

Review

Understanding of Nanofiber Face Mask as Corona Virus Disease Prevention in Human

Tofan Agung Eka Prasetya^{1,*}, Indiah Ratna Dewi², Muhamad Rifki Taufik³ and Khandaker Fadwana Islam⁴

¹Health Department, Faculty of Vocational Studies, Universitas Airlangga, Indonesia

²Center of Leather, Rubber, and Plastics, Ministry of Industry, Republic of Indonesia

³Research and Development Center, Indonesian agency for Meteorology Climatology and Geophysics (BMKG), Indonesia

⁴Maternal and Child Health and Nutrition Research Project of Johns Hopkins University (Bangladesh), Bangladesh

Article history

Received: 30 March 2024

Revised: 27 April 2024

Accepted: 27 April 2024

Published Online: 30 April 2024

*Correspondence:

Tofan Agung Eka Prasetya

Address: Health Department, Faculty of Vocational Studies, Universitas Airlangga, Surabaya 60286, Indonesia.

Email: tof-an-agung-e-p@vokasi.unair.ac.id

How to cite this article: Prasetya TAE, Dewi IR, Taufik MR, Islam KF. Understanding of Nanofiber Face Mask as Corona Virus Disease Prevention in Human. *Health Dynamics*, 2024, 1(4), 134-141. <https://doi.org/10.33846/hd10405>



Copyrights: © 2024 by the authors. This is an open access article under the terms and conditions of the Creative Commons Attribution – NoDerivatives 4.0 International (CC BY-ND 4.0) license (<https://creativecommons.org/licenses/by-nd/4.0/>).

ABSTRACT

Background: Corona virus has become a global issue. It makes various countries have taken this outbreak very seriously. One of the necessary precautions is by using a face mask. The nanofiber technology on face masks greatly helps the public and government to increase the prevention of disease spread. The purpose of this study was to conduct a systematic literature review on nanofiber face masks as human corona virus disease prevention. **Methods:** Stages of systematic literature review of 632 documents was carried out using text mining techniques, while hierarchical cluster analysis were carried out for the extraction of terms in documents. **Results:** The terms "mask" and "nanofiber" were the most words that appear (more than 40 times) in the WoS and PubMed nanofiber mask document form. On the other hand, the terms "disease" and "respiration" mostly appeared in human corona virus disease prevention. Both of these terms were used to obtain specific articles as a basis for the study of nanofiber mask as human corona disease prevention. **Conclusion:** This study is very important since prevention measures against corona disease (corvid-19) are a very high concern. The next study is expected to bring this review literature into an experimental study of nanofiber applied to face masks.

Keywords: Nanofiber; Face Mask; Covid-19

1. INTRODUCTION

Diseases originating from viruses and bacteria are health problems that are still difficult to control.⁽¹⁾ Humans live side by side with them and are at risk of being infected for the rest of their lives.⁽²⁾ But despite all kinds of risks faced, humans are trying to develop various ways to prevent or survive from the Covid19. A report (11th February 2020) in China depicts that a total of 44,672 confirmed cases were reported from 1,386 counties of 31 provinces, autonomous regions, and municipalities.⁽³⁾

Today the world is faced with a new disease that comes from the corona virus family.⁽⁴⁾ This case is caused by the

Covid-19 which causes respiratory tract and other organ disorders.⁽⁵⁾ Most cases of infection and death occur in mainland China and have spread to various countries.⁽⁶⁾ WHO has made this case an international emergency on 30 January 2020 in which the vaccine has been tested and will be available for this disease at least at this end of 2020.^(7, 8) Although the case fatality rate was lower than SARS and MERS, but Covid-19 has killed more patients.⁽⁹⁾ The new virus spreads much more readily than the one that caused severe acute respiratory syndrome, or SARS (also a coronavirus), and has infected more than ten times the number of people who contracted SARS.⁽¹⁰⁾

Some infected patients have reportedly recovered.⁽¹¹⁾ Disease countermeasures and prevention have been disseminated and published by WHO and various health service centers around the world related to Covid-19.⁽⁴⁾ One of the suggestions from WHO to reduce the spread of this virus is to use medical masks in communities, at home, and in healthcare facilities in areas that have reported outbreaks caused by the 2019 novel corona virus (COVID 19).⁽¹²⁾

