Skin lesions resulting from use of personal protective equipment in the context of COVID-19: a cross-sectional study

Objective: During the SARS-CoV-2 (COVID-19) pandemic, to prevent the transmission of the virus, the use of personal protection products and equipment were recommended by international and national organisations. The need to use it more frequently and for a long time can damage the skin of health professionals. The aim of this study was to estimate the prevalence and factors associated with skin lesions in health professionals resulting from the use of personal protective equipment (PPE).

Method: This was a cross-sectional exploratory study through an online questionnaire. The first part of the questionnaire collected socio-labour characterisation data and the second part related to exposure factors. The variables were analysed according to the prevalence and the odds ratio (OR), within a 95% confidence interval (CI).

Results: Of the 398 participants who met the inclusion criteria, 65.3% were self-diagnosed with skin lesions: 37.3% with pressure injury, 25.8% with contact/allergic dermatitis and 2.7% with acne. Regarding the use of PPE, of the 240 professionals who reported using an N95 mask, 80.4% developed injuries, 70.4% of which related to a work regime of >6 hours per day (OR: 2.08, 95% CI: 1.79–2.42).

Conclusion: The results of this study showed a significant prevalence of skin lesions in health professionals. Among exposure factors, the N95 mask and goggles stand out. Longer or more frequent exposure time to personal protective products and equipment proved to be important factors to be considered.

Declaration of interest: The authors have no conflicts of interest.

health personnel • injury • pandemic • personal protective equipment • PPE • skin • wound • wound care • wound dressing • wound healing

The transmission of SARS-CoV-2 (COVID-19) among humans has occurred worldwide and happens mainly through contact with respiratory droplets.[1–4] The incubation period lasts an average of 5–6 days, ranging from 0–14 days.[5]

In Brazil, the first confirmed case of COVID-19 was registered on 28 February 2020, with exponential progression throughout the country. The health system overload caused a significant impact, particularly on the absence of health professionals (due to illness with the disease), a worrying reality according to data from the Federal Nursing Council (Conselho Federal de Enfermagem-COFEN)[6] and other entities. For example, in Rio de Janeiro, in April 2020, >1200 public health professionals were absent from work.[7]

To prevent transmission, measures have been recommended in relation to the use of products and personal protective equipment (PPE) by national and international organisations.[8–11] Such measures aim to avoid the collapse of care systems, especially in high-complexity healthcare services. Among them, there are consensual recommendations for products for use directly on the skin, such as soaps and antiseptics, in addition to the rational use of surgical masks, aprons, gloves, glasses or facemasks, and during procedures that generate aerosols in patients with COVID-19, where use of the following is mandatory: N95/FFP2 mask, coat, gloves, eye protection and apron.[11]

Fulfilling these recommendations introduces challenges that need to be recognised and analysed in order to develop coping strategies, as they can compromise the physical and emotional health of professionals. Adverse events resulting from the use of individual and collective protection measures have demonstrated the importance of a better understanding of the aetiological and adjuvant factors, aiming at the creation of protocols and preventive measures.[12]

The greater vulnerability of the skin and mucous membranes to chemical, biological and physical agents, in the context of COVID-19, requires a new approach. In addition, health professionals do not always have the resources to follow the recommended quality and safety standards.[9,13] Thus, in this pandemic scenario, they used PPE for a long time, or reused it, resulting in damage to the main protective barrier to COVID-19 .[14]

Euzeli da Silva Brandao,[1] PhD, Associate Professor at 'Aurora de Afonso Costa' School of Nursing, Professor of the Permanent Staff of the Postgraduate Program of the Professional Master's Degree in Nursing Assistance, Specialist in Dermatology Nursing*; **Maria Helena Sant'Ana Mandelbaum**,[2] PhD, Professor and Coordinator of the Postgraduate Course in Nursing in Dermatology, Specialist in Dermatology Nursing; **Regina Serrão Lanzillotti**,[3] PhD, Volunteer Professor at the Institute of Mathematics and Statistics; **Paula Dadalti Granja**,[1] PhD, Adjunct Professor of Dermatology in the Internal Medicine Department; **Liliane Faria da Silva**,[1] PhD, Associate Professor at "Aurora de Afonso Costa" School of Nursing, Professor of the Permanent Staff of the Postgraduate Program of the Professional Master's Degree in Nursing Assistance; **Renato Tonole**,[4] Master in Nursing by the Professional Master's Degree in Assistance Nursing

***Corresponding author email:** euzelibrandao@gmail.com

1 Fluminense University/UFF, Niterói, Rio de Janeiro, Brazil. **2** University of Vale do Paraíba - UNIVAP, São Paulo, Brazil. **3** Rio de Janeiro State University/UERJ, Rio de Janeiro, Brazil. **4** National Cancer Institute, São Paulo, Brazil.

