Meta Analysis Article

Factors Related to Occupational Safety of Health Workers

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ABSTRACT

The high mortality rate of medical personnel and health workers in Indonesia is among the highest compared to other countries, so efforts need to be made to implement medical safety and protection for medical health workers, so that they can continue to provide health services but remain protected and their safety is guaranteed as an effort to minimize the risk of Covid-19 transmission. This study aims to analyze the relationship between the use of PPE and negative pressure rooms in procedures that generate aerosols with the occupational safety of health workers in hospitals during the Covid-19 pandemic. This study uses a meta-analysis research design with a correlation meta-analysis research design. The search was carried out using the PRISMA diagram and using the PubMed, Science Direct, JAMA, and Google Scholar databases. By using a fixed effect model, the relationship between the use of PPE and occupational safety has a combined p value of 0.010, then the fixed effect model of the relationship between the use of negative pressure rooms and occupational safety produces a combined p value of 0.000. The conclusion of this study is that the use of PPE and the use of negative pressure rooms have a relationship with the occupational safety of health workers.

Keywords: Personal protective equipment, negative pressure rooms, health care workers occupational safety, SARS-Cov-2

INTRODUCTION

At this time the world is struggling with a pandemic caused by a new type of Corona Virus or Novel Corona Virus/2019-CoV/COVID-19.[1] Based on world health data, it has infected as many as 225,446,779 people worldwide, with 202,007,442 people having recovered from Corona, while 4,643,599 people have died. The country with the most patients is the United States, with a total of 41,853,362 cases, a total recovery of 31,871,868 and a total death of 677,988 people, followed by Brazil with a total of 20,999,779 cases, with 20,050,471 recovered and 586,882 deaths.[2]

The Corona virus or Covid-19 threatens everyone, including medical and other health workers who work at all levels of service throughout the world, including in Indonesia. According to the Ministry of Health (2021), the mortality ratio of medical personnel and health workers in Indonesia is among the highest in Asia. This means that for every 100 deaths there are around 6-7 health workers who died, until August 2021, there were 1,891 health workers who died during the Covid-19 pandemic with details of 640 doctors; 637 nurses; 377 midwives; 98 dentists; 34 nutritionists; 33 laboratory technologists, and 13 public health experts.[3]

Medical personnel as the front line in efforts to prevent the accelerated rate of COVID-19 have a high risk of transmission, so it is imperative that all parties pay attention to the safety of health workers. Occupational safety itself is a science and practice aimed at preventing accidents and occupational diseases caused by the work and environment. According to the American Society of Safety and Engineers (ASSE), work safety is

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defined as a field of activity aimed at preventing all types of accidents related to the work environment and situation. There are several theories of Occupational Safety and Health, including: The Three Main Factor Theory, which states that the cause of accidents is equipment, the work environment, and the workers themselves; The Two Factor Theory, says that work accidents are caused by unsafe conditions and unsafe actions; The human factor theory, emphasizes that in the end all work accidents, directly and indirectly, are caused by human error; Heinrich's Domino Seguence Theory, accidents result from a chain of sequential events, metaphorically like a line of falling dominoes. When one domino falls, it triggers the next, and the next, but removing a key factor (such as an unsafe condition or unsafe action) prevents a chain reaction from starting.[4]

Various control methods can be used to overcome the hazards of the work environment, especially in this pandemic, but technical control of the source of the hazard itself is considered the most effective and is the recommended first alternative, while the use of Personal Protective Equipment (PPE) is the last option. One of the efforts in the framework of providing labor protection for Occupational Safety and Health in hospitals is by providing PPE. Provision of PPE to workers is a last resort if engineering and safe work practices have been maximized, in addition to patients who transmit infectious diseases, especially those transmitted through the air. so that germs and viruses will not contaminate the outside air in a negative pressure isolation room.[5]

Personal Protective Equipment (PPE) is used in surgical procedures and procedures on patients with suspected/probable/confirmed COVID-19, aerosol-generating activities (intubation, extubation, tracheotomy, cardiopulmonary resuscitation, bronchoscopy, NGT insertion, gastrointestinal endoscopy, dental and oral care) for suspected/probable/confirmed COVID-19 patients, namely headgear, eye and face protection (face shield), N95 masks or equivalent, scrub clothes/guard clothing, coveralls/dress and apron, latex surgical gloves and boots/shoes rubber with shoe protectors (Kemenkes RI, 2020). The main purpose of using PPE during the Covid-19 pandemic is to protect health workers and patients from cross-contamination of the Corona virus.[6]

