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Infodemiology and Metascience to Prevent Disinformation

Yanıltıcı Bilgi ile Mücadelede İnfodemiyoloji ve Meta-Bilim

Osman Hayran

İstanbul Medipol Üniversitesi, Tıp Fakültesi, İstanbul, Türkiye

ORCID ID: Osman Hayran: https://orcid.org/0000-0002-9994-5033

***Sorumlu Yazar / Corresponding Author:** Osman Hayran, **e-posta / e-mail:** ohayran@gmail.com

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Abstract

There is an enormous amount of data flow through social media and digital networks and the Big-Data has become the most important source of information. Developed data processing techniques and increased use of digital technology enable us to access more data to process more reliable information. However, the same developments have also led to new safety problems during the provision of healthcare services. Disinformation, misinformation, pseudoscience and non-replicable scientific publications are currently at the forefront of these challenges. While dis(mis)information mainly influences ordinary people, pseudoscience and publications with non-reputable methodology mislead scientists. All need to be managed rigorously for better decision-making processes.

Infodemiology and metascience are two rapidly emerging areas of study in the information age that address some of the most pressing challenges in this regard. By understanding and improving how information is spread and how science is conducted, these fields can help build a healthier, more informed, and scientifically literate society.

Keywords Infodemiology, meta-science, dis(mis)information, reproducibility

Öz

Sosyal medya ve dijital ağlar üzerinden akmakta olan muazzam miktardaki veri akışına bağlı olarak Büyük Veri en önemli bilgi kaynağı haline gelmiştir. Gelişmiş veri işleme teknikleri ve dijital teknolojinin artan kullanımı ise daha fazla veriye erişerek daha güvenilir bilgileri işleyebilmemizi sağlamaktadır. Ancak, aynı gelişmeler sağlık hizmetlerinin sunumu sırasında yeni güvenlik sorunlarına da yol açmıştır. Dezenformasyon, yanlış bilgi, sahte bilim ve tekrarlanamayan bilimsel yayınlar şu anda bu sorunların başında yer almaktadır. Dezenformasyon öncelikle sıradan insanları etkilemekte, sahte bilim ve güvenilir olmayan yöntemler içeren yayınlar bilim insanlarını yanıltmaktadır. Daha iyi karar alma süreçleri için tüm bunların titizlikle yönetilmesi gerekmektedir.

Infodemioloji ve metabilim, bilgi çağında bu konuda en acil sorunların bazılarını ele alan, hızla gelişen iki çalışma alanıdır. Bilginin nasıl yayıldığını ve bilimin nasıl yürütüldüğünü anlamak ve iyileştirmek için gerekli olan bu alanlar daha sağlıklı, daha bilgili ve bilimsel açıdan daha okuryazar bir toplumun oluşturulmasına katkı sağlayacaktır.

Anahtar Kelimeler *İnfodemiyoloji, meta-bilim, dezenformasyon, tekrar edilebilirlik*

INTRODUCTION

Safety is the most important topic of medical decisions as it is expressed in the famous phrase "First do no harm". Presence of reliable and secure information systems is a prerequisite and number one issue to ensure this.

Information means processed data that has been organized or structured in a meaningful way, making it useful for decision-making, analysis, communication, or comprehension. Accurate and reliable information is the major raw material for high quality knowledge production. It is also the most significant input for correct medical decision-making processes.

In the Age of Information there is an enormous amount of data flow through social media and digital networks, and the Big-Data has become the most important source of information. Developed data processing techniques and increased use of digital technology enable us to access more data to process more reliable information. However, the same developments have also led to new security problems. Disinformation, misinformation and pseudoscience are currently at the forefront of these challenges. Vaccine hesitancy and publication of several unreputable academic articles during the COVID-19 pandemic are the most prominent examples in this regard.

Excessive information bombardment known as infodemic is a reality of our daily lives but may become a danger during times of health crisis. Infodemiology, an interdisciplinary science has emerged because of the efforts to understand the dynamics of infodemic and manage the related problems.

