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COVID-19 Preventive Behavior and Digital Media: A Bibliometric Study

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Abstract

COVID-19 preventive behavior is crucial for reducing the spread of COVID-19 infection. During the pandemic, digital media can be used to educate on the behavior. Therefore, it is imperative to study COVID-19 preventive behavior and digital media. Despite extensive examinations on this matter, a distinct lack of bibliometric exploration has been observed. This study involves a bibliometric analysis utilizing data obtained from the Scopus database. Following a comprehensive search and screening procedure, our research examined a total of 68 articles. The findings indicate that Liu, Romer, and Jamieson emerge as the most influential researchers in the realm of studies focused on COVID-19 preventive behavior and digital media. The US and China are observed as the most referenced countries for research on COVID-19 preventive behavior and digital media. The International Journal of Environmental Research and Public Health, PLoS ONE, and the Journal of Medical Internet Research stand out as the three most productive and referenced journals in studies relating to this research topic. Concerning the state of the art, fundamentally, existing research refers to five major topics: the influence of Protection Motivation Theory (PMT) factors, the influence of COVID-19 coverage (infodemiology), the influence of media exposure/information and Health Belief Model (HBM) factors, the influence of e-health literacy, knowledge, and attitude, and the role of digital media in public health intervention strategy to prevent the spread of COVID-19. In conclusion, this bibliometric study sheds light on the multifaceted landscape of COVID-19 preventive behavior and digital media research. By delving into researcher analyses, preferred publication outlets, and the topical state of the art, this study contributes a novel perspective to the existing literature.

Keywords: bibliometric, COVID-19, digital media, health communication, preventive behavior

1. Introduction

The outbreak of a novel coronavirus disease (COVID-19) was initially reported in Wuhan, Hubei Province, China, in December 2019 (Huang et al., 2020). Since then, the disease has been declared as a global pandemic by the World Health Organization (WHO) since COVID-19 had spread extensively and had serious global impacts (Chahrour et al., 2020). As of July 2022, WHO had reported more than 546 million COVID-19 confirmed cases and 6.3 million fatalities all over the world (WHO, 2021). Bearing in mind the highly significant adverse impacts that COVID-19 has, many researchers are interested in conducting research on COVID-19 and the various impacts it has on various aspects of life, such as society, economy, health, communication, and education (Wang et al., 2021;Yuki et al., 2020; Ji et al., 2021; Mohadab et al., 2020; Zannudin et.al., 2021; Afifi et.al., 2022; Ashrianto, et.al., 2023; Afifi et.al., 2023).

COVID-19 is a disease that has a high transmission level (Chahrour et al., 2020). This is due to the fact that the virus can be transmitted from one individual to another both directly and indirectly (Alves et al., 2020). In light of this, WHO has proposed a global action plan aimed at reducing the spread of COVID-19 infection (WHO, 2021). Nonetheless, the guideline still has its limitation, in which it does not focus on understanding how individuals adopt COVID-19 preventive behavior (Lin et al., 2020). Accordingly, many researchers examine factors that influence COVID-19 preventive behavior (Liu, 2021; Latkin et al., 2021; Xin et al., 2022). Generally speaking, the purpose of those studies is to acquire a COVID-19 preventive behavior model so we can understand how to improve our COVID-19 preventive behavior.

Studies on COVID-19 preventive behavior need to be examined as not everyone automatically wants to adopt COVID-19 preventive behavior, despite of COVID-19 having been declared as a highly contagious disease. Some people remain convinced that COVID-19 is fake (Van der Linden et al., 2020). There are also those who believe that COVID-19 is biologically engineered in a laboratory in Wuhan (Andersen et al., 2020; Cohen, 2020). As a result, they become non-believers of COVID-19. On the other hand, there are also those who believe that COVID-19 exists, but they don't consider the disease as a very dangerous one (Sallam et al., 2020). These arguments have, possibly, led to numerous people not wanting to perform COVID-19 preventive behavior.

To improve COVID-19 preventive behavior, several studies consider the significance of health communication (Li & Liu, 2020; Liu, 2021). Health communication can be used as health education, including efforts to educate the public about COVID-19 (Demuyakor et al., 2021). Health communication is also useful to raise public awareness of COVID-19 (Ades, 2020). Health communication can be used to change a person's health behavior, including COVID-19 preventive behavior (Gong et al., 2021; Vandormael et al., 2021; Choi, 2021).

One of the health communication media that is quite reliable for promoting health during the COVID-19 pandemic is digital media (Wadham et al., 2019). This has been the case since the COVID-19 pandemic forced people to limit their mobility and restrict having direct contact with others to minimize the spread of COVID-19. Many countries had even applied a lockdown policy to reduce mobility (Meo et al., 2020). Hence, health promotion using traditional media became limited throughout the COVID-19 pandemic. Meanwhile, digital media is able to facilitate the public in gaining information surrounding COVID-19 without having to have direct contact. By merely relying on the internet, people are able to have access to many COVID-19 related information at home from numerous digital media sources. Digital media as the main media for disseminating health information about COVID-19 to the public has been acknowledged by many researchers such as (Mat Dawi et al., 2021; Tsao et al., 2021; Liu et al., 2020).

Based on the explanation above, it is understood that studies on COVID-19 preventive behavior and digital media are interesting to explore. Furthermore, many researchers have also made various studies on the topic. Nevertheless, a bibliometric study discussing the topic of COVID-19 preventive behavior and digital media has yet to be done. On the other hand, a bibliometric study can provide numerous uses once a lot of research on a certain topic has been made. In general, bibliometric studies are aimed at mapping out research specialties (Zupic and Čater, 2015). To be specific, bibliometric studies are useful for analyzing how disciplines, fields, specialties, and individual papers are related to one another (Zupic and Čater, 2015). Bibliometric studies are crucial since they are able to (1) gain a one-stop overview, (2) identify knowledge gaps, (3) derive novel ideas for investigation, and (4) position their intended contributions to the field (Donthu et al., 2021). Therefore, a bibliometric study on researches discussing COVID-19 preventive behavior and digital media is of utmost significance.

The current paper is a bibliometric study on researches discussing COVID-19 preventive behavior and digital media. Specifically, the objectives of this bibliometric study are to: (1) map out researchers conducting studies on COVID-19 preventive behavior and digital media, their country of origin, and existing multinational collaborations; (2) map out landscape of journal outlets publishing COVID-19 preventive behavior and digital media; and (3) map out the state of the art of research on COVID-19 preventive behavior and digital media as well as identify opportunities for future studies.

2. Literature Review

2.1 Covid-19 Preventive Behavior

COVID-19 is a disease that has a high mortality risk (Esakandari et al., 2020). The disease also has a high transmission level (Chahrour et al., 2020). This is the case because the transmission of COVID-19 can be done both directly and indirectly via human-to-human contact (Alves et al., 2020). It can directly happen through respiratory tract secretions and droplets. While on the other hand, indirect transmission can occur through contact with surfaces that have been contaminated by the virus originating from both symptomatic and asymptomatic COVID-19 cases (Alves et al., 2020).

Considering that no medicine has, to date, been proven to cure COVID-19, one of the efforts that can be made to minimize COVID-19 transmission is preventive behavior (Arefi et al., 2022). The COVID-19 prevention behaviors are essential to mitigate the rate of increase in new cases, aiming to subsequently lower the mortality rate associated with the infection (Lin et al., 2020). In other words, as the implementation of COVID-19 preventive measures increases among the populace, the likelihood of virus transmission decreases, contributing to a lower overall mortality rate. The COVID-19 prevention behaviors are not only vital for individual but also contribute to protect fellow citizens against the ongoing pandemic (Herbas-Torrico & Frank, 2022).