The damage related to PPE has many clinical presentations, such as: skin tears; device-related pressure ulcers (DRPUs); friction injury; irritant contact dermatitis (ICD); and moisture-associated skin damage (MASD).[15] Gefen et al. discussed the physiopathology of PPE damage, and emphasised that the main causes are pressure, friction/shear, and the resulting sustained cell and tissue deformations. These authors valorised the effects of moisture and temperature as exacerbating factors.[15] They also mentioned the psychological and emotional impacts of these lesions, that may lead to a significant impairment in the health and wellbeing of the health professional.[15]

With the alarming initial number of COVID-19 cases, mainly in China and European countries, the development of skin injuries, resulting from the use of PPE, in health professionals was observed.[14,16]

It is important to emphasise that the development of an injury on the skin of health professionals increases their vulnerability to contagion, illness and absence from work, especially at a time when their performance has enormous importance. As this is an emerging topic, it is noteworthy that there is a lack of research with a significant level of evidence, only recommendations made by associations of experts.[17–20]

Disease prevention among health workers should be prioritised.[21] In this sense, it is important to investigate the prevalence of skin injuries in health professionals, in addition to understanding the factors associated with their development, in order to find strategies to prevent them. Thus, the following objective was defined: to estimate the prevalence of skin injuries and associated factors in health professionals due to the use of PPE in the context of COVID-19.

Method

This was an exploratory, analytical cross-sectional study. Health professionals working in the care of patients with COVID-19 in Rio de Janeiro during the pandemic participated in the research.

The minimum estimated number of participants was obtained by adopting a simple random sampling model to estimate the prevalence proportion of 50% for a dichotomous response, with 95% reliability, and a sampling error of 10%, which determined that there should be at least 384 participants.

Data were collected between 16 May 2020 and 1 July 2020. Health professionals from the state of Rio de Janeiro involved in caring for people with COVID-19 during the pandemic were selected. The selection of participants was made by convenience sampling, excluding professionals away from work during the research period, until the number of participants in the minimum calculated sample was reached.

The professionals were invited through social media. Upon accepting the invitation, they received more information about the research, in addition to accessing the Free and Informed Consent Form (FICF) and the questionnaire. From the 458 people who accessed the link, 400 met the criteria and agreed to participate, accessing Google forms; however, two were away from work, leaving 398 participants. The first part of the questionnaire contained data on demographic and labour characterisations. To define the exposure factors, the following data were collected: type of PPE used; average time in hours of use during the work shift; availability at the institution for exchange when necessary; number of hand hygiene measures per work shift; number of PPE exchanges per work shift; development of skin/body region injury; type of injury; injury characteristic; use of product for prevention. The selection of the variables used was based on the relevance found in the literature regarding the occurrence of skin injuries caused by the use of products and PPE during the COVID-19 pandemic.[22]

The contingency tables for the association of variables were obtained using the Statistical Package Software for Social Science (SPSS), version 24 (IBM Corp., US). These allowed calculation of prevalence, prevalence ratios and respective 95% confidence intervals (CI) of the odds ratio (OR).

Ethical approval

The study was approved by the Research Ethics Committee of the Faculty of Medicine of Fluminense Federal University/UFF (CAAE: 31263020.2.0000.5243). All participants signed the FICF.

Results

A total of 398 participants took part in the study. Age ranges were 22–64 years for female participants (average 41.4 years) and 22–68 years for male participants (average 40.6 years).

With regard to the workload (hours per week), and within the 95%CI, male and female participants averaged 30.89–37.69 hours per week and 35.06–37.55 hours per week, respectively, with extreme values between 96–100 hours per week that may indicate professional exhaustion or inaccuracy in the answer.

Regarding the professions, nurses, physicians and nursing technicians accounted for 54.0%, 18.6% and 17.8% of participants, respectively. The remaining 9.6% were pharmacists, nutritionists, dentists, social workers, perfusionists and oral health assistants.

