Available online at IJTID Website: https://e-journal.unair.ac.id/IJTID/

Indonesian Journal of
Tropical and Infectious Disease

Vol. 10 No. 3 September–December 2022

Review Article

Prolonged Use of Protective Masks Induced Facial Skin Injury in Primary Healthcare Workers during COVID-19 Pandemic: A Systematic Review

Alvian Mohamad Yapanto[1*], Aulia Rahma Isnaeni[1], Khairani Ayu Lestari[1], Agung Bagus Sista Satyarsa[2]
[1]Faculty of Medicine, Universitas YARSI, Jakarta, Indonesia
[2]Faculty of Medicine, Universitas Udayana, Bali, Indonesia

Received: June 15th, 2022; Revised: August 12th, 2022; Accepted: November 23rd, 2022

ABSTRACT

COVID-19 transmission necessitates health workers to use personal protective equipment (PPE), especially protective masks when delivering medical services. Long-term use of protective masks might cause facial skin injuries. Our study aims to provide a systematic review to explore the phenomenon and incidence of protective masks induced facial skin injuries in primary healthcare workers. This systematic review was created by obtaining articles from the PubMed database and the Cochrane library from 2020 to 2021, using the keywords "Face skin injury," "Wearing protective masks for a long time," and "Wearing protective masks and facial skin disorders." Inclusion criteria were studies that fully report the phenomenon of wearing protective masks and the incidence of facial skin injuries. One hundred and sixty-eight studies were obtained, but only 14 articles matched the inclusion criteria with more than 10,430 participants from different countries that covered various characteristics of facial skin injuries in primary healthcare workers. The findings obtained dominant characteristics of health workers who experienced facial skin injuries: women, N95 masks, and daily N95 coverage for more than 6 hours ($p<0.05$). Facial skin injuries are often seen after using protective face masks, as it is used for an extended period as part of a defensive effort during work. Therefore, measures that protect health workers from COVID-19 and prevent health workers from potential injuries of protective masks must be taken into account.

Keywords: *COVID-19; facial skin injury; long duration; primary health workers; protective masks*

ABSTRAK

Penularan COVID-19 mengharuskan tenaga kesehatan untuk menggunakan alat pelindung diri (APD), khususnya masker pelindung saat memberikan pelayanan medis. Penggunaan masker pelindung jangka panjang dapat menyebabkan cedera kulit wajah. Penelitian kami bertujuan untuk memberikan tinjauan sistematis untuk mengeksplorasi fenomena dan kejadian cedera kulit wajah terkait penggunaan masker pelindung pada tenaga kesehatan primer. Tinjauan sistematis ini dibuat dengan memperoleh artikel dari database PubMed dan perpustakaan Cochrane dari tahun 2020 hingga 2021, menggunakan kata kunci "Face skin injury," "Wearing protective masks for a long time," dan "Wearing protective masks and facial skin disorders". Kriteria inklusi adalah penelitian yang secara lengkap melaporkan fenomena pemakaian masker pelindung dengan kejadian luka pada kulit wajah. 168 penelitian diperoleh, tetapi hanya 14 artikel yang sesuai dengan kriteria inklusi dengan lebih dari 10.430 peserta dari berbagai negara yang mencakup berbagai karakteristik cedera kulit wajah pada petugas kesehatan primer. Temuan didapatkan karakteristik dominan tenaga kesehatan yang mengalami cedera kulit wajah: perempuan, masker N95, dan cakupan N95 harian lebih dari 6 jam ($p<0,05$). Cedera kulit wajah sering terlihat setelah menggunakan masker pelindung, karena digunakan dalam

* Corresponding Author:
alvian.mohamad@students.yarsi.ac.id

waktu lama sebagai bagian dari upaya defensif selama bekerja. Oleh karena itu, langkah-langkah yang melindungi petugas kesehatan dari COVID-19 dan mencegah petugas kesehatan dari potensi cedera masker pelindung harus diperhitungkan.

