

Recollection

Global Overview and Insights on Infodemiology and Infodemic Management

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The coronavirus disease 2019 (COVID-19) pandemic has underscored the global challenge of managing infodemics. In a situation report published on February 2, 2020, the World Health Organization (WHO) observed that the disease outbreak and response were accompanied by an extensive infodemic, complicating the process for individuals to identify trustworthy sources and obtain reliable guidances during such a critical period (1). On February 15, 2020, the Director-General of the WHO, Dr. Tedros Adhanom Ghebreyesus, highlighted the seriousness of this issue by stating, “We’re not just fighting an epidemic; we’re fighting an infodemic. Fake news spreads faster and more easily than this virus and is just as dangerous (2).”

The WHO defines an infodemic as an excessive amount of information during a disease outbreak, which can vary in terms of quality and accuracy. This rapid influx of information may lead to confusion and risk-taking behaviors posing potential health risks. Furthermore, it may cause a decline in trust in health authorities, consequently undermining the effectiveness of public health responses.

Rumors and misinformation have been prevalent throughout human history; however, the COVID-19 pandemic has led to an unprecedented surge of information dissemination compared to previous epidemics. This phenomenon can be partially attributed to the rapid advancements in digital technology and the widespread use of the internet and social media platforms. As of December 2022, the number of internet users in China has reached 1.067 billion, with a coverage rate of 75.6%. Additionally, 99.8% of these users access the internet through cell phones (3). In contrast, during the H1N1 influenza pandemic in December 2009, these figures were significantly lower, standing at 0.384 billion, 28.9%, and 60.8%, respectively (4).

Individuals depend on both real-world and virtual networks to engage and exchange information, thereby enhancing the effectiveness, range, and influence of information dissemination, regardless of its accuracy.

With the increasing diversity of information content, individuals can selectively access information based on their preferences. Concurrently, websites and platforms are inclined to promote content that appeals to users. In the absence of sufficient information and health literacy, individuals may encounter increasingly limited sets of data, inadvertently confining themselves within an information cocoon. This situation makes it challenging to acquire a comprehensive and objective understanding of information.

As understanding and managing infodemics is essential, significant efforts have been made in both research and practice. This article aims to delineate the evolution of infodemiology, present a recommended framework with practical tools for infodemic management, and subsequently discuss the progress and future directions for public health communities in China.

EVOLUTION OF INFODEMOLOGY

The evolution and significance of infodemiology and infodemics can be understood through four stages of development. Gunther Eysenbach, from the University of Toronto, Canada, first introduced the term “infodemiology” in 2002. At that time, the widespread use of the internet prompted researchers to express concern about the abundance of health information available online, much of which was inaccurate and inconsistent with the best scientific evidence. Consequently, infodemiology emerged as a new research field dedicated to studying the determinants and distribution associated with this phenomenon. The dissemination of health-related information on the internet has resulted in a mixture of both accurate and deceptive sources. In response to this issue, Dr. Eysenbach proposed a conceptual framework that highlights key indicators of information quality, focusing on aspects such as the source, content, and technical features of the information. Moreover, he created the eight-criteria CREDIBLE principle, which serves as a valuable tool for health professionals and

patients to identify and select high-quality online health information (5).

In May 2003, David Rothkopf from the United States first introduced the term “infodemic” within a Washington Post article to characterize the “information epidemic” that occurred during the severe acute respiratory syndrome (SARS) outbreak (6). Rothkopf emphasized the significant influence of infodemics in transforming SARS from a regional health crisis in China into a global economic and social catastrophe. Through the utilization and amplification of rumors and fear via contemporary information technologies, infodemics has possessed the capacity to affect national and international economies, politics, and security in ways that are vastly disproportionate to the underlying realities.

The third stage emerged around 2006 when infoveillance became a critical approach to disease surveillance and early warning systems. Infoveillance was introduced by Gunther Eysenbach as an expanding area of infodemiology, wherein he developed an information surveillance strategy to monitor flu-related searches on the internet for influenza syndromic surveillance and epidemic prediction. This strategy utilized statistics on ads triggered by keywords “flu” or “flu symptoms” provided by Google AdSense as a proxy for flu-related searches (7). In 2009, researchers from Google employed search query data to accurately identify influenza epidemics 1–2 weeks earlier than the CDC’s ILI (influenza-like illness) surveillance system, which led to the development of the well-known tool, Google Flu Trends (8).