Negative pressure room, used for infectious diseases, especially those transmitted through the air to prevent germs and viruses from contaminating the outside air. This measure aims to prevent the spread of disease and break the chain of trasmission. This room is called a negative pressure room because the air pressure inside the room is lower than the air pressure outside the room. This means that when the door is opened, potentially contaminated air or other harmful particles from inside the room will not flow out into the uncontaminated area.[7]

The high mortality ratio of medical personnel and health workers in Indonesia is among the highest compared to other countries, it is necessary to make efforts to carry out medical safety and protection for medical personnel, so that they can continue to provide health services but are protected and guaranteed safety as an effort to minimize the risk of contracting Covid-19 virus. Steps and efforts to accelerate protocols and guidelines for the protection of dentists and other health workers in carrying out practice in hospitals must be supported by hospital leadership policies, in the form of policies for handling outbreaks/policies for handling extraordinary events Covid-19.[8]

Research on the use of PPE and negative pressure rooms shows varying results. The results of a study conducted by Robert Lenz (2020) stated that PPE can provide higher protection, but different results in Hyunju Kim's (2021) study, that the use of PPE is not associated with the incidence of COVID 19 infection in health workers. In a negative pressure room, the results of Miri Hyun's research (2020) said that there was a relationship when operations were carried out in a negative pressure room is associated with the occupational safety of health workers, while the results of Amy Hanzeirling's research (2020) found that a negative pressure room had no impact on preventing COVID-19 infection on health workers. Based on the problems and gaps in the negative research above, it is necessary to conduct research on the relationship between the use of PPE and pressure rooms in action with the work safety of health workers in hospitals during the COVID-19 pandemic.[9,10] This study aims to analyze the relationship between the use of PPE and negative pressure rooms in procedures that generate aerosols with the occupational safety of health workers in hospitals during the Covid-19 pandemic.

METHOD

This study uses a meta-analysis research design with a correlation meta-analysis research design. Meta-analysis is used to analyze empirical studies that have been carried out by previous researchers, quantitative research results, research results in a form that can be compared, for example, mean, correlation coefficient, RR and

Odds-Ratio. The independent variable (independent variable), the independent variable in this study is the use of PPE and a negative pressure room and the dependent variable in this study is the Occupational Safety of Health Workers. The study used CMA3 application to analyzed the data.

The research protocol uses the concept of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).[11]) The quality assessment of the article is based on the criteria of the Joanna Briggs Institute Checklist for analytical cross-sectional studies (JBI). JBI is an instrument to assess the methodological quality of a study and to determine the extent to which a study has addressed potential bias in its design, implementation and analysis. This instrument includes 8 questions with the answers Yes, No, Unclear, and Not applicable. The results of this assessment can then be used to inform the synthesis and interpretation of research results. Literature or articles that can be said to be good and valid to be used as research material if they get results above 50% of the research.

