Artificial intelligence (AI) and ChatGPT involvement in scientific and medical writing, a new concern for researchers. A scoping review

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Abstract

Purpose – The study aims to evaluate PubMed publications on ChatGPT or artificial intelligence (AI) involvement in scientific or medical writing and investigate whether ChatGPT or AI was used to create these articles or listed as authors.

Design/methodology/approach – This scoping review was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines. A PubMed database search was performed for articles published between January 1 and November 29, 2023, using appropriate search terms; both authors performed screening and selection independently.

Findings – From the initial search results of 127 articles, 41 were eligible for final analysis. Articles were published in 34 journals. Editorials were the most common article type, with 15 (36.6%) articles. Authors originated from 27 countries, and authors from the USA contributed the most, with 14 (34.1%) articles. The most discussed topic was AI tools and writing capabilities in 19 (46.3%) articles. AI or ChatGPT was involved in manuscript preparation in 31 (75.6%) articles. None of the articles listed AI or ChatGPT as an author, and in 19 (46.3%) articles, the authors acknowledged utilizing AI or ChatGPT.

Practical implications – Researchers worldwide are concerned with AI or ChatGPT involvement in scientific research, specifically the writing process. The authors believe that precise and mature regulations will be developed soon by journals, publishers and editors, which will pave the way for the best usage of these tools.

Originality/value – This scoping review expressed data published on using AI or ChatGPT in various scientific research and writing aspects, besides alluding to the advantages, disadvantages and implications of their usage.

Keywords Scientific writing, ChatGPT, Artificial intelligence, Authorship, Research integrity

Paper type Literature review

Introduction

The scientific research process, including data analysis, manuscript writing and publication, is essential for individual researchers and the scientific community throughout various disciplines and specialties, eventually leading to knowledge advancement and contributing to individual researchers' career development (Iskander, Wolicki, Leeb, & Siegel, 2018; Kennedy, 2018; Khalifa, 2022; Pittman, Stahre, Tomedi, & Wurster, 2017). However, this process could be exhausting, time-consuming and requiring teamwork, making researchers eager to find and develop research and writing assisting tools and applications (Pittman *et al.*, 2017; Salvagno, Taccone, & Gerli, 2023).

Artificial intelligence (AI) has been involved in different aspects of our life for a considerable time, and scientific research is not an exception (Haenlein & Kaplan, 2019; Salvagno *et al.*, 2023); however, starting from November 2022, the idea and usage of AI was transformed enormously after the introduction of Generative Pretrained Transformer "ChatGPT" (OpenAI, San Francisco, CA, USA), which is an open AI platform trained on a massive amount of online data (including media, books and articles), enabling this tool to perform sophisticated tasks (Gao *et al.*, 2023; Sallam, 2023).

AI and ChatGPT soon found their way to be extensively involved in nearly all aspects of scientific research, including data collection, analysis, drafting manuscripts and final formatting (Alattar & McDowell, 2023; Alkaissi & McFarlane, 2023; Qasem, 2023), which created fears and controversies among the scientific communities, where some researchers are very enthusiastic for these new tools (Chen, 2023; O'Connor, 2023). In contrast, others reported considerable concerns and worries related mainly to misusing these tools (Kunze, Jang, Fullerton, Vigdorchik, & Haddad, 2023; Leopold, Haddad, Sandell, & Swiontkowski, 2023; Majovsky, Cerny, Kasal, Komarc, & Netuka, 2023; Stokel-Walker, 2023).

The primary objective of the current review was to evaluate the recent PubMed publications on ChatGPT or AI involvement in scientific or medical writing. The secondary objectives were to determine whether ChatGPT or AI was used in creating any of these articles, and, if yes, whether it was listed as an author or acknowledged by the human authors. Furthermore, the aim was to shed some light on the advantages, disadvantages and future perspectives reported in the included articles.

Methods

Design: We used the scoping review methodology according to Arksey and O'Malley (Arksey & O'Malley, 2005). The review was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines (Tricco *et al.*, 2018) (Supplementary file, Table S1). Per Arksey and O'Malley (Arksey & O'Malley, 2005), we followed their recommended six steps for conducting the current scoping review; however, they reported that the last is optional.

Stage 1: identifying objectives
This was mentioned earlier.

Stage 2: identifying relevant studies
After performing a preliminary screening of the literature to obtain and formulate an idea about the search terms to be used, the two authors independently created search terms, which were discussed among the authors to agree on a final search strategy. The Title/Abstract filed of the PubMed database was searched from January 1, 2023 to November 29, 2023, using the following search strategy: ((((ChatGPT[Title/Abstract]) OR (AI[Title/Abstract])) OR (Artificial intelligence[Title/Abstract])) AND (medical writing[Title/Abstract])) OR

(scientific writing[Title/Abstract]). The search was limited to articles on humans and published in the English language.

