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Review Article

Artificial Intelligence–Driven Scientific Misconduct: Synthetic Data, Ai-Generated Manuscripts, And Emerging Threats to Research Integrity—A Narrative Review

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Abstract

The rapid integration of generative artificial intelligence (AI) into scholarly publishing has transformed scientific communication, offering unprecedented opportunities for literature synthesis, language enhancement, data analysis, and manuscript preparation. Simultaneously, these technologies have created new avenues for scientific misconduct, including fabrication of synthetic datasets, generation of misleading manuscripts, production of hallucinated references, semantic plagiarism, and large-scale publication fraud facilitated by paper mills. This narrative review examines the evolving landscape of AI-driven scientific misconduct and its implications for research integrity. Drawing upon recent empirical studies, research integrity reports, policy documents, and scholarly commentaries published between 2020 and 2025, the review synthesizes current evidence regarding emerging forms of misconduct enabled by generative AI technologies. Particular attention is given to synthetic data fabrication, AI-assisted authorship, citation manipulation, paper-mill operations, and challenges associated with detecting increasingly sophisticated fraudulent content. The review further discusses the impact of these practices on evidence synthesis, reproducibility, academic evaluation systems, and clinical decision-making. Recognizing that AI is neither inherently beneficial nor inherently harmful, the article also highlights legitimate applications of AI in research and publishing, including plagiarism detection, image forensics, editorial support, and enhancement of research accessibility. Current evidence suggests that while concerns regarding AI-enabled misconduct are well founded, substantial knowledge gaps remain regarding its prevalence, detection, and long-term consequences. Protecting research integrity in the AI era will require coordinated efforts involving researchers, publishers, institutions, funders, and regulatory organizations to ensure transparency, accountability, and responsible use of emerging technologies.

Keywords: Artificial Intelligence, Research Integrity, Scientific Misconduct, Paper Mills, Synthetic Data, Hallucinated References, Academic Publishing, Evidence-Based Medicine.

Introduction

Artificial intelligence (AI) has emerged as one of the most influential technological developments affecting contemporary scientific research and scholarly communication. The introduction of large language models (LLMs), exemplified by ChatGPT and similar generative systems, has fundamentally altered how researchers access information, analyse data, prepare manuscripts, and interact with the scientific literature [1–3]. Within a remarkably short period, AI-powered tools have become integrated into multiple stages of the research lifecycle, ranging from literature retrieval and language editing to statistical programming and peer-review support [4–7]. These developments have generated substantial enthusiasm because of their potential to improve research efficiency, facilitate global scientific participation, and reduce barriers faced by non-native English-speaking researchers [4,5].

The transformative capabilities of generative AI, however, have also introduced new vulnerabilities within the scientific ecosystem. Unlike previous digital tools that primarily assisted researchers, contemporary AI systems are capable of producing sophisticated text, images, datasets, code, and analytical outputs that closely resemble authentic scientific work [8–10]. While these capabilities offer legitimate benefits when used responsibly, they also create opportunities for fabrication, falsification, plagiarism, and manipulation that challenge traditional safeguards designed to protect research integrity [8,11,12].

Concerns regarding AI-enabled misconduct have intensified following reports demonstrating that LLMs can generate convincing scientific abstracts, fabricate realistic bibliographic citations, and produce synthetic datasets that closely mimic authentic research data [8–10,13–15]. Parallel advances in image-generation technologies have raised additional concerns regarding falsified scientific figures, manipulated visual evidence, and fabricated experimental outputs [16,17]. The growing accessibility of these technologies has coincided with increasing attention toward paper mills and publication factories that exploit AI tools to generate large volumes of fraudulent manuscripts for commercial gain [18-20].

The implications extend beyond individual cases of academic dishonesty. Biomedical research, evidence synthesis, and clinical decision-making depend upon the reliability of published literature. The introduction of fabricated data, hallucinated references, and misleading scientific narratives into the evidence base has the potential to distort systematic reviews, influence clinical guidelines, and undermine confidence in scientific institutions [11,12,21]. Simultaneously, the inability of existing plagiarism detection systems and AI-detection tools to consistently identify sophisticated AI-generated content has exposed important limitations within current editorial and peer-review processes [22-25].