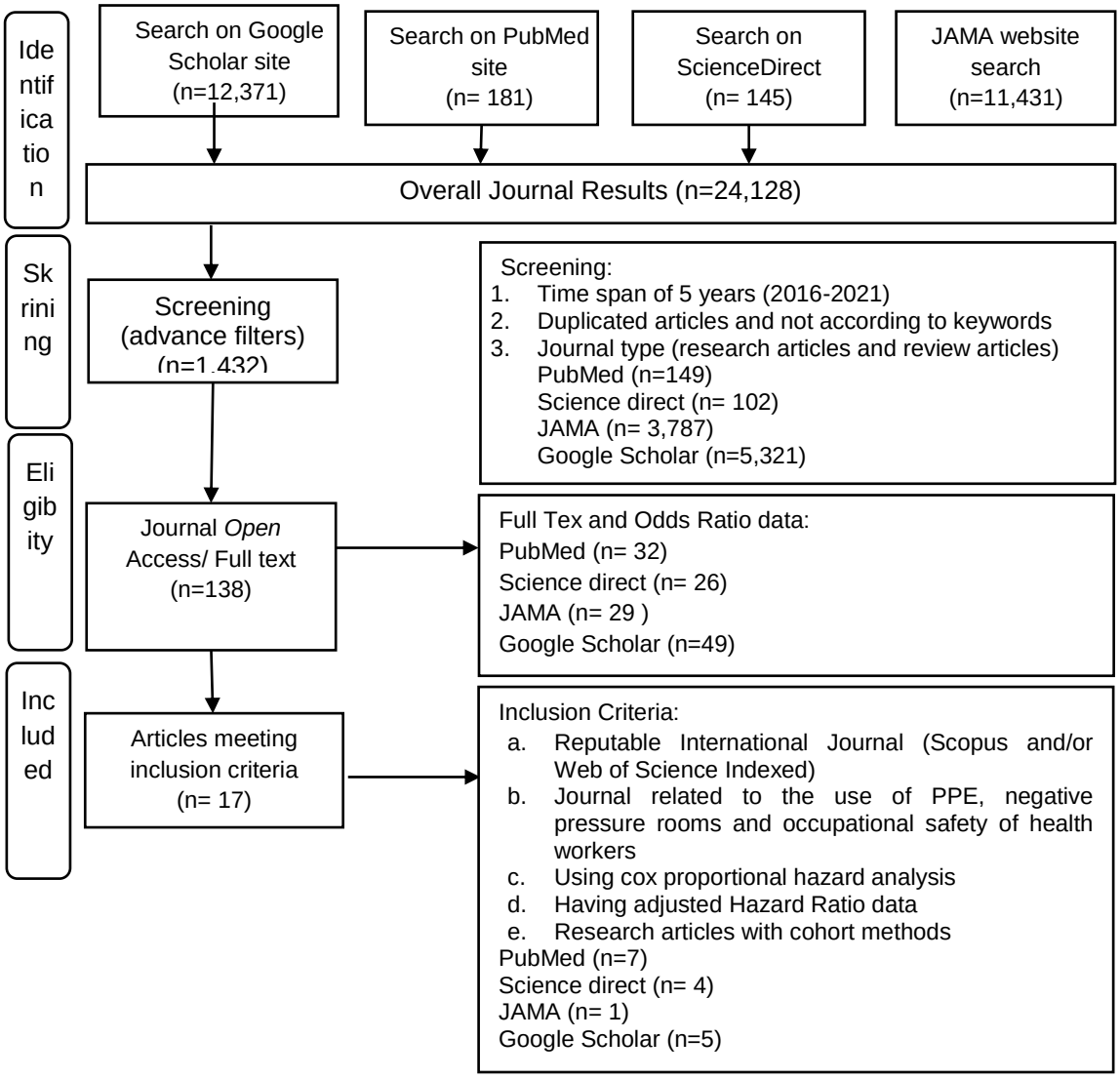

Figure 1. PRISMA Diagram

Data search refers to database sources, namely Pub Med, Science Direct, Google Scolar and JAMA which are adjusted to the research title. The keywords used to search for articles are "PPE", "Personal Protective Equipment (PPE) "Negative pressure room", "Negative pressure room", "Health worker occupational safety", "Health Employee Safety", "Covid-19",

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"Coronavirus", "SARS-CoV-2". Data screening in this study was carried out by searching for journals according to the keywords that have been explained. The journals searched for are journals accredited with a minimum of Sinta 3 for national journals and reputable journals for international journals. The journals were then selected according to the method and analysis test of at least 10 journals. The assessment of quality or eligibility is based on data (research articles) with full text by meeting the specified criteria (inclusion and exclusion criteria). Data quality assessment uses the Newcastle-Ottawa Scale instrument. All data (research articles) are in the form of quantitative research articles that meet all the requirements and criteria for further analysis.

Table 1. JBI Analysis

No	Author	Criteria								Result
		1	2	3	4	5	6	7	8	
1	Letz (2020)	V	V	V	V	V	V	V	V	8/8
2	Heinzerling (2020)	V	V	V	V	-	V	V	V	7/8
3	Baker 2021	V	V	V	V	V	V	V	V	8/8
4	Atnafie S (2021)	V	V	V	V	V	V	V	V	8/8
5	Asinyo ME (2021)	V	V	V	V	V	-	V	V	7/8
6	Bundgaard (2020)	V	V	V	V	-	V	V	-	6/8
7	hyunju K (2021)	V	V	V	V	-	V	V	V	7/8
8	Chatterjee (2020)	V	V	V	V	V	V	V	V	8/8
9	Pawinee (2020)	V	V	V	V	-	V	V	-	6/8
10	Ran (2020)	V	V	V	V	-	V	V	V	7/8
11	Miri Hyun (2020)	V	V	V	V	V	V	-	V	7/8
12	Aghazadeh Javad (2018)	V	V	-	V	-	V	V	V	6/8
13	Ashinyo ME (2020)	V	V	V	V	-	V	V	V	7/8