The types of masks currently available in the community include ordinary cloth masks, medical masks, and special masks (for example, the N95 respirator type mask). Of the various types of masks, the effectiveness of preventing viral infection from them is still being debated.⁽¹³⁾ Cloth masks or medical masks are the easiest to get. This is because besides being available in adequate quantities, the price is also affordable. However, the effectiveness of using any mask is still a big question in dealing with the transmission of the Covid 19 virus or other corona viruses.⁽¹⁴⁾

Nanofiber technology has been developed to improve mask efficiency.⁽¹⁵⁾ A study states that adding nanofiber to medical masks can increase its utility in dealing with infections of the respiratory tract.⁽¹⁶⁾ This systematic literature study wants to investigate more deeply about nanofiber mask and the prevention of corona virus disease in human. This study is the first step to ascertain whether there is a strong basis for nanofiber applications in medical face masks. The results of this study are very important as a reinforcement of corona virus prevention.

2. METHODS

The data used in this systematic literature review was based on the Web of Science (WoS) and PubMed search engine. First, the search terms were used are “nanofiber face mask” and “human corona virus disease prevention” as the main string to investigate. Second, the finding was only publication between 2010 and 2020, non-English and abstract only will be excluded. We specify with advance search by selecting the topic with “nano-fiber” string as a priority in terms of searching “nanofiber facemask” and “human corona virus” string as a priority in terms of searching “human corona virus disease prevention”. Third, data extraction was performed using text mining by the R program to present the characteristic of publication and statistical methods, such as term quantity, term replication, Hierarchical cluster analysis (HCA) (cluster dendrogram-unsupervised machine learning) and conclusion. Descriptive analysis was used to present the percentage and frequency of data characteristics.

As many as 75 documents were found based on WoS advance search engine and 557 were found based on the PubMed advance search engine. Text mining with R program was performed to investigate the term quantity, replication, and clustering. The results obtained from the analysis were set to find, specify, select, and understand the full-text material of nanofiber facemask as corona virus disease prevention in human.

Text mining started with data preparation that is importing text and string operation. Importing text (txt. File) was carried out from 632 documents abstract. String operation in this case was used to remove boilerplate content, stripping extraneous whitespace, and converting lowercase. A corpus of data and tokenization was built after importing text. The most replied term extracted from the analysis combined into term that will be the focus on for the next investigation. The cluster dendrogram was also applied to see the distance between observations and/or clusters.⁽¹⁷⁾

3. RESULTS AND DISCUSSION

These results provide an overview of the term frequency and distance of observation. All of these results were obtained and processed through the using of a systematic analysis with the text mining technique

and the R program. Based on Figure 1, it shows us a description that "mask" has a frequency of 61 times in the text of the document. "Nanofiber" is repeated 48 times. The terms "use" and "electrospun" are repeated

29 times and 30 times. The terms "fiber", "high" and "membrane" are repeated more than 10 times and are less than 20 times.