Kata kunci: *COVID-19; cedera kulit wajah; durasi panjang; masker pelindung; petugas kesehatan layanan primer*

How to Cite: Yapanto, A. M., Isnaeni, A. R., Lestari, K. A., Satyarsa, A. B. S. Prolonged Use of Protective Masks Induced Facial Skin Injury in Primary Healthcare Workers During COVID-19 Pandemic: A Systematic Review. Indonesian Journal of Tropical and Infectious Disease. 10(3). 198–204. Dec. 2022.

INTRODUCTION

Coronavirus disease (COVID-19) is an ongoing global threat requiring the public to abate its transmission by improving personal and communal hygiene practices.[1,2] Personal Protective Equipment (PPE) is essential for health workers as they are more at risk of contracting COVID-19.[3-5]

Although wearing PPE, especially protective masks, is mandatory to prevent COVID-19 infection, its long-term use increases the temperature, which leads to sebum excretion. Moreover, the pressure and friction from the protective masks can cause contact dermatitis (injuries of facial skin), seborrheic dermatitis, and acne vulgaris. The most frequent side effect of PPE is pressure-based wounds induced by N95 masks, such as the indentation of the mask on the bridge of the nose of health workers.[5]

This systematic review will provide a comprehensive overview of the available literature regarding the side effects of the long-term use of protective masks. Our main objective is to understand the extent of facial skin injury induced by protective mask-wearing among primary healthcare workers during the Pandemic of COVID-19.

METHODS

Study Design

This was a systematic review of facial skin injury induced by protective masks during the COVID-19 Pandemic. In conducting the literature search and reviewing the article, we adhered to PRISMA guidelines.[4]

PubMed and Cochrane library were the primary databases to search for articles published from January 2020 to November 2021. The literature search process used the Boolean operator "AND" or "OR" using the keywords "Face skin injury," "Wearing protective masks for a long time," and "Wearing protective masks and facial skin disorders."

Study Selection

Articles were selected from the databases based on inclusion and exclusion criteria. The article's inclusion process followed several criteria, such as 1) Studies reporting the significance of protective masks induced facial skin injury during the Pandemic of COVID-19; 2) Age > 18 years old; 3) Medical staff who wore level 2 or 3 PPE while working at the frontline against COVID-19, regardless of gender. Exclusion criteria included review articles written in languages other than English, conference abstracts, nonhuman research, and studies that did not evaluate the outcome measures.

Two independent reviewers selected the articles and extracted the key findings. Disagreements between the two authors were resolved by reaching a consensus aided by the third reviewer. The full literature search and selection process followed the PRISMA Guideline.

Study Quality

Assessing the quality of evidence within a systematic review is as important as analyzing the data. Selecting an appropriate tool to help analyze strength of evidence and embedded biases within each paper was also essential. Therefore, the author used Joanna Briggs Institute (JBI) that provides robust

checklists for the appraisal and assessment of most studies.

Data Extraction and Analysis

Key findings were independently extracted, starting by noting baseline characteristics and outcomes from included articles. Extracted data contained first author name, year of publication, study design, age range, diagnosis, sample size, and results. All data results are presented and described descriptively in tabular form.

RESULTS AND DISCUSSION

The querying process returned 168 studies, with 167 originating from online databases (PubMed and Cochrane library) and one article sourced from an organic search. A total of 123 studies were obtained after removing duplicates using computer software (Citation Manager). Upon screening the title and abstract, 17 studies were eligible for further assessment. However, 3 studies did not satisfy the inclusion criteria, 14 of which were still included in the qualitative analysis (systematic study).[5–18] Figure 1 summarizes the literature search process as indicated by the PRISMA Guideline.

