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Historical Developments, Hotspots, and Trends in Infodemic Scientific Publications: A Bibliometric Analysis

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Abstract

Introduction: With the prevalence of global crises, an overwhelming influx of reliable and unreliable information occurs, referred to as an infodemic. Given the significance of the infodemic phenomenon, this study examines trends in the dissemination of scientific publications on infodemics.

Methods: This study is a descriptive and analytical study conducted with a bibliometric approach. The study population included all scientific publications on infodemic in the Web of Science database until July 15, 2023. The data analysis was performed using the bibliometrix package in the R software.

Results: 1157 scientific publications on infodemics have been extracted since 2019, with the highest number of publications occurring in 2021. The majority of these publications were articles. The most important keywords in infodemic scientific publications were "health," "information," "news," "social media," and "communications." The keywords during the 2019-2020 outbreak period were "outbreak," "information," and "COVID-19." In the year 2021, the keywords were "health," "determinants," and "news." During 2022, the keywords were "information," "impact," and "health literacy." In the year 2023, the keywords were "attitudes," "health," and "African-American."

Conclusion: Infodemic research aims to utilize new and updated data in the field of health and medicine, as well as develop methods to combat infodemics. This study offers a more accurate understanding of this field and provides valuable information for future interdisciplinary and medical research.

Keywords: Infodemic, Information, Scientific, Research, Bibliometrics

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Introduction

Today, maintaining health relies on receiving reliable information, and the Internet has become the primary source of health information for many people. In the United States, 80% of adults search for their health information online (1). An overabundance of information (accurate or inaccurate) that occurs during an epidemic is known as an infodemic. During the outbreak of COVID-19 and with the spread of this disease, the volume of information related to this disease increased rapidly, which caused the emergence of the infodemic and has been recognized as a great threat by the World Health Organization (2, 3). Infodemics encompass both rumors and conspiracy theories, as well as an overload of information—both false and accurate—that can lead to increased confusion, sensitivity to misinformation, and mistrust (4). On the contrary, the lack of high-quality information can also lead to information gaps that are quickly filled with false information (5). Infodemics can be published online through social media and messaging apps or offline in conversations and through traditional media (such as newspapers, television, and radio). Infodemia is a situation in which there is a large amount of information offline and online, which makes it difficult to identify reliable information, and it creates ambiguity (6).

During the COVID-19 pandemic, the exchange of information has been increasing at an astonishing rate, driven by advances in information and communication technologies, especially social media platforms. Such platforms have not only facilitated access to information on various issues related to the epidemic, but have also been particularly important for maintaining people's communication at home (7).

Small et al. reveal that infodemics are as serious as epidemics and can spread at a faster rate than epidemics. Therefore, proper and timely handling of an infodemic is very important and necessary to promote health and well-being and help to prevent, vaccinate, and manage the disease (8). Also, Kwood Hari et al. state that the emergence of the Internet and social media has intensified the creation and dissemination of false information in all health fields (9).

Since current thinking and future directions in any scientific field are built upon insights gained from its historical context, it is of educational, epistemological, and scientific value for researchers and scientists to have a perspective on the developments and historical trends in the published literature regarding infodemics.

One of the methods for evaluating scientific activities is bibliometrics. Bibliometrics is a field that quantitatively analyzes scientific production and publications, providing a comprehensive and multidimensional analysis of the scientific knowledge in a specific field. The analysis of bibliometrics logically and precisely evaluates the contribution of research and publications to the advancement of knowledge in a subject, offering an objective, empirical, and unbiased insight into that particular subject (10, 11).

Moreover, to better understand quantitative data and their relationships in a scientific field, visualization and mapping of scientific landscapes are mentioned as suitable solutions. A scientific map represents the spatial relationships between disciplines, domains, specialties, and individual or group-authored articles, displayed through physical proximity or relative positions. Drawing the scientific and social structure of researchers in a scientific field provides valuable information about the position of each researcher within the body of that field's knowledge and serves as an indicator of their influence (12)

Based on the previous investigations, no studies were found that specifically examined the scientific literature analysis of infodemics using bibliometric and scientometric indicators. However, this approach can be valuable as it offers a more comprehensive and extensive analysis of scientific advancements in the field of infodemics over time. Furthermore, considering the increase and proliferation of unintentional and intentional misinformation during health crises such as pandemics and the emphasis of the

World Health Organization on the importance of addressing infodemics, the present study aimed to analyze scientific publications and map the scientific structure of the field of infodemics. Nonetheless, greater emphasis should be placed on the reasons for choosing this approach and its importance in filling the existing research gaps.

