# Implications of the health information pollution for society, health professionals, and science

Matheus LOTTO[1] | Olívia Santana JORGE[1] | Agnes CRUVINEL[2] | Thiago CRUVINEL[1]

[1]Universidade de São Paulo, Faculdade de Odontologia de Bauru, Departamento de Odontopediatria, Ortodontia e Saúde Coletiva, Bauru, Brasil.
[2]Universidade de São Paulo, Faculdade de Medicina de Bauru, Bauru, Brasil.

## Abstract

In the era of ultra-connectivity, the proliferation of speculative notions driven by personal emotions eclipses the credibility of scientific evidence. This trend has led to an alarming surge in information pollution, particularly by the pervasive influence of social media platforms. Consequently, this overflow of falsehoods poses a significant threat to public health and overall societal well-being. In this sense, this critical review aims to present the harmful impacts of the health information pollution on society, health professionals, and health science, as well as strategies for their mitigation. The management of information pollution requires coordinated efforts to develop and implement multiple effective preventive and debunking strategies, such as the regulation of big tech companies' actions and algorithm data transparency, the education of health professionals on responsible social media use, and the establishment of a novel academic culture, shifting from the valorization of productivism to socially relevant scientific production. By acknowledging the complexities of this contemporary issue and drawing insights from distinct perspectives, it is possible to safeguard the integrity of information dissemination and foster a more informed and resilient community.

**Keywords:** Access to information. Disinformation. Information-seeking behavior. Science. Social media.

Corresponding address:
Thiago Cruvinel - Universidade de São Paulo, Faculdade de Odontologia de Bauru, Departamento de Odontopediatria, Ortodontia e Saúde Coletiva - Alameda Dr. Octávio Pinheiro Brisolla, 9-75, Vila Universitária, Bauru, SP, 17012-901, Brasil.
Phone: +55 14 3235 8000
e-mail address: thiagocruvinel@fob.usp.br

# Introduction

According to the United Nations Development Programme, information pollution refers to false, misleading, and manipulated content—whether online or offline—created, produced, and disseminated either intentionally or unintentionally, with the potential to cause societal or physical harm.[1] Research has scholarly explored various types of information pollution, including misinformation, disinformation, mal-information, and conspiracy theories. Misinformation, by definition, involves inaccurate information shared without the intention to deceive, often containing elements of truth. In contrast, disinformation is a deliberately fabricated falsehood intended to harm individuals, groups, organizations, or nations. Mal-information refers to accurate information used maliciously to cause harm.[2,3] Conspiracy theories attempt to explain major social and political events by attributing them to covert operations conducted by powerful figures.[4]

Although information pollution has long existed, its spread has accelerated in recent years,[5] driven by advances in information and communication technologies that facilitate the widespread sharing of subjective opinions, especially via social media platforms.[3] This pervasive distribution poses significant threats to public health and to the overall population well-being. First, it diminishes health and eHealth literacy, impairing the public's understanding of essential health information. Second, it undermines the principles of evidence-based medicine by fostering skepticism toward established medical practices and treatments. Third, it compromises individuals' abilities to discern the authenticity of information, creating an environment conducive to the dissemination of falsehoods. Fourth, it triggers a crisis of confidence in professional expertise, leading to a climate of distrust that hampers patient-professional relationships. Finally, the erosion of trust and circulation of misleading information can discourage engagement with certain medical treatments, negatively influencing decision-making processes and public health outcomes. Consequently, it is imperative to mitigate these harmful effects with targeted interventions and evidence-based strategies.[6-9]

Understanding why and how people get in touch with information pollution is crucial. Individuals are naturally attracted to novel and engaging content,

reflecting an inherent curiosity about the world.[10] False messages often contain innovative elements designed to capture attention. Furthermore, weak social ties within digital networks contribute to the rapid dissemination of these messages,[11] particularly among individuals with specific demographic characteristics, including conservative ideologies, lower analytical capabilities, and of older age.[12,13] In the post-modern era, marked by post-truth, speculative beliefs derived from personal emotions and subjective experiences often overshadow the credibility of scientific evidence (see an allegorical representation of the digital ecosystem in Figure 1).[14] For instance, a survey revealed that only modest proportions of the populations in China and the United States consider global warming an issue critical to the preservation of life on Earth.[15]

This critical review aims to present the harmful impacts of the health information pollution to health researchers and academics, ranging from broad societal contexts to specific implications for health professionals and health science. Additionally, it highlights the urgent need for developing and implementing multiple effective strategies to address and mitigate the spread of falsehoods. Figure 2 summarizes the interrelations of the contextual topics discussed in this article.

## Society

This section briefly contextualizes the ecosystems of the health information pollution regarding specific groups of actors.

## Health consumers

Proactive individual behaviors in managing health conditions toward well-being are contributing to the gradual shift from a biomedical to a holistic and participatory healthcare framework, in which people are stimulated to actively seek and share health-related information.[16-18] Consequently, cyberspace presents abundant information, making it difficult for digital users to identify reliable health information. This environment inadvertently supports the circulation of inaccurate or misleading health content, which spreads more quickly than accurate information,[19] especially when it is influenced by political agendas that include xenophobic, racist, and homophobic narratives.[20]