Despite growing concern, the available literature reveals substantial heterogeneity regarding the nature, prevalence, and consequences of AI-driven scientific misconduct. Some threats, such as hallucinated references and undisclosed AI-assisted writing, are increasingly documented in empirical studies [26-28], whereas others remain largely theoretical or insufficiently quantified. Consequently, there is a need for a balanced examination that distinguishes established evidence from emerging concerns while recognising both

the risks and benefits associated with AI technologies.

The aim of this narrative review is to critically examine the evolving landscape of AI-driven scientific misconduct, evaluate current evidence regarding its impact on research integrity, present a conceptual framework for understanding emerging threats, identify areas where evidence remains limited, and discuss strategies for responsible governance of AI within scholarly publishing and biomedical research.

Literature Identification Strategy

This narrative review synthesizes contemporary literature addressing the relationship between artificial intelligence and research integrity. Relevant publications were identified through searches of PubMed, Web of Science, Scopus, and Google Scholar covering the period from January 2020 to June 2025. Search terms included combinations of "artificial intelligence," "large language models," "ChatGPT," "research integrity," "scientific misconduct," "paper mills," "synthetic data," "hallucinated references," "academic publishing," "peer review," and "plagiarism." Additional sources were identified through reference-list screening and examination of guidance documents issued by organizations involved in publication ethics and scientific governance, including the International Committee of Medical Journal Editors (ICMJE) and the Committee on Publication Ethics (COPE). Priority was given to peer-reviewed empirical studies, systematic reviews, bibliometric investigations, editorials, policy statements, and reports that contributed to understanding either the opportunities or risks associated with AI technologies in scholarly publishing. The objective was not to perform a systematic evidence synthesis but rather to provide a critical narrative overview of current knowledge, emerging concerns, and future directions relevant to safeguarding research integrity in the era of generative AI.

Artificial Intelligence in Modern Scientific Publishing

The integration of artificial intelligence into scientific publishing has progressed from experimental adoption to routine use across multiple stages of the research process. Contemporary large language models and multimodal AI systems can assist researchers in literature retrieval, manuscript preparation, language refinement, statistical programming, data visualization, and editorial workflows [29-36]. For many investigators, particularly those working in resource-limited settings or communicating in a second language, these technologies have improved accessibility and efficiency within scholarly communication [30,32].

AI-assisted literature review platforms can rapidly screen large volumes of publications, identify relevant studies, and summarize key findings, thereby accelerating evidence synthesis and preliminary research planning [31]. Similarly, AI-supported coding tools can generate statistical scripts, assist with data analysis, and improve reproducibility when used under appropriate methodological supervision [33]. Within publishing workflows, AI-based systems are increasingly employed for technical screening, reviewer matching, plagiarism assessment, image verification, and manuscript triage [35.36,22].