Methods
Study Design
This study is a descriptive and analytical research conducted using bibliometric techniques. The study included all scientific publications in the field of infodemics that were indexed in the core database of the Web of Science (WOSCC). In bibliometrics studies, given the varying structure of scientific data across different databases, data is typically extracted from a single scientific database and then analyzed. This approach ensures consistency and comparability of the results (13-15). Furthermore, given that this study is specifically centered on the bibliometric analysis of historical developments, research hotspots, and trends in infodemic research, the search was meticulously conducted using the core keywords of the concept. This search was applied on the titles, abstracts, and keywords of the publications, following the established search strategy (TS=(infodemics) OR TS=(infodemic)). The choice of the Web of Science Core Collection (WOSCC) as the primary database was due to its comprehensive coverage of high-impact journals and its reliability for bibliometric analysis in this field (16).

Data Extraction
The bibliographic details of the retrieved publications, including author names, titles, abstracts, keywords, publication years, journals, and affiliated institutions, were systematically extracted and compiled into a structured dataset. The data were then meticulously cleaned and standardized to maintain consistency across the dataset. This process involved unifying author names and keywords to avoid duplication and enhance the accuracy of the subsequent analysis.

Bibliometric Analysis Techniques
Data analysis was conducted using the Biblioshiny tool, which is based on the Bibliometrix package in R software. Bibliometrics is a tool that visualizes information in Bibliometrics analyses based on scientific productions and publications,

such as country/region indices, journals, authors, articles, author keywords, and research institutions. This tool provides all the necessary features for comprehensive bibliometric analysis and various scientific mapping (17-19). The following analyses were performed in this study:

Annual Trend Analysis: To examine the growth of infodemic-related research over time, we conducted an analysis of the annual publication trends.

Publication Type Analysis: The distribution of different types of scientific publications (e.g., original articles, reviews, editorial materials) was analyzed to understand the nature of the contributions in this field.

Geographic and Institutional Contributions: The contributions of different countries and institutions were analyzed to identify key players and research hubs in the field of infodemics.

Collaboration Network Analysis: A collaboration network was constructed to visualize and analyze the level of international cooperation among researchers and institutions in infodemic-related studies.

Keyword Co-occurrence Analysis: The relationships between keywords in the retrieved

publications were analyzed to identify the key themes and research focuses within the field.

Thematic Mapping: A strategic thematic map was generated to categorize and visualize research themes based on their centrality and density, providing insights into the development and importance of various topics within the infodemic research domain.

Thematic Evolution Analysis: The evolution of research themes over different periods was examined to understand how the focus of infodemic research has shifted over time.

Visualization: The results of these analyses were visualized using various charts and maps generated by the Excel Software and Biblioshiny tool, including trend charts, bar charts, network maps, word clouds, and thematic maps. These visualizations provided a clear and comprehensive overview of the scientific landscape, key contributors, and evolving trends in the field of infodemics.

