Faktor Risiko Penularan Virus SARS-Cov 2 pada Tenaga Kesehatan

Risk Factors for Transmission of the SARS-Cov 2 Virus in Health Workers

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ABSTRACT

***Background**: Healthcare workers (HCWs) serve as front liners in the battle against COVID-19. They are often expected to be in constant contact with infected patients, posing higher risk of transmission. To date, literature on risk factors of COVID-19 transmission in HCWs are still limited. **Purpose**: We conducted this systematic review to identify the risk factors for SARS-CoV-2 virus transmission among HCWs. **Methods**: We conducted a systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocol. Four internet databases were searched using predefined search terms. The keywords used were {"COVID-19" OR "SARS-CoV-2"}, {"transmission" OR "transmission risk"}, and ("healthcare professionals" OR "healthcare workers" OR "healthcare staff"). All English articles which were published from January 2020 to June 2021 involving HCWs in hospitals treating COVID-19 were included into the study. **Results**: Out of initial 636 studies found using the predefined search terms, 18 studies fulfilled the inclusion criteria and were subsequently analyzed. We found that risk factors for COVID-19 could be divided into 5 categories: use of personal protective equipment (PPE), infection control procedures, unsafe workplace practices, provision of institutional support, and presence of individual risk factors in healthcare workers. Good hospital governance is necessary to establish policies regarding control of COVID-19 infection which will protect the patients and HCWs. **Conclusion**: Proper use of PPE, compliance to proper infection control procedures, establishment of safe workplace practices, provision of institutional support for prevention measures, and lack of individual risk factors may reduce the transmission risk of SARS-CoV-2 virus among healthcare workers. Further studies are warranted to identify methods for reducing incidence and mortality rate due to COVID-19 at HCWs.*

***Keyword**: COVID-19, healthcare workers, risk factors, transmission*

INTRODUCTION

Coronavirus Disease 2019, abbreviated as COVID-19, started with a series of clusters of pneumonia-like symptoms in December 2019 in China (Xiao *et al.*, 2020). The disease has rapidly evolved into a pandemic encompassing the entire world (Bandyopadhyay *et al.*, 2020). As of June 2021, the number of confirmed cases reported globally now exceeds 175 million, with 3 million confirmed deaths (The World Health Organization, 2021). Healthcare workers (HCWs), including doctors, nurses, laboratory technicians, physiotherapists, and many others are responsible for the treatment and patient care (Xiao *et al.*, 2020). In their line of work, HCWs were expected to be constantly in close contact with patients, including patients confirmed as having COVID-19, posing for them higher risks for transmission than normal populations. One previous study reported a mortality rate of 37.2 deaths per 100 infections for HCWs, especially those belonging to the elderly age group. As of May 2020, a total of 152.888 HCWs have been infected with COVID-19, accounting for 3.9% of the population worldwide. Among these, 1413 HCWs were reported dead due to COVID-19, making up 0.5% of the number of deaths worldwide (Bandyopadhyay *et al.*, 2020). Previous study also reported that at least 90,000 healthcare workers worldwide have been infected by COVID-19. The study showed a rate of 5.62% (273 out of 4854 cases) infection among HCW in Iran (Sabetian *et al.*, 2021).

Healthcare workers working on the front lines in the battle against COVID-19 face challenges in providing treatment for their

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patients. They have to prevent the spread of infection, develop short-term management strategies, and establish long-term plans of care for patients with COVID-19, in addition to their regular work with non-COVID-19 patients and taking care of their personal affairs (Shreffler, Petrey and Huecker, 2020). In addition to battling fears of COVID-19 exposure and infection, HCWs were also exposed to psychological stress related to shortages of personal protective equipment (PPE) and other essential supplies. They may have irregular working hours due to the pandemic, as well as higher workload and new responsibilities due to new clinical roles, which may be unfamiliar to them (Blake *et al.*, 2020).

