Review Article

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

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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

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."\(^7\)

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

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Study design</th>
<th>Age</th>
<th>Gender</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jiang et al., 2020</td>
<td>Multicenter observational study</td>
<td>35 years (median)</td>
<td>Male (12.7%)</td>
<td>4308</td>
</tr>
<tr>
<td>Battista et al., 2021</td>
<td>Observational study</td>
<td>35.0 ±11.7 years</td>
<td>Female (87.3%)</td>
<td>381</td>
</tr>
<tr>
<td>Abiakam et al., 2021</td>
<td>Prospective study</td>
<td>45 years (median)</td>
<td>Male (33.1%)</td>
<td>307</td>
</tr>
<tr>
<td>Ippolito et al., 2021</td>
<td>A cross-sectional survey</td>
<td>40 years (median)</td>
<td>Female (66.9%)</td>
<td>2711</td>
</tr>
<tr>
<td>Han et al., 2021</td>
<td>A cross-sectional study</td>
<td>37.5±10.83 years</td>
<td>Male (12.0%)</td>
<td>20</td>
</tr>
<tr>
<td>Choo et al., 2021</td>
<td>Multicenter observational study</td>
<td>35.50±14.45 years</td>
<td>Female (10.0%)</td>
<td>200</td>
</tr>
<tr>
<td>Uthayakumar et al., 2021</td>
<td>Rapid report</td>
<td>34 years (median); Range 23-60</td>
<td>Male (34.8%)</td>
<td>67</td>
</tr>
<tr>
<td>Purushothaman et al., 2021</td>
<td>Cross-sectional</td>
<td>25.843 years (mean)</td>
<td>Female : male (4:1)</td>
<td>250</td>
</tr>
<tr>
<td>Techasatian et al., 2020</td>
<td>Prospective</td>
<td>Range 20-48</td>
<td>Male (71.6%)</td>
<td>833</td>
</tr>
<tr>
<td>Singh et al., 2020</td>
<td>Cross-sectional</td>
<td>Range 18-87 years</td>
<td>Female (73.3%)</td>
<td>43</td>
</tr>
<tr>
<td>Coelho et al., 2020</td>
<td>Cross-sectional</td>
<td>34.08 (8.9) (mean(SD))</td>
<td>Male (59.7%)</td>
<td>1106</td>
</tr>
<tr>
<td>Yuan et al., 2020</td>
<td>Cross-sectional</td>
<td>N/A</td>
<td>Female (83.6%)</td>
<td>129</td>
</tr>
<tr>
<td>Shanshal et al., 2020</td>
<td>Cross-sectional</td>
<td>N/A</td>
<td>Male : Female (1:2)</td>
<td>276</td>
</tr>
<tr>
<td>Christopher et al., 2020</td>
<td>Cross-sectional</td>
<td>26.94±7.23 years</td>
<td>Male (33%)</td>
<td>200</td>
</tr>
</tbody>
</table>
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) recommends 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

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<table>
<thead>
<tr>
<th>Author, year</th>
<th>PPE and Duration</th>
<th>Outcome</th>
<th>Quality of Study (Score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jiang et al., 2020</td>
<td>Level 3 PPE, protective masks &gt;4 hours</td>
<td>The device-related pressure injury (DRPI) was prevalent among healthcare workers wearing PPE against COVID-19. The risk factors for facial skin injury (p&lt;0.05) were male, wearing level 3 PPE, longer wearing time &gt;4 hours and sweating.</td>
<td>High (8)</td>
</tr>
<tr>
<td>Battista et al., 2021</td>
<td>Surgical Mask, Cotton Mask, N95, Combination Surgical + FFP2/3, &lt;1 hours until &gt;12 hours PPE (FFP3), eye protection, gloves, gown &gt;8 hours</td>
<td>Most affected individuals were healthcare workers wearing N95 respirator masks for more than six h/day (p&lt;0.05)</td>
<td>Moderate (6)</td>
</tr>
<tr>
<td>Abiakam et al., 2021</td>
<td>PPE (FFP3), eye protection, gloves, gown &gt;8 hours</td>
<td>The adverse skin reactions (facial skin injury) had a significant association with the average daily time of PPE usage during &gt;8 hours (p&lt;0.05)</td>
<td>Moderate (7)</td>
</tr>
<tr>
<td>Ippolito et al., 2021</td>
<td>Mask (Surgical, N95, FFP3, PAPR), Gown, &gt;6 hours</td>
<td>59% of the participants had significant pressure injury on the face area after using an N95 mask in ICU for &gt;6 hours (p&lt;0.05)</td>
<td>High (8)</td>
</tr>
<tr>
<td>Han et al., 2021</td>
<td>KF94 respirator dan medical mask 4 hours, 8 hours, dan 14 hours N95/KF94/KF80, Surgical, Cotton ≥6 hours</td>
<td>Skin injury significantly differed between PPE-covered and uncovered areas after 4 and 8 hours (p&lt;0.05).</td>
<td>Low (2)</td>
</tr>
<tr>
<td>Choi et al., 2020</td>
<td>Daily use of N95 masks significantly increases the incidence of new contact dermatitis. The duration of wearing PPE &gt;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&lt;0.05).</td>
<td>Moderate (6)</td>
<td></td>
</tr>
<tr>
<td>Uthayakumar et al., 2021</td>
<td>Protective masks N95 &gt;6 hours</td>
<td>PPE marked an increase in the impact of facial skin injury; 70% reported a significant adverse effect on their work or study (p&lt;0.05)</td>
<td>Low (4)</td>
</tr>
<tr>
<td>Purushothaman et al., 2021</td>
<td>N95 + surgical mask, &gt;4 hour/day</td>
<td>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&lt;0.05).</td>
<td>Moderate (7)</td>
</tr>
<tr>
<td>Techasatian et al., 2020</td>
<td>N95 masks, surgical mask, 4 to 8 hours/day</td>
<td>1.92% facial skin injury among 4-8 hours (48.9%) after used protective mask was a significant value in statistics (p&lt;0.05).</td>
<td>High (8)</td>
</tr>
<tr>
<td>Singh et al., 2020</td>
<td>N95 masks, face shields, and goggles Average 8.76 hours</td>
<td>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&lt;0.05).</td>
<td>Moderate (7)</td>
</tr>
<tr>
<td>Coelho et al., 2020</td>
<td>Cap, gloves, apron, N95 mask, surgical mask, PFF2 mask, face protector, and glasses &gt;6 hours</td>
<td>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&lt;0.05).</td>
<td>High (8)</td>
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</tbody>
</table>
Further evidence suggested N95 respirator as protective mask causes more severe facial injuries than the KN95 respirator.\textsuperscript{5} Applying polyester tape layering and emollient effectively prevented severe injuries, especially on the cheekbones, chin, nasal bridge and behind the ears.\textsuperscript{25–29} N95 masks cause skin injury because the material is thick and stiff, causing greater pressure on the skin.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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**

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES