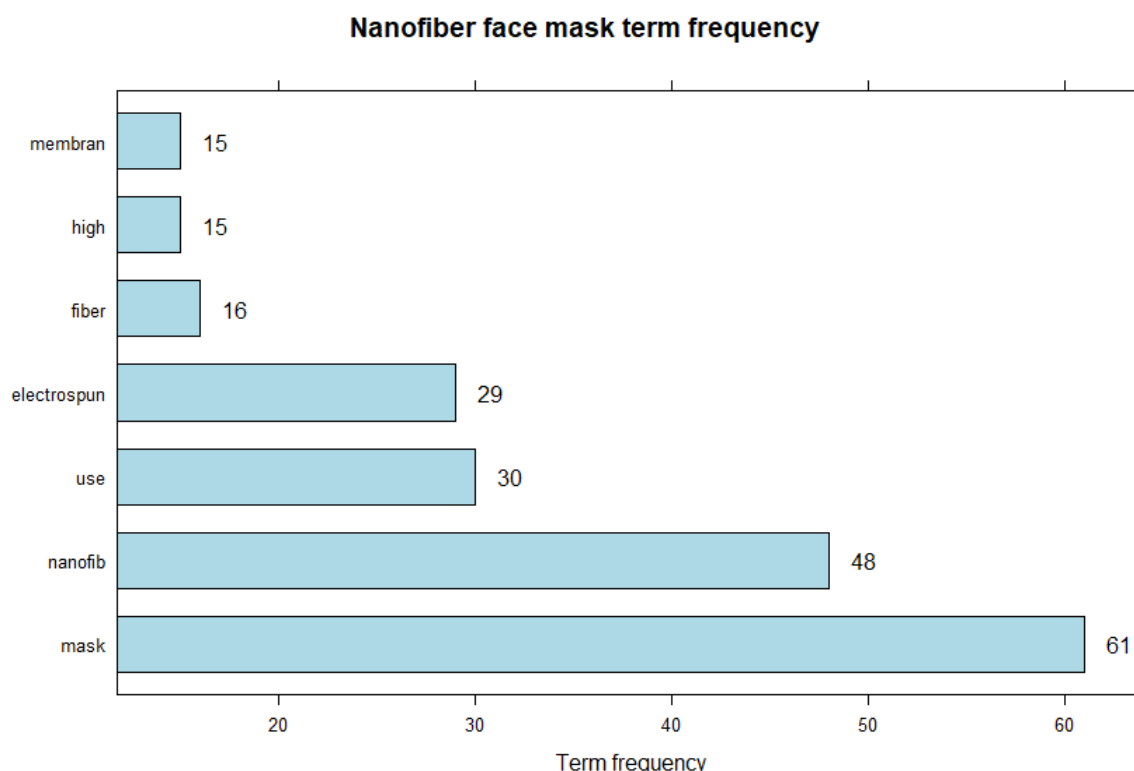


Figure 1. Nanofiber face mask terms frequency found in WoS and PubMed 2010-2020

Figure 2 shows that the terms "nanofiber" and "mask" are in the same cluster and have the highest difference compared to other terms (4-6 height). Meanwhile, the other terms that are in different clusters have lower distances (0-3 height). The Figure 3 illustrates that the terms "disease", "respiratory", "infect", "health" and "virus" are the most repeated in text documents about more than 1000 times and are less than 1600 times. The terms "merscov", "china", "coronavirus", "prevent", "control" and "center" are repeated more than 800 and are less than 1000 times. Based on Figures 1 and 3, five new terms are obtained from the string "nano fiber mask", namely "use", "electrospun", "fiber", "high" and "membrane". The new term of the string "human corona virus disease prevention" that is "respiration", "infect", "health", "virus" and "merscov". To simplify the search on search engines, two new terms that was most repeated were "mask nanofiber disease respiratory". Based on the search results on the two search engines, specific

articles were obtained which became the primary reference for the study of nanofiber mask as corona disease prevention in human.

Figure 4 illustrates that the terms "disease" and "detect" have a distance as far as 4 (height) compared to other terms. Other terms that belong to other clusters have a distance in the range 0-2 (height). It should be noted that the dendrogram cluster displayed is part of a very large dendrogram cluster that is not possible to display in full.

4. DISCUSSION

The case of Covid-19 infection has become a worldwide concern.⁽¹⁸⁾ WHO calls it a Public Health Emergency of International Concern.⁽¹⁹⁾ Some countries have raised awareness after many of their citizens have been infected by Covid-19.⁽²⁰⁾ Caring or curing action for those who have been infected and rehabilitation for