The quality of the study of each article that was determined as a reference for the systematic review was determined based on the quality analysis of the JBI critical assessment tool, so that 13 articles were obtained that were in accordance with the provisions of the systematic review and were checked according to the components of the questions mentioned previously. These were given a quality score of 5-6 sufficient, 7-8 good, in studies with articles using the JBI critical appraisal tools

RESULT AND DISCUSSION

The relationship between the use of PPE and the safety of health workers in hospitals during the COVID-19 pandemicen

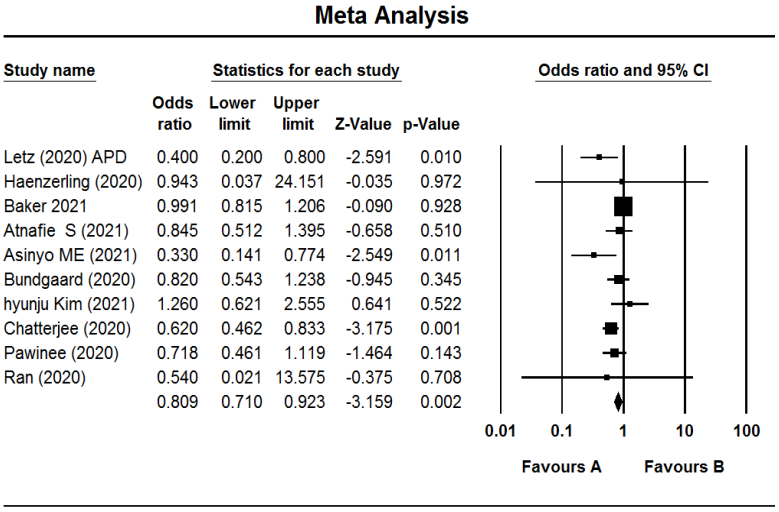

Figure 2. Forest Plot Graph of Relationship Between The use of PPE and The Safety of Health Workers

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The forest plot above shows the Odds Ratio (OR) of each study (black box) with its confidence interval (horizontal line) while the combined OR is depicted in the form of diamonds (black color).

Tabel 2. Effect Size of Combined Research

		Effect Size and 95% CI			Significant Test	
Model	**Number of Research**	**Combined Effect**	**Lower Limit**	**Upper Limit**	**Z**	**P**
Fixed	10	0,744	0,593	0,932	-2,566	0,010

In table 2, it can be seen that the analysis using the fixed effect model resulted in a combined ES value in the form of diamond of 0.744 (95% CI 0.593-0.932) with a significant test z-value = -2.566 p-value 0.010 because p-value <0.05 indicates the significance of the study, meaning there is a relationship between the use of PPE with the work safety of health workers.