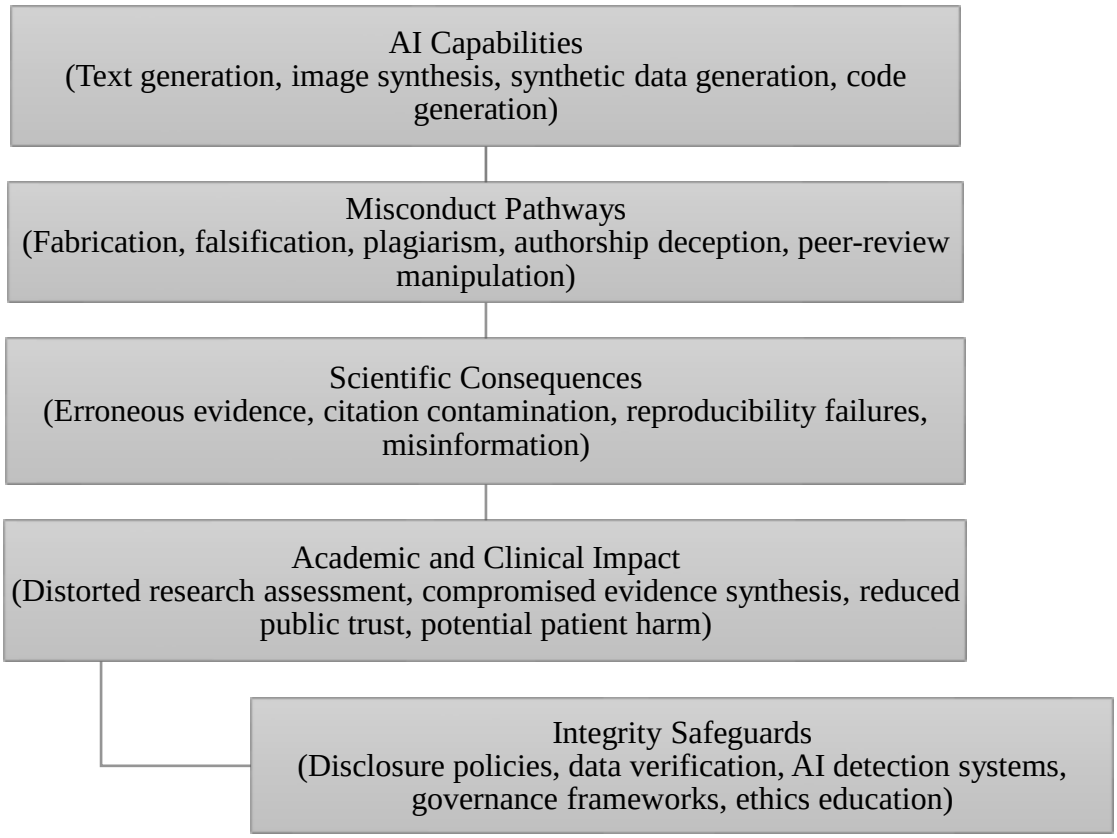
The expanding role of AI in research reflects a broader technological transformation rather than a temporary trend. However, the same capabilities that enhance productivity may also be exploited to generate fabricated data, misleading manuscripts, falsified

visual content, and manipulated scholarly records [8,11,21]. Consequently, understanding AI-driven scientific misconduct requires a framework that distinguishes technological capability from unethical application. Rather than viewing individual incidents as isolated forms of misconduct, emerging evidence suggests that AI-related threats arise from a continuum of interconnected activities that span data generation, manuscript preparation, publication processes, and post-publication dissemination.

Conceptual Framework of AI-Driven Scientific Misconduct

The relationship between artificial intelligence and scientific misconduct can be conceptualized as a multi-stage pathway linking technological capabilities to integrity-related consequences.

Figure 1. Conceptual Framework of AI-Driven Scientific Misconduct



This framework highlights that AI itself is not the source of misconduct. Rather, misconduct emerges when technological capabilities are intentionally employed to misrepresent scientific observations, conceal intellectual ownership, manipulate publication processes, or fabricate evidence. The framework also illustrates that the consequences extend beyond individual publications, influencing broader scientific, educational, and healthcare systems.

Taxonomy of AI-Driven Scientific Misconduct

Current evidence suggests that AI-enabled misconduct can be classified into four major categories according to the stage of the

research and publication process in which manipulation occurs.

1. Content Fabrication

Content fabrication represents the most direct threat to research integrity and involves the generation of scientific outputs that do not originate from authentic observations, experiments, or clinical investigations. Recent studies have demonstrated that generative AI systems can produce synthetic datasets with realistic distributions, correlations, and statistical characteristics that closely resemble genuine patient-level data [13,15]. Such datasets can be designed to support predetermined hypotheses while appearing methodologically plausible.