Several factors contribute to this scenario. For example, digital influencers motivated by social and
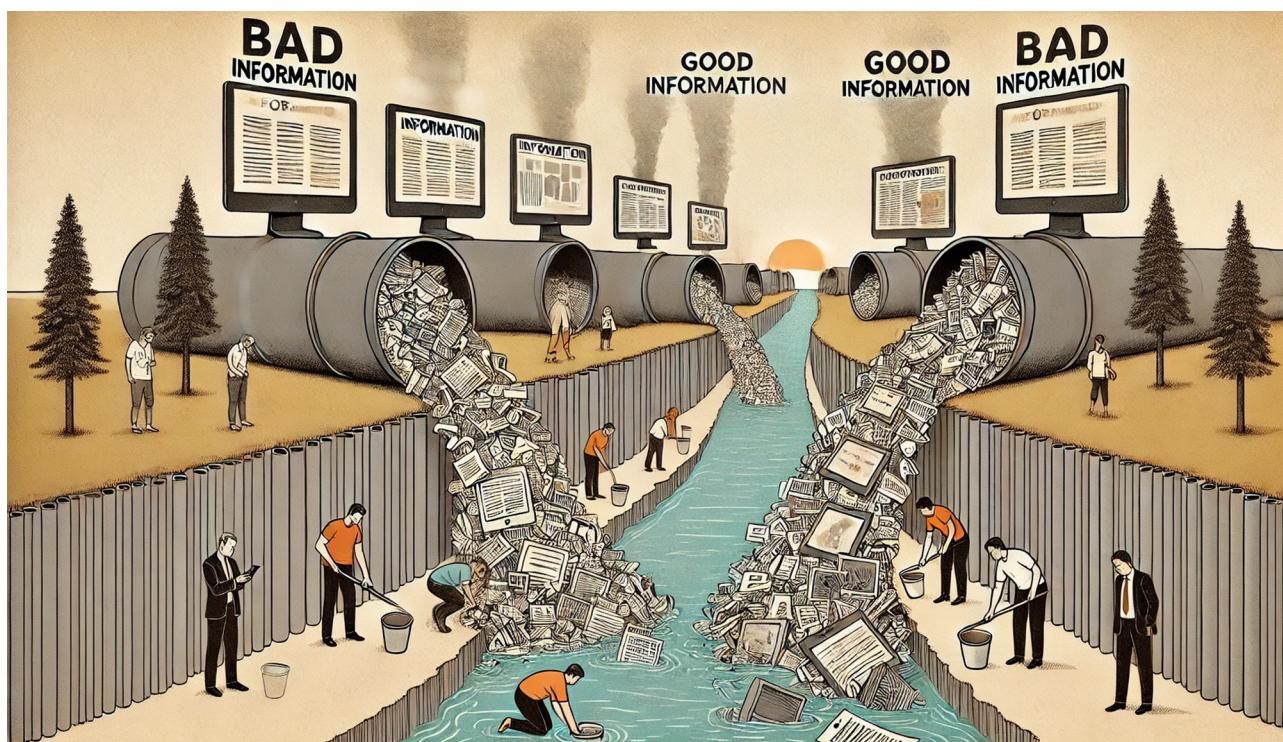
**Figure 1-** Allegorical representation of the production, diffusion, and consumption of information (good information) and information pollution (bad information) in the digital ecosystem. In this depiction, people communicating via social networks share common access to the hydric channel (cyberspace) and its content (e.g., posts). However, they are often unaware of the factual accuracy of this content. Information pollution circulates faster in the channel and exhibits higher levels of novelty and attractiveness, drawing more attention than accurate information. While the channel's capacity to carry information is almost unlimited, individuals' ability to select, collect, and store information is considerably constrained. Consequently, the consumption of ubiquitous information pollution is influenced by structural and individual factors. Some people may be more selective in filling their buckets, while others indiscriminately gather whatever content first comes within reach. Additionally, the acceptance or rejection of content is influenced by individuals' digital access and confirmation biases, symbolized by different clothing groups (e.g., white t-shirts, orange t-shirts, or suits and ties). While it is relatively simple to locate the distribution pipes of information from various production sources, identifying the authors of the content, understanding the logic behind its production and distribution, or determining the system's controllers remains challenging. The congruent interests in validating or rejecting the facticity of thematic content bring people closer together (they desire to be closer to the distribution pipes that deliver reaffirmations of their convictions), and divergent interests push people apart (they want to distance themselves from the distribution pipes that deliver contradictions of their beliefs). Also, the system's administration builds more distribution pipes of content that align with the preferences of their clients, leading to the formation of homophilic groups. The more individuals consume specific content, the more credible it becomes, increasing the likelihood that they will accept it as true, incorporate it into their belief systems, and share it. This can result in the exclusive consumption of content aligned with their convictions (echo chambers). Over time, people may become more radicalized in favor of the views they share with "their friends" and begin to attack those who do not share their views ("their enemies"), leading to polarization. These clashes with divergent groups blur the users' ability to see and discuss the interests of content producers and distributors. They no longer care about all the pollution found within the channel. On the contrary, they crave more pollution to subsidize and fuel their battles against their peers. Meanwhile, the pollution industry and the owners of the digital ecosystem are profiting like never before. "So why change the system?" they ask. Image created using the DALL-E image generator (OpenAI, San Francisco, USA).
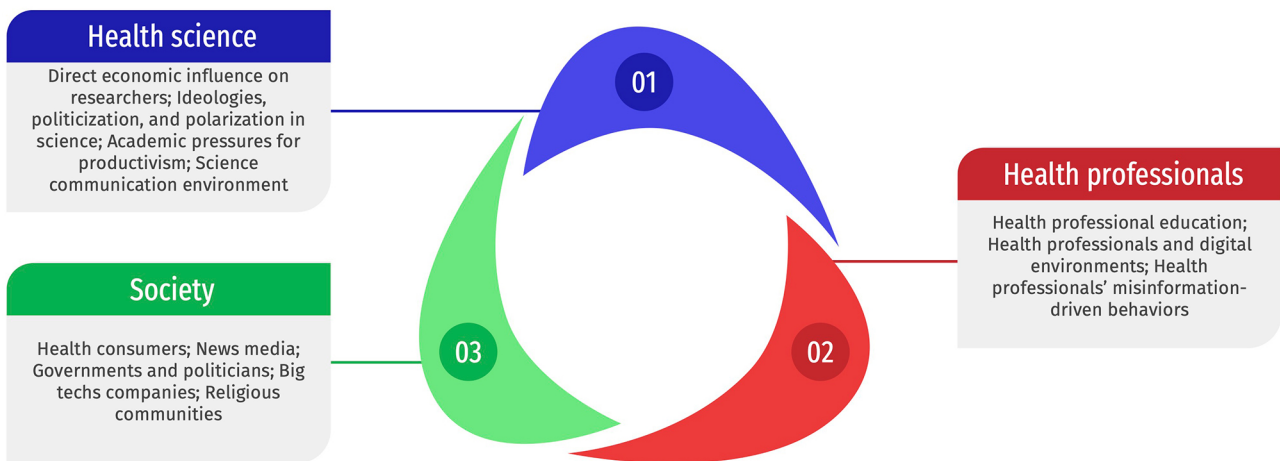
financial gains can promote biased, manipulated, and imprecise health-related content, fostering the dissemination of non-evidence-based messages that mislead the public and compromise the integrity of shared information.[9,21] Additionally, low levels of critical thinking and health literacy hinder the effective personal evaluation of the credibility and accuracy of digital content.[22-24] Furthermore, individuals may be driven by narcissistic traits and the fear of missing out (FOMO) syndrome, sharing online content to enhance their social image.[5]

In addition, health misinformation can persuade and aggregate digital consumers with aligned beliefs, forming echo chambers.[25] Repeated exposure to echoed misinformation creates confusion and may potentially lead to cyberchondria, which undermines expert counterarguments, as seen in the anti-vaccination discourse.[10,26,27] Another factor is therapeutic pluralism, characterized by the simultaneous adoption of antagonistic health practices by individuals, such as allopathic and homeopathic applications in the treatment of severe pain.

## News media

Although specific regulations are established to oversee the news media conduct in terms of ethics, transparency, and the pursuit of truth, frequent violations lead to the spread of misinformation.[28]

**Health science**
Direct economic influence on researchers; Ideologies, politicization, and polarization in science; Academic pressures for productivism; Science communication environment

**Health professionals**
Health professional education; Health professionals and digital environments; Health professionals' misinformation-driven behaviors

**Society**
Health consumers; News media; Governments and politicians; Big techs companies; Religious communities

**Figure 2-** Diagram summarizing the perspectives of society, health professionals, and health science concerning information pollution.