Regarding institutions, there was a higher prevalence of professionals working in the federal (40.7%), municipal (21.6%), state (17.3%) and private (17.1%) sectors. The remaining 3.3% were self-employed, worked in a philanthropic institution or were working in more than one institution.

With regard to the regime and sector of work, the following prevalences stand out: from the 257 health professionals on duty at the time of responding to the questionnaire, there were: 31.9% working in intensive care units (ICUs); 28.0% in wards; 18.7% in emergency departments (EDs); 5.8% in surgical centres; 3.5% in emergency care units; 2.3% in outpatient clinics; 1.9% in imaging sectors; 1.6% in basic health units (BHUs);

and 1.2% in maternity hospitals, with 5.1% in other sectors. Among the 141 day workers: 25.6% were employed in wards; 24.9% in outpatient clinics; 11.3% in BHUs; 8.5% in ICUs; 4.3% in operating rooms; 3.5% in EDs; 2.8% in wound dressing and infection control committees; 2.1% in offices; 2.1% in home care; and 14.9% in other peripheral sectors in the healthcare services, but who were also exposed to COVID-19.

The prevalence of self-reported skin injuries was 65.3%. The associations correspond to the exposure variables, availability of PPE, work regime and training in PPE use (Table 1).

From the 260 participants who self-reported development of skin injuries, the highest prevalence rates were: 37.3% pressure injury (PI), 25.8% contact/allergic dermatitis (CD/ACD) and 16.5% PI and CD/ACD. Although acne had a low prevalence in isolation (2.7%), it was declared concomitantly with other lesions: with CD/ACD (5.38%); with PI (3.85%); and with PI and CD/ACD (6.54%); presenting an overall prevalence of 18.47% (Table 2).

Among the prevalences corresponding to the affected body regions, 36.6% were on the face, 10.3% hands, 6.5% ear auricle and 0.4% feet. Concomitantly, 19.6% face and ear auricle; 11.5% face and hands; 8.5% face, ear auricle and hands; 2.3% ear auricle and hands; 0.4% hands and feet; 0.4% face, ear auricle and head; 0.4% face, ear auricle, hands and feet; and 3.1% did not report the affected body area.

Regarding the region of the body and the type of injury presented, the highest prevalence rates corresponded to PI on the face (19.2%); face and ear auricle (10.8%); and ear auricle (4.2%). In relation to CD/ACD, the most affected areas were the face and hands (6.2% and 10%, respectively).

Among the signs presented, erythema had a prevalence of 35.0% alone, and a prevalence of 73.0% when associated with one or more other signs (Table 3).

Regarding symptoms, there was a greater prevalence of pain, stinging and burning (37.3%), followed by 13.5% for pruritus and 12.7% for stinging alone. The prevalence for the association of symptoms (pruritus, stinging/burning) was also 12.7%.

Regarding the use of PPE, it was observed (Table 4) that of the 240 professionals who reported using an N95/FFP2 mask, 193 developed facial injuries, 24 of whom worked for up to six hours per day and 169 for >6 hours per day (OR: 2.08, 95%CI 1.79–2.42). A similar value (OR: 2.03, 95%CI 1.69–2.44) was found for the protective goggles, but in this case, 146 participants developed injuries, 16 of whom were working up to six hours per day and 130 were working >6 hours per day.

Concerning hand hygiene, we found no significant probability of injuries when using soaps and antiseptics up to 10 times per work shift.

Among the 398 participants, the use of different PPE stands out, including: 46.7% using surgical masks; 60.3% using N95/FFP2 masks; 45.5% using protective goggles; 51.2% using face shields; and 51.2% using gloves.

Regarding the use of products for prevention, it was observed that of the 138 participants who had no injuries, only 35 (25.4%) indicated the product used. Among these, the following prevalence rates were observed: 54.3% moisturising cream (MC); 11.5% barrier spray cream (BSC); 8.6% extra fine hydrocolloid (EFH); 5.7% MC and BSC; 2.8% MC and essential fatty acids (EFA); 2.8% MC, silicone plate (SP); 2.8% MC, SP and foam; 2.8% SP; 2.8% SP and EFH; 2.8% BSC and EFH; 2.8% BSC and SP.