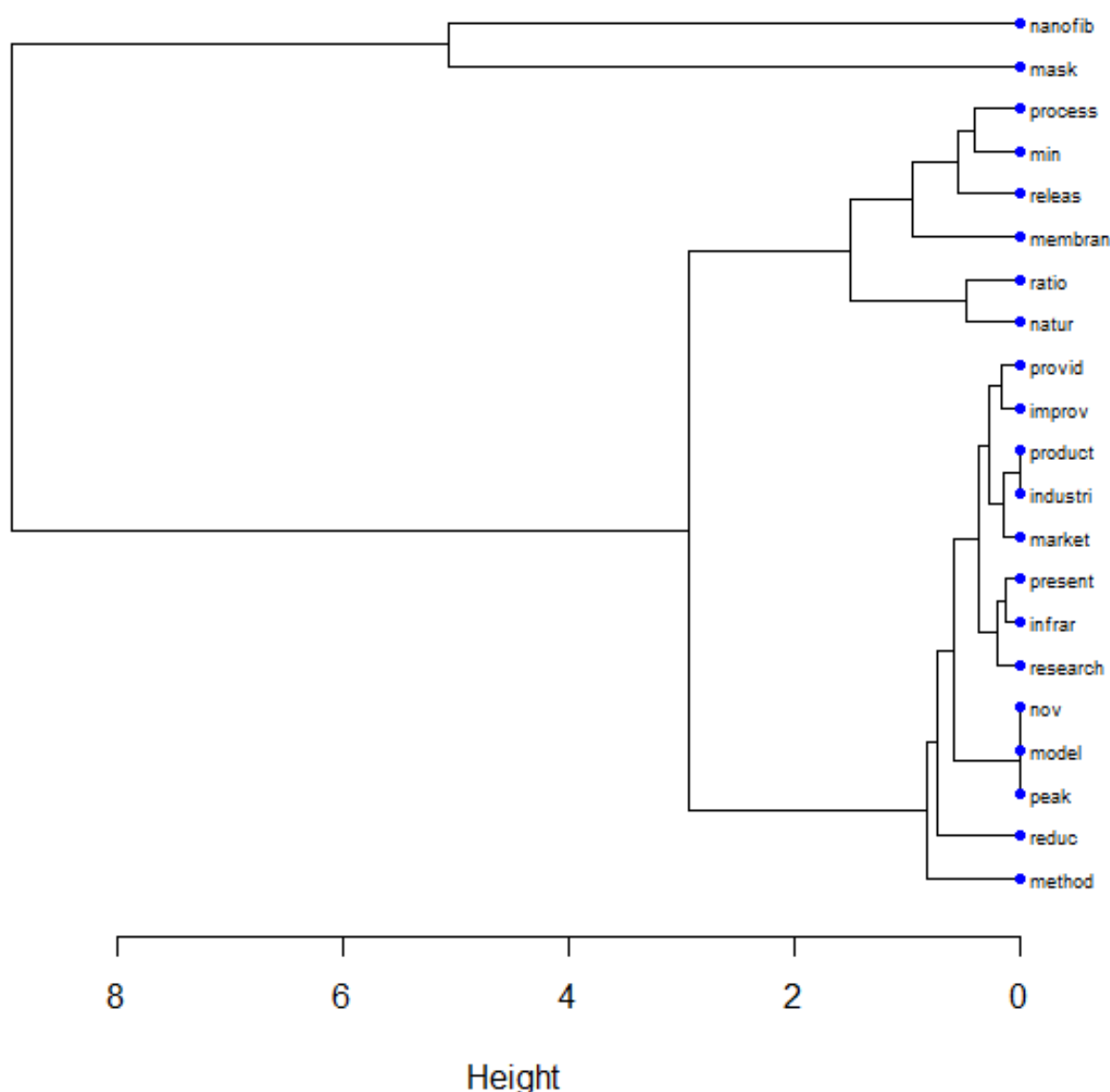


Figure 2. Cluster Dendrogram Nanofiber face mask terms found in WoS and PubMed 2010-2020

those who have recovered have been carried out to the maximum.⁽²¹⁾

Preventive action is the most important action at this time to reduce outbreaks of covid-19 infection.⁽²²⁾ Several steps that must be done include routinely washing hands and masks to prevent the transmission.⁽²³⁾ The use of masks is now very important since this virus can infect and spread through droplets that appear when a person sneezes.⁽²⁴⁾ Nowadays masks are becoming high-value medical equipment.⁽²⁵⁾ The function of medical face masks is to reduce exposure to bacteria and viruses or other hazardous material in the

air.⁽²⁶⁾ Various kinds of medical masks certainly have a variety of different specifications depending on their function and use.

One of the most used masks is medical face masks. This mask is commonly used in various medical services.⁽²⁷⁾ People can get it at various drug stores or pharmacies. The appearance of this mask consists of two parts, a white part and a blue or green part with hooks used to fasten it to the head or ears. At the top there is a kind of flexible metal whose purpose is to make the mask that attached right to the nose and around the face.⁽²⁸⁾