Stage 3: study selection
We decided to include all articles (regardless of type) discussing AI or ChatGPT involvement in scientific writing. Furthermore, excluded articles reported on the role of AI or ChatGPT in medical education, disease diagnosis, radiograph assessment, writing medical reports and if the article was not centered on scientific writing and its related aspects.

All the results were downloaded to the Endnote program in reference form for evaluation against the predetermined inclusion and exclusion criteria. Both authors independently performed traditional screening (first by title and abstract, followed by full-text screening); any disagreement was resolved by discussion between the authors until a consensus was reached.

Stage 4: charting the data
After agreeing on the finally included articles, each author independently extracted data into a predesigned Excel sheet. The following data were collected: first, study characteristics: Authors, country of origin, journal where the article was published and type of the article; second, evaluating the content of the articles and the central theme the authors discussed; and, finally, to document the role of AI or ChatGPT in creating the articles (if it was used or not? If used, was it listed as an author or not? If its use was mentioned in the acknowledgment section or not?). The data extracted by the authors were compared to resolve any discrepancies by discussion and agreement among the authors.

Stage 5: summarizing and reporting the results
As we aimed to formulate a scoping review, the collected findings were used to provide an overview of the subject in concern rather than an individual study quality assessment. The results were grouped and presented in a table. A brief qualitative assessment was performed, and a descriptive summary was reported. Both authors discussed the final results and agreed on the final presentation.

Stage 6: consultation
Arksey and O'Malley suggested an optional final step, which is consultation with stakeholders and experts to provide ideas beyond what is collected from the literature; however, this step was not needed for the current review and was not performed.

Results
Search results
The initial search revealed 127 articles, of which 41 were eligible for final analysis (Abuyaman, 2023; Alkaissi & McFarlane, 2023; Altmae, Sola-Leyva, & Salumets, 2023; Athaluri *et al.*, 2023; Babl & Babl, 2023; Buholayka, Zouabi, & Tadinada, 2023; Chen, 2023; Currie, 2023; Daugirdas, 2023; Dave, Athaluri, & Singh, 2023; Doyal, Sender, Nanda, & Serrano, 2023; Dunn *et al.*, 2023; Gandhi & Gandhi, 2023; Gao *et al.*, 2023; Giglio & Costa, 2023; Gilat & Cole, 2023; Homolak, 2023; Huang & Tan, 2023; Khlaif *et al.*, 2023; Koga, 2023; Lee, Salim, Abdullah, & Teo, 2023; Levin, Brezinov, & Meyer, 2023; Macdonald, Adeloye, Sheikh, & Rudan, 2023; Majovsky *et al.*, 2023; Marescotti, 2023; Mavrogenis & Scarlat, 2023; Misra & Chandwar, 2023; Ocampo, Silva, Alencar-Palha, Haiter-Neto, & Oliveira, 2023; Pal, Bhattacharya, Islam, & Chakraborty, 2023; Rozencwajg & Kantor, 2023; Sallam, 2023; Salvagno *et al.*, 2023; Shafiee, 2023; Svab, Klemenc-Ketis, & Zupanic, 2023; Temsah *et al.*,

2023; Verhoeven, Wendling, & Prati, 2023; Wohlfarth, Streit, & Guttormsen, 2023; Wu &
Dang, 2023; Xia & Wang, 2023; Yasin & Al-Hamad, 2023; Zheng & Zhan, 2023). The PRISMA
flow diagram illustrates the search results (Figure 1).

Study context and design
Articles were published in 34 different journals. The *Cureus* journal had the highest
contributions, with six (14.6%) articles, and editorials were the most common article type,
with 15 (36.6%) (Figure 2). Authors originated from 27 countries, and authors from the USA
contributed the most, in 14 (34.1%) articles (Figure 3).