To date, several scientific literature have reported risk factors for COVID-19 transmission risk on both general populations and medical workers, but little studies were conducted to identify the risk factors for transmission in HCWs. Studies available on the risk factors for HCWs were focusing on different aspects of healthcare, necessitating a synthesis of their findings. This systematic review aims to synthesize the risk factors for COVID-19 transmissions among HCWs working in hospitals providing care for COVID-19 patients, as reported in previous studies.

METHODS

This was a systematic review conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methods. The search for relevant literature was conducted using several electronic databases; namely MEDLINE (PubMed), EMBASE, SCOPUS, and MedSci. The following keywords combinations were used in our search: (i) {"COVID-19" OR "SARS-CoV-2"} AND (ii) {"transmission" OR "transmission risk"} AND (iii) ("healthcare professionals" OR "healthcare workers" OR "healthcare staff"). All articles published in English from January 2020 to June 2021 and were available for free in full text were included in our search. Article types included systematic reviews, reviews, clinical trials, meta-analyses, and randomized clinical trials.

Inclusion criteria for this systematic review included: Articles published in English, Articles were available in full text without additional cost (free full text), articles published in January 2020 to June 2021, studies conducted in hospitals treating COVID-19 patients, study participants included HCWs working in hospitals treating COVID-19 patients, and study were conducted on the risk factors for SARS-CoV-2 transmission among healthcare professionals.

Articles not published fully in English, articles not available free in full text, articles not published in January 2020 to June 2021, and articles containing protocols, discussion, opinions, and editorial letters were excluded. Studies not conducted in hospitals treating COVID-19 patients, studies not conducted with healthcare professionals as their focus, and studies not focusing on the risk factors for SARS-CoV-2 transmission among healthcare professionals were excluded from the review.

An initial literature search was conducted on four databases, the results of which were screened for duplication. Duplicates were excluded and the remaining articles were screened for abstracts and titles relevant to our research question. Articles with titles and abstracts not relevant to our research questions were excluded, and the remaining articles were reviewed in full text. Data were extracted, including study sample size and characteristics, aims, research methods and designs, and risk factors for SARS-CoV-2 transmission among healthcare professionals.

A total of 637 articles were identified using the predetermined search keywords on four scientific journal databases. After screening for duplications, 17 articles were removed. Subsequently, title screening was performed to determine the articles' relevance to our research question, after 573 articles were removed due to them being irrelevant to our research questions. Abstract screening was performed on the remaining 48 articles, and 18 articles were found to be eligible and retained for analysis.

Descriptive summary statistics were used to report the number of published studies. The search results are presented in a PRISMA diagram below (Figure 1). All studies were analyzed descriptively, and the findings were synthesized.

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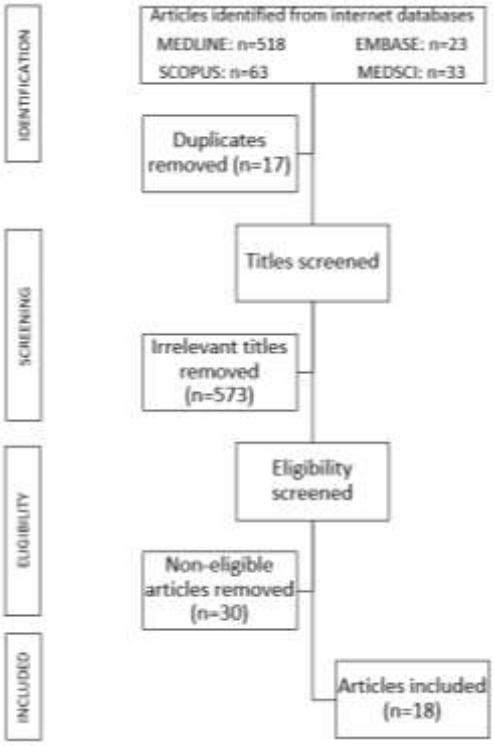
Figure 1. PRISMA Flow Chart