This situation highlights the urgency of developing mechanisms to hold media outlets accountable for inaccuracies and omissions that may align with ideological biases, primarily to maximize profits. Certain outlets overtly support specific political agendas, contributing to a polarized media environment that tailors its reporting to enhance audience engagement.[29]

Additionally, the news media often produce science communication pieces based on preprint results, which have not been validated by peer review. Journalists also frequently overstate the significance of studies with low-level evidence, such as *in vitro* experiments, presenting them as if their findings were conclusive clinical advances.[30]

## Governments and politicians

The desire to maintain power drives political leaders to make ideological decisions that favor specific groups at the expense of broader societal welfare, often under the guise of promoting economic growth and social stability. Such communication strategies secure popularity and reinforce political support. Governments frequently task nonexpert professionals with formulating science policies, which can lead to decisions that deviate from the current scientific consensus. For example, some cities have ceased their water fluoridation programs due to populist influence, even though this decision contrasts with strong evidence supporting the strategy as an effective and safe measure to prevent dental caries.[21,31]

## Big tech companies

Technological corporations encounter substantial financial conflicts of interest when addressing the spread of misinformation on their platforms. These companies generate profit through advertisements that maximize user engagement and stimulate the propagation of messages irrespective of their facticity. Hence, the operational mechanisms of algorithms are designed to hold users' attention by promoting content aligned with their preferences.[32]

Big tech companies are hesitant to implement available solutions to identify and mitigate information pollution,[33] publicizing concerns about the risk of censorship. Although freedom of expression is a fundamental human right, it must be limited to information, considering the harmful impacts of misinformation.[34] The complexity of this problem increases with the emergence of deepfake technology, intensifying the challenges associated with discerning factual and non-factual content.[35]

## Religious communities

The preachings of some religious leaders determined people's avoidance of mask-wearing and vaccination,[36] contributing to the increase in virus transmission rates and higher mortality during the COVID-19 pandemic. This fact illustrates the influence of religious values beyond individuals' spiritual beliefs.[37] Religion can interfere with health choices and behaviors and propagate health misinformation that is uncritically absorbed by adherents. It produces more pronounced impacts in intensively ideologized communities, in which divine authority justifies church directives, even regarding the socially-, economically-, and politically-shaped interests.

## Health professionals

Health professionals play a pivotal role in managing the health information pollution by

their responsibility to disseminate health practices grounded in scientific evidence. Otherwise, they risk aligning themselves with prevailing trends of science denial and pseudoscience, consequently, undermining trust in science. This section concentrates on health professionals' contributive factors of formal and informal education to information pollution.

## Health professional education

Health professionals are typically trained using biomedical model principles: a curative, hospital-centric, hierarchical, and individualistic approach that emphasizes the professional role in treating the physical aspects of diseases.[38] This reductionist approach permeates health education, which is structured around specialized and segmented disciplines, leaving professionals ill-equipped for reflective and critical thinking. Additionally, it favors the predominance of profit-driven practices over the quality of patient care.

Undergraduate students expect a learning environment that reflects their digital experiences, characterized by immediacy, interactivity, and visual stimulation.[39] Smartphones and social media are integral to their daily lives.[40] The discrepancy between this expectation and the traditional passive learning models employed by many medical schools presents a significant educational challenge, hindering the development of critical and reflective skills needed for clinical decision-making.[41]

Moreover, the rapid expansion of health professional training programs, particularly in developing countries, is constrained by the availability of qualified educators.[42] As a result, institutions often employ less experienced staff at reduced salaries, which can compromise the quality of education.[43] This perpetuates outdated principles of non-patient-centered care, increasing the risk of developing professional practices based on beliefs rather than scientific evidence.[44]

## Health professionals and digital environments

There are notable exchanges of experiences and discussions about health practices with the increasing presence of health professionals on social media. These platforms can serve as valuable sources of information by sharing knowledge via colleagues' profiles, pages, and health organizations.[45] However, the propagation of information on social networks may lead to professionalism breaches, including lapses in

honesty, ethical dilemmas, inadequate self-regulation, and diminished social responsibility.[46]

Additionally, many health professionals access unverified sources of information as a form of continuing education, given the plethora of options for online courses and social media content. This allows them to select resources that align with their pre-existing views rather than those grounded in scientific rigor, leading to inadequate critical assessment skills.[47]

As patients often assess the quality of a healthcare provider or organization based on the number of digital followers on social media,[48] health professionals may adopt sales-oriented strategies typical of digital influencers—such as challenges, dances, and giveaways—to increase their visibility and credibility. The public's validation of such behaviors may encourage health practices based on dubious information, while skepticism can foster mistrust and reinforce negative perceptions of the professional community.[47]

Finally, health professionals can compromise evidence-based practices by affiliating with brands in a digital environment for personal gain and by promoting products without adequate verification of their quality and origin. Financially driven professionals might endorse products and methods that are ineffective, scientifically unsubstantiated, or even detrimental to health.[49] This situation is serious, as health professionals are recognized authorities who influence health-related behaviors within their social networks. Therefore, the professional endorsement of unproven or harmful products and practices leads patients to adopt risky behaviors based on misplaced trust.[50]

## Health professionals' misinformation-driven behaviors

Currently, it is possible to find scientific references supporting various viewpoints on an issue, due to the questionable integrity of many studies. Consequently, professionals can provide seemingly reliable references that align with their beliefs, exploiting them for personal advantage even when they are aware of the poor quality of evidence.[51] Science deniers reject or oppose established scientific principles, often advocating theories rooted more in personal conviction than empirical evidence. They are adept at crafting arguments that superficially appear valid, despite lacking substantial scientific support.[52] This leads to public confusion, as these individuals

present their theories as credible alternatives to accepted knowledge, despite being based on unreliable evidence.[53] In other situations, health professionals may sincerely promote questionable or false practices due to cognitive biases.[47]

Additionally, health professionals engaging in contentious social media debates often present polarized views supported by selective evidence, exacerbating the spread of misinformation. This behavior is concerning, as it may cause confusion and mistrust among the public, ultimately eroding confidence in health professionals and science.[54]

## Health science

Health science may seem protected from information pollution; however, this is not the reality. Like broader society, research is susceptible to social degradation processes that undermine the accuracy and integrity of information.[55] This section explores the specific contexts in which these vulnerabilities become evident.

## Direct economic influence on researchers

Within the domain of health corporation–sponsored research, there is a significant risk of the endorsement of technologies with limited evidence or unverified cost-effectiveness in exchange for monetary compensation or industry advantages. For example, airline companies sponsored studies that downplayed the importance of social distancing during the COVID-19 pandemic to enhance their profits at the expense of public health.[56] This situation demonstrates how research conducted with a particular financial agenda can erode scientific integrity and the pursuit of unbiased truth.

This issue becomes even more critical when corporation-sponsored researchers are erroneously perceived as more relevant, which may create a selective effect in favor of these voices to guide future developments in a given scientific field. Contemporary philosophers have expressed significant concerns about the commercialization of science. Research innovation influenced exclusively by scientists' personal interests driven by market forces can disproportionately benefit consumer elites, exacerbating overlooked issues and creating information voids that contribute to the spread of information pollution.[57]

## Ideologies, politicization, and polarization in science

Researchers also may resist revising their perspectives on a given issue when presented with new scientific evidence that challenges their established beliefs, often because of confirmation bias.[58] This reluctance to embrace the dynamic nature of science can lead researchers to adopt a defensiveness anchored in subjective knowledge, driven by fears of losing academic prestige, difficulties in adapting to new research paradigms, and perceived financial losses due to reduced sponsorship from corporations they advocate for. In such situations, researchers may employ various discursive strategies to maintain their social influence, including emphasizing the lack of consensus within the scientific community, encouraging community resistance against perceived adverse interests of industries and governments, and formulating persuasive arguments to shift the burden of proof.[56] For example, they might provoke social unease about updated health-related knowledge by highlighting the supposed insufficient evidence for the biological safety of a validated innovation, such as a vaccine.