Data synthesis
The included articles discussed various aspects of AI and ChatGPT involvement in scientific
writing; however, the three main topics (themes) discussed were, first, AI tools and writing
capabilities in 19 (46.3%) articles; second, the advantages and disadvantages in 12 (29.3%)
articles; and, lastly, 11 (26.8%) articles discussed ethical issues and concerns. As reported by
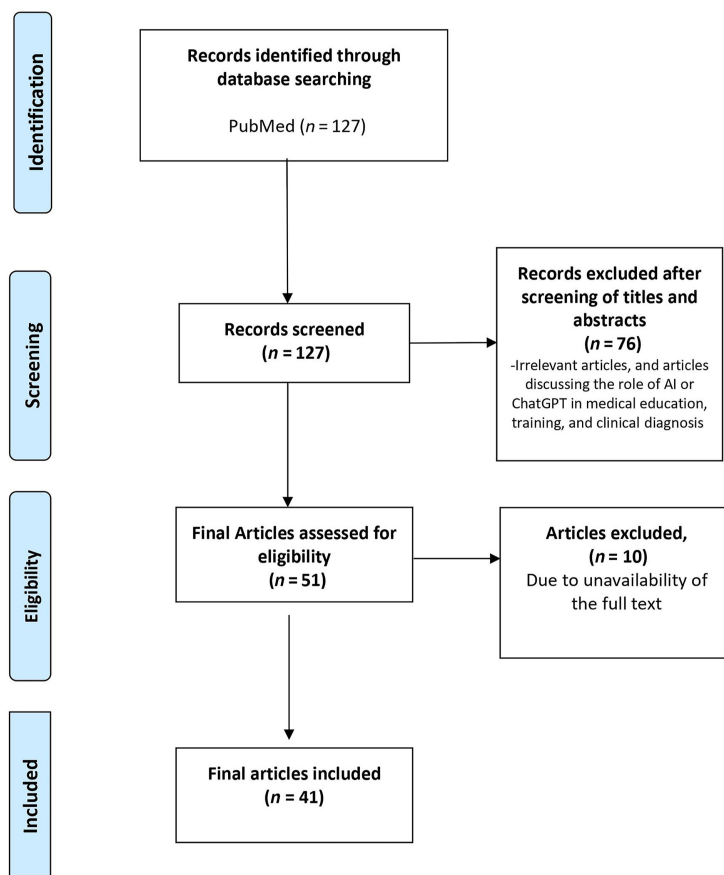
Source(s): Figure by authors

Fig. 1.
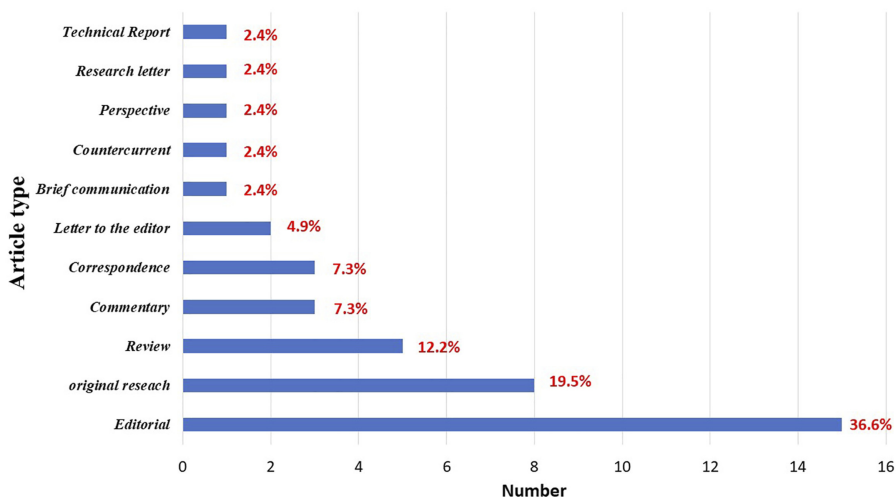PRISMA chart of the
search strategy

Fig. 2.
Chart indicating the
number of article types
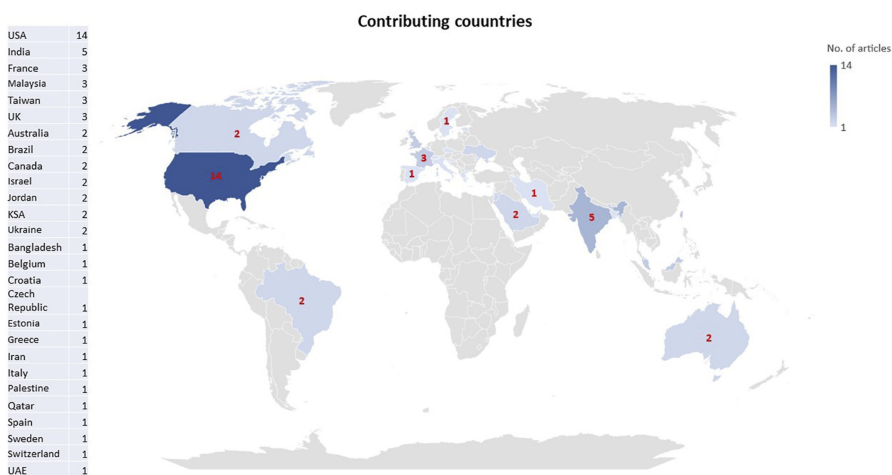
Source(s): Figure by authors

Fig. 3.
Map chart showing the
contributing countries

Source(s): Figure by authors

the authors, AI or ChatGPT was involved in various aspects of article preparation (manuscript drafting, study or experiment formulation and language corrections) in 31 (75.6%) articles. None of the articles listed AI or ChatGPT as an author, and in 19 (46.3%) articles, the authors mentioned utilizing AI or ChatGPT in the acknowledgments. Details and characteristics of the included articles are shown in Table 1.

