REVIEW

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Factors affecting the occurrence of covid-19 transmission on health workers: a literature review

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ABSTRACT

Introduction: The COVID-19 pandemic has a serious impact on health care workers both physically and psychologically since they become more susceptible to COVID-19 infection due to frequent exposure to individuals infected by COVID-19, work pressure, inadequate conditions of protective equipment, and the accuracy of decision making. This study aims to identify factors affecting the spread of COVID-19 in hospitals.
Methods: The study used the literature review method, with article searches on five databases, namely PubMed, EBSCOhost, MEDLINE, ProQuest, and google scholar. The searching process for articles used keywords, including related word synonyms and MESH. The number of the research articles identified included PubMed, EBSCOhost, MEDLINE, ProQuest and google scholar, with 1302. The next step was to use prism chart analysis and select 15 journals that met the inclusion and predefined exclusion criteria.
Results: The research analysis results showed that the health workers who were most affected by the COVID-19 transmission were the nursing profession. Factors that influenced the message of COVID-19 in hospitals included internal factors, such as comorbidities, work experience, education and training, stress, hand hygiene, and external factors: hospital environmental design, reduction of personal protective equipment, culture and ethnicity, government policies.
Conclusion: The COVID-19 pandemic that has not ended requires changes in the design of care facilities, culture, the behavior of health workers, government policies that can break the chain of transmission of COVID-19 to health workers in hospitals.

Keywords: COVID-19, Health Workers, Transmission.
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INTRODUCTION

The 2019 coronavirus disease outbreak (COVID-19) is a highly contagious disease caused by Coronavirus 2 (severe acute respiratory syndrome) (SARS-CoV-2). SARS-CoV-2 is a virus variant that has never been identified in humans.[1] Coronavirus is known to cause severe respiratory symptoms, including Middle East Respiratory Syndrome (MERS) and severe acute respiratory syndrome (SARS). Symptoms of acute respiratory distress, such as fever, cough, and shortness of breath, are common signs and symptoms of COVID-19 infection. In general, coronavirus incubation lasts five to six days, with the longest incubation period being fourteen days. COVID-19's most severe symptoms can result in pneumonia, kidney failure, acute respiratory problems, and even death.[1]

As of July 9, 2020, the number of cases has been rapidly increasing and covering a wide range of countries in a relatively short period. WHO (World Health Organization) confirmed 11.84.226 cases with 545.481 deaths worldwide (Case Fatality Rate/CFR 4,6%). The COVID-19 pandemic has had a physical and psychological impact on health care workers.[2] Due to their frequent contact with affected individuals, health care workers are more vulnerable to COVID-19 infection than the general population. Health care workers have been asked to work under stressful conditions, without adequate protective equipment, and to make difficult decisions with serious consequences. Globally, health and social systems are currently struggling.[2] This situation is difficult, especially in a humanitarian context, particularly in fragile low-income countries with already weakened health and social systems. According to the World Health Organization, one out of every ten health workers is infected with coronavirus in some countries.[2] In March 2020, 9% of the people in Italy who got affected by COVID-19 were health care workers.[3] The International Council of Nurses reported in May 2020 that the COVID-19 pandemic had infected at least 90,000 health care workers and killed over 260 nurses. By March 2020, one in every four doctors in the UK would have died caused by the illness, exile, or caring for a family member infected with COVID-19. Several countries have expressed concern about increasing the cost of personal security.[4] In China, insufficient staff training, a lack of PPE, a lack of understanding of PPE use, and ambiguous PPE guidelines have resulted in infections and deaths among healthcare workers.[5] Several countries

have reported deaths of nurses and doctors due to COVID-19; as of May 2020, at least 260 nurses had died caused by COVID-19. At least 50 doctors were reported to have been killed from COVID-19 in Italy in March 2020.[6]

Based on the reasons stated above, the authors are interested in conducting literature review research from studies that have been completed and published in reputable scientific journals from both outside and inside the country. It aims to conclude the factors influencing COVID-19 transmission to frontline health workers to reduce the impact and mortality during the COVID-19 pandemic. Given that the COVID-19 pandemic has not ended, the number of health workers who have died due to contracting COVID-19 is increasing, despite improvements in officer PPE and large-scale social restrictions to break the chain of transmission of COVID-19. Furthermore, as the government has not lifted the disaster alert, the literature review titled "Factors Influencing the Decline of COVID-19 in Health Workers on the Front Lines" is critical to study.