On the other hand, increased number of published research articles that are not prepared with rigor and care is another information age problem especially during times of crisis. Although they are published in reputable journals and written by people with academic titles many of them do not have sufficient scientific standards. Especially during the COVID-19 pandemic period, many publications that are extremely weak in terms of methodology have invaded reputable journals. Meta-science is the emerging discipline to examine such studies.

In summary, misinformation and pseudoscience are twin threads to medical decision-making processes during the information age. Publications with non-reputable methodology mislead scientists while misinformation mainly influences ordinary people. It is important to manage both for better healthcare and healthy societies.

Infodemiology and metascience to struggle with information problems are the disciplines that have gained importance especially during the COVID-19 pandemics.

Recent increases in the number of publications regarding infodemiology and meta-research may be concluded as an indirect reflection of the growing importance of these topics. First publication regarding infodemiology has been indexed in 2002 by PubMed and the number of articles has sharply increased during the 2020-2025 period as it is seen on Figure 1.

First appearance of metascience articles have longer history than infodemiology. However very limited number of publications have been indexed till the year 2015 and a progressive increase has been observed in the following years (Figure 2).

Similar distributions have been observed for Web of Science articles, but not all of them were related with medicine and health services.

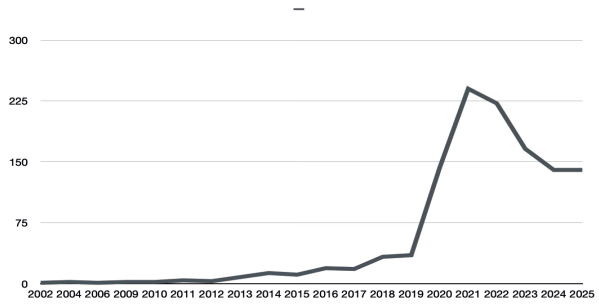

Figure 1. Distribution of PubMed articles containing "infodemiology" or "infosurveillance" or "infoveillance" or "infoveillance study" or "infodemic management" key words by years (n=1155)

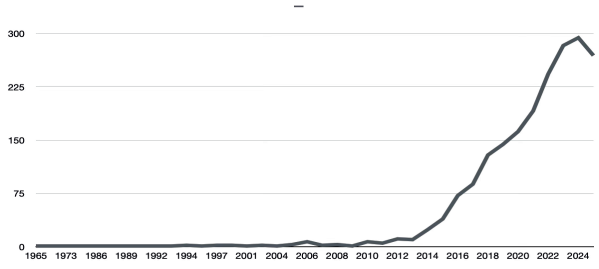

Figure 2. Distribution of PubMed articles containing"metascience" or "meta research" or "research on research" or "meta-science" or "meta-research" key words by years (n=1798)

Infodemiology: Charting the Information Landscape

Infodemiology, a term coined by Dr. Gunther Eysenbach in 2002, is a hybrid of "information" and "epidemiology."[1] It refers to the study of how information, particularly in the context of health, spreads through digital and traditional media and affects public health. The concept has become increasingly relevant with the rise of the internet and social media that have transformed how people access and share information.[2]

Other concepts used for similar purpose are syndromic surveillance and info surveillance. Syndromic surveillance is the monitoring of diseases by analyzing various health-related data when there are no symptoms of the disease to take timely measures against problems that may threaten public health.[3,4]

Syndromic surveillance methods were initially developed with the aim of helping to make predictions using clinical databases and information. However, it is also possible to make predictions using only internet search engines and to perform disease surveillance through open sources. Eysenbach's work on Google during the 2004 influenza pandemic (avian flu) is an important milestone in this regard.[5]

Collecting health data and information needed for correct decisions in the health systems is not a new issue and has a history as long as the history of humanity. Since ancient times humans have been making observations, collecting data and information regarding natural and environmental conditions to understand the probable threads for their health. Almost every nation has established its own health information and surveillance systems. Besides, World Health Organization (WHO) routinely collects and monitors health data that are needed for global warnings when necessary. However, what is new in our time is the management of the rapidly and uncontrollably circulating enormous amount of information. It is necessary to monitor this information, analyze it, and use it to make the right decisions.