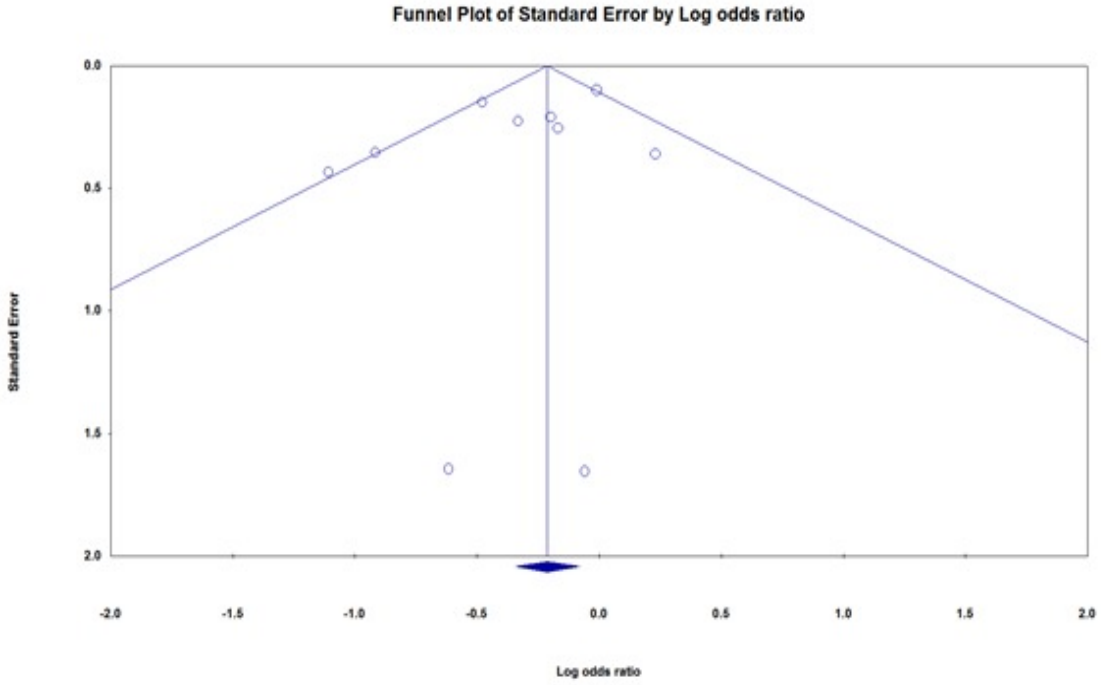

Figure 3. Funnel Plot Diagram of PPE usage Variable

According to Figure 3, the points are symmetrical with vertical lines, this indicates that there is no publication bias. The points below the curve and parallel to the curve indicate the ES tends to be accurate, while a point above the curve indicates the ES is less accurate.[12]

The results of the analysis of 10 journals on the relationship between the use of PPE and work safety found that 3 journals (30%) had a relationship, of the 5 journals that had a relationship, most of the results of the Phenomenon of Interest were health workers using personal protective equipment (PPE) at patient service centers, in this case hospitals. The results of the study analysis showed different variance and weight values. The test results showed low heterogeneity so that using a fixed effect model in measuring the combined effect of data in the data input model in the CMA3 application, the results obtained were OR = 0.809 with a 95% confidence interval of 0.710-0.923. The combined effect also produced a Z-value of -3.159 and a p-value of 0.002. Because the p-value <0.05 indicates the significance of the study, so there is a relationship

between the use of PPE and the work safety of health workers.

Ten (10) studies were analyzed with the results in Figure 1 forest plot

is the result of a synthesis in a meta-analysis that describes the conclusions drawn from several similar studies that are combined along with the ES value of each study and the combined ES value. In the forest plot there is a small black box shape (■) this is the estimated effect in each study and (-) the horizontal line in the small box is the 95% CI value, the narrow CI value horizontal line indicates good precision and is always more informative than a wide CI, if the sample is large then the horizontal line shape will be narrow. Then in the diamond shape (♦) which is the combined ES value of studies with a certain CI. From the 10 studies, the p-value = 0.000 <0.05 was concluded that there was a tendency for a relationship between the use of PPE and the occupational safety of health workers and the combined ES of the OR of the use of PPE with the occupational safety of health workers was 0.809 with a width of 95% CI lower limit of 0.710. and upper limit of 0.923. Therefore, the statistical test results indicated a relatively strong effect.

This study is the first meta-analysis study that analyzes the use of PPE and negative pressure rooms with the occupational safety of health workers in hospitals. For this reason, statistical analysis was carried out using meta-analysis to prove the quality of each study so that new quantitative data was obtained and more accurate conclusions could be drawn. The results of this study are in accordance with the study by Robert Lenz (2020) which examined the relationship between the use of PPE and occupational safety. The results of the study stated that there was a relationship between the use of PPE and occupational safety, namely the type of PPE was related to contamination with a value of p = 0.010.[9]. Another supporting study was conducted by Marlina (2021) on the use of PPE with occupational safety, stating that there was an effect of the use of complete PPE on the occurrence of clinical symptoms of COVID-19, p = 0.001 (p <0.05), the risk of COVID-19 is lower for health workers with very good use of PPE, considering that PPE can provide physical protection that can block the spread of respiratory droplets from infected individuals.[13]

In addition to looking at the magnitude of the combined effect of the 10 journals, publication bias also needs to be seen from the results of the funnel plot. Visually, it can be seen that the distribution of the funnel plot is symmetrical in the triangle area. Seen from the image 2 funnel plots, the distribution of the plot looks symmetrical in large samples and small samples. Research on large samples and small samples does not show publication bias, which means that the sample represents the population. In the variable of the use of PPE, there is a very small publication bias seen in the distribution of the plots that spread in the funnel plot image and are within the triangle line, only one is outside the triangle line.