Preventive behavior can be understood as "any behavior that people engage in spontaneously or can be induced to perform with the intention of alleviating the impact of potential risks and hazards in their environment" (Kirscht, 1983). Thus, preventive health behavior can be defined as "any behavior that according to professional medical and scientific standards, prevent disease or disability and/or detect disease in asymptomatic stage, and which is voluntarily undertaken by a person

who believes himself to be healthy" (Langlie, 1979). According to the above definitions, COVID-19 preventive behavior is a set of measures individuals can perform to prevent COVID-19 risks wherein the effectiveness of these measures has been acknowledged by medical experts.

Although COVID-19 preventive behavior strategies have been recognized to be able to alleviate the transmission of COVID-19, there are differences in standard Covid-19 preventive behavior in different countries and regions (Liu et al., 2020). According to a study by Nguyen et al. (2020), COVID-19 preventive behavior can be specified into two categories, personal and community preventive behaviors. Personal preventive behavior are measures that can be taken to personally avoid COVID-19, such as physical distancing, wearing a face mask, cough etiquette, regular hand washing and using an alcohol hand sanitizer, body temperature check, disinfecting mobile phones, and so forth. Meanwhile, community preventive behavior refers to measures that individuals can take to avoid catching and spreading COVID-19 within their community, e.g., avoiding meetings or large gatherings, going to the market, avoiding travel in a vehicle/bus with more than 10 passengers, and not traveling outside of the local area during lockdown. Breakwell and Jaspal (2021) revealed that experts have different approaches in measuring COVID-19 preventive behavior. However, they are generally of the view that COVID-19 preventive behavior consists of a set of measures that can prevent COVID-19 when carried out in an integrated manner. Accordingly, the current bibliometric study was done by using the keywords "preventive behavior" to indicate that "preventive behavior" is a set of measures or actions instead of only a single specific action or measure.

2.2 Digital Media

Digital media refers to communication media that has experienced exponential growth in the last few years (Dannenberg et al., 2020). The rapid development of digital media has generated interest both among the general public and within academic circles in understanding the concept (Parry et al., 2021). Moreover, social media has been studied in various scientific fields (Parry et al., 2021). Digital media is quite reliable for disseminating health information (Wadham et al., 2019). Health promotion through digital media has been demonstrated to be a cost-effective way to involve a diverse range of community members (Mehmet et al., 2020).

Digital media is a communication media with numerous advantages, among them are: (1) the ability to obtain the latest health information according to user's needs; (2) the ability to verify health information when receiving uncertain information; and (3) the ability to get assistance on information for health management. Additionally, digital media is also useful for brightening up each other's spirit when addressing health issues (Mat Dawi et al., 2021).

Digital media for public communication in the health sector needs to gain constant public attention, including the use of referential messages that are context rich and actively combines emotional and visual designs in their composition (Verma, 2022). Digital media can also be used to develop various persuasion techniques relating to certain health issues with various sentiments such as being for, against, or neutral (Scannell et al., 2021). Digital media networks have globally influenced public discourse, sentiment, and response to global health issues (Roberts et al., 2017).

In relation to COVID-19, digital media can be used to promote preventive behavior (Li & Liu, 2020). This also includes communication media, which the public heavily relies upon to obtain information about COVID-19 (Mat Dawi et al., 2021; Tsao et al., 2021; Liu et al., 2020). As an example, a study by Trifonova (2020 as cited in Mat Dawi et al., 2021) reports that as many as 36% of people use social media to constantly get updated information about COVID-19.

Digital media can be defined as "electronic devices, where information is stored and transmitted in digital form" (Degner et al., 2022). Boulianne and Theocharis (2020) examine that digital media refers to "technologies that connect to the internet". More specifically, Digital media is a communication media format that allows the users to simultaneously conduct two things, i.e., consume information and produce contents because such media platform makes it possible to share information in various media formats, such as texts, photos, videos, and audios (Chassiakos et al., 2016). Boulianne and Theocharis (2020) add that digital media refers to "technologies that connect to the internet". Based on these explanations, digital media can be defined as communication media/channels that is stored and transmitted in internet-based digital form for mutually sharing information such as texts, photos, audios, and videos.

According to a study by Liu (2020), several types of digital media that can utilized for disseminating various health information include: (1) social media (e.g., Facebook, Twitter, Instagram, YouTube, Weibo, etc.); (2) mobile social networking apps (MSNs) (e.g., WhatsApp, WeChat, etc.); (3) online news media; and (4) social live steaming services (SLSSs) (e.g., YouNow and Tumblr). Furthermore, Lavorgna et al. (2018) add that e-health is also a part of digital media. These various types of digital communication media are also corroborated by Mat Dawi et al. (2021) and Wadham et al. (2019).

3. Method

3.1 Database Selection

Selection of database in this research was based upon the level of area coverage of scientific fields included in scientific article databases. Scopus database was chosen based on findings that this particular database has a more extensive field coverage level

compared to other scientific article databases (Yaman et al., 2019). Scopus database is popularly known to have scientific coverage in four basic fields, namely Life Sciences, Physical Sciences, Social Sciences, dan Health Sciences, and it has a collection of more than 69 million articles (Elsevier, 2022). The Scopus database has been used considerably as a source of scientific reference in bibliometric analyses under similar themes (Lusmilasari et al., 2022; Shushtari et al., 2021).

Comprehensive data were acquired by applying a two-step approach. First, relevant keywords were selected and put in the search engine of the scientific article database (subsection keywords), then in the second stage, content analysis was done to crosscheck the acquired articles so that those included in the subsequent analysis are truly relevant articles (subsection inclusive criteria).

3.2 Keyword Selection

Systematic search was applied in this study by using the keywords: (“covid 19” AND "preventive behavior") AND ("digital media" OR "social media" OR "Facebook" OR "Twitter" OR "e-health" OR "YouTube" OR "Instagram"). These keywords may appear on the title, abstract, or keywords sections of scientific articles included in the Scopus database. The keywords “Covid 19” and “preventive behavior” were used in this bibliometric study because it focuses on studies analyzing COVID-19 preventive behavior as a set of measures that the public need to carry out for preventing COVID-19, as elaborated in the subchapter titled “COVID-19 Preventive Behavior” above.

3.3 Inclusive Criteria Selection

Numerous articles in the Scopus database from 2020 until 2022 were collected with the consideration that the COVID-19 outbreak began in 2020. Only articles categorized as articles, conference papers, book chapters, and books were analyzed (articles in the form of meeting abstracts, obituaries, corrections, editorials, etc. were not) (Niñerola et al., 2021). Each selected articles were subsequently examined using content analysis so that any article irrelevant with COVID-19 preventive behavior is eliminated from further examination.

Figure 1 showcases the analyses-steps carried out to find the relevant articles. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was applied in the paper search and review process of this study (Moher et al., 2015). In the early stage of identification, 85 articles were found in the Scopus database. Upon application of inclusive criteria in the screening phase, as many as 75 relevant articles were obtained. Subsequently, 68 relevant articles were acquired after applying content analysis in the eligibility stage. Ultimately, in the final stage, bibliometric analysis was applicable to as many as 68 relevant articles. The bibliometric analysis in the present study was conducted using the VosViewers software as a basis for advanced analysis.