RESULTS AND DISCUSSION

Study Characteristics

Out of 18 total articles that were reviewed and analyzed, the study designs of the eligible articles mainly included retrospective cohort study (n=1), literature reviews (n=10) and systematic reviews (n=7). Countries where the articles originated included: 4 studies from China; 2 studies from India; 2 studies from Various African Countries as aggregate data; 2 studies from the Netherlands; and one study each from Turkey, Canada, Nepal, United Arab Emirates, Germany, France, USA, and Indonesia. All studies except one were exclusively focused on HCWs. The findings were summarized in Table 1.

Table 1. Findings from eligible articles

Author/Year	Country	Sample Characteristics	Design	Risk Factors Identified
(Ağalar and Öztürk Engin, 2020)	Turkey	Healthcare Providers (HCP); particularly lab workers	Literature Review	Use of personal PPE, hand hygiene, and precautions against close contact in high-risk procedures. In the laboratory setting: cleaning and disinfection of equipment, manual touchpoints
(Arora, Sardana and Sinha, 2020)	India	HCWs; particularly in dermatology practices	Literature Review	Proper use of PPE, adherence to social distancing protocols
(Bandyopadhyay *et al.*, 2020)	India	HCWs	Systematic Review	Shortage of HCW, lack of protocols and operating procedures to ensure the safety of HCW increase the risk of transmission of COVID-19 in HCWs
(Chersich *et al.*, 2020)	Various African Countries	HCWs	Systematic Review	Adequate protection against transmission (proper PPE, hand hygiene, infection control), systemic support such as the provision of proper PPE, establishment of policies prioritizing HCP for testing, treatment, and research for reducing transmission.
(Carlsten *et al.*, 2021)	Canada	HCWs	Literature Review	Hazardous work characteristics (including exposure to infected aerosols, lack of proper PPE, poorly-

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Author/Year	Country	Sample Characteristics	Design	Risk Factors Identified
				designed/poorly-ventilated workspace that did not facilitate social distancing, prolonged face-to-face contact); Being in high-risk demographics (elderly, comorbidities)
(Du *et al.*, 2021)	China	HCP	Literature Review	Lack of PPE and lack of awareness on the importance of personal protection were the main contributing factors in the early stage of the pandemics.
(Eijkholt *et al.*, 2021)	Netherlands	HCWs	Literature Review	Availability of proper PPE, potential duration of exposure to COVID-19, individual factors (age, body mass index (BMI), comorbidities).
(Giri *et al.*, 2021)	Nepal	HCP	Systematic Review	Inadequate and improper use of PPE increased the risk of transmission
(Gholami *et al.*, 2021)	United Arab Emirates	HCWs	Systematic Review	PPE, workplace setting, profession, exposure, contacts, and testing
(Gross, Mohren and Erren, 2021)	Germany	HCWs	Systematic Review	Shortage of PPE, insufficient knowledge and training related to safety precautions. Longer working hours were also reported to be associated with high risk of transmission
(Li *et al.*, 2020)	China	General populations, HCWs as subgroup	Systematic Review and Meta-Analysis	For the HCWs group, wearing masks was shown to have a reduced risk of infection by nearly 70%.
(Kaur *et al.*, 2020)	USA	HCWs	Literature review	Standard droplet and contact precautions (gowns, gloves, mask), working in high-exposure department, performing aerosol-generating procedures
(Patel *et al.*, 2021)	African Countries	HCWs	Literature review	Training and education on IPC played an important role in reducing the risk of transmission of COVID-19 among HCW
(Ran *et al.*, 2020)	China	HCWs	Retrospective Cohort Study	Working in high-risk department, longer work hours, suboptimal hand-hygiene after contact were associated with increased risk of COVID-19 transmission
(Romano-Bertrand *et al.*, 2020)	France	HCWs	Literature review	Lack of/inadequate PPE, high exposure to infected patients, work overload, poor infection control, presence of individual risk factors

