,79 (0,76-18,97)
History of irritant contact dermatitis								
Yes No	6 7	9 112	**0,001***	**10,67 (2,95-38,54)**	3 6	12 113	0,064*	4,71 (1,05-21,28)
History of allergic contact dermatitis								
Yes No	4 9	7 114	**0,012****	**7,24 (1,78-29,45)**	3 6	8 117	**0,027****	**7,31 (1,54-34,80)**

* Chi-square test
** Fisher test
*** Mann-Whitney test

4. Discussion

Frontline HCWs fighting against COVID-19 pandemic. When taking care of patients with COVID-19, HCWs must first protect themselves by performing adequate hand hygiene and using protective equipment due to the highly contagious spread of COVID-19.[6] Hand hygiene and PPE may cause adverse skin reactions. However, existing studies on adverse skin reactions due to hand hygiene and PPE by HCWs are limited.[13]

We used a questionnaire to conduct a quantitative study to determine the prevalence of adverse skin reactions caused by hand hygiene and PPE among HCWs. Ultimately, a total of 134 valid questionnaires were collected from respondents. Females dominated the study with 57,5%, with a mean age ± SD of 31,18 ± 4,89 years old. As seen in other literature, the majority of the respondents were female (68,8%), with a mean age ± SD of 32,2 ± 6,5 years old.[12] Most of the respondents work in non-COVID-19 departments (51,5%). However, remain to treat around 6-10 patients each day (35,1%), with mean ± SD working hours of 47,78 ± 25,34 hours/week.

World Health Organization recommends performing routine hand hygiene frequently with an alcohol-based hand rub if hands are not visibly

soiled/dirty or with soap and water if hands are dirty, and rational use of PPE for preventing transmission of COVID-19. In addition, WHO also recommends avoiding excessive use of PPE.[16,17] In this study, we found an increased frequency of hand hygiene with soap and alcohol-based hand rubs during the pandemic. The same pattern was found in the use of PPE. The majority of respondents increased using PPE from less than 1 hour (34,4%) before the pandemic to 4-6 hours/day (29,9%) during the pandemic.

The history of pre-existing inflammatory skin conditions in this study was atopic dermatitis (50%), irritant contact dermatitis (11,2%), and allergic contact dermatitis (8,2%). Lin et al. reported adverse skin reactions to hand hygiene and PPE in their study were 74,5%.[12] Similar to Hu et al. reported the prevalence of adverse skin reactions to PPE worn around 60.7% to 95.1%.[13] In contrast with the previous study, our study reported lower adverse skin reactions by 16,4% of respondents. Low adverse skin reaction was caused by the majority of respondents not treating COVID-19 patients directly. In addition, there are restrictions on working hours and education from dermatovenereologist at Dr. Mohammad Hoesin General Hospital Palembang regarding the prevention of irritant contact dermatitis due to hand hygiene during the COVID-19 pandemic has been published.[14]

The most common affected sites were hands (40,9%). A systematic review and meta-analysis study Montero-Vilchez et al. and another study by Lin et al. reported hands, cheeks, and nose were the top three most affected sites.[7,12] Hand hygiene products disrupt the skin barrier by causing denaturation of stratum corneum proteins, changes in intercellular lipids, decreased corneocyte cohesion and decreased stratum corneum water-binding capacity.[18] For hand care, we suggest using alcohol-based hand rub instead of soaps, as the former show high antimicrobial activity, and frequent applying moisturizers offer protection against adverse skin reaction.[7,12] Hadjieconomou et al. advised regular applications of fragrance-free moisturizers. To improve treatment acceptance and compliance, they offered a lighter emollient (cream or lotion) to be applied during the day and a lipid-rich emollient (ointment) at home.[19] Handwashing products with low irritation surfactants should also be advisable to decrease adverse skin reactions.[14,20]

Itching (54,5%) was the most common symptom. Erythema (59,1%) and scale (59,1%) was the most commonly reported lesion, followed by papule (45,4%). These clinical findings were in accordance with the findings of the previous studies.[7,12]

In this study, two main findings were found, (1) adverse skin reactions were associated with hand hygiene ($p < 0.001$) and PPE ($p = 0.001$) during a pandemic. However, (2) adverse skin reactions were not associated with an increased frequency of hand hygiene and duration of PPE worn during a pandemic. Respondents who performed hand hygiene more often (> 10 times/day) and had a longer duration of PPE worn do not have a greater risk of adverse skin reactions than subjects who performed hand hygiene less frequently or shorted duration of PPE worn. In contrast with a previous study, frequency of hand hygiene and duration of PPE worn increased the risk of adverse skin reaction.[7] Akbulut et al. reported duration of exposure to PPE of more than six hours per day was associated with a 1,93 fold higher risk of adverse skin reactions. The study also found washing hands more than 10 times a day increased 2,29 fold higher risk of adverse skin reactions.[21] Understand WHO recommendations regarding hand hygiene and rational use of PPE during the COVID-19 pandemic is important.[16,17]

Risk factors for adverse skin reactions during pandemics have been reported in many studies. Adverse skin reaction due to hand hygiene and PPE was higher in those who did not apply moisturizer.[22] Demographic characteristics are also related to adverse skin reactions, including sex,[8,21–24] age, and occupation.[8,21,23] However, in this study, no significant association was found between various demographic characteristics of respondents and the occurrence of adverse skin reactions.

A systematic review and meta-analysis study Montero-Vilchez et al. and another study by Lin et al.

reported a history of pre-existing inflammatory skin conditions to increase the risk of adverse skin reactions.[7,15] History of pre-existing inflammatory skin conditions, including atopic dermatitis (p=0,002), irritant contact dermatitis (p=0,001), and allergic contact dermatitis (p=0,012), significantly increased risk of adverse skin reaction due to hand hygiene. However, only a history of allergic contact dermatitis (p=0,027) was found significantly increase the risk of adverse skin reactions due to PPE worn. A respondent with a history of atopic dermatitis, irritant contact dermatitis, and allergic contact dermatitis in this study showed a higher risk of adverse skin reaction due to hand hygiene of 14,4, 10,67, and 7,24-folds, respectively. History of allergic contact dermatitis revealed a 7,31-fold higher risk of adverse skin reaction due to PPE worn. Similar to a previous study, Akbulut et al. reported history of underlying chronic dermatosis was associated with a 2,38-fold higher risk of adverse skin reaction.[21] Techastian et al. also reported having previous hand eczema showed a strong association with a 58-fold higher risk of adverse skin reaction during the COVID-19 pandemic.[24]

This present study has the following limitations: First, the present study was set in a warm climate in Palembang, South Sumatra. Climate issues, environmental temperature, and the humidity of the environment may affect the results of adverse skin reactions. Second, this study included response bias depending on the answers given by the HCWs themselves. Third, adverse skin reactions reported by respondents were not diagnosed by dermatovenereologist. Fourth, we did not study based on each PPE, also on varying levels of PPE. Future studies should explore this factor, and the authors believe that the results may differ.

5. Conclusion

The present study revealed the prevalence, characteristics, and risk factors for adverse skin reaction to hand hygiene and PPE among HCWs in Indonesia during the COVID-19 pandemic. The prevalence of adverse skin reactions in this study was 16,4%, while hand hygiene and PPE wore on HCWs increased during a pandemic. Adverse skin reactions were associated with hand hygiene and PPE worn. However, adverse skin reactions were not associated with increased frequency of hand hygiene and duration of PPE worn during a pandemic. The risk factor for adverse skin reaction to hand hygiene and PPE is a history of pre-existing inflammatory skin conditions. Awareness and education to minimize, prevent and treat adverse skin reactions are important for HCWs.

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