Discussion

Although various AI-assistive scientific writing tools are present and being increasingly used over the past few years (Chen, 2023; Katsnelson, 2022), it is evident that the introduction of

No.	Authors*	Country of origin	Journal	Type of article	Article Theme	AI or ChatGPT used in creating any aspect of the manuscript	ChatGPT is listed as an author	AI or ChatGPT mentioned in the acknowledgment
1	Alkaissi and McFarlane	USA	Cureus	Editorial	Testing ChatGPT writing capabilities	Y	N	Y
2	Altmäe et al	Spain, Sweden, Estonia	Reproductive Biomedicine Online	Countercurrent	Testing ChatGPT writing capabilities	Y	N	N
3	Arman Shafiee	Iran	International Journal of Surgery	Correspondence	Testing ChatGPT writing capabilities	Y	N	Y
4	Athaluri et al	India, Ukraine	Cureus	Original research	Testing ChatGPT writing capabilities (testing mainly its ability to provide correct references)	Y	N	N
5	Babl and Babl	Australia	Emergency Medicine Australasia	Original research	Testing ChatGPT writing capabilities (testing its ability to generate conference abstracts)	Y	N	N
6	Buholayka et al	USA, KSA	Cureus	Technical report	Testing ChatGPT writing capabilities	Y	N	Y
7	Dave et al	Ukraine, India	Frontiers in Artificial Intelligence	Review	General discussion (including advantages and disadvantages)	N	N	NA
8	Doyal et al	USA	Cureus	Editorial	General discussion (handling some ethical concerns)	Y	N	Y
9	Dunn et al	USA	Journal of American Academy of Dermatology	Research letter	Testing ChatGPT writing capabilities (testing its ability to generate abstract, and testing the ability of AI output detection tools)	Y	N	N

(*continued*)

Table 1.
Details of the included articles

No.	Authors*	Country of origin	Journal	Type of article	Article Theme	AI or ChatGPT used in creating any aspect of the manuscript	ChatGPT is listed as an author	AI or ChatGPT mentioned in the acknowledgment
10	Gandhi and Gandhi	India	*Critical Care*	Correspondence	General discussion (handling some ethical concerns)	N	N	NA
11	Gao *et al*	USA	*npj Digital Medicine*	Brief communication	Testing ChatGPT writing capabilities (testing its ability to generate abstract), and testing the ability of AI output detection tools	Y	N	N
12	Geoffrey M. Currie	Australia	*Seminars in Nuclear Medicine*	Review	General discussion (including advantages and disadvantages)	Y	N	Y
13	Giglio and Costa	Brazil	*Revista da Associação Médica Brasileira*	Original research (bibliometric analysis)	Testing ChatGPT writing capabilities (testing its ability to support the scientific writing, and manage references)	Y	N	Y
14	Gilat and Cole	USA, Israel	*Arthroscopy*	Letter to the editor	General discussion (including advantages and disadvantages)	Y	N	Y
15	Huang and Tan	USA, Taiwan	*American Journal of Cancer Research*	Review	General discussion (including an example of ChatGPT generated text)	Y	N	Y
16	Jan Homolak	Croatia	*Croatian Medical Journal*	Commentary	Testing ChatGPT writing capabilities (testing its ability to generate abstract), and testing the ability of AI output detection tools	N	N	NA

(continued)

Table 1.

No.	Authors*	Country of origin	Journal	Type of article	Article Theme	AI or ChatGPT used in creating any aspect of the manuscript	ChatGPT is listed as an author	AI or ChatGPT mentioned in the acknowledgment
17	John T. Daugirdas	USA	American Journal of Kidney Diseases	Editorial	Testing ChatGPT writing capabilities	Y	N	Y
18	Khalif et al	Palestine, Malaysia	JMIR Medical Education	Original research	Testing ChatGPT writing capabilities (testing its ability to generate full research article)	Y	N	Y
19	Lee et al	Malaysia	Malaysian Family Physician	Commentary	General discussion (including advantages, disadvantages, and ethical concerns)	Y	N	Y
20	Levin et al	Canada, USA, Israel	Archives of Gynecology and Obstetrics	Original research (bibliometric analysis)	Evaluating trends of ChatGPT-related publications	N	N	NA
21	Macdonald et al	UK	Journal of Global Health	Editorial	Testing ChatGPT writing capabilities (testing its ability to generate full research article)	Y	N	Y
22	Májovský et al	Czech Republic	Journal of Medical Internet Research	Original research	Testing ChatGPT writing capabilities (testing its ability to generate full research article) and testing the ability of AI output detection tools	Y	N	Y
23	Malik Sallam	Jordan	Healthcare (Basel)	Review	General discussion (including advantages, disadvantages and ethical concerns)	N	N	NA