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Author/Year	Country	Sample Characteristics	Design	Risk Factors Identified
(Verbeek *et al.*, 2021)	Netherlands	HCWs	Systematic Review	Proper use of PPE
(Widjaja, Shatri and Putranto, 2020)	Indonesia	HCWs	Literature review	Longer duty hours, performing high-risk medical or surgical procedures, hand hygiene
(Xiao *et al.*, 2020)	China	HCWs	Literature review	Poor institutional infection control measures, lack of awareness, lack of training in terms of infection control, poor compliance with PPE requirements, close contact in physical examination and therapy, performing procedures involving direct contact with patients' bodily fluid

Healthcare workers, as defined by the World Health Organization (WHO), refers to "all people engaged in actions whose primary intent is to enhance health" (Olum *et al.*, 2020). This group includes "doctors, nurses, midwives, paramedical staff, hospital administrators and support staff and community workers". They are more often expected to be in constant contact with the patients, sometimes in prolonged duration based on their specialty and unit (Eijkholt *et al.*, 2021). During the COVID-19 pandemic, the term HCWs has become synonymous with 'front-liners' in the battle against COVID-19. This poses occupational hazard of being infected with COVID-19 or even death (Bandyopadhyay *et al.*, 2020).

In this rapid systematic review, it was found that factors affecting the risk of transmission of COVID-19 can be divided into 5 categories. Those categories were use of personal protective equipment, proper infection control procedures, workplace practices, institutional support, and individual risk factors.

Use of Personal Protective Equipment

Fourteen out of the remaining 18 articles listed the use of personal protective equipment as a factor in the transmission risk of COVID-19 among healthcare providers. A previous study noted that wearing PPE in a proper and appropriate manner is paramount to reduce the risk of transmission. Properly-worn personal protective equipment provides protection against pathogenic agents in otherwise-exposed areas of the body and thus limiting the entryway for pathogenic agents to enter into the body (Arora, Sardana and Sinha, 2020). Standard protective equipment for droplet precautions, including gowns, masks, and gloves, could reduce the transmission risk of the SARS viruses (Kaur *et al.*, 2020). Another study reported that the risk of infection in HCWs could be reduced by 70% by wearing protective equipment, particularly masks (Li *et al.*, 2020). However, there was a report that while the use of PPE might reduce the risk of transmission, it did not fully eliminate the risk of transmission (Ağalar and Öztürk Engin, 2020).

The World Health Organization recommended the use of contact and droplet precautions when caring for patients with suspected, probable, and confirmed COVID-19. For aerosol-generating procedures, the WHO further recommended the use of airborne precautions (The World Health Organization, 2020). However, the transmission of COVID-19 among HCWs was also reported to be higher with improper and inadequate use of PPE (Giri *et al.*, 2021). This is due to the fact that PPE provides protection against pathogenic agents by covering otherwise-exposed areas of the body.

Proper Infection Control Procedures

Proper infection control procedures, particularly hand hygiene, has also been associated with SARS-CoV-2 virus transmission, as proper hand hygiene is expected to limit the number of bacteria transferred through physical skin contact. In our study, 7 studies listed proper infection control procedures as playing a role in lowering the COVID-19 transmission in HCWs. For example, a previous study

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found that poor hand hygiene practice following patient contact, especially in high-risk departments, poses a higher transmission risk of COVID-19 among HCWs (Ran *et al.*, 2020). Lack of other infection control procedures was also associated with higher risk among HCWs for transmission of COVID-19 (Bandyopadhyay *et al.*, 2020; Chersich *et al.*, 2020; Widjaja, Shatri and Putranto, 2020).