Personal Protective Equipment (PPE) is a tool that has the ability to protect a person whose function is to isolate part or all of the body from potential hazards in the workplace. Protection of worker safety through technical efforts to secure places, machines, equipment, and the work environment must be prioritized.

According to OSHA or the Occupational Safety and Health Association, personal protective equipment is defined as a tool used to protect workers from injury or illness caused by contact with hazards in the workplace, whether chemical, biological, radiation, physical, electrical, mechanical and others.

According to the research results of Elena Savoia, et all (2020) entitled Factors Associated With Access And Use Of PPE During COVID-19: A Cross-Sectional Study Of Italian Physicians, there was a relationship between the use of PPE and exposure of doctors working in hospitals, [OR = 2.2 95% C.I. 1.7-2.8] and decreased risk perception [OR = 0.5, 95% C.I. 0.4-0.6].[14]

Every job always contains the potential for hazards in the form of work accidents. The magnitude of the potential for accidents and work diseases depends on the type of production, the technology used, the materials used, the layout and environment of the building and the quality of management and implementing personnel, related to the Covid 19 pandemic, the existence of PPE is very important. Health workers are at high risk of contracting Covid-19, this was stated by WHO that more than 10,000 health workers in 40 countries have been infected with Covid-19.[2] Among the reasons health workers are infected with Covid-19 is the lack of awareness of personal protection. Inadequate Personal Protective Equipment (PPE) and the readiness of the place.[15,16,17,18]

The relationship between negative spressure rooms and the work safety of health workers in hospitals during the Covid 19 pandemic

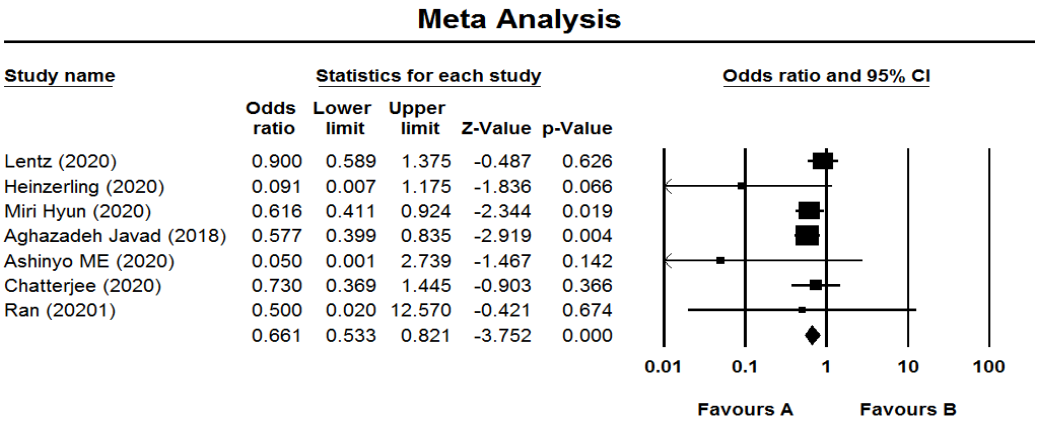

Figure 4. Forest Plot Relationship of Negative Pressure Room with Health Worker Safety

The forest plot above shows the Odds Ratio (OR) of each study (black box) with its confidence interval (horizontal line) while the combined OR is depicted in the form of diamonds (black color).

Table 3. Effect size of Combined Research

	Effect Size and 95% CI				Significant Test	
Model	**Number of Research**	**Combined Effect**	**Lower Limit**	**Upper Limit**	**Z**	**P**
Fixed	7	0,661	0,533	0,821	-3,752	0,001

Based on table 3 above, it can be seen that the analysis using the random effects model resulted in a combined ES value of diamond of 0.661 (95% CI 0.533–0.821) with a significant test z-value of -3.752 and p-value = 0.000. Because the p-value <0.05, statistically it shows a significant value, it means that there is a relationship between a negative pressure room and the work safety of health workers.