Similarly, perpetrators of pseudoscience can employ these tactics. They promote sectarianism using rhetorical tools such as emphasizing the need for a holistic understanding of human needs, criticizing academics for their hesitation to pursue new scientific directions, devaluing researchers for their lack of daily clinical experience, proposing alternatives that align with the values of intended care recipients, and arguing against "utopic theories".[59] These claims typically lack substantial scientific backing and often incur additional financial costs for consumers of alternative treatments.[60] Moreover, polarized health discussions are exploited by ideological groups to deepen social divisions. For instance, movements that challenge vaccine efficacy have been co-opted by political entities to weaken adversaries and manipulate public opinion with conspiracy theories, merging populist rhetoric with messianic narratives of social salvation by "citizen heroes", who position themselves as opponents of the economic voracity of the pharmaceutical industry.[61]

## Academic pressures for productivism

The development of researchers involves extensive training, during which graduate students work closely with mentors to refine their expertise in specific areas

of knowledge while focusing on high-value academic topics. Although this approach often neglects social listening to identify the population's needs, it can facilitate more rapid and straightforward recognition of researchers throughout their careers. As a result, scientific databases are frequently filled with redundant, confirmatory, implausible, and stereotype-driven studies. However, limited research coverage forces people to devise homemade solutions for their neglected problems, which most researchers deem trivial.[62,63]

Another critical issue is the "publish or perish" paradigm, which deviates from the classical scientific objective of enhancing people's quality of life. Motivated by career advancement demands, researchers may adopt a production-oriented approach, supervising an excessive number of graduate students, practicing "salami slicing"—publishing minimal publishable units to increase output—and selecting topics and methodologies that are readily publishable. These practices erect barriers to diverse and pluralistic knowledge, facilitating the spread of unchecked and imprecise findings lacking reproducibility, exacerbating competition for editorial space, and diminishing the democracy of scientific publishing by restricting the range of explored topics. Prioritizing convenience over substance yields minimal social benefits, burdening highly qualified professionals with secondary goals at the expense of addressing genuine issues and producing robust clinical evidence.[64]

The advancement of knowledge depends on finding satisfactory explanations for an object (thing), using provisional theories that interpret reality.[65] Over time, researchers gain more experience in specific areas, thereby increasing their capacity to contribute to their field by collecting meaningful evidence. However, focusing on trending topics rather than becoming an authority in a specific area can adversely affect the quality of research leading to questionable outcomes. Researchers whose work has societal applications should avoid promoting opportunistic research behavior for media attention. This issue includes the "Twitterization" of science, which fosters ideologically driven studies and the promotion of results on social media to a polarized audience. For example, low-quality studies questioning the efficacy of COVID-19 vaccines became extremely popular among supporters of the anti-vaccine movement. This amplified public unease, lowered vaccination rates, and simultaneously

allowed researchers to gain recognition for the popularity of their findings in the media, positively impacting metrics that assess the "dissemination of scientific knowledge" on social media.[56]

Another relevant factor is the perpetuation of a so-called "virtuous cycle", observed when research funding is linked to a researcher's productivity-driven outcomes with manipulable and inadequate "quality metrics", such as impact factors. The increasing allocation of funding to research groups focused on academically hegemonic areas leads to a privileged scientific elite that monopolizes both human and economic resources. Fraudulent behaviors, such as the activities of "citation cartels", contribute to this scenario. These practices involve journals and research groups manipulating the evaluation system by agreeing that articles published in their journals must cite previously published articles in a partner journal, thereby artificially boosting their h-indices. Similarly, closed groups of researchers may agree to cite each other, enhancing their indices.[66] By the perverse logic of "outrunning the tiger", the deliberate practice of not citing studies from competing groups also negatively impacts science development, potentially resulting in decreased research funding for areas of societal interest and contributing to the spread of information voids and misinformation.

## Science communication environment

The impact of information pollution is particularly evident in science communication, since scientific articles may include various forms of data falsification or adulteration related to reporting research outcomes. Some malpractices include:

i. Results fabrication: researchers may fabricate results wholly or partially, either without conducting experiments or after experimental failures. Notably, results can be created using generative artificial intelligence. The Retraction Watch observatory maintains an updated list of articles and peer reviews with evidence of being written by ChatGPT.[67]

ii. Results manipulation: data may be manipulated to enhance the publication's appeal, such as presenting statistically significant differences regardless of ethical implications. This manipulation may involve excluding deviant outcomes from analyses or duplicating values close to the mean.[68]

iii. Selective outcome reporting: this involves selecting a subset of the originally recorded outcomes

for inclusion in a publication. Researchers may report only those results they consider relevant, which reduces the reproducibility of results, fosters a misleading perception of the impact, and conceals failures encountered during the study.[69]

iv. Plagiarism: researchers may commit plagiarism by replicating results or excerpts from scientific articles authored by others or from their prior work without proper citation.[70]

v. Study design metamorphosis: during the peer review process, researchers may alter the design of their studies in response to critiques about originality or limitations related to sample size or blinding. For example, observational studies might be reclassified as randomized clinical trials. Researchers may modify their results to rectify perceived flaws, thereby enhancing the likelihood of swift publication.[71]

It is essential to recognize that technical limitations in the design and execution of scientific studies, although not directly linked to intentional falsifications, can lead to information pollution. This problem is evidenced by the gap between the potential and real levels of evidence produced by scientific studies, which can reduce certainty. The GRADE (Grading of Recommendations, Assessment, Development, and Evaluations) approach recommends acknowledging a reduction in the quality of evidence due to risks, such as biases, inconsistent results, indirect evidence, and publication bias. Consequently, findings from studies lacking rigorous scientific methods, such as those using convenience sampling or having poor statistical representativeness, can contribute to information overload, confusion, and a perceived lack of consensus.[72]

Moreover, scientific content deemed suitable for public consumption often does not rely solely on the quality of outcomes. Limitations on the amount, type, and scope of articles published in established journals are influenced by factors such as the journals' impact factors and target audiences. Editorial boards are pressured to select articles that are more likely to maintain or boost their journals' reputations. This restriction limits the appreciation of robust science that adheres to a rationale associated with traditional print publication methods—an approach that is outdated when the computational system is capable of supporting comprehensive science communication. For instance, some journals delay the release of articles until they can be included in a specific issue,

maintaining characteristics of print publication. Such practices lead to the spread of preprints—published data that have not been revised or validated—by the media and subsequent studies.[73]

Maintaining robust peer review systems is challenging due to the increasing number of journals, heightened academic workload, and growing researcher disinterest in a task that is becoming less rewarding. This disenchantment is fueled by the trade-off between time spent on peer reviews and one's research advance, compounded by the lack of compensation for peer review in relation to the need to pay article processing charges (APCs) to profit-driven publishers. As a result, researchers may hesitate to act as referees, leading to a deterioration in the quality of peer review reports and negatively impacting the scientific curation process.[74] Some researchers might offer superficial one-line reviews, either supporting publication or deeming a study unsuitable without sufficient justification, often influenced by personal biases rather than empirical or scientific evidence.[75] Additionally, some researchers have resorted to deceptive tactics like nominating fictitious reviewers to appraise their work during manuscript submission. These purported reviewers are registered using email accounts created by the researchers, allowing them to receive and evaluate their submissions.[76]

Moreover, commercial and scamming strategies exploit the high vulnerability of researchers who, under pressure to increase academic productivity, are eager to disseminate their work. These strategies can be divided into three actor groups: i) predatory journals that operate as commercial enterprises rather than scholarly platforms, which are characterized by the acceptance and publication of low-quality articles, becoming sources of errors, inaccuracies, and falsehoods;[77] ii) paper mills that sell authorships and articles for publication in various online journals, with prices ranging from hundreds to thousands of U.S. dollars depending on the field of research and the journal's prestige;[78] and iii) slot machine scammers who mimic the actions of profit-oriented outlets, such as creating fake online journal profiles to attract researchers and sending fraudulent acceptance letters that demand payment of APCs.