From the 260 participants who developed an injury, 139 used prevention products: 71 (51.0%) MC; 11 (7.9%) EFH; 8 (5.8%) BSC; 8 (5.8%) SP; 8 (5.8%) MC and

Table 1. Skin injury prevalence ratio according to demographic, labour characteristics and use of product for prevention

	Skin Injury			Prevalence ratio
	Yes	No	Total	
Health professional, n				1.00
Yes	187	99	286	
Other	73	39	112	
Total	260	138	398	
Sex, n				0.98
Female	215	115	330	
Male	45	23	68	
Total	260	138	398	
Age (years), n				0.88
>40	120	76	196	
≤40	140	62	202	
Total	260	138	398	
Work regime, n				
On duty	178	79	257	1.19
Day workers	82	59	141	
Total	260	138	398	
Institution, n				0.99
Public	210	112	322	
Private	50	26	76	
Total	260	138	398	
Training PPE use, n				1.04
No	88	43	131	
Yes	172	95	267	
Total	260	138	398	
PPE availability, n				
No	70	23	93	1.21
Yes	190	115	305	
Total	260	138	398	
Prevention product, n				0.68
No	121	103	224	
Yes	139	35	174	
Total	260	138	398	

PPE—personal protective equipment

Table 2. Prevalence of skin injuries

Type of injury	Participants	%
Acne	7	2.70
Contact/allergic dermatitis	67	25.77
Contact/allergic dermatitis, acne	14	5.38
Pressure injury	97	37.31
Pressure injury, acne	10	3.85
Pressure injury, contact/allergic dermatitis	43	16.54
Pressure injury, contact/allergic dermatitis, acne	17	6.54
Pressure injury, urticaria	1	0.38
Not reported	4	1.53
Total	260	100.00

Table 3. Prevalence of signs

Signs	Participants	%
Erythema	91	35.0
Desquamation	9	3.5
Fissure	5	1.9
Erosion	3	1.2
Vesicle	3	1.2
Red plaques	1	0.4
Erythema/desquamation	21	8.1
Erythema/red plaques	17	6.5
Erythema/erosion	7	2.7
Desquamation/fissures	6	2.3
Erythema/fissures	5	1.9
Erythema/vesicles	4	1.5
Desquamation/erosion	3	1.2
Erythema/desquamation/red plaques	14	5.4
Erythema/desquamation/fissures	12	4.6
Erythema/desquamation/erosion	10	3.8
Desquamation/erosion/fissures	6	2.3
Erythema/erosion/red plaques	5	1.9
Did not report the type of sign presented	5	1.9
Other combinations	33	12.7
Total	260	100.0

EFA; 7 (5.0%) MC and EFH; 5 (3.6%) MC and SP; 3 (2.2%) MC and BSC; 2 (1.5%) transparent film; 2 (1.5%) MC and transparent film; 2 (1.5%) EFH and polyurethane foam; and the remaining 12 (8.4%) included three or more product associations.

Discussion

The results of this study showed a strong association between the use of products and PPE and the development of skin injuries in health professionals in the scenario of the COVID-19 pandemic. Among the self-reported injuries, PI, CD/ACD and acne stand out.

The PIs result from the prolonged use of PPE,[19] especially in areas of bony prominence or cartilage, such as the nasal bridge and ear auricle. In this sense, the prevalence of injuries on the face stands out: 82.2% related to the use of face shields, 79.8% protective goggles, 79.3% N95/FFP2 masks and 73.7% surgical masks for >6 hours during the work shift.

During a multicentre study conducted in China with 4308 health professionals, the rate of skin injuries associated with the use of PPE was 42.8% (30% PI, 10.8% moisture-associated injuries and 2.0% lacerations). Among the affected regions, the face stands out, with 30.1% in the nasal bridge, 28.3% in the malar regions and 14.8% in the forehead, in addition to 25.3% in the ear auricle.[22]

A study conducted in Italy investigated only the development of PI among 266 nurses working in ICUs. Of these, 205 (77.1%) developed at least one PI, the most prevalent in the nose (n=179, 87.3%) and in the ear auricle (n=78, 38.0%). Regarding the PPE used, among the 261 respondents, in addition to the N95 masks, 44 (16.9%) wore goggles, 85 (32.6%) used face shields, 130 (49.8%) used both pieces of equipment, and two (0.77%) used electric air purifiers. With regards to prevention, of the 263 respondents, 141 (53.6%) used EFH, 33 (12.5%) foam dressings, 24 (9.1%) MC and four (1.5%) used transparent dressings.[23]

Although some publications focus only on PIs and strategies to prevent them,[17,20,23,24] attention should also be paid to other skin injuries. In Italy, there was an increase in consultations during the COVID-19 pandemic with health professionals with CD. Among the most affected regions were the face and hands, with complaints of dryness, pruritus and burning,[25] a fact also observed in the present study.