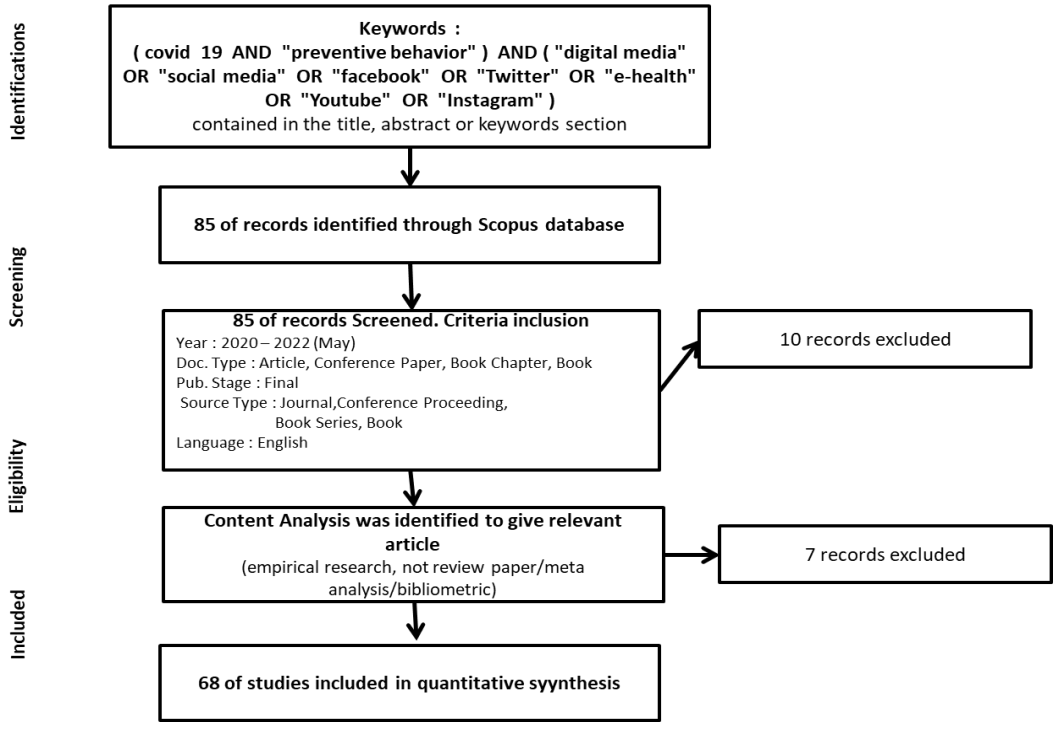

Figure 1. Preferred reporting items for systematic reviews and meta-analyses (PRISMA)

4. Results

4.1 Overview

The development of research on COVID-19 preventive behavior and its relations with digital media has accumulatively experienced an increase each year. Figure 2 shows a positive trend in research within this domain, with 2022 as an exception since the data processed in this research was last taken in May 2022. This indicates that there are various thoughts and studies considering the impacts that digital media have on preventive behavior toward exposure to COVID-19.

Figure 3 presents a distribution of the types of scientific publication made pertaining to studies on the relation between digital media and COVID-19 preventive behavior. As most apparently shown by Figure 3, the percentage of articles (97%) far dominates the other type of publication (book chapter, 3%). This may be due to the fact that the on-going COVID-19 phenomenon has yet to be explored more deeply and that ample studies are still required to collect existing knowledge and accumulate them into a book.

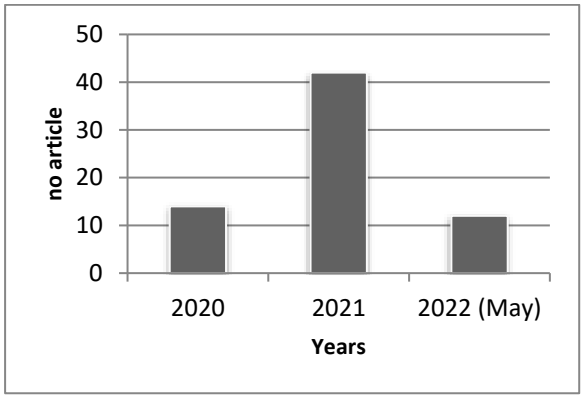

Figure 2. Trend in Annual Scientific Publication

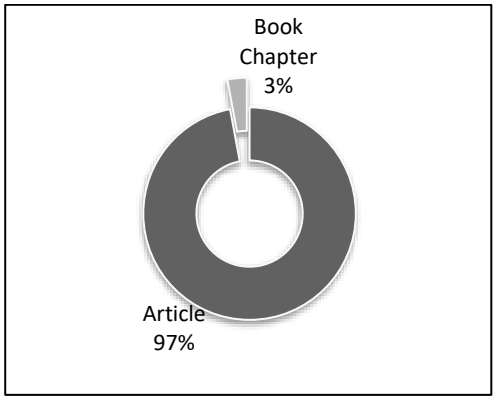

Figure 3. Distribution by Publication Type

4.2 The Results of Author Data Analysis

4.2.1 Most Productive Researcher

Researchers who hold a key role in the research topic of COVID-19 preventive behavior and its relations with digital media are presented in Table 1. Apparently, Liu is the most productive researcher with the highest number of citations compared to other researchers. There are two researchers who are most often cited but only wrote one paper concerning the topic in this study, they are Jamieson and Romer. The contexts of the researches are discussed in another subchapter.

Table 1. Most productive and cited author

No.	Author	Documents	Citations
1	Liu P.L.	2	110
2	Basch C.E.	2	99
3	Basch C.H.	2	99
4	Hillyer G.C.	2	99
5	Caime C.	2	99
6	Wang Z.	2	35
7	Chen H.	2	32
8	Chang Y.P	2	16
9	Chen Y.L.	2	16
10	Yen C.F.	2	16
11	Wang T.	2	5
12	Yang Y.	2	2
13	Jamieson K.H.	1	256
14	Romer D.	1	256
15	Al-Azzam S.	1	74

4.2.2 Geographic Distribution and Multinational Collaboration

Based on their country affiliation, we can observe the geographic distribution of authors interested in studying COVID-19 preventive behavior and its relation to digital media. There are at least 25 affiliated countries that have published articles on the topic analyzed in this study. Figure 4 shows that, compared to other countries, US and China (more than

11 articles) are the most productive in publishing scientific articles on this topic. When we look at the sources of scientific reference, US and China (more than 24 citations) are also the main countries of reference for studies on COVID-19 preventive behavior and its relation to digital media (Figure 5). Scientific articles affiliated with the US have been cited 393 times, while those affiliated with China have been cited 115 times. In other words, 58.9% of scientific article citations refer to these two countries from a total of 895 article citations on this topic (Table 2).

US and China have emerged as focal countries in terms of scientific article publication and citation on the topic of this study. This is a reasonable phenomenon as these two countries have the most advanced level of technological development and the highest level of COVID-19 exposure compared to other countries.