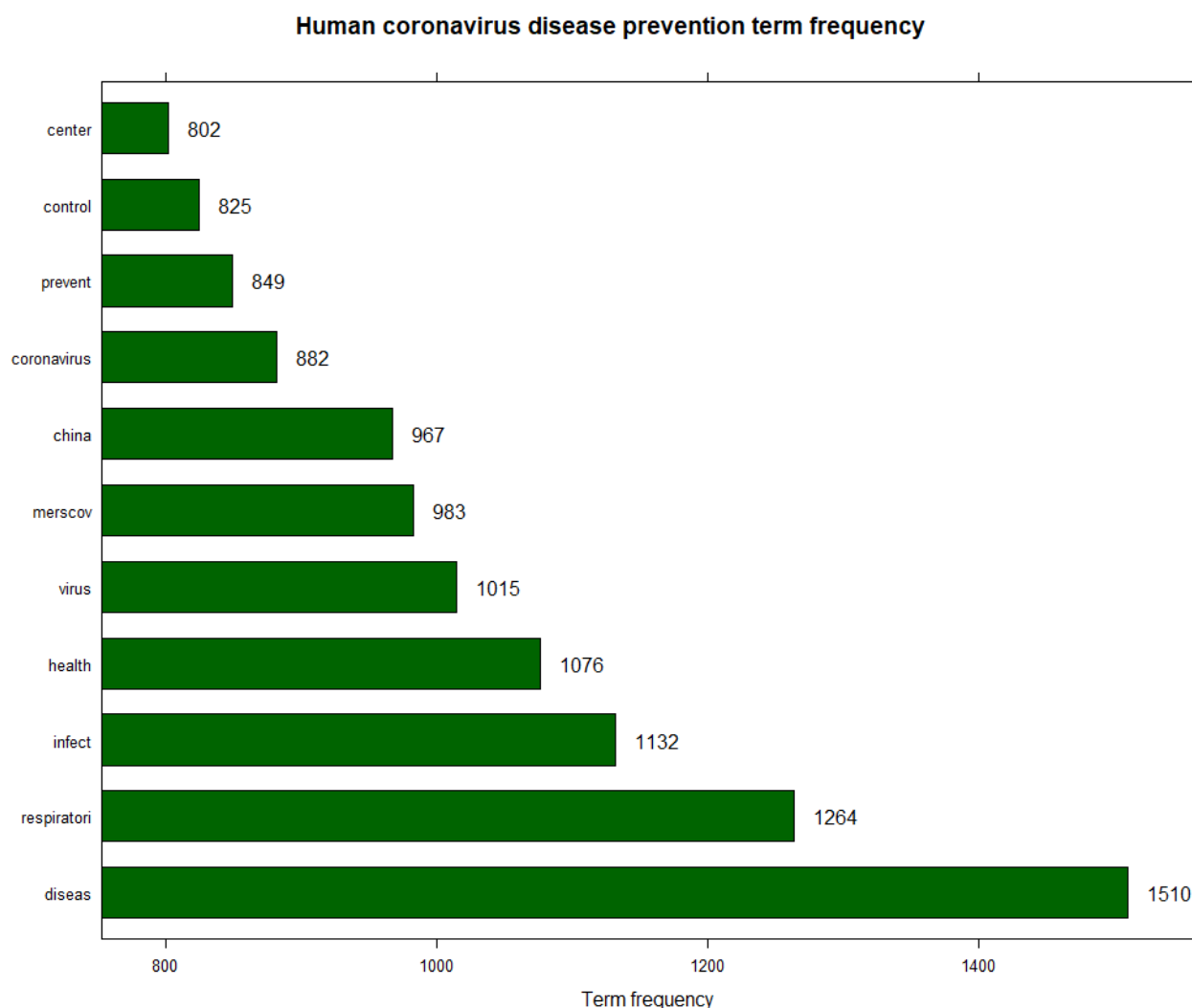


Figure 3. Human corona virus disease prevention terms frequency found in WoS and PubMed 2010-2020

Another type of mask is a specific type, N95, which is usually used for individuals who face high exposure to specific hazards (physical, biological or chemical hazards), including bacteria and viruses.⁽²⁹⁾ This mask provides more protection than previous medical face masks even the effectiveness is still debatable.⁽¹³⁾ This is because it has smaller filters for certain types of exposure. Another type of mask is a type of mask with a cartridge that is used by workers exposed to hazardous material.⁽³⁰⁾

Based on the results of a systematic literature review, it was obtained that the use of nanofiber for medical face masks is very limited. Improved function of face masks to prevent bacterial transmission has been discussed in a study whose results can improve the function of these masks.⁽¹⁵⁾ Improved function of medical face masks with nanofiber applications provides other options for the community in terms of

preventing the transmission of disease.⁽³¹⁾ For the government, this can also be an option for maintaining public health.