Acute and chronic dermatitis are related to individual factors, such as xerosis and hypersensitivity to certain substances, but also exogenous factors such as the nature of the product in contact with the skin. CDs are divided into primary ICD and ACD. ICD is the most common occupational skin disease, resulting from direct cytotoxicity due to contact with chemical or physical irritants. Severity depends on the irritant and the exposure time. It is characterised by erythema, desquamation, oedema and vesicles, the most common symptoms being burning and itching, mainly affecting the hands of health professionals. However, in the context of the pandemic, there were several reports of involvement of the malar regions and nasal bridge, related to the use of masks. On the other hand, ACD is a type IV sensitivity reaction in response to environmental antigens. Several allergens associated with masks were identified, for example, rubber antioxidants, such as paraphenylenediamine, and metals used in the rims for nasal adaptation, such as nickel and cobalt. Although such metals should not be placed directly on the skin, the prolonged and repeated use of PPE, combined with sweating, facilitate their release and transfer, increasing their chance of becoming allergens.[26] Otherwise, these PPE injuries can enhance the risk of infectious agents, such as bacteria, fungi and viruses, including

Table 4. OR estimates and 95%CIs of the health professionals in relation to the development of a skin injury by work regime/occurrence of hand hygiene and use of products and PPE

Personal protective equipment	Health professionals, n	Work regime/occurrence of hand hygiene	Health professionals, n (%)	Skin injuries, n (%)	OR estimate (95%CI)	
Protective goggles	181	≤6 hours/day	18 (9.9)	Face 16 (88.9)	2.03	1.69–2.44
		>6 hours/day	163 (90.1)	Face 130 (79.8)		
Surgical mask	186	≤6 hours/day	38 (20.4)	Face 31 (81.6)	1.58	1.35–1.86
		>6 hours/day	148 (79.6)	Face 109 (73.7)		
N95/FFP2 mask	240	≤6 hours/day	27 (11.2)	Face 24 (88.9)	2.08	1.79–2.42
		>6 hours/day	213 (88.8)	Face 169 (79.3)		
Face shield	204	≤6 hours/day	19 (9.3)	Face 16 (84.2)	1.16	0.98–1.36
		>6 hours/day	185 (90.7)	Face 152 (82.2)		
Gloves	204	≤6 hours/day	19 (9.3)	Hands 6 (31.6)	1.01	0.87–1.18
		>6 hours/day	185 (90.7)	Hands 58 (31.3)		
Hand hygiene	260	>10 times	234 (90.0)	Hands 78 (33.3)	1.02	0.68–1.53
		≤10 times	26 (10.0)	Hands 9 (34.6)		

CI—confidence interval; OR—odds ratio; PPE—personal protective equipment

coronavirus, that could penetrate through the skin and reach the bloodstream.[27]

In the present study, CD/ACD presented prevalences of 6.2% and 10.0% in the face and hands, respectively. Among those who washed their hands >10 times during the work shift, hand injuries presented a prevalence of 33.3%, and among participants who wore gloves for ≥6 hours, hand injuries presented a prevalence of 31.3%. Among the symptoms were pain, stinging and burning (37.3%), and pruritus (13.5%). Among the clinical signs were erythema (35.0%) and desquamation (3.5%).

With regard to acne, the prevalence of 18.5% is noteworthy, due to occlusion and increased temperature caused by masks,[28] in addition to the use of comedogenic agents such as oily moisturisers, coatings or protective sprays that trigger papular or pustular injuries.[29]

Our data are consistent with those of a study conducted in China.[14] In this case, 526 (97%) of the participants had skin changes due to the use of PPE, especially on the face, with emphasis on the nasal bridge 83.1%, malar regions 74.5% and forehead 57.2%. The hands were affected in 76.8% of the professionals who cleaned their hands more than 10 times and used two pairs of gloves during the six-hour shift. Among the symptoms were dryness (70.3%) and among the signs desquamation (62.2%).[14] Despite some similarities with the present study on the prevalence observed in the use of gloves and hand hygiene, the authors did not indicate the type of injuries, which were limited to signs and symptoms.