(continued)

Table 1.

Table 1.

No.	Authors*	Country of origin	Journal	Type of article	Article Theme	AI or ChatGPT used in creating any aspect of the manuscript	ChatGPT is listed as an author	AI or ChatGPT mentioned in the acknowledgment
24	Manuela Marescotti	UK	*Brain Communications*	Editorial	General discussion (including advantages, disadvantages and ethical concerns)	Y	N	Y
25	Mavrogenis and Scarlat	Greece, France	*International Orthopaedics*	Editorial	General discussion (including advantages, disadvantages and ethical concerns)	N	N	NA
26	Misra and Chandwar	India	*Journal of the Royal College of Physicians of Edinburgh*	Editorial	General discussion (including recommendations for authors, editors and peer reviewers)	N	N	NA
27	Ocampo et al	Brazil	*Imaging Science in Dentistry*	Editorial	General discussion (handling some ethical concerns)	N	N	NA
28	Omar Abuyaman	Jordan	*JMIR Formative Research*	Original research	Testing ChatGPT writing capabilities (testing its ability to generate abstract)	Y	N	N
29	Pal et al	India, Bangladesh	*International Journal of Surgery*	Correspondence	General discussion (handling some ethical concerns)	N	N	NA
30	Rozencwajg and Kantora	France	*Anaesthesia Critical Care and Pain Medicine*	Editorial	General discussion (including recommendations for authors, editors and peer reviewers)	Y	N	N

(continued)

No.	Authors*	Country of origin	Journal	Type of article	Article Theme	AI or ChatGPT used in creating any aspect of the manuscript	ChatGPT is listed as an author	AI or ChatGPT mentioned in the acknowledgment
31	Salvagno et al	Belgium, Italy	Critical Care	Perspective	General discussion (including advantages and disadvantages)	Y	N	Y
32	Shunsuke Koga	USA	Korean Journal Of Radiology	Letter to the Editor	General discussion (handling some ethical concerns)	Y	N	Y
33	ŠVAB et al	USA	Slovenian Journal of Public Health	Editorial	General discussion (including advantages and disadvantages)	Y	N	Y
34	Temsah et al	KSA, UAE, Malaysia	Cureus	Review	Evaluating trends of ChatGPT-related publications	Y	N	Y
35	Tzeng-Ji Chen	Taiwan	Journal of the Chinese Medical Association	Editorial	General discussion (including the role of ChatGPT in translation)	Y	N	N
36	Verhoeven et al	France	British Medical Journal	Editorial	General discussion (handling some ethical concerns) and Testing ChatGPT writing capabilities	Y	N	N
37	Wohlfarth et al	Switzerland	Cureus	Editorial	General discussion (including advantages, disadvantages and future perspectives)	Y	N	N

(continued)

Table 1.

Table 1.

No.	Authors*	Country of origin	Journal	Type of article	Article Theme	AI or ChatGPT used in creating any aspect of the manuscript	ChatGPT is listed as an author	AI or ChatGPT mentioned in the acknowledgment
38	Wu and Dang	Taiwan, USA	*American Journal of Otolaryngology– Head and Neck Medicine and Surgery*	Original research	Testing ChatGPT writing capabilities (testing its ability to support the scientific writing and manage references)	Y	N	N
39	Xia and Wang	UK, USA	*Biomaterials international*	Editorial	General discussion (including advantages and disadvantages)	Y	N	Y
40	Yasin and AL-Hamad	Qatar, Canada	*Research in Nursing and Health*	Editorial	General discussion (including advantages, disadvantages and future perspectives)	N	N	NA
41	Zheng and Zhan	USA	*The American Journal of Medicine*	Commentary	General discussion (handling some ethical concerns) and testing ChatGPT writing capabilities	Y	N	N

Note(s): *Articles are ordered according to the authors' alphabetical order
N: no, Y: yes, NA: not applicable
Source(s): Table by authors

ChatGPT as a new tool involved in various aspects of scientific research and writing occurred rapidly and grasped the attention and concern of many researchers and scientists. The current review showed that articles discussing AI and ChatGPT involvement in scientific writing were published by authors from different parts of the world in various journals; furthermore, a lot of these authors themselves tried ChatGPT and its ability to formulate scientific text, besides reporting its advantages, disadvantages and the ethical concerns related to its use.