Beyond numerical data, advances in generative image technologies have enabled the creation of highly convincing scientific figures, including microscopy images, radiological scans, western blots, and graphical representations of experimental findings [16,17]. Although legitimate synthetic data applications exist for privacy protection and methodological research, deliberate presentation of AI-generated outputs as genuine observations constitutes scientific fabrication and threatens the validity of subsequent evidence synthesis [14,15].

2. Textual and Authorship Misconduct

The emergence of powerful language models has transformed the nature of authorship-related concerns in scholarly publishing. AI systems can generate coherent abstracts, introductions, discussions, and complete manuscript drafts that closely resemble conventional scientific writing [38,38]. While responsible use of AI-assisted language editing may improve clarity and accessibility, undisclosed reliance on AI for substantive intellectual content raises concerns regarding transparency, accountability, and academic responsibility [37,39].

A related challenge involves semantic plagiarism, whereby AI tools rephrase existing content while preserving its underlying meaning and intellectual contribution [40,41]. Unlike traditional plagiarism, semantic plagiarism may evade conventional similarity-based detection systems because lexical overlap is substantially reduced despite retention of the original concepts. The resulting ambiguity complicates assessments of originality and attribution within academic publishing [24,42].

3. Citation and Knowledge Manipulation

One of the most distinctive features of contemporary AI systems is their tendency to generate fabricated references that appear authentic despite lacking any corresponding publication [26,27]. These hallucinated citations frequently include plausible author names, article titles, journal details, and digital identifiers, creating an illusion of scholarly legitimacy [28].

Citation fabrication poses risks extending beyond individual manuscripts. When unverified references enter the literature, they may be inadvertently propagated through subsequent publications, creating misleading citation networks and compromising evidence synthesis [26-28]. The problem is particularly concerning in medicine and public health, where inaccurate references may influence clinical decision-making, educational materials, and policy development.

4. Publication Process Manipulation

The final category encompasses misuse of AI technologies to manipulate editorial and publication systems. The convergence of

generative AI with commercial paper-mill operations has enabled large-scale production of manuscripts containing fabricated data, misleading narratives, and falsified references [19,20,43-46]. AI-assisted generation substantially reduces the cost and effort required to produce fraudulent articles, increasing the volume of questionable submissions reaching scholarly journals.

Additional concerns include AI-generated peer-review reports, automated reviewer impersonation, fabricated reviewer identities, and manipulation of editorial workflows [18,47]. Although these practices are not unique to AI, generative technologies have amplified their scale and sophistication. Consequently, publication manipulation now represents a systemic challenge affecting journals, publishers, and research institutions worldwide.

The four categories described above are interconnected rather than independent. A single fraudulent manuscript may simultaneously contain synthetic data, AI-generated text, hallucinated references, and manipulated peer review. Understanding these interactions is essential for developing effective strategies to detect and prevent misconduct in increasingly complex publishing environments.

Table 1. Taxonomy of AI-Driven Scientific Misconduct and Associated Integrity Risks

Category	Representative Practices	Detection Difficulty	Potential Impact on Scientific Record
Content Fabrication	Synthetic datasets, fabricated figures, generated experimental outputs	High	Introduction of false evidence and irreproducible findings
Textual and Authorship Misconduct	Undisclosed AI authorship, ghost writing, semantic plagiarism	Moderate–High	Erosion of authorship accountability and originality
Citation and Knowledge Manipulation	Hallucinated references, fabricated citations, citation inflation	Moderate	Distortion of citation networks and evidence synthesis
Publication Process Manipulation	Paper mills, fake peer review, editorial workflow abuse	High	Systemic compromise of scholarly publishing integrity

The proposed taxonomy provides a structured approach for understanding the evolving spectrum of AI-enabled misconduct while recognizing that different forms of misuse vary considerably in prevalence, detectability, and potential impact. Importantly, available evidence indicates that some concerns, particularly hallucinated references and AI-assisted manuscript generation, are already well documented, whereas others remain

emerging risks requiring further empirical investigation.