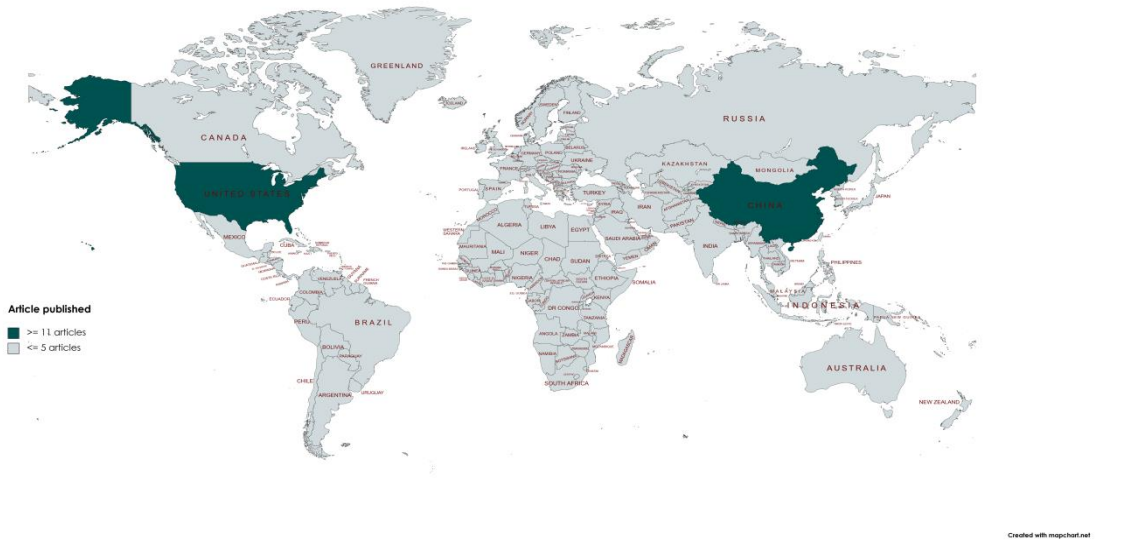

Figure 4. Geographic location of all contributing authors on paper Covid-19 preventive behaviour related to social media

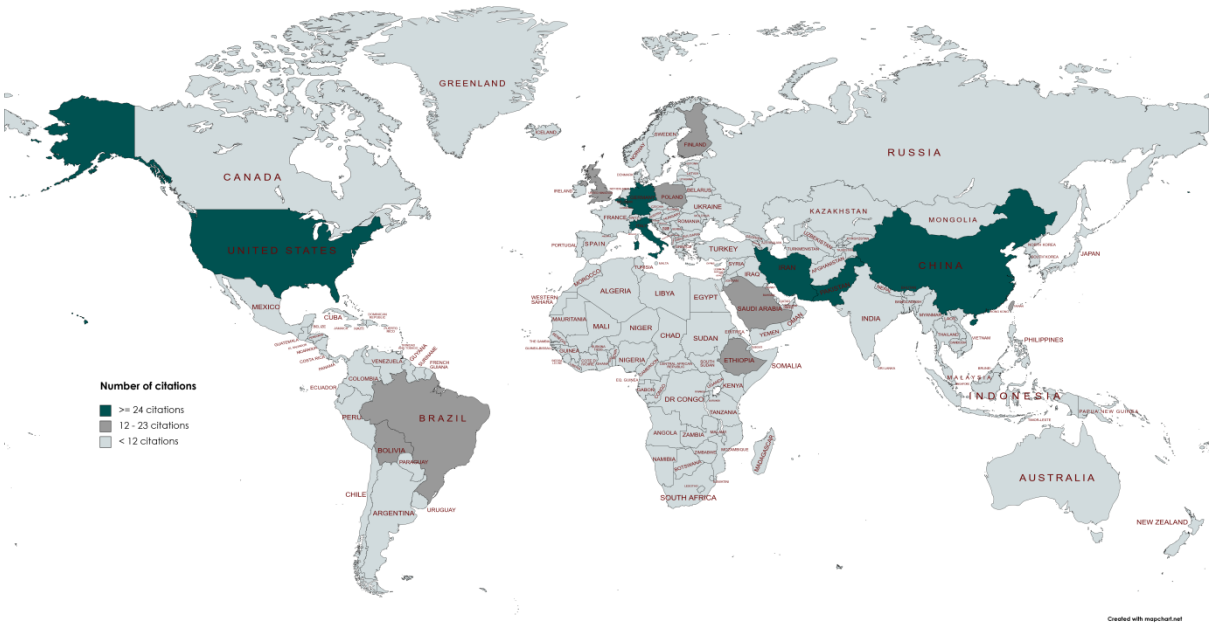

Figure 5. Geographic location of all received citations of paper Covid-19 preventive behaviour related to social media

Table 2. Document and citation distribution based on author's country affiliation

Country	Documents	Citations
United States	15	393
China	12	135
Iran	5	34
Saudi Arabia	5	21
Germany	4	36
India	4	9
Italy	3	32
Pakistan	3	24
Belgium	2	32
Ethiopia	2	23
Hong Kong	2	30
Poland	2	13
South Korea	2	9
Taiwan	2	16
United Kingdom	2	22
Australia	1	1
Bolivia	1	20
Brazil	1	20
Cameroon	1	0
Czech Republic	1	4
Egypt	1	0
Finland	1	13
France	1	5
Ghana	1	2
Indonesia	1	1

In the next stage, we focus on discussing multinational collaborations between authors and their country affiliation. Out of the 25 affiliated countries (Table 2), ten of them have networks of co-authors affiliated with those countries (Figure 6). Fifteen other countries, including Indonesia, have been identified to have no multinational collaboration in conducting analyses on this topic. When we compare Table 2 and Figure 6, Iran and Saudi Arabia have productively published articles relating to this topic, yet they have no collaborative network with other countries.

Based on the country co-authorship (Figure 6), it is obvious that US and China are the main actors in studies relating to the topic of this research. This is apparent from the high number of network connections with other countries and the substantial size of the diameter of the circle (indicating more articles published from those countries) on the country co-authorship network. Four major clusters out of the ten interconnected countries can be identified when we categorize them by the country co-authorship frequency rate (Table 3). As observed in the first cluster, there is a relationship made between France, Germany, and UK. Cluster 2 consists of China, Hongkong, and Pakistan. In the fourth cluster, South Africa is a country with only one cluster member, this is because the calculation of the country's frequency rate of country co-authorship with US (main central cluster 1) and Germany (main central cluster 2) is the same.

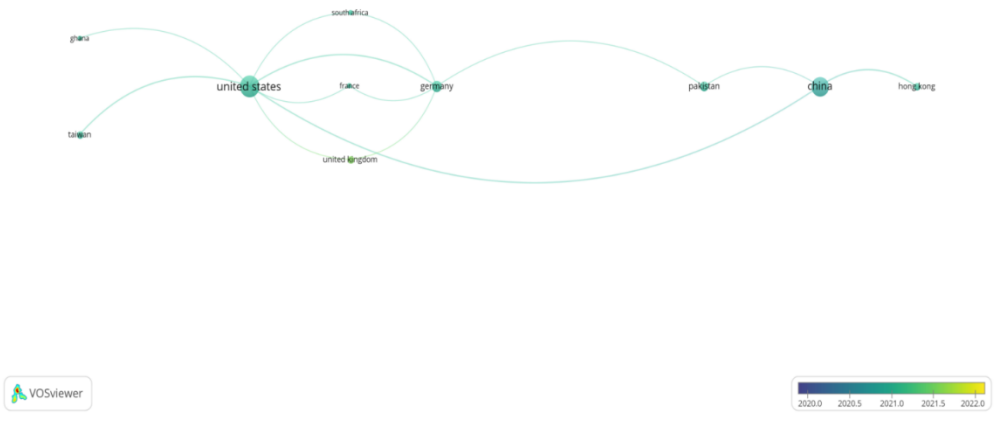

Figure 6. Country co-authorship network of Covid-19 preventive behaviour related to social media papers

Figure 6 can also provide information on undetected further elaborations when merely based on the distribution of productivity frequency of affiliated countries (Table 2), where it is apparent that the main focal countries relating to papers

categorized under the topic of COVID-19 preventive behavior and its relation to digital media are US, China, and Germany. These countries are identified as focal countries due to their high level of productivity and collaboration with other countries. Furthermore, in Figure 6, we can clearly see direct collaborations between the main central countries of US and China. Further information that we can acquire from Figure 6 is that there is a tendency in country co-authorship collaboration with UK for more recent researches (as shown by UK's yellow diagram dots and network line in 2022).