Results
The search results in the WOSCC database have extracted 1157 scientific publications related to infodemics. Given the precisely designed search
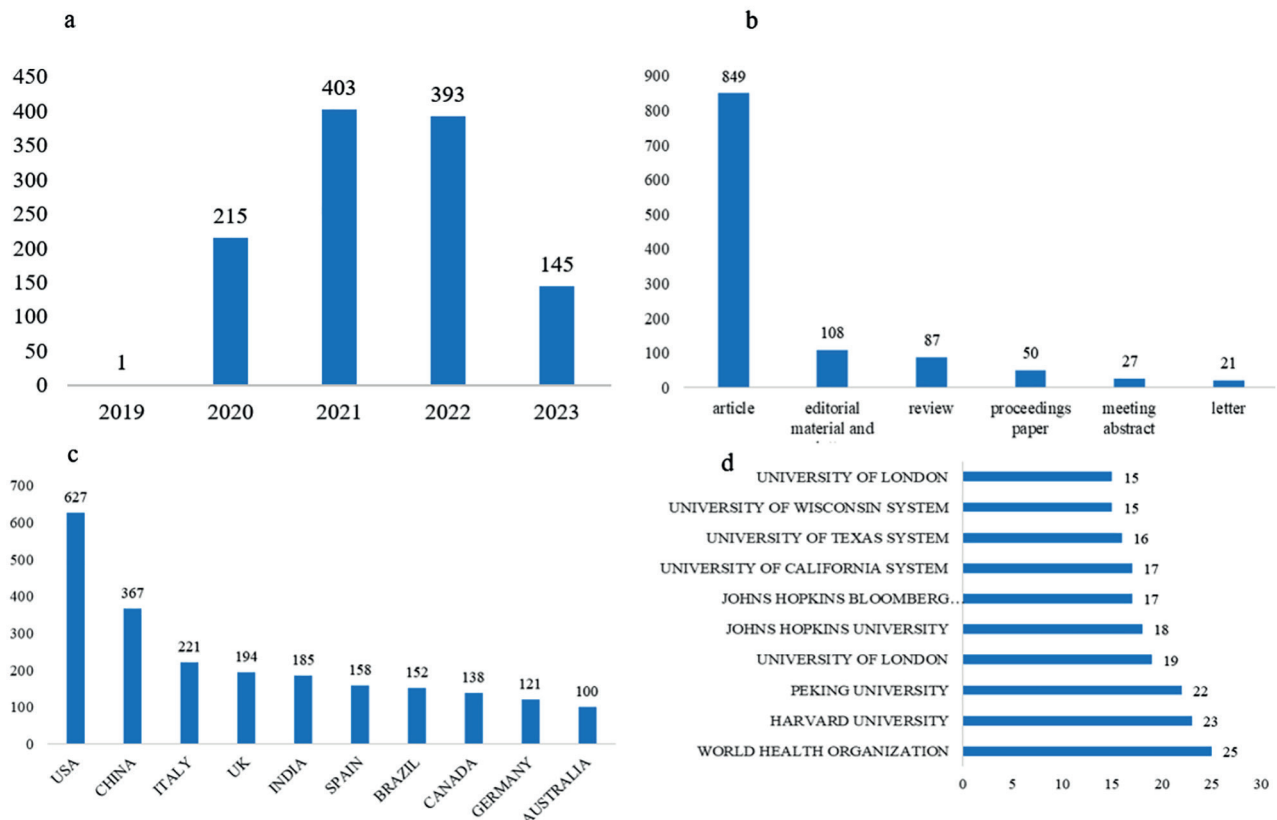

Figure 1: a) Annual Trend Chart of Scientific Publications in Infodemics. b) Chart of Types of Scientific Publications in Infodemics. c) Top Countries in the Number of Scientific Publications in Infodemics. d) Top Organizations in the Number of Scientific Publications in Infodemics. *The data has been extracted for the period from 2023 to July 15

strategy, all relevant scientific publications that are in the same line with the study objectives were extracted. Therefore, no specific inclusion or exclusion criteria were applied. Figure 1 illustrates the temporal distribution of scientific publications, categorizes the types of these publications, and highlights the top countries and institutions contributing to the production of infodemic-related research.

Figure 1 shows that scientific publications on infodemics have been released since 2019, with the highest number of publications (403) occurring in 2021. Furthermore, the majority of scientific publications consisted of 849 original articles, 108 editorial materials, and 87 reviews. The top countries in terms of publication volume were the United States with 627 cases, China with 367 cases, and Italy with 221 cases of scientific publications. The leading institutions in terms of

the highest number of scientific publications were the World Health Organization with 25 cases, Harvard University with 23 cases, and Peking University with 22 cases of scientific publications.