METHODS

Sources of information and literature searches

This literature review was created by conducting a systematic data search from international and national research journals published from PubMed sources, EBSCOhost, Science Direct, ProQuest, and Google Scholar, using keywords: COVID-19, health officers, influencing factors. Additional searches for gray literature were also conducted, including investigations on government and non-government websites such as the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) in the United States. The searching process used some keywords such as COVID-19 transmission OR SAR-CoV-2 transmission OR coronavirus transmission AND health workers OR nurses OR physicians OR medical doctor AND influencing factors OR impacting factors.

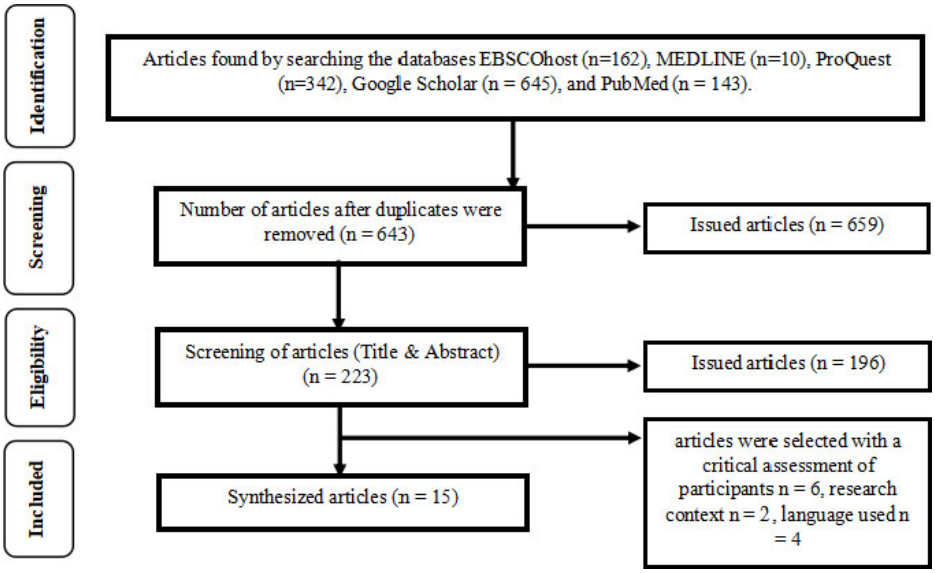

Figure 1. Prism diagram chart.

Inclusion Criteria and Screening Process

Article searches were conducted using journal selection criteria, including the publication from December 2019–December 2020, free paper, journal discussion on the issue of COVID-19 transmission to officers, clear research methods, and articles in Indonesian and English. We created prior screening criteria for each of the three stages: title, abstract, and full text. Two researchers independently screened articles. Disagreements in the two researchers' understanding results were resolved through discussion. The synthesized systematic search for articles in this literature review was described in a prism diagram chart below, which refers to the systematic review prism diagram illustrated in Figure 1.

RESULTS

The majority of the 15 articles reviewed were experimental studies (and = 10) with a total sample of 11,495 people divided into doctors (n = 1615), nurses (n = 8128), and medical technicians (n = 1615). In terms of non-experimental research (n = 1), the most research sources and origins came from Asia (n=5), America (n=4), Africa (n=3), and Europe (n=3), with 86 medical record data in two teaching hospitals and a literature review (n = 3) with a total of 43 reviewed articles. The hospital's research facility was divided into high-risk transmission rooms, operating rooms, infectious disease care rooms, intensive care rooms, emergency care rooms, non-risk categories, administration rooms, and management offices.