Table 3. Clusters of co-authorship by countries

Cluster 1	Cluster 2	Cluster 3	Cluster 4
France	China	Ghana	South Africa
Germany	Hong Kong	Taiwan	
United Kingdom	Pakistan	United States	

4.3 The Results of Journal Data Analysis

4.3.1 Distribution of Research Field

The distribution of research fields from journals publishing studies relating to the topic of COVID-19 preventive behavior and digital media is presented in Figure 7. We can see the dominance of journals in the field of medicine with a proportion of 44.3%, followed by the field of social science at 12.2%, and environmental science at 11.3%, the remaining percentage is distributed throughout other research areas. Interestingly, when we consider the keyword topic in this study, it is only natural that more studies fall within the context of social sciences, but we found that the papers are dominated by the field of medicine instead. This might have occurred because the topic of this research may be considered as a multidisciplinary research topic, which requires not only expertise in the field of social science but in the field of medicine as well. In more detail, digital media studies commonly involve expertise in social science, particularly communication science. Meanwhile, COVID-19 preventive behavior studies strongly correlate with expertise in public health and/or medicine.

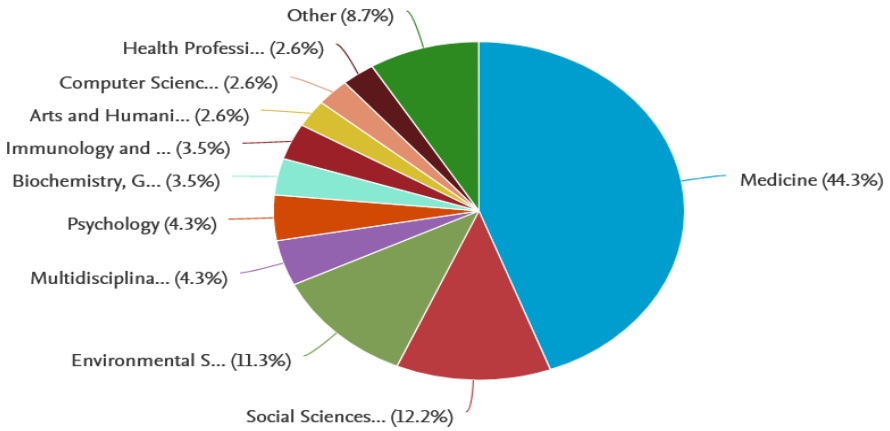

Figure 7. Number of articles by research field

4.3.2 Most Preferred Journal

As presented in Table 4, we can apparently see that the International Journal of Environmental Research and Public Health, PLoS ONE, and the Journal of Medical Internet Research are the three most productive and referenced journals that published studies relating to the topic of the current study. Interestingly, the Journal of Social Science and Medicine, in terms of productivity, merely published three scientific articles, yet these three articles were referenced by 272 other scientific articles. This indicates that these three articles are the three main sources of reference concerning COVID-19 preventive behavior and its relations with social media. Upon closer observation, the three scientific articles were written by Shin et al.(2021), Liu(2021), dan Romer & Jamieson (2020).

Table 4. List of journals and proceedings that provided at least three relevant articles (number of articles and citations)

Journal	Total Article	Cite
International Journal of Environmental Research and Public Health	11	74
PLoS ONE	5	34
Journal of Medical Internet Research	4	107
BMC Public Health	3	30
Frontiers in Public Health	3	19
JMIR Public Health and Surveillance	3	99
Social Science and Medicine	3	272

4.3.3 Most Cited Journal and Citation Analysis

The International Journal of Environment is one of the journals much cited by other journals, as indicated by bigger diagram dots compared to other journals (Figure 8). This journal also has quite a high connectivity level with the other journals (connected with four other journals). According to Figure 8, the trend in the last one-year period indicates that the Journal of Medical Internet Research has been much cited as shown by the yellow connecting lines (year 2022).

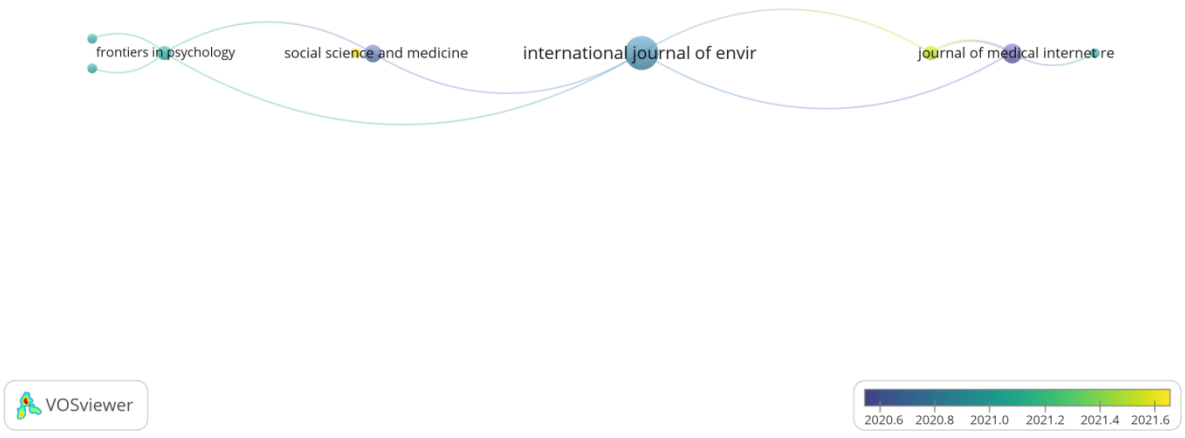

Figure 8. Journal citations network

4.4 State of the Art

4.4.1 Most Cited Paper and Citation Analysis

There are at least 7 papers with the highest citation, more than 20 citations for each document (Table 5). It is obvious that one paper is a top outlier, i.e., the paper written by Romer & Jamieson (2020). This paper has been cited more than 252 times within a period of less than 2 years. The paper examined the correlation between the impact that accepting COVID-19-related conspiracy theories through digital media has on COVID-19 preventive behavior. They found that the intensity of belief in COVID-19-related conspiracy theories sourced from digital media leads to resistance in COVID-19 prevention behaviors promoted by local governments. The greater the intensity of belief people have in COVID-19-related conspiracy theories via digital media, the more resistant they are to COVID-19 preventive efforts, particularly vaccination programs. The second most cited paper was written by Liu (2020), it has been cited by 90 other articles in less than 2 years period. The paper informs that the intensity of information search through digital media has a direct influence on COVID-19 preventive behavior. The more intensively people access information about COVID-19 through digital media, the higher impact it will have on their "worry" level.