The WHO recommended the use of the 5 Moments of Hand Hygiene to prevent HCWs from spreading infectious agents through skin contacts (Nguyen *et al.*, 2020). As such, an increased transmission risk for infectious disease, especially COVID-19, has been linked to poor hand hygiene. Other infection control measures might include proper waste management and proper cleaning and disinfection of equipment (Ağalar and Öztürk Engin, 2020). Due to frequent medical procedures, equipment, surface and healthcare environment in general were at an increased risk of contamination with pathogens, especially the SARS-CoV-2 virus. Therefore, the healthcare environment should always be cleaned and disinfected properly in order to prevent transmission (Ye *et al.*, 2020).

Workplace Practices

Several factors related to workplace practices were also reported as risk factors for COVID-19 transmission among HCWs. Hazardous work conditions, such as poorly-designed and poorly-ventilated workspace, as well as workspace that did not facilitate social distancing presenting a clear transmission risk of the SARS-CoV-2 virus (Carlsten *et al.*, 2021). Similarly, another study also reported that workplace setting is a risk factor for COVID-19 transmission among HCWs (Gholami *et al.*, 2021).

In addition to poor workplace settings, shortages of staff were also found to be associated with the transmission risk of COVID-19 (Bandyopadhyay *et al.*, 2020). Shortages of staff necessitated healthcare professionals to work longer hours with increasing workload, which were already risk factors for the transmission of COVID-19 among healthcare providers (Ran *et al.*, 2020; Romano-Bertrand *et al.*, 2020; Widjaja, Shatri and Putranto, 2020).

Working in high-risk departments and performing high-risk medical and surgical procedures were also reported by 10 out of the analyzed 18 studies as risk factors for COVID-19 transmission among HCWs. High-risk procedures might include, among others, aerosol-generating procedures such as intubation, suctioning, bronchoscopy, bag mask ventilation, invasive and non-invasive ventilation (NIV), and nebulization (Kaur *et al.*, 2020). Moreover, the duration of the high-risk procedure itself contributed to COVID-19 transmission among HCWs (Eijkholt *et al.*, 2021).

Previous reports suggested that hazardous workplace characteristics might present an increased risk of transmission, especially for vulnerable HCWs. These hazardous workplace characteristics included densely populated workplace, poorly-ventilated workplace, and poorly-designed work environment that hinders social distancing (Carlsten *et al.*, 2021). Previous studies found that transmission of the COVID-19 was linked to close contact between individuals in closed settings, and therefore a work environment that did not facilitate social distancing and provide proper air circulation further increased the risk of transmission (Fisher *et al.*, 2020).

Research conducted in 2016 showed that hypertension occurrence is linear with aging (Artiyaningrum, 2015). Age groups > 40 years old have a high risk of uncontrolled hypertension compared to the 18 - 40 years old age group. The elasticity of the arteries begins to decrease at > 40 years old, making it easier to narrow or stiffen due to plaque buildup and are susceptible to high blood pressure. During 18-40 years old, physical condition is still stable, the enthusiasm for doing physical activities is better, so that the health condition tend to be normal (Sutanto, 2011).

Institutional Support

Institutional support is also an important risk factor for COVID-19 transmission among HCWs. Provision of proper personal protective equipment and establishment of proper infection control protocols were reported to be associated with lower risk of transmission (Chersich *et al.*, 2020). In addition, lack of awareness on the transmission risk and health protocols were associated with higher risk of transmission among HCWs (Du *et al.*, 2021). Another study also reported risk of transmission tended to be higher in HCWs with lack of training and knowledge in terms of infection control measures (Gross,

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Mohren and Erren, 2021). Lack of testing for HCWs might also lead to asymptomatic workers spreading COVID-19 to patients and other HCWs, thus increasing the risk of transmission (Gholami *et al.*, 2021).