Figure 2 illustrates the level of collaboration among countries in scientific publications on infodemics.

The data illustrated in Figure 2 shows that the highest level of collaboration in scientific publications on infodemics has been observed among the countries of the United States, the United Kingdom, China, and Italy.

Figure 3 presents a word cloud of the top 50 keywords in infodemic scientific publications, highlighting 'health,' 'information,' 'news,' 'social media,' and 'communications' as the most prominent keywords

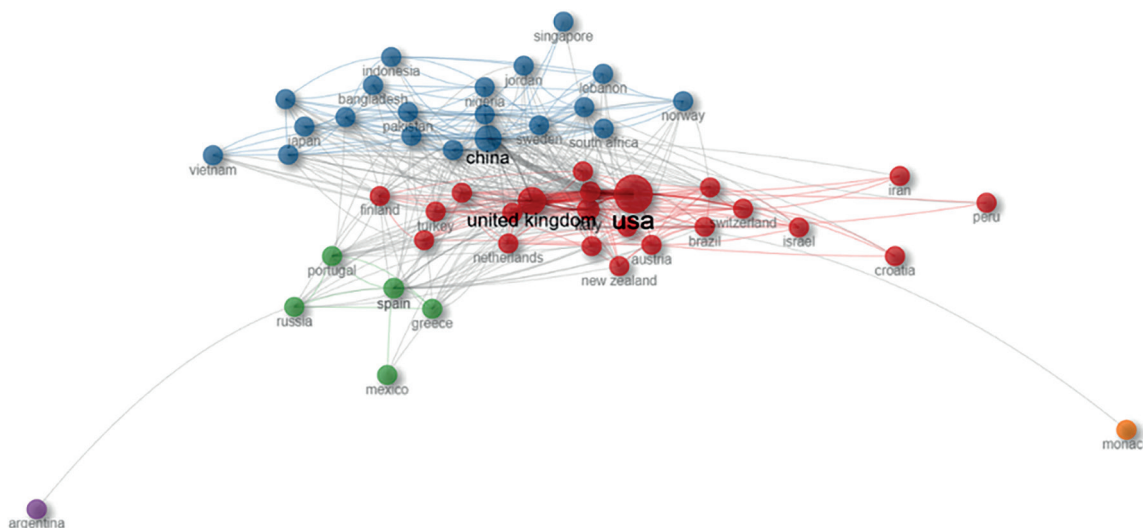Figure 4 illustrates a thematic map that depicts the relationship between density

Figure 2: Level of International Collaboration in Scientific Publications on Infodemics

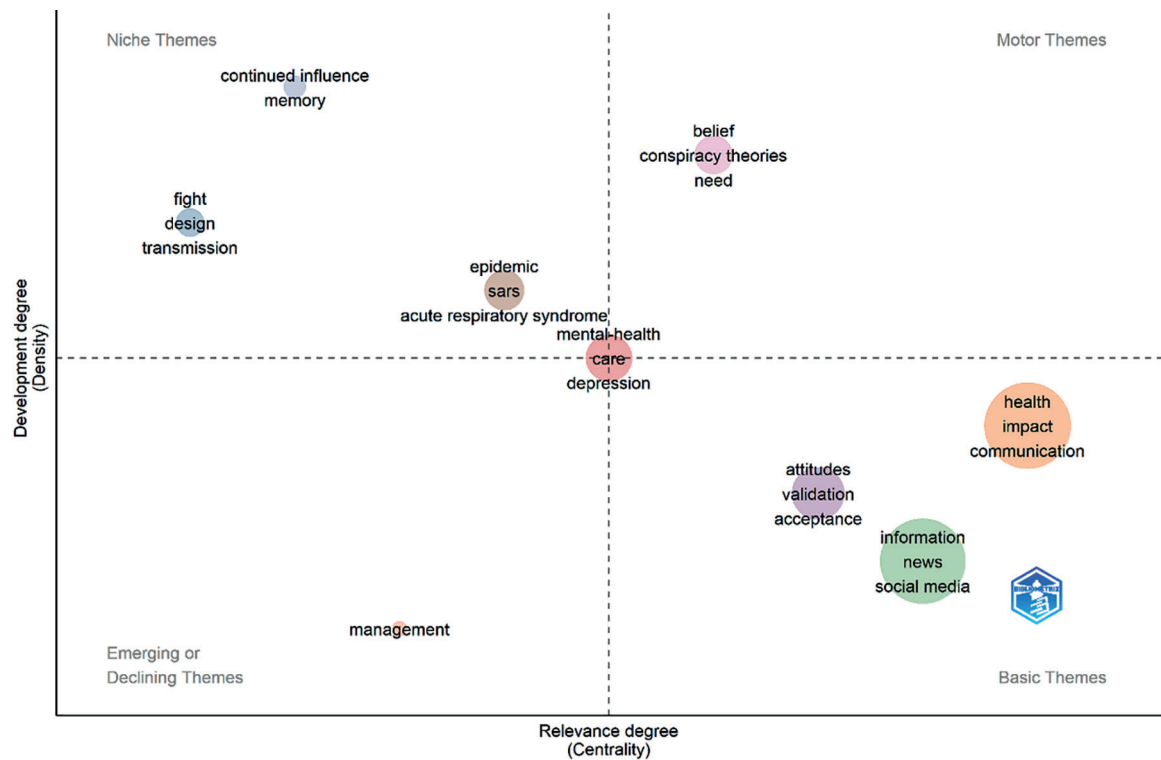**Figure 3:** Key Thematic Keywords of Infodemic Scientific Publications