Table 5. Most cited paper

No	Document title	Authors	Year	Cited by	Reference
1	Conspiracy theories as barriers to controlling the spread of Covid-19 in the U.S.	Romer, D., Jamieson, K.H.	2020	252	(Romer & Jamieson, 2020)
2	COVID-19 Information Seeking on Digital Media and Preventive Behaviors: The Mediation Role of Worry	Liu, P.L.	2020	90	(Liu, 2020)
3	Preventive behaviors conveyed on YouTube to mitigate transmission of Covid-19: Cross-sectional study	Basch, C.H., Hillyer, G.C., Meleo-Erwin, Z.C., (...), Mohlman, J., Basch, C.E.	2020	64	(Basch et al., 2020)
4	Social media use, eHealth literacy, disease knowledge, and preventive behaviors in the Covid-19 pandemic: Cross-sectional study on Chinese netizens	Li, X., Liu, Q.	2020	61	(Li & Liu, 2020)
5	The role of YouTube and the entertainment industry in saving lives by educating and mobilizing the public to adopt behaviors for community mitigation of Covid-19: Successive sampling design study	Basch, C.E., Basch, C.H., Hillyer, G.C., Jaime, C.	2020	32	(Basch et al., 2020)
6	Behavioral intention to receive a Covid-19 vaccination among Chinese factory workers: Cross-sectional online survey	Zhang, K.C., Fang, Y., Cao, H., (...), Zhou, X., Wang, Z.	2021	30	(Zhang et al., 2021)
7	Social media exposure, risk perception, preventive behaviors and attitudes during the Covid-19 epidemic in La Paz, Bolivia: A cross sectional study	Zeballos Rivas, D.R., Lopez Jaldin, M.L., Nina Canaviri, B., (...), Alanes Fernández, A.M.C., Aguilar Ticona, J.P.	2021	20	(Zeballos Rivas et al., 2021)

Figure 9 showcases the citation networks of paper/documents analyzing the topic of this study. Due to the limited time span (2020 – May 2022), the interconnected papers (with total members of at least two papers) only amounted seven 187 listers (see Table 6). The paper "actor" in each cluster is determined based on the number of most cited in the cluster. In cluster 1 (Karasneh et al., 2021) is identified as the most cited paper. This paper presents a finding, which is the role of the media to promote compliance with measures pertaining to COVID-19 preventive behavior. In cluster 2 we can clearly see that (Romer & Jamieson, 2020) is the center of the cluster. Interestingly, in clusters that have more than two members, we can see the identified papers serving as a connection leading to the emergence of other papers. For instance, in cluster 1 we can observe the paper written by (Mahmood et al., 2021) is detected as a paper that brought about information flow. It is also apparent that the paper by (Nazir et al., 2020) in cluster 1 is the initiator in this cluster.

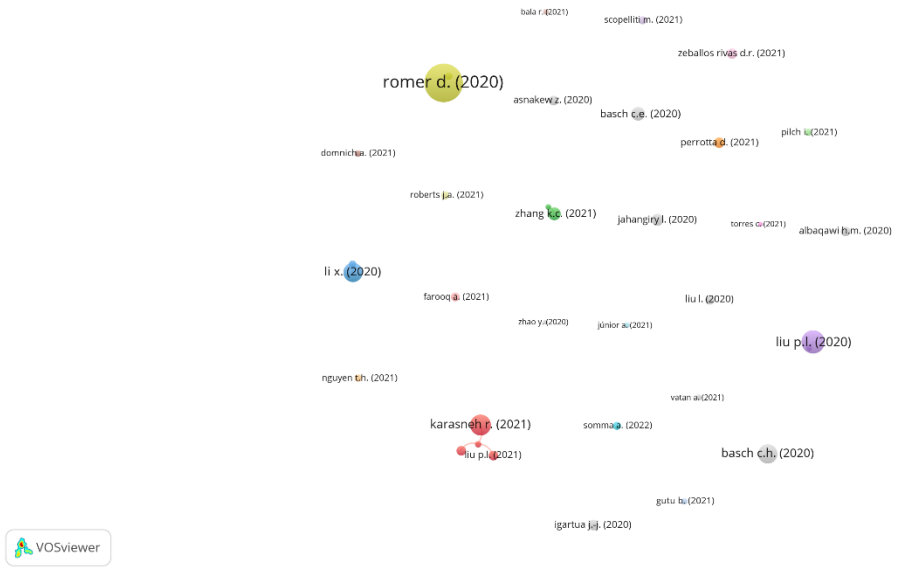

Figure 9. Document citation network

Table 6. Cluster of Citation network (min 2 paper per cluster)

Cluster 1	Cluster 2	Cluster 3	Cluster 4
(Karasneh et al., 2021)	(Romer & Jamieson, 2020)	(Zhang et al., 2021)	(Hong et al., 2021)
(Liu, 2021)	(Shin et al., 2021)	(Chen et al., 2021)	(Li & Liu, 2020)
(Mahmood et al., 2021)	(Wang et al., 2021)		
(Nazir et al., 2020)			
Cluster 5	Cluster 6	Cluster 7	
(Liu, 2020)	(Mat Dawi et al., 2021)	(Jahangiry et al., 2020)	
(Zeballos Rivas et al., 2021)	(Vatan et al., 2021)	(Karimy et al., 2021)	

4.4.2 Keyword Co-occurrence Analysis

This subchapter discusses about most of the topics raised in studies on COVID-19 preventive behavior and its relations with digital media. The unit of analysis in this section is based on the keywords written by the authors in their paper. Table 7 shows the top 25 keywords that authors use in their paper. Authors overlook words with general characteristics in their studies like COVID-19, coronavirus disease 2019, sars-cov-2, human, humans, and pandemics. It is apparent that adult, female, male, cross sectional study, questionnaire, attitude to health, health behavior, middle aged, prevention and control, and epidemiology are the most frequently identified keywords in the article collection. Accordingly, we can further analyze that studies relating to COVID-19 preventive behavior and digital media mostly discuss about: response differences by age and gender to COVID-19 preventive behavior; preventive behavior and its relations with digital media; methods and measuring tools most often used for cross sectional study and questionnaire as assessment media. Others discuss the influences that attitude and health knowledge have on COVID-19 preventive behavior.

Table 7. Keyword occurrences

No	*Keyword*	*occurrences*
1	*Covid-19*	*61*
2	*Human*	*49*
3	*social media*	*48*
4	*Humans*	*41*
5	*Adult*	*40*
6	*Female*	*40*
7	*Male*	*39*
8	*coronavirus disease 2019*	*34*
9	*cross-sectional study*	*34*
10	*Article*	*33*
11	*Pandemic*	*30*
12	*Questionnaire*	*28*
13	*sars-cov-2*	*26*
14	*attitude to health*	*25*
15	*cross-sectional studies*	*25*
16	*Pandemics*	*25*
17	*surveys and questionnaires*	*22*
18	*health behavior*	*20*
19	*middle aged*	*19*
20	*young adult*	*19*
21	*health knowledge, attitudes, practice*	*17*
22	*prevention and control*	*17*
23	*controlled study*	*16*
24	*Epidemiology*	*15*
25	*preventive behavior*	*15*