Misinformation, disinformation are important issues to be managed especially during times of crises as it has been experienced during COVID-19 pandemic. As a matter of fact, for this purpose, the World Health Organization organized the Infodemiology Conference in June-July 2020 and addressed the problem in all its dimensions.[6]

Infodemiological methods, which were initially developed to analyze and manage false, erroneous and harmful information, later became the methods of monitoring and analyzing information to make predictions about important public health problems. The methods developed for infodemic studies are also used by the discipline called digital epidemiology or e-epidemiology. Digital epidemiology means "epidemiology using digital data". More precisely, it is epidemiology that uses data collected outside the health-

care system for non-research purposes. The data used is actually a very important part of Big Data and is classified as "spontaneous or naturally occurring data". It is different from the "researcher-generated data" that are collected in a planned manner by using scientific methods.

Meta-Science: Ensuring the Reliability of Knowledge

Meta-science means "the study of research". "The science of science", "Meta-Research" or Evidence-Based Research" are usually used as synonyms.[7] It focuses on the methods and practices of scientific research itself. It aims to improve the quality, reproducibility, and efficiency of scientific inquiry. With the development of information technologies, research methods and results whose accuracy could be questioned long after they were published, can now be questioned as soon as they are published.

The importance of meta-science lies in:

- Reproducibility Crisis: Many scientific findings are difficult to replicate, undermining the credibility of research. Meta-science seeks to identify the causes of this crisis and develop solutions.
- Research Waste: Inefficient research practices lead to wasted resources and time. Meta-science helps optimize research design and conduct to maximize impact.
- Publication Bias: The tendency to publish positive results can distort the scientific literature. Meta-science addresses this issue by developing methods to identify and correct publication bias.
- Public Trust in Science: By improving the transparency and reliability of scientific research, meta-science helps build public trust in science.

Meta-science is crucial for maintaining and enhancing the credibility of science. By addressing issues like the reproducibility crisis and bias, meta-science helps ensure that scientific findings are reliable and that the scientific process is robust. This, in turn, fosters public trust in science and ensures that scientific research can effectively contribute to solving complex global challenges, from climate change to pandemics.

Discussion of quality problems in scientific research is a topic of every period and the problem of reproducibility has a long history.[8] The problem of replicability or "replication crisis" came to the agenda when it was observed that the results of many studies did not support the initially planned objectives and hypotheses, but were tried to be supported by forced interpretations, and that the methods were not clear enough to be replicated by others.[9]

Thanks to the development of information technologies, research methods and results that did not attract attention before and whose accuracy could be the subject of debate long after they were published are now questionable as soon as they are published, which has facilitated studies in this field.

The "manifesto for reproducible, testable science" prepared by a group of scientists and published in Nature in 2017 is an important step in the development of meta-science.[10]

Some of the meta-scientific problems described in various meta-science studies can be summarized as following:

Inconsistency of the conclusions

In a comprehensive study conducted in 1966, the statistical methods of 295 articles published in reputable medical journals were analyzed and it was found that the interpretations and conclusions made in 73% of them were not consistent with the findings.[8]

Crisis of credibility

Fake news and fake research are realities of the modern world and part of the reason scientists, researchers and clinicians are facing a crisis of credibility as McGee and Dawson have emphasized in their article.[11]

A systematic review and meta-analysis have found that ap-

proximately 2% of researchers admit to deliberate research misconduct and 33% admit to questionable research practices.[12]

Reproducibility problem

Reproducibility problem, which emerged in the form of selective reporting, statistical fetishism and unrepeatable workflows, first attracted attention in social sciences research, then in health sciences, and finally its presence in epidemiological research began to be discussed.[13,14]

Prolific authorship

In a search of the Scopus database covering the period between 2000 and 2016, it was found that 9000 people published more than 72 publications per year (i.e. one publication every five days), and 265 authors of them were found to be hyperprolific.[15] Analysis of the profile of hyperprolific authors showed that more than half of the hyperprolyfic authors were from the field of Medicine or Health Sciences, mostly from the USA, Germany and Japan, usually from the field of epidemiology and cohort studies. It is worth emphasizing that only one third of the 81 hyperprolific authors in 2016 fulfilled all four of the Vancouver criteria set by the International Committee of Medical Journal Editors in 1988.