The problem found is that covid-19 causes respiratory disease and other damage to other organs.⁽³²⁾ Prevention of diseases caused by this virus that can be done is prevention in general, one of which uses medical face masks.⁽³³⁾ Whether medical face masks prevent certain viruses is also still a big question.⁽³⁴⁾ An effort to reduce this gap is to improve the function of medical face masks with nanofiber applications.

The nanofiber application is expected to provide changes to the structure of the mask filter.^(35,36) If previously the efficiency of facial medical masks had the ability to filter bacteria above 80%, then with the application of this nanofiber, it is expected to reach 95% against particulate aerosols (of 0.3 microns in size) free

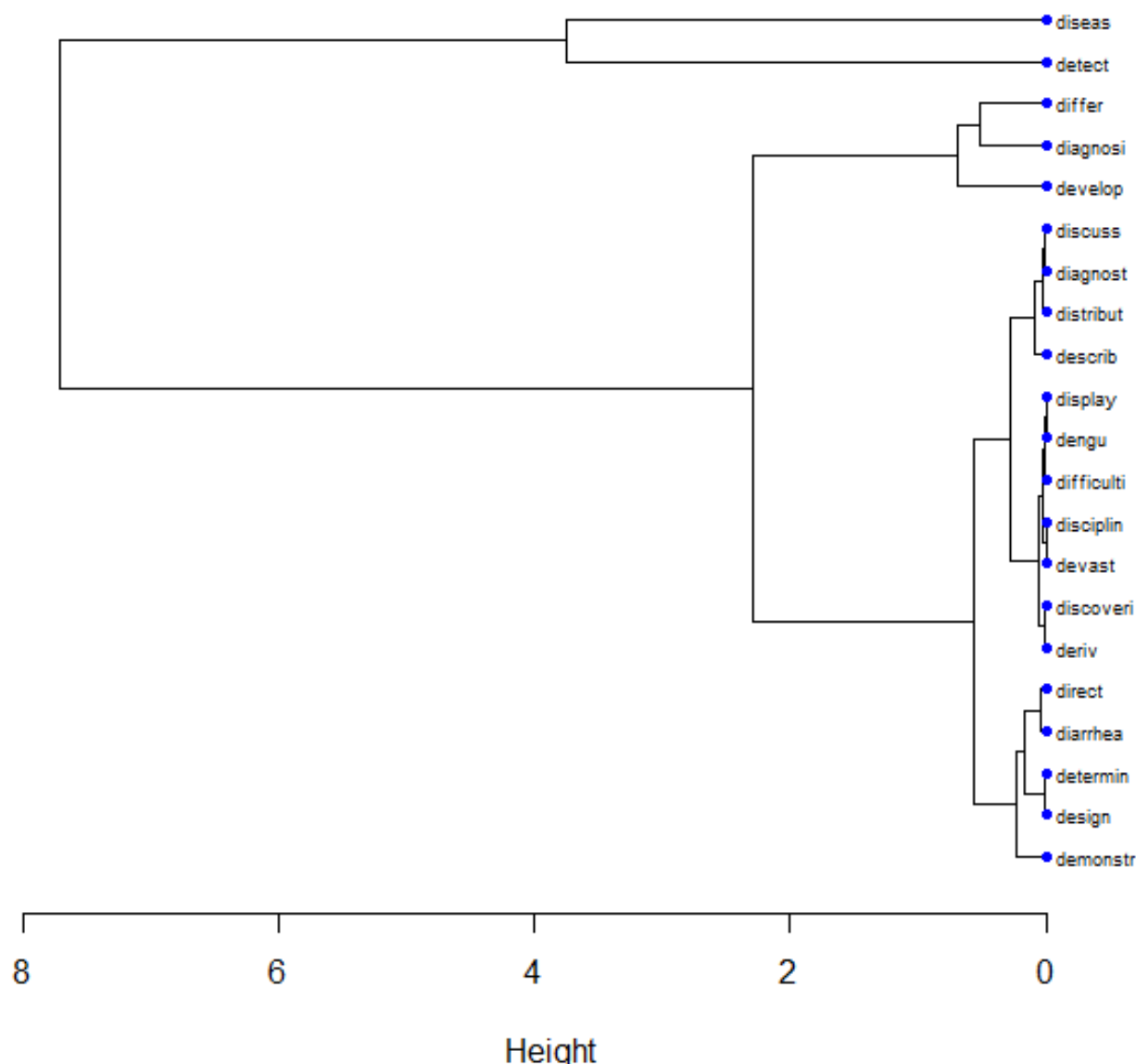


Figure 4. Cluster Dendrogram human corona virus disease prevention terms found in WOS and PubMed 2010-2020