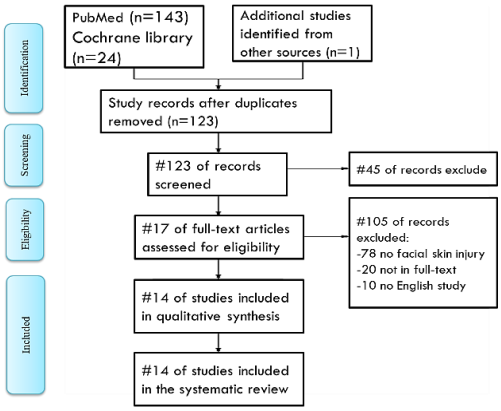

Figure 1. Flowchart PRISMA

From all included articles, 10,430 respondents participated in several observational studies. The median age of respondents was 35 years, with most respondents being women (available in Table 1).

The dominant health workers are nurses with the most use of N95 while handling patients during a pandemic. In addition, the working time of health workers in each study was between 4–12 hours.

Table 1. Characteristics of Studies

Author, year	Study design	Age	Gender	Sample size
Jiang *et al*., 2020[5]	Multicenter observational study	35 years (median)	Male (12.7%) Female (87.3%)	4308
Battista *et al*., 2021[6]	Observational study	35.0 ±11.7 years	Male (33.1%) Female (66.9%)	381
Abiakam *et. al*., 2021[7]	Prospective study	45 years (median)	Male (12.0%) Female (88.0%)	307
Ippolito *et al*., 2021[8]	A cross-sectional survey	40 years (median)	Male (49%) Female (51%)	2711
Han *et al*., 2021[9]	A cross-sectional study	37.5±10.83 years	Male (10.0%) Female (90.0%)	20
Choi *et al*., 2021[10]	Multicenter observational study	35.50±14.45 years	Male (34.85%) Female (65.15%)	330
Uthayakumar *et al*., 2021[11]	Rapid report	34 years (median); Range 23-60	Female : male (4:1)	67
Purushothaman *et al*., 2021[12]	Cross-sectional	25.843 years (mean) Range 20-48	Male (28.4%) Female (71.6%)	250
Techasatian *et al*., 2020[13]	Prospective Cross-sectional	32 (25-41) years (median (IQR)) Range 18-87 years	Male (26.7%) Female (73.3%)	833
Singh *et al*., 2020[14]	Survey study	32.78±14.51 years	Male (59.7%) Female (40.3%)	43
Coelho *et al*., 2020[15]	Cross-sectional	34.08 (8.9) (mean(SD))	Male (16.4%) Female (83.6%)	1106
Yuan *et al*., 2020[16]	Cross-sectional	N/A	Male : Female (1:2)	129
Shanshal *et al*., 2020[17]	Cross-sectional observational	N/A	Male (36%) Female (64%)	276
Christopher *et al*., 2020[18]	Cross-sectional	26.94±7.23 years	Male (33%) Female (67%)	200

Personal protective equipment (PPE) is one piece of equipment used by health workers to prevent nosocomial infections and protect patients from the possibility of infection, starting from the patient entering and receiving healthcare and medical action until the patient returns from the hospital.[19–22]

The scientific summary released by the World Health Organization (WHO) reported the presence of SARS-CoV-2 ribonucleic acid (RNA) in air samples taken from under the patient's bed and windows. Both areas would have minimal direct contact with patients or health care. Researchers also found that 66.7% of air samples taken from hospital hallways contained viral.[23,24]

The World Health Organization (WHO) recommendation is that surgical masks should be sufficient when treating COVID-19 patients, and N95 or PAPR respirators should be used only in the case of aerosol-generating procedures. The CDC insists that N95 respirators be used by all medical professionals who contact COVID-19 patients. Based on this, if there are difficulties in procurement or vacancies for N95 masks, surgical masks are allowed to make contact with COVID-19 patients and to protect, face shields can be used. Several studies state no clinically significant evidence of a difference in safety between surgical masks and N95.[5,8,20]