Figure 4: Strategic Thematic Map of Infodemic Scientific Publications

(y-axis) and centrality (x-axis). Centrality is the significance or importance of the selected theme, while density represents the level of development or progress associated with the chosen theme.

In Figure 4, the upper-right quadrant represents motor themes characterized by high centrality and density. These themes, namely belief, conspiracy, and need, are described as more developed and essential in an infodemic. In the upper left quadrant, there are niche themes that represent peripheral and specific topics within the research field. Some of the related topics in this quadrant include "continued influence," "fight design and transmission," and "epidemic,

SARS, acute respiratory syndrome."

The fundamental themes are depicted in the lower right quadrant. These themes are foundational, broad, and cross-cutting within the research domain. Topics related to "health, impact, communication," "information, news, social media," and "attitude, validation, acceptance" serve as fundamental themes in the context of the infodemic. In the lower left quadrant, emerging or declining themes can be observed. One of the themes present in this quadrant is management. Figure 5 illustrates the temporal evolution of thematic trends in scientific publications on infodemics in four time intervals: 2019-2020, 2021, 2022, and 2023.
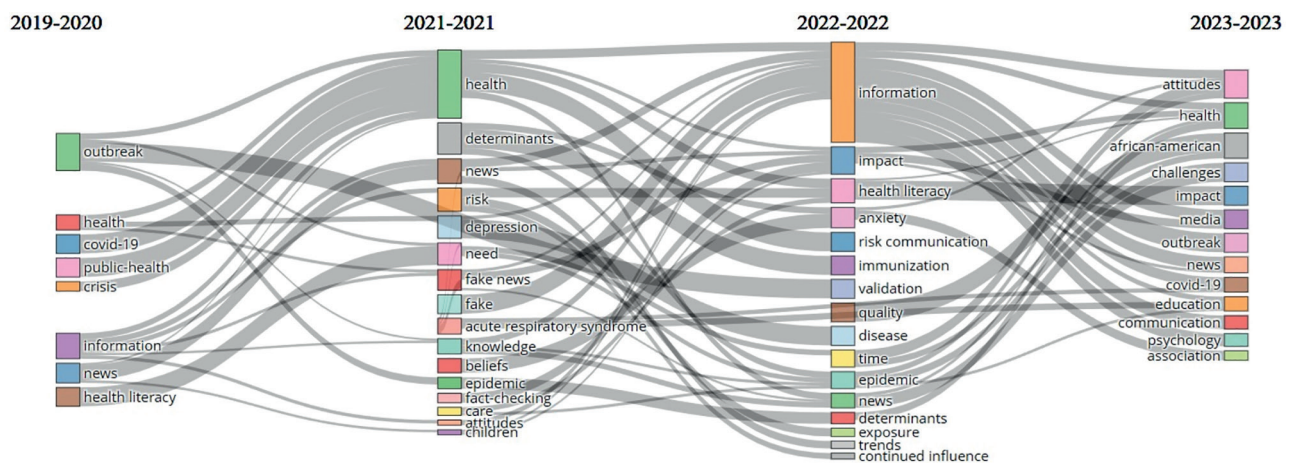