of oil as Healthcare or surgical N95 respirator Filtration efficiency.⁽³⁷⁾ The expected result is that the smaller filter on the mask surface the function will increase. It should be emphasized that the prevention function is inseparable from human actions and behavior. Therefore, the main thing that needs to be improved is human behavior to always live healthily and take action to prevent disease.⁽³⁸⁾

5. CONCLUSION

WoS and PubMed document form was used as the document search engine in this literature study. On the other hand, the terms "disease" and "respiration" mostly appeared in human corona virus disease

prevention. Both of these terms are used to obtain specific articles as a basis for the study of nanofiber mask as human corona disease prevention. This study is considered to be very important because prevention measures against corona disease (Covid-19) are very high concern. The next study is expected to bring this review literature into an experimental study of nanofiber that is applied to face masks. The hope is to increase the function of face masks that are more effective and specific to the virus.

Acknowledgement

This research was supported by Universitas Airlangga and Center of Leather, Rubber, and Plastics, Ministry of Industry, Republic of Indonesia.

Conflict of Interest

The authors declare no conflict of interest.

REFERENCES

- Bloom DE, Cadarette D. Infectious disease threats in the twenty-first century: Strengthening the global response. *Frontiers in Immunology*. 2019;10(MAR):1–12.
- Lindahl JF, Grace D. The consequences of human actions on risks for infectious diseases: a review. *Infection Ecology & Epidemiology*. 2015;5(1):30048.
- Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. *China CDC Weekly*. 2020;2(8):113–22.
- World Health Organization (WHO). Coronavirus disease 2019 (COVID-19). Vol. 2019. 2020.
- Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W, et al. Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. *The Lancet*. 2020;6736(20):1–7.
- Wu Z, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention. *Jama*. 2020;2019:24–7.
- Lancet T. Editorial COVID-19: fighting panic with information. *The Lancet*. 2020;395(10224):537.
- Makoni M. Africa prepares for coronavirus. *The Lancet*. 2020;395(10223):483.
- Mahase E. Coronavirus: covid-19 has killed more people than SARS and MERS combined, despite lower case fatality rate. *theBMJ (British Medical Journal)*. 2020;2020(17 Feb-23 Feb):m641.
- Mallapaty S. Why does the coronavirus spread so easily between people? Vol. 579, *Nature*. England; 2020. p. 183.
- Pan F, Ye T, Sun P, Gui S, Liang B, Li L, et al. Time Course of Lung Changes On Chest CT During Recovery From 2019 Novel Coronavirus (COVID-19) Pneumonia. *Radiology*. 2020;200370.
- World Health Organization (WHO). Advice on the use of masks in the community, during home care and in healthcare settings in the context of the novel coronavirus (2019-nCoV) outbreak. WHO. 2020;2020(January):1–2.
- Radonovich LJ, Simberkoff MS, Bessesen MT, Brown AC, Cummings DAT, Gaydos CA, et al. N95 respirators vs medical masks for preventing influenza among health care personnel: A randomized clinical trial. *JAMA - Journal of the American Medical Association*. 2019;322(9):824–33.
- Chung JS, Ling ML, Seto WH, Ang BSP, Tambyah PA. Debate on MERS-CoV respiratory precautions: Surgical mask or N95 respirators? *Singapore Medical Journal*. 2014;55(6):294–7.
- Akduman C, Akcakoca Kumbasar EP. Nanofibers in face masks and respirators to provide better protection. *IOP Conference Series: Materials Science and Engineering*. 2018;460(1).
- Li X, Gong Y. Design of Polymeric Nanofiber Gauze Mask to Prevent Inhaling PM2.5 Particles from Haze Pollution. *Journal of Chemistry*. 2015;2015.
- Zhang Z, Murtagh F, Poucke S Van, Lin S, Lan P. Hierarchical cluster analysis in clinical research with heterogeneous study population: Highlighting its visualization with R. *Annals of Translational Medicine*. 2017;5(4).
- Heymann DL, Shindo N. COVID-19: what is next for public health? *The Lancet*. 2020;395.
- World Health Organization (WHO). Rolling updates on coronavirus disease (COVID-19) [Internet]. 2020. p. 1–22. Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen>
- Sun K, Chen J, Viboud C, Viboud C, Sun K, Chen J. Early epidemiological analysis of the coronavirus disease 2019 outbreak based on crowdsourced data: a population-level observational study. *Lancet Digital Health*. 2020;7500(20).
- Shen M, Peng Z, Xiao Y, Zhang L. Modelling the epidemic trend of the 2019-nCoV outbreak in Hubei Province, China. *bioRxiv*. 2020;
- Peeri NC, Shrestha N, Rahman S, Tan Z, Bibi S, Baghbanzadeh M. The SARS, MERS and novel coronavirus (COVID-19) epidemics, the newest and biggest global health threats: what lessons have we learned? *International Journal Of Epidemiology*. 2020;1–10.
- Ki HK, Han SK, Son JS, Park SO. Risk of transmission via medical employees and importance of routine infection-prevention policy in a nosocomial outbreak of Middle East respiratory syndrome (MERS): a descriptive analysis from a tertiary care hospital in South Korea. *BMC pulmonary medicine*. 2019;19(1):190.
- Center for Disease Control and Prevention (CDC). What You Need to Know about coronavirus disease 2019 (COVID-19). Vol. CS 314937-, *Choice Reviews Online*. 2020.
- Offord C. Feb 21, 2020. 2020. p. 1–5 How COVID-19 Is Spread.
- Lai ACK, Poon CKM, Cheung ACT. Effectiveness of facemasks to reduce exposure hazards for airborne infections among general populations. *Journal of the Royal Society Interface*. 2012;9(70):938–48.
- Rogers KB. Face masks: which, when, where and why? *Journal of Hospital Infection*. 1981;2:1–4.
- Khayan K, Anwar T, Wardoyo S, Lakshmi Puspita W. Active Carbon Respiratory Masks as the Adsorbent of Toxic Gases in Ambient Air. *Journal of Toxicology*. 2019;2019.
- Brousseau L, Ann RB. NIOSH Science Blog. 2010. p. 1–47 N95 Respirators and Surgical Masks Evolution of Respiratory Protection against Particulate Exposures. Available from: <https://blogs.cdc.gov/niosh-science-blog/2009/10/14/n95/>