MIND MAP

The researchers summarized and created a framework that describes the findings and information that refers to the social-ecological model after screening and analyzing the articles reviewed in the literature review, as shown in Figure 2.[22]

Several factors that can influence COVID-19 transmission to frontline health workers have been reported in the literature, including officer factors, history of chronic disease (comorbid), work experience, handwashing culture, training history (including how to use and remove PPE), work stress, not obeying the use of masks, compliance with washing hands, and touching the face while working.[22] Nurses, doctors, and medical technicians are the factors of the type of health professionals, influenced by the kind of medical or nursing action performed and the number and length of contact with confirmed COVID-19 patients.[22] Environmental factors, workrooms with

Table 1. Research on factors affecting the occurrence of COVID-19 transmission on health workers.

Researcher & Year	Title	Respondent	Location	Results	Strength	Limitation	Description/ Opinion
Long H Nguyen et al. 2020[7]	Risk of COVID-19 among frontline healthcare workers and the general community, cohort study	Doctors, nurses, and medical technicians, as well as members of the public	UK, USA, using the mobile phone app	The findings of this study showed that nurses at the front lines of health care were more likely to be infected, that management must ensure the availability of adequate PPE, that service strategies must be redesigned during a pandemic, and that race and ethnicity required additional research	The selection process of the samples utilized many research methods, cohort study	Other confounding factors	Other confounding factors included the type of PPE used, work experience, specific type of work, PPE training, and length of contact with COVID-19 patients.
Malizgani Mhango et al. 2020[8]	COVID-19 Risk Factors Among Health Workers: A Rapid Review	HWCs/ dentists, nurses, general practitioners	South Africa, using PubMed, Google Scholar, and EBSCOHost	In conclusion, transmission to officers was caused by inadequate PPE and patient dishonesty at the beginning of the pandemic. Nurses were the most infected officers	Rapid review, dependable database	The number of extracted articles	The number of articles extracted is 11, with limited sources in three databases.
Noha Mohamed Rashed et al. 2020[9]	Risk assessment and management of exposure of health care workers in the context of COVID-19 in Egypt	HWCs/ Nurses, Doctors, laboratory workers	Egypt, Giza City Hospital	This study reports a high risk of COVID-19 to three clusters: (1) a group not wearing PPE with infected cases (20%); (2) health workers using PPE but do not have all of the equipment and are in contact with the patient's environment (20 to 35%); and (3) a high-risk group exposed to biological material accidents during interactions with COVID-19 patients (34%)	Descriptive research design	Other confounding factors	Other health workers, such as pharmacists, ambulances, others, and different types of PPE are underrepresented.
Mulusew Andualem Asemahagn et al. 2020[10]	Factors determining the knowledge and prevention practice of healthcare workers towards COVID-19 in Amhara region, Ethiopia: a cross-sectional survey	HCWs/ nurses, doctors	Ambara region of Ethiopia	In this study, most nurses had good knowledge but poor COVID-19 prevention practices. COVID-19 understanding is influenced by socio-demographic factors and access to information sources. Similarly, all constraints are housing, a lack of PPE, a heavy workload, comorbidities, knowledge, and access to training and guidelines.	A cross-sectional survey of research design	Other confounding factors	A large area uses the internet; however, not all officers can access it due to limited internet facilities.
Li Ran et al. 2020[11]	Risk Factors of Healthcare Workers with Corona Virus Disease 2019: A Retrospective Cohort Study in a Designated Hospital of Wuhan in China	Nurses, doctors	Wuhan University Hospital	Health workers who work in high-risk departments (HRD) and have poor hand hygiene after contacting patients were more likely to contract COVID-19. Longer working hours were found to be associated with a higher risk, particularly in HRD	Measuring multiple factors	Other confounding factors	The results are difficult to generalize due to the small sample size, single-center aspect, and unrepresentative research subjects.