Machine learning (ML) is considered an advancement of AI, where a decision could be made using ML algorithms based on data collected from large data sets (Sallam, 2023). Furthermore, neural networks (NN) are considered a specific type of ML algorithm capable of recognizing even more complex data sets patterns, which was ultimately advanced to form the large language models (LLMs) trained on a vast amount of data enabling these models to generate content-defined text and predict the best following text elements, thus leading to the production of naturally read texts (Choi, Coyner, Kalpathy-Cramer, Chiang, & Campbell, 2020; Gao et al., 2023; Luitse & Denkena, 2021).

ChatGPT recently became one of the most popular LLMs used by personnel among different disciplines; soon, it found its way to being deeply involved in scientific research and academic writing, owing to the large amount of data it was trained on and its human-like writing capabilities (Buholayka et al., 2023; Sallam, 2023). However, there is still an ongoing debate and hassle among journals, publishers and even individual researchers regarding the optimum ChatGPT use in scientific research activities and ethical regulations controlling its involvement in the scientific writing process (Stokel-Walker, 2023; Thorp, 2023; Tools such as ChatGPT threaten transparent science; here are our ground rules for their use, 2023).

In a bibliometric analysis by Levin et al., the authors reported 42 articles published in PubMed after they used the search term "ChatGPT" on February 15, 2023 (Levin et al., 2023). At the time of preparing the current review, a new search was performed using the same search terms used by Levin et al., which revealed 1809 results, meaning that in about ten months, the publications increased by about 43 folds, indicating a plethora of increasing concerns of this topic. On the contrary, in the current review, the initial search revealed 127 articles, which is considerably few compared to the results obtained from using the search terms mentioned in the previous study; however, this could be attributed to the high selectivity of the articles using strict search terms.

Moreover, in the study by Levin et al., the most common publication type was editorials, constituting 52%, and authors from the UK contributed the most (33%). In the current review, we reported the same results regarding the article type where editorials represent the commonly published article type (36.6%); however, authors from the USA were the highest contributors (34.1%). The predominance of editorials, which are mostly written by eminent researchers, reflects the concern regarding this considerably new phenomenon; furthermore, contributing authors are from countries across the world, indicating the global interest in evaluating this issue.

The articles included in the current review handled various themes and topics, showing the authors' interest in discussing and evaluating various aspects of AI or ChatGPT involvement in scientific writing; furthermore, in some articles, more than one theme was discussed (Table 1). The most commonly evaluated issue was the role of AI or ChatGPT as an assistant during different aspects of manuscript writing (language corrections, especially for non-English speakers, abstract formulation, building a structured manuscript and obtaining related references). Then, various articles reported the advantages and disadvantages of these tools' involvement in the scientific writing process, and few provided some recommendations and future perspectives for their use. Lastly, the ethical issues and increasing concerns regarding the misuse of these tools were raised in some articles (Table 2).

I Advantages

1 Making a linguistically coherent text from bullet points or short notes collected from different references while performing a literature review

2 Sorting and managing references

3 Performing study design, analysis of the study results and drafting them into text, which is thought to help writers overcome "Blank-sheet syndrome."

4 ChatGPT, with the supervision of a human author, significantly shortened the manuscript writing time, reaching up to one hour for a complete manuscript draft

5 It could help with different manuscript preparation steps, including formatting, linguistic correction and translation for non-English-speaking authors

6 It could rapidly analyze and summarize data from many articles, which is helpful while performing a literature search and review

7 Overall, it helps improve the writing quality by detecting areas of inconsistencies and potential errors

8 Plagiarism detection could be performed using these tools

II Disadvantages and worries

1 Text generated by ChatGPT could be a mix of accurate and fabricated data

2 Sometimes, the references suggested by ChatGPT are either wrong or non-existent

3 The text generated to answer a particular question is not necessarily accurate, and the answer could change if the question were asked multiple times

4 Controversy regarding the intellectual property rights if the text was generated using ChatGPT, do they belong to the human authors or the algorithm?