30. MacIntyre CR, Wang Q, Seale H, Yang P, Shi W, Gao Z, et al. A randomized clinical trial of three options for N95 respirators and medical masks in health workers. *American Journal of Respiratory and Critical Care Medicine*. 2013;187(9):960–6.
31. Skaria SD, Smaldone GC. Respiratory source Control using surgical masks with nanofiber media. *Annals of Occupational Hygiene*. 2014;58(6):771–81.
32. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical Characteristics of 138 Hospitalized Patients with 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA - Journal of the American Medical Association*. 2020;1–9.
33. Center for Disease Control and Prevention (CDC). Vol. 2019, Prevention & Treatment. 2020. Coronavirus disease 2019 (COVID-19). Available from: <https://www.cdc.gov/coronavirus/2019-ncov/about/prevention-treatment.html>
34. Neilson S. The surgical mask is a bad fit for risk reduction. *Cmaj*. 2016;188(8):606–7.
35. Haider A, Haider S, Kang IK. A comprehensive review summarizing the effect of electrospinning parameters and potential applications of nanofibers in biomedical and biotechnology. *Arabian Journal of Chemistry*. 2018;11(8):1165–88.
36. Ramakrishna S, Fujihara K, Teo WE, Yong T, Ma Z, Ramaseshan R. Electrospun nanofibers: Solving global issues. *Materials Today*. 2006;9(3):40–50.
37. Qian Y, Willeke K, Grinshpun S, Donnelly J, Coffey C. Performance of N95 respirators: filtration efficiency for airborne microbial and inert particles. *American Industrial Hygiene Association Journal*. 1988;59(2):123–32.
38. Newson RS, Lion R, Crawford RJ, Al. E. Behaviour change for better health: nutrition, hygiene and sustainability. *BMC Public Health*. 2013;13(S1):1–13.