The fourth stage began with the COVID-19 outbreak, during which the WHO acknowledged the infodemic issue and allocated significant resources, engaged multidisciplinary experts, and involved multisector stakeholders in implementing infodemic management, research, and practice. Amidst an information tsunami, factual information, which is accurate and based on current knowledge, contends with misinformation (false information not intended to cause harm) and disinformation (false information created to profit from or cause harm) (9). This mixture of misinformation and disinformation, also known as *inforus*, serves as the driving force behind the infodemic (10). The global infodemic management initiative led by the WHO seeks to understand the distribution, determinants, and impact of information, as well as to develop methodologies and tools that foster factual information while counteracting misinformation and disinformation.

FRAMEWORK FOR INFODEMIC MANAGEMENT

Managing an infodemic can be compared to the prevention and control of infectious disease epidemics. In the context of infectious diseases, it is imperative to maintain routine surveillance and emergency preparedness during non-epidemic periods. When an outbreak occurs, the prompt identification of cases and contacts, analysis of transmission modes, implementation of measures to treat cases and prevent new infections, and evaluation of intervention effectiveness are essential. Furthermore, enhancing health systems and increasing the immunity of susceptible populations play a crucial role.

Similarly, managing an infodemic entails several steps. First, consistent monitoring of health knowledge and behavior gaps in the population is crucial, as well as developing infodemic management (IM) capacity within public health institutions. Second, during outbreaks, identifying and tracking rumors, misinformation, and disinformation are essential. The third step involves gathering and translating the best evidence, sharing accurate facts, and debunking false information. Finally, assessing the effectiveness of IM interventions is necessary, in addition to improving the IM system and enhancing the health information literacy of individuals.

The WHO has established distinct competencies for each phase of the epidemic curve (11). The infodemic management framework and corresponding competencies are concisely outlined in Table 1.

TOOLS FOR INFODEMIC SURVEILLANCE

Since the beginning of 2020, the WHO has gathered global experts from various disciplines to share knowledge and research findings, develop guidelines, tools, and resources for managing infodemics. These resources are published on their designated infodemic webpages. The initial step in infodemic management involves social listening, which is a labor-intensive task that can be facilitated by information technology. Two prominent digital platforms for public health social listening are the Early AI-supported Response with Social Listening (EARS), developed by the WHO, and the Vaccination Demand Observatory (VDO), created by the United Nations Children’s Fund (UNICEF).

TABLE 1. Adapted workstream and competency framework for IM based on WHO Recommendations.

Workstream	Monitor & prepare	Detect	Intervene	Strengthen
Epidemics	Routine disease surveillance and emergency preparedness capacity building.	Promptly detect cases and contacts, and analyze the mode of transmission.	Treat cases and prevent new infections.	Evaluate the impact of interventions; strengthen health systems, and improve population immunity.
Infodemics	Monitor health knowledge and behaviors, and enhance the IM capacity within public health institutions.	Detect misinformation and disinformation, and analyze the spread and impact of infodemics.	Collect and translate the best evidence, share facts, and debunk false information.	Evaluate the impact of IM interventions; strengthen the IM system and improve population health information literacy.
Competencies for infodemic management	1) Social listening to monitor and analyze population knowledge gaps, health behaviors, and determinants; 2) build IM capacity within public health institutions.	1) Fact check to identify mis/disinformation; 2) analyze the impact and factors contributing to infodemics.	1) Identify the most robust evidence, translate scientific findings into high-quality health information, and proactively disseminate information from accurate and reliable sources to target audiences; 2) promptly debunk mis/disinformation; 3) risk communication and community engagement to build trust.	1) Quantify the impact of IM activities; 2) build individual and community resilience against mis/disinformation; 3) strengthen the ability to access high quality health information; 4) enhance the IM system by incorporating data-driven insights and lessons learned, and establish policies, resources, and mechanisms to support its effective implementation.

Abbreviation: IM=infodemic management; WHO=World Health Organization.

In 2021, the WHO introduced its artificial intelligence (AI)-powered social listening tool, EARS. This platform delivers real-time analysis of COVID-19 related narratives from various sources, including Twitter, Facebook, online forums, news articles, and blogs. EARS plays a crucial role in combating the infodemic by proactively identifying emerging topics and information gaps, thus enabling health authorities to address public concerns in a timely manner. The data gathered is automatically classified into 41 categories, such as cause, illness, treatment, and interventions, through a semi-supervised machine learning algorithm. The EARS dashboard enables users to monitor trends over time, categorized by country and WHO region. Presently, EARS performs analyses in nine languages and encompasses 30 countries (12).

The UNICEF VDO was established to address the consequences of misinformation and mistrust surrounding vaccines, which have been accentuated by the initiation of COVID-19 vaccination efforts in 2021. In response to the global vaccine hesitancy exacerbated by the infodemic, the VDO supports local communication initiatives by providing insights and evidence-based recommendations for infodemic managers and relevant stakeholders. This tool collects data from both online and offline sources (e.g., surveys, search engine trends, social media, and traditional media) in real-time, utilizing machine learning and natural language processing to identify patterns and monitor trends related to vaccine mis/disinformation.