Implications for Research Integrity and Scientific Quality

The integrity of scientific research depends upon the accuracy, transparency, and reproducibility of published evidence. As generative AI becomes increasingly embedded within research and publishing workflows, concerns have emerged regarding its potential to amplify existing vulnerabilities in scholarly communication. Although isolated instances of scientific misconduct have long existed, AI technologies have introduced unprecedented speed, scalability, and sophistication to activities that were previously limited by human effort and expertise [11,19,21].

One of the most significant concerns relates to the contamination of the scientific evidence base. Research findings derived from fabricated datasets, manipulated images, or misleading manuscripts can enter citation networks and influence subsequent investigations. Because evidence synthesis relies heavily on the credibility of primary studies, even a small number of fraudulent publications may affect systematic reviews, meta-analyses, and clinical recommendations if they remain undetected [48-50]. The challenge is particularly relevant in biomedical sciences, where decisions regarding diagnosis, treatment, and public health policy often depend upon published evidence.

AI-enabled misconduct may also exacerbate longstanding concerns regarding reproducibility. Scientific findings are expected to withstand independent verification, yet fabricated datasets and generated results lack an authentic empirical foundation. If such material is incorporated into the literature, subsequent researchers may devote substantial resources attempting to reproduce observations that never existed. The resulting waste of time, funding, and scientific effort undermines research efficiency and delays genuine scientific progress [48,49].

Academic evaluation systems represent another area of vulnerability. Contemporary research culture frequently relies on publication metrics, citation counts, and bibliometric indicators to assess scholarly productivity. The availability of tools capable of rapidly generating manuscripts or supporting publication manipulation raises concerns regarding the inflation of academic output without corresponding scientific contribution [51]. Such practices may distort hiring, promotion, and funding decisions while creating unfair advantages for individuals willing to engage in questionable publication practices.

Beyond institutional consequences, public trust in science may also be affected. Scientific credibility depends upon confidence that published findings are derived from rigorous investigation and ethical conduct. Highly publicized cases involving fabricated evidence, manipulated publications, or AI-generated misinformation have the potential to weaken confidence in scientific institutions and contribute to broader skepticism regarding expert knowledge [50,52]. Preserving public trust therefore requires not only the detection of misconduct but also the development of transparent governance mechanisms capable of demonstrating accountability.

Importantly, available evidence does not indicate that AI-driven misconduct has fundamentally transformed the scientific landscape. Rather, current observations suggest that generative AI has intensified existing integrity challenges while introducing new forms of deception that require adaptation of traditional oversight

mechanisms. Distinguishing documented risks from hypothetical concerns remains essential for evidence-informed policy development.

Artificial Intelligence as a Tool for Research Integrity

Discussions surrounding AI and scientific misconduct frequently emphasize potential harms, yet such a perspective provides only a partial understanding of the technology's role in contemporary research. The same tools capable of facilitating misconduct may also strengthen mechanisms designed to protect scientific integrity. Consequently, evaluating AI solely through the lens of risk fails to acknowledge its emerging contributions to transparency, quality assurance, and research governance.

One area of growing importance is the use of AI-assisted systems for identifying potential irregularities within submitted manuscripts. Machine-learning algorithms are increasingly employed to detect image manipulation, duplicated figures, inappropriate statistical patterns, and textual anomalies that may warrant further investigation [22,35,53]. These technologies can assist editors in screening large volumes of submissions more efficiently than would be possible through manual review alone.

AI-based analytical tools also show promise for detecting publication fraud associated with paper mills and coordinated misconduct networks. Bibliometric algorithms can identify unusual authorship patterns, citation clusters, repetitive textual structures, and publication behaviors that may indicate organized manipulation of scholarly publishing systems [43,45,46]. Although such approaches remain imperfect, they offer opportunities to enhance existing research integrity surveillance mechanisms.

The peer-review process may similarly benefit from responsible implementation of AI technologies. Emerging applications include reviewer identification, conflict-of-interest screening, manuscript classification, and technical assessment of reporting quality [35,36]. These functions may reduce administrative burden while allowing reviewers and editors to focus on scientific evaluation rather than routine procedural tasks.