Researcher & Year	Title	Respondent	Location	Results	Strength	Limitation	Description/ Opinion
Tsion Firew et al. 2020[12]	Protecting the front line: across-sectional survey analysis of the occupational factors contributing to healthcare workers' infection and psychological distress during the COVID-19 pandemic in the USA	Doctors, nurses, emergency medical technicians (EMS), non-clinical staff	USA	Overall, the findings supported the idea that there was a link between various risk factors and health care worker infection, with more recent studies identifying PPE adequacy, clinical setting, gender, and ethnic background as important factors in health worker infection	Cross-sectional survey, large sample size	The survey was conducted in a single language, via social media, and with limited access	Cohort research is more appropriate for investigating the factors that contribute to COVID-19 transmission in health workers.
Ying-Hui Jin et al. 2020[13]	Perceived infection transmission routes, infection control practices, psychosocial changes, and management of COVID19 infected healthcare workers in a tertiary acute care hospital in Wuhan: a cross-sectional survey	Nurses, doctors	Zhongnan Hospital of Wuhan University	PPE application technique (taking off and putting on), length of contact, and action procedure (suction, throat swab)	The cross-sectional and single-center study, measuring HRD and HRD in one survey	Other confounding factors	The study was only conducted in one hospital, with a small sample of doctors and nurses who had symptoms confirmed.
S. Rizza et al. 2020[14]	High body mass index and night shift work is associated with COVID-19 in health care workers	Doctors, nurses, and other health care workers who work at night	Tor Vergata University Hospital in Italy	According to the findings of this study, the risk of transmitting COVID-19 in hospitals is unrelated to the type of work (nurse/doctor) or clinical conditions. High vs. low-risk departments and obesity are the main risk factors for contracting COVID-19 in health workers.	A cross-sectional survey with a large sample size of 22,073 people was conducted.	There are no comorbid data (diabetes, cardiovascular disease, kidney failure), nor is the sample's gender known	Cohort research is more appropriate for investigating the risk factors that lead to COVID-19 transmission to employees.
Guven Celebi et al. 2020[15]	Specific risk factors for SARS-CoV-2 transmission among health care workers in a university hospital	Health professional at a teaching hospital	University Hospital in Turkey	Nurses, doctors, cleaners, non-medical areas, dining rooms, and meeting rooms are all available	Case-control study	Other confounding factors	The test did not use PCR but rather serum antigen, and it did not collect data on the frequency, duration, and intensity of exposure.
Y. Wang et al. 2020[16]	Super-factors associated with transmission of occupational COVID-19 infection among healthcare staff in Wuhan, China	Nurses and doctors working at Wuhan Hospital in China	Hospital of Wuhan China University	Wearing a mask and touching the face, nose, and mouth	Cross-sectional study	Other confounding factors	The sample size was small, as the study was conducted at the beginning of the pandemic, and the patients were comorbid.

Researcher & Year	Title	Respondent	Location	Results	Strength	Limitation	Description/ Opinion
C. Zheng et al. 2020[17]	Characteristics and transmission dynamics of COVID-19 in healthcare workers at a London teaching hospital	Professional staff, work area, ethnicity	London Teaching Hospital	Doctors, emergency rooms, non-medical staff (janitors, security administration, ambulance drivers), vulnerable European ethnicities, lack of PPE, experience, training, infection control	Cross-sectional study	The sample contained no comorbid data, and workload data was a factor that could cause data bias	Cohort research is more appropriate for investigating the risk factors that lead to COVID-19 transmission in health workers.
Lan, Fan-Yun et al. 2020[18]	Work-related COVID-19 transmission in six Asian countries/areas: A follow-up study	Health workers who were in 6 Asian countries	China	Health workers (22%), drivers and transportation workers (18%), service and sales workers (18%), cleaning and household workers (9%), and public safety workers (7%) were the five occupational groups with the most cases.	Observational study	Other confounding factors	Descriptive data analysis, a large number of samples, and a large geographical area encompassing six countries
Edith Lahner et al. 2020[19]	Prevalence of Sars-Cov-2 Infection in Health Workers (HWs) and Diagnostic Test Performance: The Experience of a Teaching Hospital in Central Italy	Health workers in hospitals (doctors, nurses, and other staff)	Italy, educational center hospital	Health workers are less likely to become infected than the public.	A cross-sectional study on the retrospective data	Other confounding factors	Health workers who do not accurately report the type of examination with a rapid antigen test on positive COVID-19 patients will not obtain accurate data.
Roger Chou et al. 2020[20]	Epidemiology and Risk Factors for Coronavirus Infection in Health Care Workers, A Living Rapid Review	Databases such as PubMed, MEDLINE, and Elsevier Embase (from 2003 to 27 March 2020)	USA	Coronavirus infections, including SARS-CoV-2, pose a significant risk to healthcare workers. PPE and infection control training was linked to a lower risk of disease, while certain exposures were linked to an increased risk	Rapid review	Other confounding factors	Limited database, the types of reusable PPE are not included in the risk factors.
Matthew F. Chersich et al. 2020[21]	COVID-19 in Africa: care and protection for frontline healthcare workers	Databases such as MEDLINE and PubMed	Africa	PPE of high quality, employee welfare, and strict inspection control	Literature review	Inadequate number of databases, type of work, workload, and research journal limitations	Many databases will make it easier to collect journals, workload or working hours, and the type of work done by officers that cost risks.