Figure 5: Thematic Evolution of Infodemic Scientific Publications

The data in Figure 5 indicate that the keywords in scientific publishing infodemic have evolved. During the 2019-2020 outbreak period, the main keywords were "Outbreak", "Health," and "COVID-19". In the timeframe of 2021, the keywords shifted to "health", "determinants," and "news". In 2022, the keywords were "information", "impact," and "health literacy". Finally, in the year 2023, the keywords were "attitudes", health," and "African-American".

Discussion

Nowadays, health crises such as pandemics have increased the growth and sharing of crisis-related information. This information can be either accurate or inaccurate. Consequently, the topic of infodemics arises alongside these crises. The current study results have shown that scientific publications related to the pandemic started in 2019 and have been rapidly growing. Following the global outbreak of COVID-19 in late 2019, which was considered a global crisis, information related to this disease quickly proliferated on online platforms and social media networks. The World Health Organization has referred to it as a global epidemic and identified it as a serious public health concern (2). Accordingly, researchers have also initiated various studies to combat the phenomenon of infodemic, leading to an increase in scientific publications in the field of infodemic since 2019.

The current study results have shown that the terms "health," "information," "news," "social media," and "communications" are the most important keywords in infodemic scientific publications, and infodemic scientific publications revolve around these keywords. In this regard, it can be said that the keyword "health" is the primary term in infodemic scientific publications. Additionally, the keyword "information" is also identified as another key term in infodemic, highlighting the role and importance of information flow in promoting health and conveying accurate and reliable information about diseases in society. The keywords "news," "social media," and "communications" are also commonly used in infodemic scientific publications, referring to the transmission of information and news through social media platforms and virtual communications.

According to the literature, even social media platforms, which play a crucial role in disseminating accurate news about COVID-19, are associated with the disease. While they serve as platforms that help spread public health messages to the population; they also promote opinion-based reports (20). The overload of information, along with the production and dissemination of fake news on communication platforms like social media, is steadily increasing. This fake news acts as narratives that either add to or omit information from the facts (Naem et al., 2020), directly impacting the infodemic (21).

Past studies indicate that social media networks such as YouTube and Twitter provide direct access to an unprecedented volume of information. This shift from traditional news paradigms has deeply influenced social perceptions and narrative framing. It has also impacted communications and public discourse, particularly when controversial topics are involved (22, 23). Consequently, social media platforms amplify the sharing of news and rumors. Moreover, false and suspicious news and information spread at a faster pace on these platforms (24). Specifically, during the COVID-19 pandemic, social media played a vital role in the dissemination of information within an unmediated news cycle, with the published information and news significantly affecting public health (25).

The results obtained from the thematic map have demonstrated the themes present in the domain of infodemics in scientific publications. The thematic map illustrates the subject areas covered by scientific publications. Accordingly, four categories of themes have been well-developed: Motor themes, which are ed and well-developed topics; Niche themes, which are highly specialized and peripheral topics; Emerging or declining themes, which represent newly emerging or declining subjects; and Basic themes, which represent fundamental research areas (26).

The current study results indicate that the themes mentioned in this article are important and dynamic within infodemics. These themes include belief, conspiracy, and need identified as significant and developed themes in infodemics. This demonstrates that beliefs, conspiracy theories, and societal needs are crucial within the realm of infodemics and should receive special attention in the examination and study of this

medical field.