Publications by non-research authors

A recent study finding make the authorship issue even more interesting. In this study, a systematic mapping of authors who have more than 200 publications in various medical and general science journals with high impact factors was performed, and authors with more than 700 publications were analyzed in detail.[16] While there's no universally agreed-upon quantitative threshold for massively prolific, the criteria used in this article was authors who have published over 700 papers in at least one high impact scientific journal.

There may be reasonable explanations for hyperprolific authorship.[16] However, it was observed that the individuals with more than 700 publications in these journals were not from the scientific community. Some of them had a master's degree in journalism, and only two of them had a doctorate in medicine.

Science journalism is important to present complex scientific issues related to health in a way that can be understood by ordinary people. It even has an important function such as advocacy during periods when non-scientific rumors intensify. However, it is surprising that experts in this field have published so many publications in science journals that they outrank scientists and receive citations.

Analytical variability- Analytical flexibility – Vibration of Effects

According to a study by Vinatier et al, analytical variability based on analytical flexibility is another source of reproducibility problem.[18] From data processing choices (eg, eligibility criteria, handling of outliers, dichotomization of outcome and of covariates) to model selection, many sources of analytical flexibility exist in primary research.

The phenomenon of analytical variability is not restricted to primary research and is also observed in evidence synthesis methods. Differences in inclusion/exclusion criteria regarding Population-Intervention-Comparison-Outcomes-Study design and other analytical choices can lead to substantial analytical variability, especially for controversial topics with high clinical and statistical heterogeneity or when the evidence synthesis methods are complex and rely on assumptions that are difficult to verify (eg, exchangeability in comparative effectiveness research).[18]

Same data, different results

As an example, recently, two papers published in the same year and in the same journal investigated the same research question with the same dataset and reached divergent results regarding the benefits of retrieval bag use during laparoscopic appendectomy. The two studies reached contrasting conclusions, one found that these bags reduce

the risk of infection while the other study found no support for a difference.[19-21]

Gaming practices of "Publish or Perish" behavior

Gaming practices due to "publish or perish" pressure is a common experience of many scientists. Among them gift authorship, over-attribution of authorship, massive self-citations, citation farms (citation cartels), h-index gaming, journalistic (editorial) nepotism, journal impact factor gaming, paper mills and spurious content papers are well known examples. A set of quantitative metrics have been proposed by Ioannidis and Manias to detect such faulty behaviors.[22]

Infodemiology and Meta-Science for healthy societies

While infodemiology and metascience are distinct fields, both focus on the flow and integrity of information-whether it's the spread of health-related information to the public or the dissemination of scientific knowledge within the research community. Understanding how information spreads (infodemiology) is essential for effectively communicating scientific findings (meta-science). Conversely, meta-science can provide tools to evaluate the quality of information shared through various channels.

During a public health crisis, meta-science can help to improve the reliability of research findings, while infodemiology can ensure that accurate information reaches the public and counteracts misinformation. This synergy is essential for effective health communication and policymaking. Together, they contribute to a broader understanding of how information impacts public health and scientific progress.

As the digital age continues to evolve, the roles of infodemiology and metascience are likely to expand. The increasing volume of information available online, coupled with the challenges of misinformation and scientific integrity, will require ongoing innovation in these fields. Researchers and public health officials will need to develop new tools and strategies to monitor and manage the flow of information and to ensure that scientific research remains credible and impactful.

In conclusion, infodemiology and metascience are two vital areas of study that address some of the most pressing challenges of our time. By understanding and improving how information is spread and how science is conducted, these fields can help build a healthier, more informed, and scientifically literate society.

Ethics Approval

There is no need to ethic issue.

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Externally and internally peer-reviewed.

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Concept: O.H., Design: O.H., Data Collection or Processing: O.H., Analysis or Interpretation: O.H., Literature Search: O.H., Writing: O.H.

Conflict of Interest

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