Limitations

A limitation of the study is the lack of confirmation of a formal medical diagnosis regarding the injuries, which were self-diagnosed by the participants; this can cause bias. Another limitation was that the studied population consisted of a convenience sample, which may not be representative of the population being studied. The study did not consider a possible relation between skin injuries and the type of hygiene products and PPE used in protective personal protocols by health institutions. On the other hand, it was not possible to standardise the products and PPE used, since the participants were from different health institutions in the state of Rio de Janeiro.

Conclusion

A strong association was observed between the use of products and PPE and the development of occupational skin injuries. The prevalence of these injuries was significantly higher in health professionals who worked >6 hours per day. The results suggest the need for further study and development of protocols that reduce skin problems in health professionals using PPE. JWC

Reflective questions

- Considering the results of this study, what you think about the role and responsibilities of administrators with regard to prevention of skin injuries in health professionals?
- Are occupational health programmes and protocols adequate to prevent skin injuries by personal protective equipment (PPE) use in health professionals in your country? And if not, how do you think the situation could be changed?
- Based on this study, what would you recommend to be added to health institution protocols to avoid skin injuries as a result of PPE use?

Acknowledgements
This research project was funded by: Ministry of Science, Technology, Innovation and Communications (MCTIC), Brazil; Ministry of Health (MS); National Council for Scientific and Technological Development (CNPq), Brazil.

References

1 Li Q, Guan X, Wu P et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med 2020; 382(13):1199–1207. https://doi.org/10.1056/NEJMoa2001316

2 World Health Organization. Transmission of SARS-CoV-2: implications for infection prevention precautions. 2020. https://tinyurl.com/5n74nrew (accessed 27 October 2022)

3 Rothe C, Schunk M, Sothmann P et al. Transmission of 2019-nCoV Infection from an asymptomatic contact in Germany. N Engl J Med 2020; 382(10):970–971. https://doi.org/10.1056/NEJMc2001468

4 Kupferschmidt K. Study claiming new coronavirus can be transmitted by people without symptoms was flawed. Science 2020. https://doi.org/10.1126/science.abb1524

5 Razai MS, Doerholt K, Ladhani S, Oakeshott P. Coronavirus disease 2019 (covid-19): a guide for UK GPs. BMJ 2020; 368:m800. https://doi.org/10.1136/bmj.m800

6 Conselho Federal de Enfermagem. [Two years in overload, says COFEN about covid-19 removals] [In Portuguese]. https://tinyurl.com/22xfsx8y (accessed 27 October 2022)

7 Agência Brasil. [Public Health in Rio de Janeiro has 1,200 professionals on leave] [aricle in Portuguese]. 2020. https://tinyurl.com/3rewhf9n (accessed 27 October 2022)

8 World Health Organization. Rational use of personal protective equipment for coronavirus disease 2019 (COVID-19): Interim guidance. 2020. https://tinyurl.com/6ar29y5y (accessed 31 October 2022)

9 UK Department of Health & Social Care. Personal protective equipment (PPE) strategy: stabilise and build resilience. 2020. https://tinyurl.com/5n6mzxzh (acessed 5 November 2022)

10 Brazil Ministry of Health. [Protection recommendations for health service workers in the care of COVID-19 and other flu syndromes] [In Portuguese]. 2020. https://tinyurl.com/2u68et9y (acessed 5 November 2022)

11 Brazil National Health Surveillance Agency. Technical note gvims/ggtes/20NVISA nº 04/2020. [Guidelines for health services: prevention and control measures that must be adopted when assisting suspected or confirmed cases of infection with the new coronavirus (SARS-CoV-2)] [In Portuguese]. Updated 25 February 2021. https://tinyurl.com/hk5rejta (accessed 31 October 2022)

12 Zhou Q, Xue J, Wang LN et al. [Nursing strategies for the facial skin injuries caused by wearing medical-grade protective equipment] [In Chinese]. Zhonghua Shao Shang Za Zhi 2020; 36(8):686–690. https://doi.org/10.3760/cma.j.cn501120-20200212-00054