## Practical solutions to mitigate misinformation

Mitigating health information pollution requires the promotion of critical thinking by educational

| **SOCIETY** | |
|---|---|
| Challenges in identifying reliable health sources on social media | Verify the date of content development, check references, use fact-checking agencies for facticity verification, and triangulate information |
| Propagation of unverified health content by internet users | Verify the date of content development, check references, use fact-checking agencies for facticity verification, and triangulate information |
| Preference for sharing misinformation than accurate information | Regulate big tech companies' actions and algorithm data transparency |
| Misinformation supporting political agendas and discriminatory narratives | Verify the date of content development, check references, use fact-checking agencies for facticity verification, and triangulate information |
| Echo chambers reinforcing pre-existing health beliefs | Regulate big tech companies' actions and algorithm data transparency |
| Cyberchondria leading to repetitive health information-seeking behavior | Enhance the health literacy of users via digital education and the development of high-quality content on online channels |
| Therapeutic pluralism driven by personal health concerns | Adopt the person-centered care model and promote digital educational approaches |
| Digital influencers promoting biased, manipulated, and imprecise content | Regulate digital influencers' actions and hold them responsible for misinformation propagation on online channels |
| Digital influencer's engagement-seeking behavior | Regulate big tech companies' actions and hold them responsible for misinformation propagation on online channels |
| Science communication biased by political agenda of mass media | Improve and expand the regulation of mass media |
| Communication of unvalidated scientific claims by mass media | Stimulate the specialized formation of professionals to work with science communication, improving scientific literacy |
| Sensationalism in science communication | Stimulate the specialized formation of professionals to work with science communication, avoiding sensationalism |
| Lack of specialized professionals in science communication | Promote politics to increase the number of professionals specialized in science communication |
| Influence of populism on health policy formulations | Implement supra-governmental policies to ensure the central role of researchers in committees responsible for strategic scientific decisions |
| Misinformation disseminated via user engagement-driven algorithms | Regulate big tech companies' actions and algorithm data transparency |
| Religious beliefs influencing health behaviors | Promote and maintain a laic state, offering science-driven health education within religious communities |
| **HEALTH PROFESSIONALS** | |
| Biomedical model in healthcare practice | Promote person-centered healthcare training |
| Workforce's critical thinking shortcomings | Promote critical thinking, scientific education, and health literacy standards |
| Profit-driven health practices | Emphasize ethical principles during professional education |
| Traditional healthcare education | Modernize teaching methods with engaging and active technologies |
| Unstandardized expansion of healthcare training courses | Implement educational quality standards, investing in the professor's formation |
| Insufficient number of qualified health professors | Investments in the professor's formation, building an attractive academic career |
| Professional knowledge acquired from unreliable sources | Promote critical thinking, scientific education, and health literacy standards |
| Lack of capacitation in educational content production | Implement training and capacitation for digital health content production |
| Unethical behaviors in the context of e-professionalism | Ethical monitoring of health professionals on social media |
| Health professionals with commercial-driven attitudes | Ethical monitoring of health professionals, promoting transparency of professionals' conflicts of interest on social media |
| Increasingly influence of health professionals on social media | Educate health professionals on responsible social media use |
| Challenges in quality screening of evidence | Educate health professionals on the critical evaluation of scientific articles |
| Health professional engagement in polarized debates | Foster open and evidence-based dialogue among health professionals |
| Science denialists | Promote scientific literacy and emphasize the dissemination of high-quality rigorous research among health professionals |
| **HEALTH SCIENCE** | |
| Health research motivated by financial gains | Regulate the involvement of industry within the scientific research sector |
| Preliminary research-based clinical recommendations | Enhance the rigor for promoting technologies lacking sufficient scientific evidence |
| Market-driven health innovation | Develop policies to promote the creation of solutions for overlooked problems |
| Resistance against competitive theories in health research | Improve the scientific education and training of health sector researchers |

**Figure 3-** Recommendations for managing health information pollution in the contexts of society, health professionals, and health science.

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| | |
|---|---|
| Pseudoscientific health discourses | Monitor and remove pseudoscientific discourses on digital media, holding their authors responsible for public health harm |
| Polarized health discourses for social division | Implement training and capacitation for digital production of health content |
| Health conspiracy theories used for political persuasion | Regulate authors' political discourses that misuse scientific fallacies |
| Research for academic recognition | Establish a novel academic culture, shifting from the valorization of productivism to socially relevant productions |
| Prevalence of confirmatory bias in health studies | Upgrade health research education and the peer review systems |
| Neglected issues and information voids | Create policies and incentives for addressing and solving neglected problems |
| "Publish or perish" paradigm | Establish a novel academic culture, shifting from the valorization of productivism to socially relevant productions |
| "Salami slicing" practice | Establish a novel academic culture, shifting from the valorization of productivism to socially relevant productions |
| Opportunistic research for media attention | Promote research funding policies based on social demands, avoiding the fostering of scientific opportunism |
| "Tweeterization" of science | Challenge the oversimplification of research's social relevance by social media metrics |
| The perpetuation of the "virtuous cycle" | Strengthen the emphasis on scientific rigor over productivity in health research training |
| Citation cartels | Reduce the emphasis on citation metrics due to their manipulable and reductionist nature |
| Paper mills selling authorships and articles for publication | Establish a novel academic culture, shifting from the valorization of productivism to socially relevant productions |
| Information pollution in scientific articles | Incentivize the widespread adoption of open science principles, emphasizing the online pre-registration of research protocols and the sharing of data banks |
| Technical flaws in health research design | Advocate for slow science to improve data checking and publication quality, making peer reviews more effective |
| Subjectivity in scientific publishing decisions | Make the motivations behind editorial decisions more transparent, clarifying recommendations for publication and denying reasons |
| The degradation of the peer review system | Enhance peer review recognition beyond acknowledgments, regarding strategies like remuneration and research funding |
| Predatory practices | Counteract the rise of predatory journals by offering better publication opportunities in established journals |

**Figure 3-** Recommendations for managing health information pollution in the contexts of society, health professionals, and health science.

initiatives, the use of high-quality digital content, and engagement with fact-checking entities. Concurrently, health consumers should be counseled to adopt strategies for identifying trustworthy sources, such as information triangulation, which involves systematically verifying information across distinct platforms to check for discrepancies. Additionally, the proactive dissemination of digital health-related messages by health professionals, authorities, or systems enhances public access to reliable content.[79] This tactic reduces dependence on suspicious sources and improves the quality control of information.