The VDO dashboard allows users to track vaccine misinformation by country of origin, vaccine type, risk level, and specific topics such as side effects and conspiracy theories (13).

PROGRESS ON INFODEMOLOGY AND INFODEMIC MANAGEMENT IN CHINA

Infodemiology has emerged as a significant research topic in China since the COVID-19 pandemic began. Both the National Natural Science Foundation and the National Social Science Foundation have provided funding for research projects related to infodemiology. Although the discipline is still in its early stages, researchers in China have recognized its importance and are contributing to global understanding and best practices. In the Web of Science core collection database, there were a total of 1,481 publications worldwide containing the topic “infodemic” or “infodemiology” from January 1, 2022 to March 31, 2023. An analysis of the publications from the top 10 countries was presented in Table 2. Canadian researchers established the discipline in 2002 with the earliest publications, followed by the United States, which has contributed the largest number of publications to date. Since the year 2020, there has been a sharp increase in the number of publications, with Chinese researchers making significant contributions to the global understanding of infodemic and infodemiology alongside peers from other

TABLE 2. Distribution of the numbers and citation frequency of infodemic/infodemiology publications in the Web of Science Core Collection through March 31, 2023.

Infodemic related publications	USA	China	England	Italy	Spain	Canada	India	Germany	Brazil	Australia
Average times cited per publication	19.07	24.93	15.68	20.98	12.24	48.55	17.14	15.32	4.38	21.77
Total number of publications	388	165	134	128	96	90	90	65	58	56
2023	9	6	4	9	1		2	3	2	3
2022	91	48	32	33	38	27	31	23	19	15
2021	146	63	60	34	24	37	33	25	30	25
2020	92	36	28	26	28	16	23	12	6	12
2019	9	1	2	5	3	3	1	1		
2018	12	2	4	8	1				1	1
2017	5	1	2	3	1					
2016	4	1	2	2		1				
2015	3			5						
2014	5	3		3		1		1		
2013	7	3								
2012	2									
2011	2	1				2				
2009						1				
2004	1					1				
2002						1				

Note: The search query included "infodemic" or "infodemiology" in the title, keywords, or abstract. The number of publications is represented by a color-coded scale, with the highest number in red and the lowest number in green.

countries.

In the context of infodemic management practices, various government levels have worked in conjunction with social media companies to create fact-checking and debunking platforms and tools, referred to as "Piyao" in Chinese. At the national level, the Cyberspace Administration of China (CAC), also known as the Central Cyberspace Affairs Commission, has collaborated with pertinent departments to establish the China Internet Joint Piyao Platform, launched in 2018. Numerous provinces, selected cities, and social media companies, such as Tencent, have also formed their local Piyao platforms. In September 2021, the CAC introduced a proposal aimed at safeguarding cyberspace from disinformation (14), and subsequently, in September 2022, executed a three-month special action to combat internet rumors and disinformation in coordination with other relevant organizations and platforms (15).

Public health institutions in China are also dedicated to preventing and reducing the risks of infodemics. For instance, China CDC conducts ongoing health education and promotion efforts while also regularly monitoring public opinion since the emergence of COVID-19. In September 2022, the first specialized

internal training on infodemic management was held. Currently, there are internal regulations and guidelines under development and nearing completion that address public opinion monitoring and crisis management, major public health information release and risk assessment, and guidance on public opinion related to the internet.

To provide accurate and timely data for public health professionals and decision-makers, China CDC developed an information tool known as the "Global COVID-19 Data Integration and Risk Analysis Platform" in 2021, designed for use by multi-level CDCs in China. This platform aggregates open data from reputable sources worldwide, encompassing information related to COVID-19 cases, deaths, testing, policies, vaccinations, variants, population mobility, and international flights. Advanced technologies facilitate real-time data collection, standardization, visualization, and simulation analysis. In the post-COVID-19 period, the platform will be adapted for use with other diseases that have epidemic potential.

There is a significant need for continued research and development within the realms of infodemiology and infodemic management. The formation of a

specialized team, composed of professionals from various backgrounds, including health, communication, and information technology, is vital for long-term engagement and dedication to both research and practical applications. Moreover, the implementation of a multisector coordination and collaboration mechanism that encompasses public health agencies and non-health organizations is of critical importance for success in this domain.

Ultimately, the primary objective of this research is to enhance media and health information literacy among the general population, thereby fostering a more informed and empowered society.

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