Table 2. Unique Publications Identified

Author, year	PPE and Duration	Outcome	Quality of Study (Score)
Jiang *et al*., 2020[5]	Level 3 PPE, protective masks >4 hours	The device-related pressure injury (DRPI) was prevalent among healthcare workers wearing PPE against COVID-19. The risk factors for facial skin injury ($p<0.05$) were male, wearing level 3 PPE, longer wearing time > 4 hours and sweating.	High (8)
Battista *et al*., 2021[6]	Surgical Mask, Cotton Mask, N95, Combination Surgical + FFP2/3, <1 hours until > 12 hours	Most affected individuals were healthcare workers wearing N95 respirator masks for more than six h/d ($p<0.05$)	Moderate (6)
Abiakam *et al*., 2021[7]	PPE (FFP3), eye protection, gloves, gown >8 hours	The adverse skin reactions (facial skin injury) had a significant association with the average daily time of PPE usage during > 8 hours ($p<0.05$)	Moderate (7)
Ippolito *et al*., 2021[8]	Mask (Surgical, N95, FFP3, PAPR), Gown, >6 hours	59% of the participants had significant pressure injury on the face area after using an N95 mask in ICU for> 6 hours ($p<0.05$)	High (8)
Han *et al*., 2021[9]	KF94 respirator dan medical mask 4 hours, 8 hours, dan 14 hours	Skin injury significantly differed between RPE-covered and uncovered areas after 4 and 8 hours ($p<0.05$).	Low (2)
Choi *et al*., 2021[10]	N95/KF94/KF80, Surgical, Cotton ≥6 hours	Daily use of N95 masks significantly increases the incidence of new contact dermatitis. The duration of wearing PPE >6 hours/day and masks made of cotton significantly increased the incidence of acne and wounds around the face. Health workers had a higher incidence of facial skin injuries ($p<0.05$).	Moderate (6)
Uthayakumar *et al*., 2021[11]	Protective masks N95 > 6 hours	PPE marked an increase in the impact of facial skin injury; 70% reported a significant adverse effect on their work or study ($P<0.05$)	Low (4)
Purushothaman *et al*., 2021[12]	N95 + surgical mask, > 4 hour/day	Excessive sweating around the mouth after used protective mask was 67.6%, resulting in poorer adherence and increased risk of infection in the face area ($p<0.05$).	Moderate (7)
Techasatian *et al*., 2020[13]	N95 masks, surgical mask, 4 to 8 hours/day	1,92% facial skin injury among 4-8 hours (48.9%) after used protective mask was a significant value in statistics ($p<0.05$)	High (8)
Singh *et al*., 2020[14]	N95 masks, face shields, and goggles Average 8.76 hours	Goggles and N95 masks were the most common culprit agent among all PPE, causing skin injuries. The most commonly noted dermatoses were irritant contact dermatitis in the face ($p<0.05$).	Moderate (7)
Coelho *et al*. 2020[15]	Cap, gloves, apron, N95 mask, surgical mask, PFF2 mask, face protector, and glasses >6 hours	The number of pressure injuries related to personal protective equipment was high (an average of 2.4 injuries per professional). Working and wearing personal protective equipment for more than six hours a day was one of the significant factors ($p<0.05$).	High (8)

Yuan *et al*. 2020[16]	N95 mask, goggles, gloves, face mask, gown, and medical protective clothing > 8 hours	A total of 122 (94.57%) healthcare professionals experienced discomfort while wearing L3PPE, including varying degrees of face skin injuries, respiratory difficulties, heat stress, dizziness and nausea.	Moderate (6)
Shanshal *et al*. 2020[17]	N95 mask, goggles, gloves, face mask, gown, and medical protective clothing > 8 hours	51% had pressure injury in the facial skin after prolonging (> 8 hours) using PPE, especially in the woman, and 82.5% had facial skin injury ($p<0.05$)	Moderate (6)
Christopher *et al*. 2020[18]	Level 1-3 PPE, protective masks ≥7 hours/day	The level of PPE worn and duration of PPE worn daily was factors considerably associated with adverse skin reactions to PPE.	Low (4)

FSI=Facial Skin Injury, manifested in several clinical features, such as dryness, itching, erythema, acne, indentation, and pressure ulcer.