a high risk of COVID-19 exposure, such as emergency rooms, intensive care units, internal and pulmonary disease care units, operating rooms, and rooms with low stakes, such as treatment rooms that do not treat COVID-19 patients or supporting spaces, such as administration, management offices, laboratories, medical rehab, poor management of COVID-19 patient care rooms, ventilation facilities and negative pressure rooms, dining rooms and staff meetings, the availability of PPE, as well as the hours and workload of officers determining the length of contact with patients, are just a few of the factors influencing the high transmission of COVID-19 in officers.[22,23] Policy factors and government regulations governing supervision in the health sector, particularly in infectious diseases and the protection of health workers, ethnic and cultural factors, climate factors, and geography of an area, require additional research. The following is a detailed description of the literature review:[22,23]

Officer Factor

A study in the United States and the United Kingdom using a prospective cohort study method with a sample of 5,545 health workers using a mobile phone application for health workers in several hospitals concluded that professions on duty with long working hours and contact with patients who tested positive for COVID-19, as well as a high level of work stress, were risk factors for transmission.[7] On the other hand, the nursing profession is the health worker who is mostly at the forefront of COVID-19 patient care and has the highest risk factor, as patient care service procedures require direct contact with patients who have been confirmed positive COVID-19. This procedure includes physical assessment nursing,

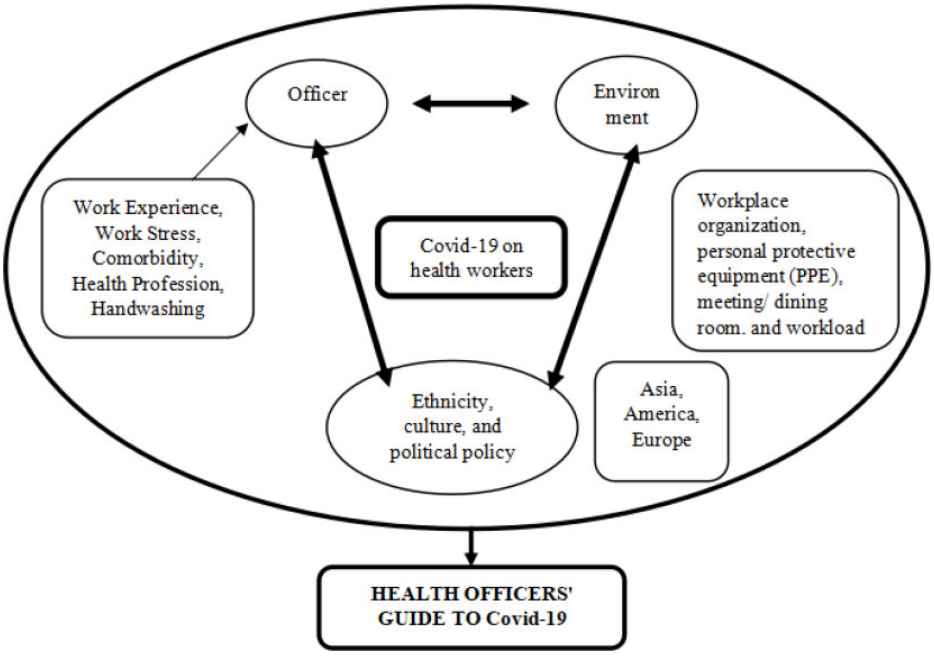

Figure 2. Research's framework.