5 ChatGPT does not necessarily follow the journal instructions if asked to formulate a manuscript according to specific journal authors' instructions

6 It is worth noting that OpenAI incorporated a disclaimer in all chat windows that AI or ChatGPT could offer incorrect and biased information

7 Possible unethical use of these tools (however, still not proven), such as its use to produce vast amounts of abstracts by organizations such as paper mills or even the production of fabricated research articles

8 AI assisting tools could help researchers to increase their research production; however, this comes without an actual increase in their real experience. This could make publication numbers less trustworthy as a parameter for promotion or hiring academics

9 If fabrication or plagiarism were detected within a text or manuscript generated with the assistance of AI tools, who would bear the responsibility and the consequences?

III Future perspectives

1 Changing the regulations and policies needed for evaluating scientific manuscripts submitted to journals and abstracts submitted for conferences, including using AI-generated text detectors

2 AI could autonomously publish different manuscript types (commentaries, editorials and reviews)

3 Implementation of new ethical roles, including clear disclosure regarding using AI-assistive tools during preparing manuscripts and at which stage it was used. Furthermore, journals should also disclose their use of AI-generated text detection tools

4 Other ethical issues that are not yet resolved, such as whether ChatGPT or any other AI-based tools should be listed as an author or not; furthermore, these tools are currently free of charge, and these could soon be paid tools, which could further increase the gap between researchers from high- and low-income countries as well as between senior and junior researchers

5 AI-detector tools investment will flourish, the same as what happened with plagiarism checkers

(continued)

IV *Theoretical and practical implications (based on the current review results)*
1 For researchers
- Judicious utilization of AI-related tools in various aspects of scientific writing (such as translation and editing) could be beneficial
- Preserving the research community integrity is the responsibility of each researcher
- Honest reporting of using these tools during manuscript preparation is mandatory
2 For decision-makers in higher education institutions and medical research
- Institution-specific regulations in the light of the reported advantages, disadvantages and ethical issues should be developed and implemented to regulate the use of these tools during various stages of scientific research
- Educational curriculums could be introduced to inform researchers of the benefits and harms of using these tools. Furthermore, it advises on the best practices and the trustable tools to be used
- Using these tools during critical thinking for proper decision-making regarding healthcare-related decisions
- Instead of ignoring or prohibiting these tools altogether, there should be beneficial controlled introduction and involvement during various processes of education, training, managing patients (adjusting drug doses, remote monitoring, symptoms development checks) and improving medical research (help in designing studies, recruiting patients and documentation)

Source(s): Table by authors

Table 2.

The current review has some limitations. First, the search was performed in one database, which could lead to missing some articles published in other databases. Second, using restricted search terms and focusing on a specific research point led to excluding articles discussing other aspects of scientific research rather than manuscript writing and preparation. Third, a full bibliometric analysis (including the number of citations of each article) was not performed. Fourth, as this was a scoping review focusing on a few points, only qualitative data synthesis and descriptive presentation were performed. Further, more detailed systematic reviews, including quantitative analysis (metanalysis), could be performed to provide more insight into AI and ChatGPT's role in scientific research and overcome the current review's drawbacks. Last, we could not offer recommendations for the proper utilization of AI or ChatGPT; however, we believe the current review could work as a foundation for formulating solid recommendations and regulations based on the data we reported.

Conclusion

Interests and worries regarding using AI or ChatGPT in different aspects of scientific research, including specifically the writing process, pose an increasing concern among researchers in different specialties. It is too early to judge these new tools; however, it is apparent that these are here to stay, and the main burden is on the shoulders of individual researchers and their moral and ethical consciousness to control their judicious use of these tools and applications. We believe that precise and mature regulations will be developed soon by journals, publishers and editors, which will pave the way for the best usage of these tools.

As Ridley Scott said, "Life is not black and white. It is a million gray areas, don't you find?" there is no absolute white (right) or black (wrong) regarding AI or ChatGPT involvement and usage in scientific research and writing; however, we are waiting for millions of gray areas, which possibly will appear shortly.

References

Abuyaman, O. (2023). Strengths and weaknesses of ChatGPT models for scientific writing about medical vitamin B12: Mixed methods study. *JMIR Formative Research*, *7*, e49459. doi: 10.2196/49459.

Alattar, A. A., & McDowell, M. M. (2023). The rise of AI co-authors: Navigating the future of scientific writing with ChatGPT. *Journal of Neurosurgery*, *139*(5), 1485–1486. doi: 10.3171/2023.3. JNS23254.

Alkaissi, H., & McFarlane, S. I. (2023). Artificial hallucinations in ChatGPT: Implications in scientific writing. *Cureus*, *15*(2), e35179. doi: 10.7759/cureus.35179.

Altmae, S., Sola-Leyva, A., & Salumets, A. (2023). Artificial intelligence in scientific writing: A friend or a foe?. *Reproductive BioMedicine Online*, *47*(1), 3–9. doi: 10.1016/j.rbmo.2023.04.009.