Further evidence suggested N95 respirator as protective mask causes more severe facial injuries than the KN95 respirator.[5] Applying polyester tape layering and emollient effectively prevented severe injuries, especially on the cheekbones, chin, nasal bridge and behind the ears.[25–29]

N95 masks cause skin injury because the material is thick and stiff, causing greater pressure on the skin.[9] Also, many studies have reported differences in risk between N95 masks and KN95 masks, as observed in our results. The difference in risk is interesting, given that N95 and KN95 masks provide relatively the same level of protection. More recent tests have also shown that N95 and KN95 are quite effective at filtering respiratory particulates, especially those protective mask used by healthcare professionals in treating patients with COVID-19. Besides that, interestingly, the KN95 mask is not as thick and stiff as the N95, so it is more comfortable to use for a longer period.[7,8,30,31]

The quality of the study and the bias assessment of the cross-sectional studies was done using the Newcastle Ottawa Scale (NOS), as presented in Table 2. The overall quality of evidence was moderate-high quality.[4,23] Our findings recommend using an alternative to KN95 masks instead of N95 in primary care for patients with COVID-19. They can promote using wound dressings and emollients to protect facial skin after carrying out services with PPE for > 4–6 hours. In particular, healthcare facilities are expected to provide supplies of protective facial mask and emollients to prevent facial injuries that use PPE too often and for a long time.[32,33]

Previous investigations have yielded similar conclusions, although this study is one of the few to report the phenomenon of facial injuries due to prolonged use of protective masks. These results can be considered, and recommendations can be used in Indonesia wisely. However, much remains to be learned about the COVID-19 Pandemic on the welfare and safety of health workers in primary health care. Future studies should explore minimal treatment and prevention options for healthcare workers who suffer these injuries so that services during the Pandemic are maximized.[34,35]

SUMMARY

Facial skin injuries are often seen after using protective masks, as it is used for an extended period of defensive effort during work. The current state of the evidence suggests that some protective face mask have their respective advantages and optimal usage duration. Therefore, measures that protect health workers from COVID-19 and prevent health workers from potential injuries from protective facial masks must be considered. The choice and duration of protective mask usage must be adjusted according to their working environment.

ACKNOWLEDGEMENT

We sincerely acknowledge the help provided by our lecturer in medical faculty of Universitas YARSI for the professional guidance and valuable support for this research.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