assisting with patient feeding, performing sputum suctioning, and adjusting sleeping positions, all of which are nursing actions that can result in direct contact.[24] The problem that caused the high transmission rate in nurses was a lack of PPE in the early days of the pandemic, as well as a lack of knowledge and training for nurses on how to use PPE, according to research conducted at the Wuhan China hospital in the early days of the pandemic using the observational study method.[11] Workplace stress, high workloads, and other psychological effects are issues that health workers frequently encounter on the front lines of patient care.[12] Obesity and a busy night shift schedule for nurses on night duty are two factors that contribute to the transmission of deteriorating conditions to fellow officers compared to officers with proportional body weight and regular shifts. The study used a cross-sectional survey method at the Vergata Hospital in Italy.[14] Furthermore, diabetes mellitus, hypertension, cancer, and cardiovascular comorbidities can worsen the impact of COVID-19 on hospital workers.[25]

Work Environment Factors

According to the study carried out at the Ethiopian Ambara hospital, the characteristic of the work environment is one of the factors that greatly influence the spread of COVID-19 transmission to health workers, with the arrangement of closed rooms and a lack of ventilation using air conditioning that becomes a current condition of hospitals around the world.[26] Furthermore, according to research conducted at Turkey Teaching Hospital using the case-control method, the dining room and staff meeting room are two areas in the hospital that are prone to officer cross-infection during a pandemic due to the design of the room and the use of unsuitable masks when officers take a break to eat.[7] The redesign of the work environment for dealing with patients with viral infections is an immediate step toward breaking the chain of transmission in hospitals. Hospital designs for viral infectious disease rooms use open ventilation with good circulation or the negative pressure room method.[22] In research utilizing the literature review method conducted by the University of South Africa and cross-sectional study in the state of Colombia, the United States of America on 3,083 online samples, Government policies, particularly those in the field of health, have a significant impact on health services and the country's approach strategies in dealing with the COVID-19 pandemic.[12] Vaccination policies, social restrictions, and quarantine for officers infected with COVID-19 will significantly impact officers' and public transmission.[8]

Factors of Political Policy, Ethnicity, and Race

Research conducted at the beginning of the pandemic at several hospitals in the UK and USA using the cohort study method revealed significant relationships between ethnicity and higher transmission of COVID-19 among Asian and African ethnicities than Caucasian. In contrast to the findings of a cross-sectional study conducted in India, it examines the relationship between race and the rate of transmission of COVID-19. The study revealed no close relationship between the two aspects. Given the growing number of Caucasian-race cases in several countries, more research is required.[7,27] Regulations for dealing with outbreaks that are still different and inconsistent have increased in cases of COVID-19 transmission in several countries, which impacts officer transmission.[23] As it is the policy of a country's health authority, providing vaccines and strict social restrictions and quarantine for migrants traveling from the red zone of COVID-19 is one of the factors that can reduce the number of COVID-19 sufferers in a country.[28] It is critical in preventing and breaking the COVID-19 transmission chain.

DISCUSSION

The literature review findings indicate that understanding the transmission process and the risk factors that most influence the transmission of COVID-19 to health workers at the forefront of COVID-19 services is critical in preparing officers who will provide health services to the community. This prevention aids of transmission to officers were carried out by maintaining the condition of officers who were truly prepared to deal with a large number of patients during a pandemic with a moderate level of mental stress and have training experience in the use of personal protective equipment.[21]

According to a study by the Swiss Epidemiological Survey Institute using the systemic method of meta-analysis of the results of the throat swab examination of health workers (reverse transcription-polymerase chain reaction), nurses were