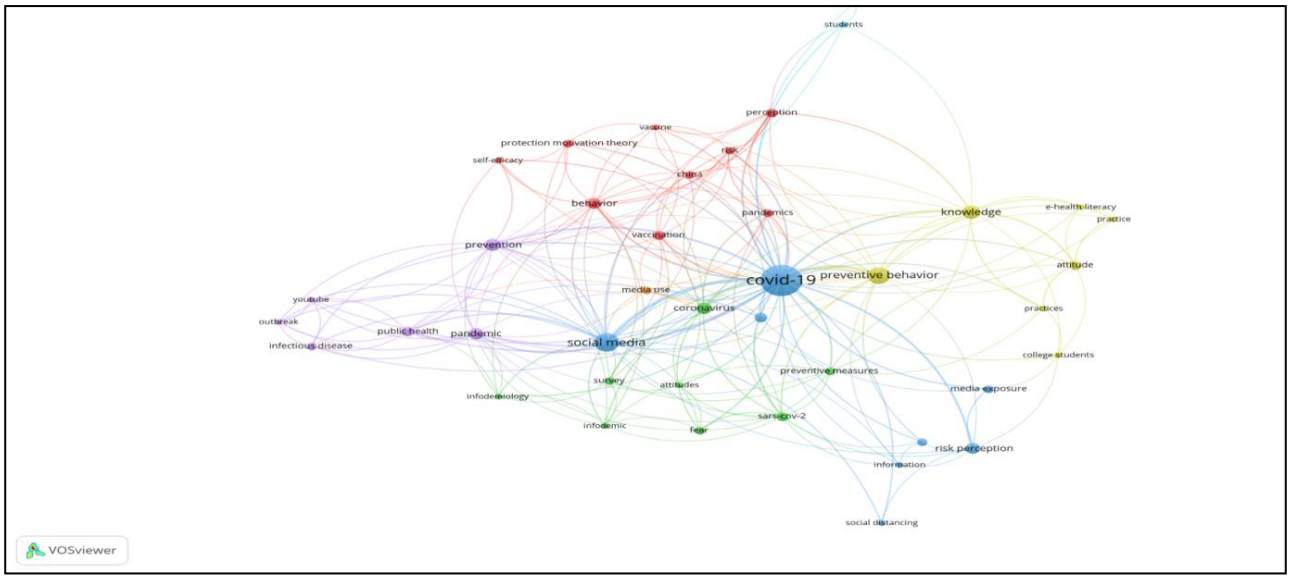

Figure 10. Co-occurrence keywords network

Topic/cluster analysis of the keywords in the article collection in this study is presented in Table 8 and Figure 10. Figure 10 illustrates co-occurrence keywords network obtained by using the VosWiever software. Similar colors indicate similar research topic clusters. Topics are defined by a minimal of two keywords per topic. In this case, five general topics were made from the collection of articles pertaining to COVID-19 preventive behavior and digital media. Table 8 shows more clearly the research topic clusters by keywords. Subsequently, the meanings of the collection of keywords for each of the topic are elaborated. Topic 1 essentially correlates with studies discussing COVID-19 preventive behavior and digital media by involving factors derived from Protection Motivation Theory (PMT). Topic 2 describes studies on COVID-19 preventive behavior and digital media that involve COVID-19 coverage factors (infodemiology). Studies on COVID-19 preventive behavior and digital media involving factors pertaining to media exposure/information and Health Belief Model (HBM) are compiled under topic 3. Meanwhile, topic 4 refers to studies that specifically analyze COVID-19 preventive behavior and digital media in college students by involving e-health literacy and other factors that are usually targeted by health education, namely Knowledge, Attitude, and Practice (KAP). The last topic examines the role of digital media, particularly YouTube, in public health intervention, namely prevention of infection transmission and COVID-19 outbreak.

Table 8. Clusters of Co-occurrence by keywords (clusters with more than 1 item)

Topic 1	*Topic 2*	*Topic 3*	*Topic 4*	*Topic 5*
Behavior	attitudes	Covid-19	attitude	infectious disease
China	coronavirus	health belief model	college students	outbreak
Pandemics	fear	information	e-health literacy	pandemic
Perception	infodemic	media exposure	knowledge	prevention
protection motivation theory	infodemiology	preventive behaviors	practice	public health
Risk	preventive measures	risk perception	preventive behavior	youtube
self-efficacy	sars-cov-2	social distancing		
Vaccination	survey	social media		
Vaccine				

4.4.3 Bibliometric Coupling Analysis

Bibliographic coupling analysis of the clusters were done to see how many clusters of research on COVID-19 preventive behavior and digital media based on the use of similar reference there are. Figure 11 shows the results of bibliographic coupling and network analysis by using the VosWiever software. Similar colors indicate similar cluster reference. Apparently, there are seven clusters of research reference, and these clusters are presented more specifically in Table 9.

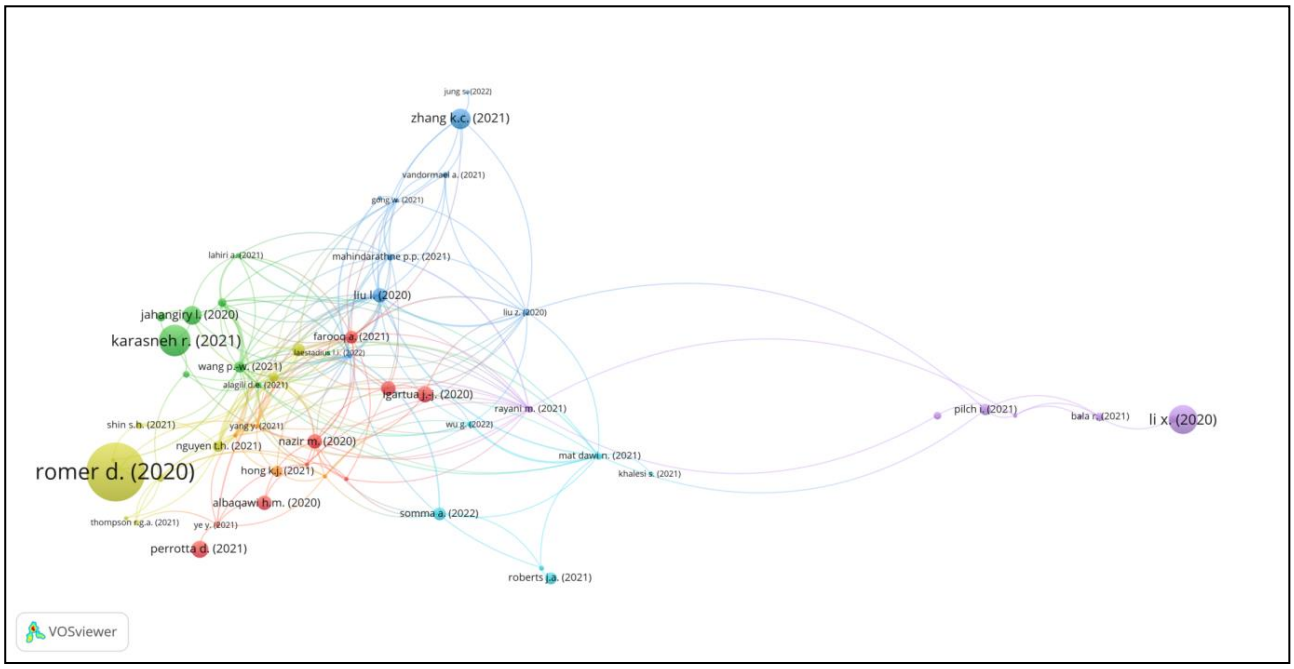

Figure 11. Bibliographic coupling and network analysis

By exploring the scientific articles of each group further, we were able to interpret the meanings of each cluster. The first cluster discusses about the context of communications use dan demographic factor relating to COVID-19 preventive behavior and digital media. The second cluster refers to studies on COVID-19 preventive behavior and digital media based on HBM and PMT. The third cluster discusses about the exposure of information via digital media relating to Covid-19 preventive behavior. Subsequently, the fourth cluster constitutes researches examining COVID-19-related conspiracy theories disseminated via digital media and the influence they have on COVID-19 preventive behavior. Studies relating to COVID-19 preventive behavior and digital media that put emphasis on e-health literacy, disease knowledge and fear of Covid-19 are discussed in the fifth cluster. The sixth cluster refers to studies relating to COVID-19 preventive behavior and digital media that underscore the influence of demographic factors. Meanwhile, the last cluster refers to studies on COVID-19 preventive behavior and digital media that focus on longitudinal analysis.