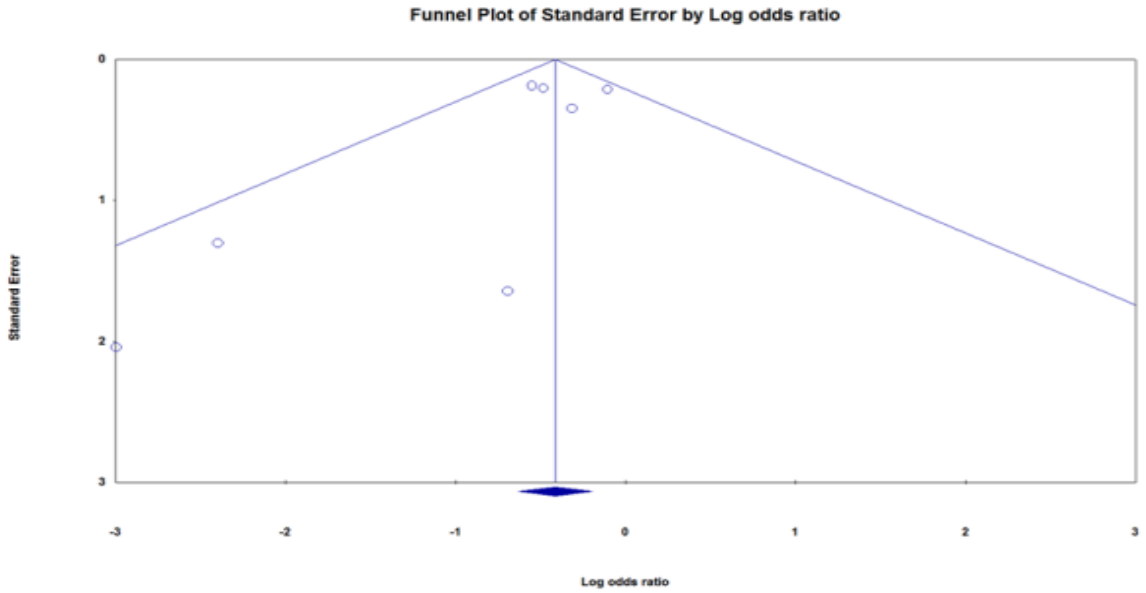

Figure 5. Funnel Plot Graph of Negative Pressure Room Variable with Health Worker Safety

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Based on Figure 5 the points are not symmetrical (asymmetrical) with a vertical line, this indicates that publication bias occurs. The dots (5 points) under the curve indicate that ES tends to be accurate, while there are no points (0 points) that are below the curve. over the curve, nothing indicates a less accurate ES.[12]

The results of the analysis of 7 journals on the relationship between the use of negative pressure rooms and work safety found that 2 (two) journals had a relationship, of the 2 journals that had a relationship, most of the results of the Phenomenon of Interest were the placement of patients suspected of being exposed to Covid 19 or SARS 2 were negative pressure rooms and actions that had the potential to cause aerosols, to reduce contact with professional officers and use PPE. Analysis of 7 (seven) studies showed different variance and weight values. The test results showed quite high heterogeneity so that using a random effect model in measuring the combined effects of data in the data input model in the CMA3 application. The results obtained were OR = 0.661 with 95% CI: 0.533 - 0.821. The combined effect also produced a Z-value of -3.752 and a p-value of 0.000 <0.05 and this means that the null hypothesis is rejected in other words there is a relationship between negative pressure rooms and work safety.

7 (seven) studies were analyzed with the results in Figure 4.3 forest plot is the result of synthesis in meta-analysis that illustrates the conclusions drawn from several similar studies that are combined along with the ES value of each study and the combined ES value. In the forest plot there is a small black box shape (■) this is the estimated effect in each study and (-) the horizontal line in the small box is the 95% CI value, the narrow horizontal line CI value indicates good precision and is always more informative than a wide CI, if the sample is large then the horizontal line shape will be narrow. Then in the diamond shape (♦) which is the combined ES value of studies with a certain CI. Analysis. The 7 (seven) studies produced a p-value = 0.000 <0.05 concluded that there is a relationship between negative pressure rooms and work safety and the combined ES of OR in negative pressure rooms with work safety of 0.661 with the width of the upper and lower CI limits of 0.533 - 0.821. So the results of the statistical test show a very high effect. Based on the results of the review, there were 5 (five) research journals or 71.42% stating that negative pressure rooms were not related to work safety, while 2 (two) research journals or 28.58% stated that there was a relationship between negative pressure rooms and work safety.