the most frequently infected personnel (48%, 95% CI: 41,56), whereas the majority of COVID-19 positive medical personnel worked in the hospital's non-emergency wards during screening (43%, 95% CI: 28.59).[24] Understanding the nursing profession as a health worker who is most at risk of contracting due to prolonged contact with patients or a heavy workload will assist care managers in developing schedules and care service strategies that reduce contact time and work stress while maintaining patient safety as a priority. The Centers for Control of Infectious Diseases (CDC) in the United States provides services in the sick health cycle that explain the healthy and ill circle influencing each other, environmental factors, individuals, and government policies.[7] Several studies have found that training and work experience have a significant impact on health workers' understanding of the process of treating infectious disease patients, which significantly impacts officers' ability to provide services that are both safe for patients and safe for staff.[23] According to research conducted in Wuhan, China, locations with a high risk of transmission in the hospital area are the area with the most activity, such as the emergency unit, operating room, intensive care, and infection care.[11] Several studies have also reported that obesity and comorbidities such as Diabetes Mellitus and cardiovascular disease influence transmission and worsen health workers' condition after being exposed to COVID-19. It aligns with research conducted in several countries with the highest mortality rate; India has 13.527.717 confirmed cases, while America has 30,772,857 confirmed cases.[29] With the highest number of deaths among health workers, comorbid factors, particularly diabetes mellitus, are to blame for the high mortality rate factor among COVID-19-infected health workers. Several studies reported that ethnicity, skin color, and gender affect the complications of COVID-19 transmission to officers. This research was conducted in the early days of the pandemic, where many health workers in Asia were exposed to COVID-19 in early 2019. Changes occurred at the beginning of 2020, when the process of spreading development entered America and Europe, with the death rate continuing to rise. Thus, ethnicity, race, the geography of an area, and culture still required further research. However, several studies have shown different results, which may be due to differences in the indicators used to measure COVID-19 transmission in each study.[30]

Furthermore, the possibility of type II error confirms the null hypothesis when the alternative view is correct. The setting of confounding variables also varies in research, explaining the variation in research findings reported by each article. The study results showed that more research would be done using a larger sample size and a broader range of factors to gather evidence.[15] The literature review results also showed that room settings affect the transmission of COVID-19. In general, hospitals worldwide currently use ventilation systems that are not prepared to deal with a pandemic outbreak, with many patients in an emergency room. Patients outnumber the hospital's capacity, causing the hospital to become overburdened in preparing a service system to serve patients.

About that, there are facilities in operation that can halt the transmission process. Officers no longer wear masks and communicate for more than 15 minutes in the officer's dining room, where there are many cross-transmission processes between officers.[15] This is consistent with research conducted at a tertiary hospital in North India on the factors causing COVID-19 transmission to officers. The study concluded that the elements were caused by "having food together" (lunch, tea, snacks) where the officer did not use a mask and the time was more than 15 minutes.[23] Government policies will have to assist in protecting health workers who work at the forefront of hospital services during health emergencies, such as a pandemic disease or natural disaster that can take a toll and cover a large area. Officers' health must be prioritized in evaluations where those with congenital diseases at high risk of contracting the COVID-19 virus are released from assignments in high-risk regions, preventing transmission and increasing the death rate of health workers.[31] Hand hygiene and compliance with mask use and not touching the face with hands when doing work in the hospital would help reduce the risk of infection.[13,31] Research conducted at the Wuhan China Education hospital revealed that the transmission process in health workers occurred due to health workers touching the face (cheeks, nose, lips). Face shields must be used when treating patients in rooms with a high risk of exposure, where masks alone are insufficient to protect staff.[31] The findings of this literature review also conclude that the type of action and duration of activity on COVID-19 patients increases the risk of transmission to officers whose work requires frequent contact with patients and lasts more than 5 minutes at a time. In general, this type of treatment is identified in nursing profession acts such as adjusting the patient's sleeping position, performing oral hygiene on intensive care patients, performing mucus swabs, performing basic care, and feeding the patient, which cannot be done without touching/contact with the patient.[13] In addition, further research is needed to compare the length of action and exposure to respiratory aerosols of patients in each risky treatment action. Specifically, it aims to identify the level of risk of exposure to each of these treatments and the mutation process of the SARS-CoV-2 virus, as the possibility of emerging new variations of this virus is very high.

CONCLUSION

Based on the findings of a literature review of 15 articles that were synthesized, it can be concluded that the transmission of COVID-19 in leading health care facilities was influenced by three major factors, namely officers, work environment, and government policies that regulate the health care system. Nurses who treated COVID-19 patients in emergency rooms, intensive care units, and inpatient rooms were among the frontline health workers who got infected with COVID-19 during the beginning of the pandemic. The limitation of this study was the number of data-based only three studies.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest in this study.

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ETHICS APPROVAL

Not applicable.

AUTHOR CONTRIBUTION

The contribution of Fitri Arofiati was searching for journals in various databases, analyzing journals and synthesizing journal analysis, and Feiby F Muntu Untu was conducting journal analysis and journal selection.

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