Health professionals committed to contributing to scientific discourse must seek advanced training to prevent the propagation of low-quality health content. It is also essential to acknowledge and invest in educators within academic environments, ensuring they undergo advanced training and remain motivated to foster a culture of continuous learning.[80] Improved practices of e-professionalism can be achieved by the development of guidelines and policies that oversee ethical social media use, promote transparency regarding commercial affiliations, and reward professionals who exemplify commendable conduct, thereby nurturing a culture of integrity and accountability.

Science prospers when conducted ethically and impartially, free from financial influences. Preserving the autonomy and integrity of the scientific process is essential for fostering significant advancements in human knowledge and addressing societal challenges,[81] while diversifying funding sources for scientific research to reduce dependence on economically motivated entities. This necessitates enhancing governmental support, expanding public funding, and promoting partnerships among academic, governmental, and non-profit sectors. Such expansion of the funding landscape ensures the maintenance of research integrity and objectivity, leading to the balanced and unbiased progression of knowledge.

Furthermore, big tech companies must prioritize data transparency by disclosing the intricate workings of their algorithms for rigorous evaluation. This transparency is critical for preventing misconceptions about their roles in combating misinformation. By leveraging their advanced technological capabilities,

these companies can effectively manage all user-generated content with sophisticated artificial intelligence models. While it is important to preserve the freedom of users to share messages, such activities must comply with the guidelines of digital platforms, which should include measures to limit the circulation of content that is verifiably false, biased, or manipulated.

Figure 3 delineates specific challenges and potential solutions for factors related to information pollution across society, health professionals, and health science contexts.

### Final considerations

Regulations to address the proliferation of health information pollution are imperative. Such policies must prioritize collective welfare over the interests of specific groups. A critical balance must be maintained between upholding freedom of expression and mitigating the risks posed by the widespread dissemination of misinformation online. Additionally, it is important to recognize that the production and propagation of information pollution are consequences of the neoliberal capitalism model, characterized by individualism, a minimal state, a self-regulated society driven by economic interests, and increasing socioeconomic inequality. Therefore, while each person must be invited to collaborate in controlling information pollution in their roles as citizens, health professionals, or researchers, it is also essential to provoke all people to act politically for profound social transformation. This seems to be the only effective alternative to combat information pollution.

### Conflict of interest

The authors declare no conflict of interest.

### Data availability statement

No new data were created or analyzed in this study. Data sharing does not apply to this article.

### Authors' contributions

**Lotto, Matheus:** Conceptualization (Equal); Visualization (Equal); Writing - original draft (Equal). **Jorge, Olívia Santana:** Conceptualization (Equal); Visualization (Equal); Writing - original draft (Equal). **Cruvinel, Agnes:** Conceptualization (Equal); Visualization (Equal); Writing - original draft (Equal). **Cruvinel, Thiago:** Conceptualization (Equal); Project administration (Equal); Supervision (Equal); Visualization (Equal); Writing - original draft (Equal); Writing - review & editing (Equal).

## References

1- United Nations Development Programme. Mapping and analysis of efforts to counter information pollution in Europe and Central Asia region [Internet]. New York: United Nations; 2022 [cited 2024 Aug 26]. Available from: https://www.undp.org/eurasia/publications/information-pollution

2- Wardle C, Derakhshan H. Information disorder: toward an interdisciplinary framework for research and policy making [Internet]. Strasburg: Council of Europe; 2017 [cited 2024 Aug 26]. Available from: https://rm.coe.int/information-disorder-toward-an-interdisciplinary-framework-for-researc/168076277c

3- United Nations Educational, Scientific and Cultural Organization. Journalism, 'fake news' & disinformation [Internet]. Paris: UNESCO; 2018 [cited 2024 Aug 26]. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000265552

4- Douglas KM, Uscinski JE, Sutton RM, Cichocka A, Nefes T, Ang CS, et al. Understanding conspiracy theories. Polit Psychol. 2019;40(S1):3-35. doi: 10.1111/pops.12568

5- Talwar S, Dhir A, Kaur P, Zafar N, Alrasheedy M. Why do people share fake news? Associations between the dark side of social media use and fake news sharing behavior. J Retail Consum Serv. 2019;72-82. doi: 10.1016/j.jretconser.2019.05.026

6- Moorhead SA, Hazlett DE, Harrison L, Carroll JK, Irwin A, Hoving C. A new dimension of health care: systematic review of the uses, benefits, and limitations of social media for health communication. J Med Internet Res. 2013;15(4):e85. doi: 10.2196/jmir.1933

7- Lazer DM, Baum MA, Benkler Y, Berinsky AJ, Greenhil KM, Menczer F, et al. The science of fake news: addressing fake news requires a multidisciplinary effort. Science. 2018;359(6380):1094-6. doi: 10.1126/science.aao2998

8- Strieder AP, Aguirre PE, Lotto M, Cruvinel AF, Cruvinel T. Digital behavior surveillance for monitoring the interests of Google users in amber necklace in different countries. Int J Paediatr Dent. 2019;29(5):603-14. doi: 10.1111/ipd.12500

9- Lotto M, Menezes TS, Hussain IZ, Tsao SF, Butt ZA, Morita PP, et al. Characterization of false or misleading fluoride content on Instagram: infodemiology study. J Med Internet Res. 2022;24(5):e37519. doi: 10.2196/37519

10- Harper CA, Satchell LP, Fido D, Latzman RD. Functional fear predicts public health compliance in the COVID-19 pandemic. Int J Ment Health Addict. 2021;19(5):1875-88. doi: 10.1007/s11469-020-00281-5

11- Granovetter MS. The strength of weak ties. Am J Sociol. 1973;78(6):1360-80.

12- Guess A, Nagler J, Tucker J. Less than you think: prevalence and predictors of fake news dissemination on Facebook. Sci Adv. 2019;5(1):eaau4586. doi: 10.1126/sciadv.aau4586

13- van der Linden S. Misinformation: Susceptibility, spread, and interventions to immunize the public. Nat Med. 2022;28(3):460-7. doi: 10.1038/s41591-022-01713-6

14- McIntyre L. Post-truth. Cambridge: MIT Press; 2018.

15- Stokes B, Wike R, Carle J. Global concern about climate change, broad support for limiting emissions [Internet]. Washington, DC: Pew Research Center; 2015 [2024 Aug 26]. Available from: https://www.pewresearch.org/global/2015/11/05/global-concern-about-climate-change-broad-support-for-limiting-emissions/

16- Foucault M. Hermeneutics of the subject. New York: Picador; 2005.