AI tools have also expanded access to scientific communication. Language-support systems can improve manuscript clarity, assist non-native English-speaking researchers, and facilitate broader participation in global research activities [30,32]. Similarly, AI-assisted literature review platforms may help researchers navigate increasingly complex scientific landscapes by identifying relevant evidence more efficiently [31].

These benefits underscore an important principle: AI technologies are not inherently incompatible with research integrity. The ethical implications of AI depend largely upon transparency, accountability, and human oversight. Effective governance therefore requires a balanced approach that discourages misuse while supporting responsible innovation capable of strengthening the scientific enterprise.

Current Evidence and Knowledge Gaps

Although concerns regarding AI-driven scientific misconduct have increased substantially in recent years, the available evidence remains uneven across different domains. Certain forms of misuse are supported by empirical investigations, whereas others are primarily informed by theoretical discussions, expert opinion, or emerging observations.

Among the most well-documented concerns are hallucinated references and AI-assisted manuscript generation. Multiple studies have demonstrated that contemporary language models can generate convincing but non-existent citations and produce scientific text that resembles conventional academic writing [10,26-28]. Similarly, evidence regarding the limitations of current AI-detection systems and plagiarism-detection software has accumulated rapidly, highlighting challenges associated with identifying sophisticated AI-generated content [23-25,47].

A growing but less extensive body of evidence addresses synthetic data generation and fabricated scientific imagery. Proof-of-concept studies have demonstrated the feasibility of generating realistic datasets and visual outputs using publicly available AI systems [13–17]. However, reliable estimates regarding the prevalence of such misconduct within the published literature remain unavailable. Current knowledge is therefore derived primarily from demonstrations of technological capability rather than large-scale assessments of real-world occurrence.

Evidence relating to paper mills and publication factories occupies an intermediate position. Investigations conducted by publishers, research integrity specialists, and journal editors suggest that organized publication fraud represents a substantial challenge [19,20,43-46]. Nevertheless, the extent to which generative AI has altered the scale, efficiency, or detection of paper-mill activity remains incompletely understood. Quantitative studies examining these relationships are currently limited.

Several important knowledge gaps persist. First, there is insufficient information regarding the true prevalence of AI-enabled misconduct across scientific disciplines. Second, the performance of available detection technologies requires further validation under real-world editorial conditions. Third, little evidence exists concerning the long-term impact of AI-generated misinformation on evidence synthesis, clinical guidelines, and public health decision-making. Finally, there remains limited understanding of how researchers, institutions, and publishers are adapting to rapidly evolving AI capabilities.

These uncertainties highlight the importance of avoiding both technological alarmism and complacency. While existing evidence justifies legitimate concern regarding misuse of generative AI, policy responses should remain grounded in empirical data rather than speculation. Future research must therefore move beyond demonstrations of technological possibility toward systematic evaluation of prevalence, impact, detection, and governance strategies.

Governance and Regulatory Responses

The rapid evolution of generative AI has challenged traditional frameworks designed to preserve research integrity. Existing publication ethics guidelines were largely developed before the emergence of systems capable of generating scientific text, synthetic data, and realistic visual content. Consequently, publishers, academic institutions, funding agencies, and professional organizations have been compelled to adapt established governance mechanisms to address novel forms of technological misuse [55-60].

One of the most significant developments has been the emergence of guidance concerning transparency in AI-assisted scholarly work. The International Committee of Medical Journal Editors (ICMJE) has clarified that AI systems cannot satisfy authorship criteria because they are unable to assume responsibility for

the accuracy, integrity, or accountability of published research [55]. Similarly, the Committee on Publication Ethics (COPE) has emphasized that authors remain fully accountable for all submitted content, including material generated or modified using AI tools [56]. These recommendations have contributed to a growing consensus that AI use should be disclosed whenever it materially influences manuscript preparation, data interpretation, or content generation [55-57].