13 Brazil Ministry of Health. [Guidance on the use of respiratory protection masks (particulate respirator N95/PFF2 or equivalent) in view of the current epidemiological situation regarding infection by sars-cov-2 (covid-19)] [In Portuguese]. 2020. https://tinyurl.com/4vpxvw49 (accessed 5 November 2022)

14 Lan J, Song Z, Miao X et al. Skin damage among health care workers managing coronavirus disease-2019. J Am Acad Dermatol 2020; 82(5):1215–1216. https://doi.org/10.1016/j.jaad.2020.03.014

15 Gefen A, Alves P, Ciprandi G et al. Device-related pressure ulcers: SECURE prevention. J Wound Care 2020; 29(Sup2a):S1–S52. https://doi.org/10.12968/jowc.2020.29.Sup2a.S1

16 Gheisari M, Araghi F, Moravvej H et al. Skin reactions to non-glove personal protective equipment: an emerging issue in the COVID-19 pandemic. J Eur Acad Dermatol Venereol 2020; 34(7):e297–e298. https://doi.org/10.1111/jdv.16492

17 de Oliveira Ramalho A, Freitas PD, Nogueira PC. Medical device-related pressure injury in health care professionals in times of pandemic. Braz J Enterostomal Ther 2020; 18:e0120

18 Alves P, Moura A, Vaz A et al. [Prevention of skin injuries caused by personal protective equipment (face masks, respirators, visors and goggles)] [In Portuguese]. Portuguese Wound Care Association, 2020. https://tinyurl.com/y7famx8e (accessed 5 November 2022)

19 LeBlanc K, Heerschap C, Butt B et al.; NSWOCC. Prevention and management of skin damage related to personal protective equipment. Update 2020. https://tinyurl.com/3ruhfenx (accessed 31 October 2022)

20 National Pressure Injury Advisory Panel. NPIAP position statements on preventing injury with n95 masks. 2020. https://tinyurl.com/45wj4kxw (accessed 31 October 2022)

21 Gallasch CH, Cunha ML, Pereira LAS, Silva-Junior JS. [Prevention related to the occupational exposure of health professionals workers in the COVID-19 scenario] [In Portuguese]. Rev Enf UERJ 2020; 28:e49596. https://doi.org/10.12957/reuerj.2020.49596

22 Jiang Q, Song S, Zhou J et al. The prevalence, characteristics and prevention status of skin injury caused by personal protective equipment among medical staff in fighting covid-19: a multicenter cross-sectional study. Adv Wound Care 2020; 9(7):357–364. https://doi.org/10.1089/wound.2020.1212

23 Bambi S, Giusti GD, Galazzi A et al. Pressure injuries due to personal protective equipment in COVID-19 critical care units. Am J Crit Care 2021; 30(4):287–293. https://doi.org/10.4037/ajcc2021178

24 Moore Z, McEvoy NL, Avsar P et al. Facial pressure injuries and the COVID-19 pandemic: skin protection care to enhance staff safety in an acute hospital setting. J Wound Care 2021; 30(3):162–170. https://doi.org/10.12968/jowc.2021.30.3.162

25 Atzori L, Ferreli C, Atzori MG, et al. Covid-19 and impact of personal protective equipment use: from occupational to generalized skin care need. Dermatol Ther 2020; 33(4):e13598. https://doi.org/10.1111/dth.13598

26 Yu J, Chen JK, Mowad CM et al. Occupational dermatitis to facial personal protective equipment in health care workers: a systematic review. J Am Acad Dermatol 2021; 84(2):486–494. https://doi.org/10.1016/j.jaad.2020.09.074

27 Gefen A, Berman HJ, Ousey K. Update to device-related pressure ulcers: SECURE prevention. Covid-19, face masks and skin damage. J Wound Care 2020; 29(5):245–259. https://doi.org/10.12968/jowc.2020.29.5.245

28 Teo W-L. Diagnostic and management considerations for "maskne" in the era of COVID-19. J Am Acad Dermatol 2021; 84(2):520–521. https://doi.org/10.1016/j.jaad.2020.09.063

29 Dreno B, Bettoli V, Araviiskaia E et al. The influence of exposome on acne. JEADV 2018; 32(5):812–819. https://doi.org/10.1111/jdv.14820