1. World Health Organization. Coronavirus Disease 2019 (COVID-19) Situation Report - 41 [Internet]. 2019 [cited 2021 Aug 10]. Available from: https://www.who.int/indonesia/news/novel-coronavirus/situation-reports
2. World Health Organization. Health worker exposure risk assessment and management in the context of COVID-19 virus. [Internet]. 2020 [cited 2021 Aug 10]. Available from: https://www.who.int/publications/i/item/10665-336265
3. Tang J, Zhang S, Chen Q, Li W, Yang J. Risk factors for facial pressure sore of healthcare workers during the outbreak of COVID-19. International wound journal. 2020;17(6):2028.
4. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Moher D. Updating guidance for reporting systematic reviews: development of the PRISMA 2020 statement. Journal of clinical epidemiology. 2021;134:103-112.
5. Jiang Q, Song S, Zhou J, Liu Y, Chen A, Bai Y, Wang J, Jiang Z, Zhang Y, Liu H, Hua J. 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. Advances in wound care. 2020;9(7):357-364.
6. Battista RA, Ferraro M, Piccioni LO, Malzanni GE, Bussi M. Personal Protective Equipment (PPE) in COVID 19 pandemic: related symptoms and adverse reactions in healthcare workers and general population. Journal of occupational and environmental medicine. 2021;63(2):e80.
7. Abiakam N, Worsley P, Jayabal H, Mitchell K, Jones M, Fletcher J, Spratt F, Bader D. Personal protective equipment related skin reactions in healthcare professionals during COVID-19. International Wound Journal. 2021;18(3):312-322.
8. Ippolito M, Ramanan M, Bellina D, Catalisano G, Iozzo P, Di Guardo A, Moscarelli A, Grasselli G, Giarratano A, Bassetti M, Tabah A. Personal protective equipment use by healthcare workers in intensive care unit during the early phase of COVID-19 pandemic in Italy: a secondary analysis of the PPE-SAFE survey. Therapeutic advances in infectious disease. 2021;8:2049936121998562.
9. Han HS, Shin SH, Park JW, Li K, Kim BJ, Yoo KH. Changes in skin characteristics after using respiratory protective equipment (medical masks and respirators) in the COVID-19 pandemic among healthcare workers. Contact Dermatitis. 2021;85(2):225-232.
10. Choi J, Shin TG, Park JE, Lee GT, Kim YM, Lee SA, Kim S, Hwang NY, Hwang SY. Impact of personal protective equipment on the first-pass success of endotracheal intubation in the ed: A propensity-score-matching analysis. Journal of clinical medicine. 2021;10(5):1060.
11. Uthayakumar AK, Panagou E, Manam S, Schauer A, Veraitch O, Walker S, Edmonds E, Crawley J, Martyn-Simmons C. PPE-associated dermatoses: effect on work and wellbeing. Future Healthcare Journal. 2021;8(1):e67.
12. Uthayakumar AK, Panagou E, Manam S, Schauer A, Veraitch O, Walker S, Edmonds E, Crawley J, Martyn-Simmons C. PPE-associated dermatoses: effect on work and wellbeing. Future Healthcare Journal. 2021;8(1):e67.
13. Techasatian L, Lebsing S, Uppala R, Thaowandee W, Chaiyarit J, Supakunpinyo C, Panombualert S, Mairiang D, Saengnipanthkul S, Wichajarn K, Kiatchoosakun P. The effects of the face mask on the skin underneath: a prospective survey during the COVID-19 pandemic. Journal of primary care & community health. 2020;11:2150132720966167.
14. Singh M, Pawar M, Bothra A, Maheshwari A, Dubey V, Tiwari A, Kelati A. Personal protective equipment induced facial dermatoses in healthcare workers managing Coronavirus disease 2019. Journal of the European Academy of Dermatology and Venereology. 2020.
15. Coelho MD, Cavalcante VM, Moraes JT, Menezes LC, Figueirêdo SV, Branco MF, Alexandre SG. Pressure injury related to the use of personal protective equipment in COVID-19 pandemic. Revista Brasileira de Enfermagem. 2020;73.
16. Yuan L, Chen S, Xu Y. Donning and doffing of personal protective equipment protocol and key points of nursing care for patients with COVID-19 in ICU. Stroke and vascular neurology. 2020;5(3).
17. Shanshal SA, Al-Qazaz HK. Knowledge and Practice of Cement Factory Workers in Relation to Respiratory Symptoms: A Cross-Sectional Study. Systematic Reviews in Pharmacy. 2020;11(6):864-870.
18. Christopher PM, Roren RS, Tania C, Jayadi NN, Cucunawangsih C. Adverse skin reactions to personal protective equipment among health-care workers during COVID-19 pandemic: a multicenter cross-sectional study in Indonesia.