Beyond disclosure requirements, journals are increasingly strengthening editorial screening procedures. Several publishers have introduced policies requiring authors to report AI-assisted writing, while others have implemented additional verification procedures for images, datasets, references, and methodological reporting [53,58]. Such measures reflect recognition that traditional editorial workflows may be insufficient to address emerging forms of technologically enabled misconduct. However, policy implementation remains heterogeneous across journals and disciplines, creating inconsistencies that may hinder effective oversight.

Academic institutions also occupy a central role in safeguarding research integrity. Universities and research organizations are increasingly developing policies that distinguish acceptable uses of AI from activities that constitute academic misconduct [58]. These policies commonly emphasize transparency, accountability, appropriate attribution, and preservation of independent scholarly judgment. Importantly, institutional responses must extend beyond punitive approaches to include education and training that prepare researchers to use AI responsibly within evolving research environments.

The development of coherent governance frameworks remains an ongoing challenge. Rapid technological advances frequently outpace regulatory responses, creating uncertainty regarding best practices and acceptable standards. Furthermore, differences in national regulations, institutional policies, and publishing requirements may contribute to fragmented oversight. Addressing these challenges will require collaboration among publishers, researchers, regulators, and professional organizations to establish broadly accepted principles capable of adapting to future technological developments [59,60].

Table 2. Selected Governance Approaches for AI Use in Scholarly Publishing

Organization/Stakeholder	Primary Focus	Key Principle
ICMJE [54]	Authorship and accountability	AI cannot be listed as an author
COPE [55]	Publication ethics	Mandatory transparency and human responsibility
Publishers [56,57]	Editorial oversight	Disclosure and verification of AI-assisted content
Academic Institutions [59]	Research conduct	Responsible use and ethics education
Research Funders [60]	Research integrity	Transparency, reproducibility, and accountability

Future Directions

The continuing development of generative AI ensures that research integrity will remain a dynamic and evolving challenge. Future efforts should focus not only on identifying misconduct but also on strengthening the resilience of scientific systems against increasingly sophisticated forms of manipulation.

One priority involves improving methods for verification of scientific outputs. Enhanced image-forensics tools, citation-validation systems, and automated checks for data consistency may help identify irregularities before publication [16,22,23]. Equally important is the development of reliable approaches for validating synthetic datasets and distinguishing legitimate privacy-preserving applications from deliberate fabrication [14,15].

Greater emphasis should also be placed on transparency and reproducibility. Wider adoption of open-data practices, public sharing of analytical code, preregistration of studies, and independent verification mechanisms may reduce opportunities for misconduct while strengthening confidence in published findings [58,60]. These approaches are likely to remain important regardless of future technological developments.

Education represents another critical area for investment. Responsible use of AI should become an integral component of research ethics training at undergraduate, postgraduate, and professional levels. Researchers must understand not only the capabilities of AI systems but also their limitations, risks, and ethical implications [58,61]. Such training may prove more effective in the long term than reliance on detection technologies alone.

Finally, international collaboration will be essential. Scientific publishing operates across institutional and national boundaries, whereas misconduct frequently exploits gaps between regulatory systems. Shared standards, coordinated reporting mechanisms, and collaborative integrity initiatives may help reduce opportunities for regulatory fragmentation and improve collective responses to emerging threats [53,62].

Conclusion

Generative artificial intelligence is reshaping the foundations of scientific communication. Its growing influence extends beyond manuscript preparation to data generation, evidence synthesis, editorial decision-making, and research evaluation. While legitimate applications may improve efficiency, accessibility, and quality assurance, misuse of these technologies introduces complex challenges for research integrity that cannot be addressed through traditional oversight mechanisms alone. Current evidence demonstrates that AI-enabled misconduct is no longer a theoretical concern, although important uncertainties remain regarding its prevalence and long-term consequences. The future credibility of the scientific record will depend on the ability of researchers, institutions, publishers, and regulators to develop adaptive governance systems that promote responsible innovation while preserving transparency, reproducibility, and public trust in science.

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