Conspiracy theories are incorrect beliefs that secret organizations organize major events. These beliefs have emerged during health crises such as COVID-19 (27), the H1N1 pandemic (28) and the measles outbreak (29). Conspiracy theories are often associated with misinformation about medical facts and weaker health outcomes; they quickly spread, influencing public beliefs and preventive behaviors regarding the crisis (30). Furthermore, the terms "health, impact, communication," "information, news, social media," and "attitude, validation, acceptance" have been identified as the key themes in the field of infodemic. These themes indicate that health, impacts, communications, information, news, social media, attitudes, validation, and acceptance of information are important factors in studying and researching infodemics. News media is among the key influential factors in a public health emergency, with a crucial responsibility for effective media communications during such situations (31). Social media also provides an important platform for information dissemination and news sharing, playing a special role and position due to the widespread access of the general public to it, facilitating communication among individuals in society (32, 33). Communications are an integral part of any response to a crisis (34). Trust and communications are interconnected in health crises as communications can either build or erode community trust (35, 36). Communication, due to its vital role in relationships, contributes to trust-building (37).

The present study also showed that the themes 'continued influence', 'fight, design, transmission' and 'epidemic, SARS, acute respiratory syndrome' have been identified as specific and related subjects in the field of infodemic. Furthermore, the keyword 'management' has been mentioned as an emerging or declining topic in scientific publications on infodemic."

These themes indicate that specific factors such as the methods of disease transmission and specific diseases like SARS and acute respiratory syndrome are important in infodemic publications. These themes suggest that pandemics and crisis factors are the driving forces behind infodemics. Additionally, the management of infodemics requires more attention and effort, and researchers should pay

closer attention to this field.

Lack of proper management of infodemics can spread rumors and misinformation, resulting in the suppression of science. Accordingly, Eizenberg proposes four solutions for effective infodemic management, which include (1) monitoring information, (2) building capacities for electronic health literacy and scientific literacy, (3) promoting knowledge refinement and quality improvement processes, and (4) translating accurate and timely knowledge (38).

The results of the current study regarding the trend of developing themes and keywords in scientific publications on infodemics have shown that infodemic research in the period of 2019-2020 focused on topics such as outbreak, information, and COVID-19. With the increasing prevalence of COVID-19 in society, in 2021, the infodemic concentration shifted towards subjects such as health, determinants, and news. Furthermore, in 2022, the infodemic focus was on topics such as information, impact, and health literacy, and in 2023, keywords like attitudes, health, and African-American emerged as the main areas of investigation in infodemic studies within the field of healthcare. In this context, reports have indicated the simultaneous spread of the infodemic alongside the outbreak of COVID-19 (39, 40).

This trend indicates that infodemic research aims to utilize new and updated data in health and medicine to improve and expand related studies. Therefore, paying attention to health literacy and attitudes during 2022 and 2023 is crucial in combating this issue, and researchers have given special attention to promoting awareness and knowledge related to it during this time. Attitudes refer to individual perspectives, beliefs, and expectations towards various issues that infodemic can influence.

Conclusion

This study provides a comprehensive understanding of the evolving landscape of infodemic research, emphasizing the critical role that health, information flow, and communication channels play in addressing the challenges posed by the spread of misinformation during health crises. The identification of key themes and their progression over time highlights the dynamic nature of this research area, underscoring the necessity for continuous monitoring and adaptation to effectively combat the detrimental

effects of infodemics on public health.

The findings suggest that while significant progress has been made in understanding and addressing infodemics, there remains a need for more targeted and strategic efforts to manage the spread of misinformation. This includes enhancing public health communication strategies, fostering greater collaboration among researchers, policymakers, and media platforms, and improving health literacy among the general population. As infodemics continue to evolve alongside global health challenges, future research must focus on developing robust frameworks and tools that can mitigate the impact of misinformation and support the dissemination of accurate and reliable information.

Ultimately, this study highlights the necessity of a multifaceted approach to addressing infodemics, emphasizing the importance of collaboration across disciplines such as health sciences, communication studies, and information technology. Conducting interdisciplinary research in this area can lead to the development of more effective strategies for combating misinformation and strengthening resilience against information crises.

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Conflict of Interest
The authors have no competing interests.

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