Table 9. Bibliographic coupling paper cluster

Cluster 1	Cluster 2	Cluster 3	Cluster 4
albaqawi h.m. (2020)	alagili d.e. (2021)	choi d.-h. (2021)	mahmood q.k. (2021)
dashti s. (2022)	chen y.-l. (2021)	gong w. (2021)	nguyen t.h. (2021)
farooq a. (2021)	domnich a. (2021)	jung s. (2022)	nowak b.m. (2021)
igartua j.-j. (2020)	jahangiry l. (2020)	liu l. (2020)	rawlings n.n. (2022)
liu p.l. (2021)	karasneh r. (2021)	liu z. (2020)	romer d. (2020)
nazir m. (2020)	karimy m. (2021)	mahindarathne p.p. (2021)	scopelliti m. (2021)
perrotta d. (2021)	laestadius l.i. (2022)	mzoughi m.n. (2021)	shin s.h. (2021)
rabbani f. (2022)	lahiri a. (2021)	vandormael a. (2021)	thompson r.g.a. (2021)
ye y. (2021)	wang p.-w. (2021)	zhang k.c. (2021)	zelič ž. (2022)
Cluster 5	Cluster 6	Cluster 7	
al-qahtani a.m. (2021)	dhawan d. (2021)	hong k.j. (2021)	
arefi m.f. (2022)	khalesi s. (2021)	kusama t. (2022)	
bala r. (2021)	mat dawi n. (2021)	liu h. (2022)	
li x. (2020)	roberts j.a. (2021)	yang y. (2021)	
pilch i. (2021)	somma a. (2022)		
rayani m. (2021)	wu g. (2022)		
vatan a. (2021)			
zhao y. (2020)			

5. Discussion

The research on COVID-19 preventive behavior and digital media is developing rapidly. The most preferred journals for publishing the research on COVID-19 preventive behavior and digital media were dominated by the journals in the field of public health. This is quite reasonable since COVID-19 is a public health issue (Heymann & Shindo, 2023). US and China have emerged as focal countries in terms of scientific article publication and citation on COVID-19 preventive behavior and digital media. This is a reasonable phenomenon as these two countries have the most advanced level of technological development and the highest level of COVID-19 exposure compared to other countries (Marginson, 2022; Dehghanbanadaki et al., 2020).

Based on research context related keyword (Table 7), social media is the most researched digital media type in the publications of COVID-19 preventive behaviors and digital media. Social media is a digital media type that its user has growth rapidly (Ortiz-Ospina, 2019). Social media is identified as an example of a new communication media era (Dutta & Bhattacharya, 2023). Before the COVID-19 pandemic, there are many studies that identified the significant role of social media in changing human life and activities (e.g. Lau, 2017; Kahne & Bowyer, 2018; Yu et al., 2018; Orben et al., 2019). During the COVID-19 pandemic, social media can easily facilitate the social problems, such as limited social interaction, that caused by the pandemic (Sumaedi et al., 2021). It was also well known that government in many countries utilized social media for sharing COVID-19 information and performing COVID-19 related health education (Pang et al., 2021; Badr et al., 2022). These facts may lead the domination of social media in the publications of COVID-19 preventive behaviors and digital media.

Based on the research method related keyword (Table 7), positivism paradigm based-research methods tend to dominate the publications of COVID-19 preventive behaviors and digital media. In other words, quantitative research method has dominated positivism paradigm based-research methods. This may be caused by two conditions. First, the publications were dominated by public health and medicine journal. Positivism is well accepted in the field of public health and medicine (Park et al., 2020). Second, there are a lot of generic models, such as Health Belief Model, Protection Motivation Theory, Theory of Planned Behavior, etc, that can be used to employ positivism paradigm based-research methods in the research of COVID-19 preventive behaviors and digital media.

Based on the research construct related keyword (Table 7), there are five research streams that dominated the publications of COVID-19 preventive behaviors and digital media, namely (1) the typology of digital media users related to COVID-19 preventive behaviors, (2) COVID-19 Infodemic, (3) the structural model of digital media use and COVID-19 preventive behaviors, (4) the effectiveness of digital media-based health education, and (5) the public health/prevention measures related content of digital media. Both the stream of the structural model of digital media use and COVID-19 preventive behaviors and the effectiveness of digital media-based health education were unsurprisingly to be exist. The effectiveness of a health education method is a key to determine whether the approach will be continuously implemented (Vandormael et al., 2021). In other hand, the structural model of digital media use and COVID-19 preventive behaviors is a key input needed to determine the health education strategy (Zeballos Rivas et al., 2021).

The existence of the stream of the public health/prevention measures related content of digital media relates with the fact that COVID-19 limits the physical activities, which included health education activities (Sumaedi et al., 2021). Given this, COVID-19 related health education was widely performed through digital media, especially social media (Basch et al., 2020; Basch et al., 2020). In other hand, digital media-based health education can be categorized as a health education approach that needs the proactive efforts of the health education subject for accessing the contents that are available in the digital media (Sumaedi et al., 2021). Therefore, the public health/prevention measures related content of digital media is widely attracted the researchers of COVID-19 preventive behaviors and digital media.

The existence of the stream of COVID-19 infodemic relates with presence of COVID-19 infodemic phenomenon during the COVID-19 pandemic (Jung & Jung, 2022). The massive hoaxes and misinformation regarding COVID-19 are well documented. For example, in a country that detected first COVID-19 case in March 2020, more than 100 COVID-19 hoaxes and misinformation were recorded in August 2020 (Sumaedi et al., 2022).

The existence of the stream of the typology of digital media users related to COVID-19 preventive behaviors relates with the characteristics of the digital media users. For example, based on the generation cohort, it is well documented that each generation, such as Gen X, Y, and Z, has different digital media related behaviors (Bravo et al., 2020). This may cause the different COVID-19 preventive behaviors related characteristics among digital media users (Chen et al., 2021). Therefore, the study on the typology of digital media users related to COVID-19 preventive behaviors attracted researchers.

6. Conclusion and Future Research

A bibliometric study relating to COVID-19 preventive behavior and digital media has been done by focusing on the following aspects: researcher analysis, journals used as publication outlets, and state of the art of the topic. In terms of researchers, Liu was identified as the researcher with the highest productivity and number of citations compared to other researchers. Two researchers were identified as being the most frequently cited but they only wrote one paper relating to the topic of this study, they are Jamieson and Romer. Hence, it can be stated that Liu, Romer, and Jamieson are influential researchers in studies on COVID-19 preventive behavior and digital media. In terms of author's country of origin, US and China are observed as reference countries for research on COVID-19 preventive behavior and digital media. There are 4 clusters of countries engaging in collaborative research in this field. US, China, and Germany are the three focal countries in each multinational collaborative research cluster among the clusters formed.

In terms of journals, most of the research on COVID-19 preventive behavior and digital media were done in the research field of medicine, social science, and environmental science. The International Journal of Environmental Research and Public Health, PLoS ONE, and the Journal of Medical Internet Research are the three most productive and most referenced journals in studies relating to the topic of this research.

Concerning the state of the art, fundamentally, the existing researches refer to five major topics, namely the influence of PMT factors, the influence of COVID-19 coverage (infodemiology), the influence of media exposure/information and HBM (health belief model) factors, the influence of e-health literacy, knowledge, and attitude, and the role of digital media in public health intervention strategy to prevent the spread of COVID-19. Accordingly, areas beyond those stated above can provide future opportunities to conduct research on COVID-19 preventive behavior and digital media. Some potential areas for future research include the influence of local culture/local wisdom on COVID-19 preventive behavior and digital media, explorations of social factors and their influence on COVID-19 preventive behavior and digital media, the relationship between COVID-19 preventive behavior and the message features as well as usage level of digital media, and the level of hoax exposure and its relations with COVID-19 preventive behavior and digital media.

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Authors contributions

SA, AY, IGMY and SS were responsible for the study design. SA, AY and SS was responsible for data collection. SA, AY, SS, and IGMY drafted the manuscript and SA revised it. All authors read and approved the final manuscript. All authors contributed equally to the study. Furthermore, all authors are main author.

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Redfame Publishing.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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