According to the Ministry of Health (2020), a negative pressure room is a specially designed room where the air inside the room is lower than the outside air. This results in no air coming out of the room, so that the outside air is not contaminated by the air from the service room, and the air in the room is continuously sucked and removed from the room.[8] Visually, the distribution of the funnel plot is symmetrical in the triangular area. As seen from Figure 4 of the funnel plot, the distribution of the plot looks asymmetrical with the vertical line, this indicates that there is publication bias. The points (6 points) that are below the curve and parallel to the curve indicate that the ES tends to be accurate, while there are no points (0 points) that are above the curve, none of which indicate that the ES is less accurate. Bias is a process of concluding each stage of research that tends to produce conclusions that are systematically different from the actual truth in the publication bias, the source is biased due to reference search bias, design bias, sampling bias, interview or examination bias and analysis bias. Due to limited documentation, not all biases can be obtained. Bias also occurs because the theoretical framework and conceptual framework with current knowledge updates. Design bias in experimental research is the presence of intervention, control, replication and random. Bias in analysis can also occur because researchers only discuss things that are significantly related (those that have a positive relationship). Publication bias is caused by different sample sizes, using different analyzes and synthesized studies from various countries in the world.[19]

Aerosol-generating procedures expose healthcare workers to high risk of transmission. Aerosol-generating procedures include airway suctioning, bronchoscopy, endotracheal intubation, tracheostomy and cardiopulmonary resuscitation. In a recent publication, according to WHO (2020) has included NIV as a reference for procedures that must be performed in a negative pressure room with a minimum of 12 air changes per hour or at least 160 L s−1 per patient in a naturally ventilated facility.[3]

Negative pressure rooms are essential to minimize the spread of coronavirus disease 2019 (COVID-19) in healthcare workers working in hospitals, the Covid 19 virus is too numerous and unknown to take even the smallest chance of spreading. But the need for such rooms can be overwhelming, which are not always ready to handle the influx of infected patients, let alone in large numbers due to the COVID-19 pandemic.[20]

Patients should be placed in an isolation room with negative pressure (at least 12 air changes per hour) with a dedicated bathroom and, if possible, an anteroom. If a negative pressure room is not available, choose a room with natural ventilation with an air flow of at least 160 L s−1 per patient. If a single room is not accessible, patients suspected of being infected with SARS-CoV-2 should be placed in the same room. Patient beds should be placed at least 1 m apart. It is essential that the area prepared to receive suspected patients is equipped with all necessary PPE. All patients should wear a medical mask. It is essential to limit the number of healthcare professionals who come into contact with confirmed or suspected COVID-19 cases. It is preferable to form a team of healthcare professionals who deal exclusively with suspected or confirmed cases to minimize the risk of transmission. It is recommended that all persons entering the patient's room, including healthcare workers and family members, reduce the use of wide doors. Awareness of aerosol-generating procedures is also key to preventing aerosol-mediated transmission of SARS-CoV-2 infection. Minimizing aerosol generation to the extent possible and taking measures to prevent exposure are essential to ensure the safety of the healthcare professional and other team members. When surgery is performed under negative pressure or by a trained surgical team, laparoscopic appendectomy can be performed under the principle of obtaining optimal clinical outcomes that can ensure the safety of health care providers and the hospital environment.[20]

CONCLUSION

In the study results, there are 10 journals for the variable of Use of PPE and as many as 3 studies or 30% state that there is a relationship while 7 studies or 70% of research journals state that there is no relationship between the use of PPE and work safety. The results of the meta-analysis are shown by the forest plot OR of each study (black box) with a combined OR of 0.744 and with a confidence interval of 95% (0.593 - 0.932). The heterogeneity test that was carried out produced an I2-squared of 48.100% and a p-value of 0.044 so that the random effect model was chosen and produced a combined p-value of 0.010 because the results showed that the use of PPE was related to the work safety of health workers.

In the study results, there were 7 (seven) research journals for the variable of the use of negative pressure rooms, as many as 2 research journals or 28.57% stated that negative pressure rooms were related to work safety, while 5 research journals or 71.42% stated that there was no relationship. The results of the meta-analysis are shown with the forest plot OR of each study (black box) with a combined OR of 0.661 with a 95% confidence interval (0.533 - 0.821). The heterogeneity test conducted produced an I2-squared of 10.324% and a p-value of 0.350 so that the fixed effect model was selected and produced a combined p-value of 0.000 because of these results, negative pressure rooms have a relationship with the occupational safety of health workers.

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