17- Jia X, Pang Y, Liu LS. Online health information seeking behavior: a systematic review. Healthcare. 2021;9(12):1740. doi: 10.3390/healthcare9121740

18- Lotto M, Jorge OS, Cruvinel T. Digital surveillance: are people actively seeking non-factual fluoride content on Google? Fluoride [Internet]. Forthcoming 2024 [cited 2024 Ag 26]. Available from: https://www.flurideresearch.online/epub/files/267.pdf

19- Vosoughi S, Roy D, Aral S. The spread of true and false news online. Science. 2018;359(6380):1146-51. doi: 10.1126/science.aap9559

20- Vilmer JB, Escorcia A, Guilaume M, Herrera J. Information manipulation: a challenge for our democracies [Internet]. Paris: Ministry for Europe and Foreign Affairs and Ministry for the Armed Forces; 2018 [cited 2024 Aug 24]. Available from: https://www.diplomatie.gouv.fr/IMG/pdf/information_manipulation_rvb_cle838736.pdf

21- Lotto M, Hussain IZ, Kaur J, Butt ZA, Cruvinel T, Morita PP. Analysis of fluoride-free content on Twitter: topic modeling study. J Med Internet Res. 2023;25:e44586. doi: 10.2196/44586

22- Sharon AJ, Baram-Tsabari A. Can science literacy help individuals identify misinformation in everyday life? Sci Educ. 2020;104:873-94. doi: 10.1002/sce.21581

23- Jones-Jang SM, Mortensen T, Liu J. Does media literacy help identification of fake news? Information literacy helps, but other literacies don't. Am Behav Sci. 2021;65(2):371-88. doi: 10.1177/0002764219886940

24- Nascimento IJ, Pizarro AB, Almeida JM, Azzopardi-Muscat N, Golçalves MA, Björklund M, et al. Infodemics and health misinformation: a systematic review of reviews. Bull World Health Organ. 2022;100(9):544-61. doi: 10.2471/BLT.21.287654

25- Ecker UKH, Lewandowsky S, Cook J, Schmid P, Fazio LK, Brashier N, et al. The psychological drivers of misinformation belief and its resistance to correction. Nat Rev Psychol. 2022;1:13-29. doi: 10.1038/s44159-021-00006-y

26- Skafle I, Nordahl-Hansen A, Quintana DS, Wynn R, Gabarron E. Misinformation about COVID-19 vaccines on social media: Rapid review. J Med Internet Res. 2022;24(8):e37367. doi: 10.2196/37367

27- Mathes BM, Norr AM, Allan NP, Albanese BJ, Schmidt NB. Cyberchondria: overlap with health anxiety and unique relations with impairment, quality of life, and service utilization. Psychiatry Res. 2018;261:204-11. doi: 10.1016/j.psychres.2018.01.002

28- Bianchi FP, Tafuri S. Spreading of misinformation on mass media and digital platforms regarding vaccines: a systematic scoping review on stakeholders, policymakers, and sentiments/behavior of Italian consumers. Hum Vaccin Immunother. 2023;19(2):2259398. doi: 10.1080/21645515.2023.2259398

29- Wonneberger A, Meijers MH, Schuck AR. Shifting public engagement: how media coverage of climate change conferences affects climate change audience segments. Public Underst Sci. 2020;29(2):176-93. doi: 10.1177/0963662519886474

30- Fleerackers A, Riedlinger M, Moorhead L, Ahmed R, Alperin JP. Communicating scientific uncertainty in an age of COVID-19: an investigation into the use of preprints by digital media outlets. Health Commun. 2022;37(6):726-38. doi: 10.1080/10410236.2020.1864892

31- McLaren L, Patterson SK, Faris P, Chen G, Thawer S, Figueiredo R, et al. Fluoridation cessation and oral health equity: a 7-year post-cessation study of Grade 2 schoolchildren in Alberta, Canada. Can J Public Health. 2022;113(6):955-68. doi: 10.17269/s41997-022-00654-4

32- Fernandez M, Bellogín A, Cantador I. Analysing the effect of recommendation algorithms on the spread of misinformation. In: Aiello LC, Mejova Y, Seneviratne O, Sun J, Kaiser S, Staab S, editors. WEBSCI '24: Proceedings of the 16th ACM Web Science Conference. New York: Association for Computing Machinery; 2024. p. 159-69. doi: 10.1145/3614419.3644003

33- Alenezi MN, Alqenaei M. Machine learning in detecting COVID-19 misinformation on Twitter. Future Internet. 2021;13(10):244. doi: 10.3390/fi13100244

34- Colomina C, Sánchez Margalef H, Youngs R. The impact of disinformation on democratic processes and human rights in the world [Internet]. Strasbourg: European Parliament; 2021 [cited 2024 Aug 28]. Available from: https://www.europarl.europa.eu/RegData/etudes/STUD/2021/653635/EXPO_STU(2021)653635_EN.pdf

35- Doss C, Mondschein J, Shu D, Wolfson T, Kopecky D, Fitton-Kane VA, et al. Deepfakes and scientific knowledge dissemination. Sci Rep. 2023;13(1):13429. doi: 10.1038/s41598-023-39944-3

36- Cheng VC, Wong SC, Chuang VW, So SY, Chen JH, Sridhar S, et al. The role of community-wide wearing of face mask for control of coronavirus disease 2019 (COVID-19) epidemic due to SARS-CoV-2. J Infect. 2020;81(1):107-14. doi: 10.1016/j.jinf.2020.04.024

37- Saeedi M, Al-Othman N, Rabayaa M, Dwaikat S. An investigation into religious awareness as a crucial factor in adherence to COVID-19 medical directives in Palestine. BMC Public Health. 2022;22(1):1336. doi: 10.1186/s12889-022-13767-9

38- Barros JAC. [Pensando o processo saúde doença: a que responde o modelo biomédico?] Considering the health-diesease process: What does the biomedical model answer to? Saude Soc. 2002;11(1):67-84. Portuguese. doi: 10.1590/S0104-12902002000100008

39- Cilliers EJ. The challenge of teaching Generation Z. People Int J Soc Sci. 2017;3(1):188-98. doi: 10.20319/pijss.2017.31.188198

40- Saxena M, Mishra DK. Gamification and Gen Z in higher education: a systematic review of literature. Int J Inf Educ Technol. 2021;17(4):1-22. doi: 10.4018/IJICTE.20211001.oa10

41- Lee HY, Cheng YP, Wang WS, Lin CJ, Huang YM. Exploring the learning process and effectiveness of STEM education via learning behavior analysis and the interactive-constructive- active-passive framework. J Educ Comput Res. 2023;61(5):951-76. doi: 10.1177/07356331221136888

42- Brown B. Competition in healthcare: a review of international evidence. Perspect Public Health. 2016;136(3):121-2. doi: 10.1177/1757913916638233

43- Santos CJ Júnior, Misael JR, Trindade EM Filho, Wyszomirska RM, Santos AA, Costa PJ. [Expansão de vagas e qualidade dos cursos de Medicina no Brasil: "Em que pé estamos?"] Expansion of vacancies and quality of medical courses in Brazil: "Where do we stand? Rev Bras Educ Med. 2021;45(2):e058. Portuguese. doi: 10.1590/1981-5271v45.2-20200523

44- Anjum RL, Copeland S, Rocca E. Complexity, rethinking causality, complexity and evidence for the unique patient. New York: Springer; 2020.

45- Ventola. Social media and health care professionals: benefits, risks, and best practices. P T. 2014;39(7):491-520.