Previous study reported that institutional support was important in preventing COVID-19 among healthcare providers. Provision of proper PPE in adequate numbers, as mentioned before, might reduce the risk of transmission from HCWs to patients, and from HCWs to other HCWs as well. Prioritizing HCWs in testing, treatment and research related to COVID-19 would help reduce the number of asymptomatic carriers and in turn would reduce the risk of transmissions among HCWs (Chersich *et al.*, 2020). Institutional support in the form of providing training and sufficient knowledge for HCWs related to infection control and safety procedures has also been found to lower transmission risks, as HCWs who have been trained were more likely to be compliant with the established health protocols (Gross, Mohren and Erren, 2021).

Individual Risk Factors

There are three out of 18 analyzed studies that listed individual risk factors in HCWs. These studies concluded individual risk factors as risk factors for the transmission of COVID-19 among HCWs. These individual risk factors included age, BMI, and the presence of other comorbidities (Carlsten *et al.*, 2021; Eijkholt *et al.*, 2021).

Individual risk factors for COVID-19 transmission were especially in vulnerable populations. COVID-19 tended to be more severe in old age and with people with other comorbidities such as obesity, diabetes mellitus, hypertension, cardiovascular disease, kidney disease, COPD, asthma, etc, and thus, HCWs with these conditions were at a higher risk of being infected with COVID-19 (Carlsten *et al.*, 2021). Other individual risk factors that might also affect the risk of transmission included individual compliance to health protocols. Lack of individual compliance was associated with higher risk of transmission among HCWs (Xiao *et al.*, 2020).

Reported Infection and Mortality Rates

There have been 152.888 cases of COVID-19 infection in HCWs, with 1413 among them resulting in death (Bandyopadhyay *et al.*, 2020). Another study reported that as of April 2020, there were 10.000 cases of COVID-19 infection in Italian HCWs, with 74 cases resulting in death (Chersich *et al.*, 2020). Similar study also cited that 3300 HCWs in China have been infected, and the rate was approximately 20% in Italy (Gross, Mohren and Erren, 2021). Similarly, a total of 1716 HCWs were infected by COVID-19 in China by February 2020 (Ran *et al.*, 2020). A report from the China CDC reported 3387 cases of COVID-19 infection among HCWs. They also cited WHO situation report stating that 22,073 cases of COVID-19 infection in HCWs have been reported globally (Xiao *et al.*, 2020). Another study reported 515 HCWs deaths due to COVID-19 as of July 2020 (Kaur *et al.*, 2020), while another reported in 2020 that at least 40 HWCs have died due to COVID-19 in Indonesia (Widjaja, Shatri and Putranto, 2020). Unfortunately, none of the analyzed articles reported the exact prevalence of COVID-19 infections among healthcare workers.

The results of this review highlight the need for special attention to those risks in clinical practice, especially regarding the proper use of PPE, and proper infection control procedures. From administration point of view, hospital leadership are recommended to create policies that ensure safe practices in their organizations, including practices in line with droplet precautions and COVID-19-related health protocols as determined by the Ministry of Health. Policies to ensure the provision of adequate and proper protective equipment, and policies to ensure that workspace and building requirements were in line with health protocols were also needed. Lastly, it may be necessary to mitigate risks for high-risk HCWs by limiting their exposure to the SARS-CoV-2 virus.

This study is not without limitation. First, only a little number of articles were analyzed in this study. However, the articles were screened using the PRISMA methods. Second, this systematic review did not particularly look at randomized clinical trials that provided quantifiable statistics for measuring risk factors, and as such could not be properly objectively quantified. Further studies are required to delve deeper into risk factors for COVID-19 transmission to stave off the infection and mortality rate among HCWs, especially considering that the pandemic remains ongoing with no end in sight.

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CONCLUSION

The use of PPE, infection control procedures, workplace practices, institutional support, and individual risk factors were the main risk factors for COVID-19 transmission among HCW. Every stakeholder should be involved to manage these risk factors in order to reduce COVID-19 transmission. Proper use of PPE, compliance to proper infection control procedures, establishment of safe workplace practices, provision of institutional support for prevention measures, and lack of individual risk factors should be encouraged as prevention measures.

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