International Journal of Dermatology and Venereology. 2020;3(04):211-218.
19. Tabah A, Ramanan M, Laupland KB, Buetti N, Cortegiani A, Mellinghoff J, Morris AC, Camporota L, Zappella N, Elhadi M, Povoa P. Personal protective equipment and intensive care unit healthcare worker safety in the COVID-19 era (PPE-SAFE): an international survey. Journal of critical care. 2020;59:70-75.
20. Hu K, Fan J, Li X, Gou X, Li X, Zhou X. The adverse skin reactions of health care workers using personal protective equipment for COVID-19. Medicine. 2020;99(24).
21. Tirupathi R, Bharathidasan K, Palabindala V, Salim SA, Al-Tawfiq JA. Comprehensive review of mask utility and challenges during the COVID-19 pandemic. Infez Med. 2020;28(suppl 1):57-63.
22. Abd-Elsayed A, Karri J. Utility of substandard face mask options for health care workers during the COVID-19 pandemic. Anesthesia and analgesia. 2020.
23. Feng S, Shen C, Xia N, Song W, Fan M, Cowling BJ. Rational use of face masks in the COVID-19 pandemic, Lancet Respiratory Medicine. 2020;8(5), 434-436.
24. van der Westhuizen HM, Kotze K, Tonkin-Crine S, Gobat N, Greenhalgh T. Face coverings for covid-19: from medical intervention to social practice. bmj. 2020;370.
25. Long Y, Hu T, Liu L, Chen R, Guo Q, Yang L, Cheng Y, Huang J, Du L. Effectiveness of N95 respirators versus surgical masks against influenza: A systematic review and meta-analysis. Journal of Evidence-Based Medicine. 2020;13(2):93-101.
26. Barycka K, Szarpak L, Filipiak KJ, Jaguszewski M, Smereka J, Ladny JR, Turan O. Comparative effectiveness of N95 respirators and surgical/face masks in preventing airborne infections in the era of SARS-CoV2 pandemic: A meta-analysis of randomized trials. PLoS One. 2020;15(12):e0242901.
27. Radonovich LJ, Simberkoff MS, Bessesen MT, Brown AC, Cummings DA, Gaydos CA, Los JG, Krosche AE, Gibert CL, Gorse GJ, Nyquist AC. N95 respirators vs medical masks for preventing influenza among health care personnel: a randomized clinical trial. Jama. 2019;322(9):824-833.
28. Smith JD, MacDougall CC, Johnstone J, Copes RA, Schwartz B, Garber GE. Effectiveness of N95 respirators versus surgical masks in protecting health care workers from acute respiratory infection: a systematic review and meta-analysis. Cmaj. 2016;188(8):567-74.
29. Vickers NJ. Animal communication: when i'm calling you, will you answer too?. Current biology. 2017;27(14):R713-5.
30. O'Kelly E, Arora A, Pirog S, Ward J, Clarkson PJ. Comparing the fit of N95, KN95, surgical, and cloth face masks and assessing the accuracy of fit checking. PloS one. 2021;16(1):e0245688.
31. Clinkard D, Mashari A, Karkouti K, Fedorko L. Evaluation of N95 respirators, modified snorkel masks and low-cost powered air-purifying respirators: a prospective observational cohort study in healthcare workers. Anaesthesia. 2021;76(5):617-622.
32. Pacis M, Azor-Ocampo A, Burnett E, Tanasapphaisal C, Coleman B. Prophylactic dressings for maintaining skin integrity of healthcare workers when using N95 respirators while preventing contamination due to the novel coronavirus: a quality improvement project. Journal of Wound, Ostomy, and Continence Nursing. 2020;47(6):551.
33. Guschel S, Chmiel K, Rosenstein J. Use of Thin Dressings Under N95 Respirators: Exploring Their Effect on Quantitative Fit Testing Results to Guide Hospital Practice During the COVID-19 Pandemic. Wound Management & Prevention. 2020;66(11):13-17.
34. Smart H, Opinion FB, Darwich I, Elnawasany MA, Kodange C. Preventing facial pressure injury for health care providers adhering to COVID-19 personal protective equipment requirements. Advances in skin & wound care. 2020.
35. Cabbarzade C. A practical way to prevent nose and cheek damage due to the use of N95 masks in the COVID-19 pandemic. Aesthetic Surgery Journal. 2020;40(10):NP608-10.