46- Steinert Y, Cruess S, Cruess R, Snell. Faculty development for teaching and evaluating professionalism: From programme design to curriculum change. Med Educ. 2005;39(2):127-36. doi: 10.1111/j.1365-2929.2004.02069.x

47- Jeyaraman M, Ramasubramanian S, Kumar S, Jeyaraman N, Selvaraj P, Nallakumarasamy A, et al. Multifaceted role of social media in healthcare: opportunities, challenges, and the need for quality control. Cureus. 2023;15(5):e39111. doi: 10.7759/cureus.39111

48- Kaczmarczyk JM, Chuang A, Dugoff L, Abbott JF, Culimore AJ, Dalrymple J, et al. e-Professionalism: a new frontier in medical education. Teach Learn Med. 2013;25(2):165-70. doi: 10.1080/10401334.2013.770741

49- Parker MH, Wardle JL, Wer M, Stewart CL. Medical merchants: conflict of interest, office product sales and notifiable conduct. Med J Aus. 2011;194(1):34-7. doi: 10.5694/j.1326-5377.2011.tb04143.x

50- Lu L, Liu J, Yuan YC, Burns KS, Lu E, Li D. Source trust and COVID-19 information sharing: the mediating roles of emotions and beliefs about sharing. Health Educ Behav. 2021;48(2):132-9. doi:10.1177/1090198120984760

51- Rosman T, Grösser S. Belief updating when confronted with scientific evidence: examining the role of trust in science. Public Underst Sci. 2024;33(3):308-24. doi: 10.1177/09636625231203538

52- Hansson SO. Science denial as a form of pseudoscience. Stud Hist Philos Sci. 2017;63:39-47. doi: 10.1016/j.shpsa.2017.05.002

53- Chavda VP, Sonak SS, Munshi NK, Dhamade PN. Pseudoscience and fraudulent products for COVID-19 management. Environ Sci Pollut Res Int. 2022;29(42):62887-912. doi: 10.1007/s11356-022-21967-4

54- Iandoli L, Primario S, Zollo G. The impact of group polarization on the quality of online debate in social media: a systematic literature review. Technol Forecast Soc Change. 2021;170:120924. doi: 10.1016/j.techfore.2021.120924

55- Fanelli D, Costas R, Ioannidis JP. Meta-assessment of bias in science. Proc Natl Acad Sci U S A. 2017;114(14):3714-9. doi: 10.1073/pnas.1618569114

56- Morris RD. How denialist amplification spread COVID misinformation and undermined the credibility of public health science. J Public Health Policy. 2024;45(1):114-25. doi: 10.1057/s41271-023-00451-4

57- Stengers I. Another science is possible: a manifesto for slow science. Cambridge: Polity Press; 2018.

58- Glick M. Believing is seeing: confirmation bias. J Am Dent Assoc. 2017;148(3):131-2. doi: 10.1016/j.adaj.2017.01.009

59- Juca AM, Jorge OS, Moreira YR, Lotto M, Menezes TS, Cruvinel T. Uncovering a pseudoscience: an analysis of 'biological dentistry' Instagram posts. Acta Odontol Scand. 2024;83:180-9. doi: 10.2340/aos.v83.40486

60- Sauvayre R. Dissemination of a "fake miracle cure" against COVID-19 on Twitter: the case of chlorine dioxide. Soc Sci. 2023;12(6):320. doi: 10.3390/socsci12060320

61- Hotez PJ. Will anti-vaccine activism in the USA reverse global goals? Nat Rev Immunol. 2022;22(9):525-6. doi: 10.1038/s41577-022-00770-9

62- Marginalia Science. Marginalised ideas are key to scientific progress. Nat Hum Behav. 2019;3(10):1024. doi: 10.1038/s41562-019-0699-y

63- Menezes TD, Martini MM, Lotto M, Jucá AM, Jorge OS, Cruvinel A, et al. Untangling the truth: user engagement with misinformation in toothache-related Facebook posts. Community Dent Health. 2024;41(2):128-33. doi: 10.1922/CDH_00190Menezes06

64- Collyer TA. 'Salami slicing' helps careers but harms science. Nat Hum Behav. 2019;3(10):1005-6. doi: 10.1038/s41562-019-06877-2

65- Popper K. Objective knowledge: an evolutionary approach. Oxford: OUP Oxford; 1972.

66- Kojaku S, Livan G, Masuda N. Detecting anomalous citation groups in journal networks. Sci Rep. 2021;11(1):14524. doi: 10.1038/s41598-021-93572-3

67- Retraction Watch. Papers and peer reviews with evidence of ChatGPT writing [Internet]. New York: Retraction Watch; 2024 [cited 2024 May 15] Available from: https://retractionwatch.com/papers-and-peer-reviews-with-evidence-of-chatgpt-writing/

68- Figueiredo D Filho, Silva L, Medeiros H. "Won't get fooled again": statistical fault detection in COVID-19 Latin American data. Global Health. 2022;18(1):105. doi: 10.1186/s12992-022-00899-1

69- Gray R, Water A, MacKay B. How prospective trial registration can prevent selective outcome reporting and salami slicing? Women Birth. 2022;35(2):105-7. doi: 10.1016/j.wombi.2021.07.007

70- Alam M, Ratner D, Coleman WP 3rd. How to understand, detect, and avoid plagiarism. Dermatol Surg. 2019;45(5):631-7. doi: 10.1097/DSS.0000000000001927

71- Esposito M. Editorial: The scientific plague affecting medical and dental research: from fake news to fake studies. Eur J Oral Implantol. 2017;10(2):119-20.

72- Schünemann H, Brożek J, Guyatt G, Oxman A, editors. GRADE handbook for grading quality of evidence and strength of recommendations [Internet]. Updated October 2013. [place unknown]: The GRADE Working Group; 2013 [cited 2024 Aug 28]. Available from: https://gdt.gradepro.org/app/handbook/handbook.html

73- Wilhite A, Fong EA, Wilhite S. The influence of editorial decisions and the academic network on self-citations and journal impact factors. Res Policy. 2019;48(6):1513-22. doi: 10.1016/j.respol.2019.03.003

74- Dance A. Stop the peer-review treadmill. I want to get off. Nature. 2023;614(7948):581-3. doi: 10.1038/d41586-023-00403-8

75- D'Andrea R, O'Dwyer JP. Can editors save peer review from peer reviewers? PLoS One. 2017;12(10):e0186111. doi: 10.1371/journal.pone.0186111

76- Siler K, Vincent-Lamarre P, Sugimoto CR, Larivière V. Predatory publishers' latest scam: bootlegged and rebranded papers. Nature. 2021;598(7882):563-5. doi: 10.1038/d41586-021-02906-8

77- Clemons M, Silva MC, Joy AA, Cobey KD, Mazzarello S, Stober C, et al. Predatory Invitations from journals: more than just a nuisance? Oncologist. 2017;22(2):236-40. doi: 10.1634/theoncologist.2016-0371

78- Else H. Multimillion-dollar trade in paper authorships alarms publishers. Nature. 2023;613(7945):617-8. doi: 10.1038/d41586-023-00062-9

79- Lotto M, Strieder AP, Aguirre PE, Oliveira TM, Machado MA Rios D, et al. Parental-oriented educational mobile messages to aid in the control of early childhood caries in low socioeconomic children: a randomized controlled trial. J Dent. 2020;101:103456. doi: 10.1016/j.jdent.2020.103456

80- Morita MC, UriarteM Neto, Fontanella VR, Haddad AE. The unplanned and unequal expansion of Dentistry courses in Brazil from 1856 to 2020. Braz Oral Res. 2020;35:e009. doi: 10.1590/1807-3107bor-2021.vol35.0009

81- Weatherall JO, O'Connor C. The misinformation age: how false beliefs spread. Yale: Yale University Press; 2019.