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32. doi: 10.1080/ 1364557032000119616.

Athaluri, S. A., Manthena, S. V., Kesapragada, V., Yarlagadda, V., Dave, T., & Duddumpudi, R. T. S. (2023). Exploring the boundaries of reality: Investigating the phenomenon of artificial intelligence hallucination in scientific writing through ChatGPT references. *Cureus*, *15*(4), e37432. doi: 10.7759/cureus.37432.

Babl, F. E., & Babl, M. P. (2023). Generative artificial intelligence: Can ChatGPT write a quality abstract?. *Emergency Medicine Australasia*, *35*(5), 809–811. doi: 10.1111/1742-6723.14233.

Buholayka, M., Zouabi, R., & Tadinada, A. (2023). The readiness of ChatGPT to write scientific case reports independently: A comparative evaluation between human and artificial intelligence. *Cureus*, *15*(5), e39386. doi: 10.7759/cureus.39386.

Chen, T. J. (2023). ChatGPT and other artificial intelligence applications speed up scientific writing. *Journal of the Chinese Medical Association*, *86*(4), 351–353. doi: 10.1097/JCMA. 0000000000000900.

Choi, R. Y., Coyner, A. S., Kalpathy-Cramer, J., Chiang, M. F., & Campbell, J. P. (2020). Introduction to machine learning, neural networks, and deep learning. *Translational Vision Science and Technology*, *9*(2), 14. doi: 10.1167/tvst.9.2.14.

Currie, G. M. (2023). Academic integrity and artificial intelligence: Is ChatGPT hype, hero or heresy?. *Seminars in Nuclear Medicine*, *53*(5), 719–730. doi: 10.1053/j.semnuclmed.2023.04.008.

Daugirdas, J. T. (2023). OpenAI's ChatGPT and its potential Impact on narrative and scientific writing in nephrology. *American Journal of Kidney Diseases*, *82*(5), A13–A14. doi: 10.1053/j.ajkd.2023.04.006.

Dave, T., Athaluri, S. A., & Singh, S. (2023). ChatGPT in medicine: An overview of its applications, advantages, limitations, future prospects, and ethical considerations. *Frontiers in Artificial Intelligence*, *6*, 1169595. doi: 10.3389/frai.2023.1169595.

Doyal, A. S., Sender, D., Nanda, M., & Serrano, R. A. (2023). ChatGPT and artificial intelligence in medical writing: Concerns and ethical considerations. *Cureus*, *15*(8), e43292. doi: 10.7759/cureus.43292.

Dunn, C., Hunter, J., Steffes, W., Whitney, Z., Foss, M., Mammino, J., ... Nathoo, R. (2023). Artificial intelligence-derived dermatology case reports are indistinguishable from those written by humans: A single-blinded observer study. *Journal of the American Academy of Dermatology*, *89*(2), 388–390. doi: 10.1016/j.jaad.2023.04.005.

Gandhi, M., & Gandhi, M. (2023). Does AI's touch diminish the artistry of scientific writing or elevate it?. *Critical Care*, *27*(1), 350. doi: 10.1186/s13054-023-04634-z.

Gao, C. A., Howard, F. M., Markov, N. S., Dyer, E. C., Ramesh, S., Luo, Y., & Pearson, A. T. (2023). Comparing scientific abstracts generated by ChatGPT to real abstracts with detectors and blinded human reviewers. *NPJ Digital Medicine*, *6*(1), 75. doi: 10.1038/s41746-023-00819-6.

Giglio, A. D., & Costa, M. (2023). The use of artificial intelligence to improve the scientific writing of non-native English speakers. *Revista da Associacao Medica Brasileira (1992)*, *69*(9), e20230560. doi: 10.1590/1806-9282.20230560.

Gilat, R., & Cole, B. J. (2023). How will artificial intelligence affect scientific writing, reviewing and editing? The future is here. *Arthroscopy*, *39*(5), 1119–1120. doi: 10.1016/j.arthro.2023.01.014.

Haenlein, M., & Kaplan, A. (2019). A brief history of artificial intelligence: On the past, present, and future of artificial intelligence. *California Management Review*, *61*(4), 5–14. doi: 10.1177/ 0008125619864925.

Homolak, J. (2023). Exploring the adoption of ChatGPT in academic publishing: Insights and lessons for scientific writing. *Croatian Medical Journal*, *64*(3), 205–207. doi: 10.3325/cmj.2023.64.205.

Huang, J., & Tan, M. (2023). The role of ChatGPT in scientific communication: Writing better scientific review articles. *American Journal of Cancer Research*, *13*(4), 1148–1154. Available from: https:// www.ncbi.nlm.nih.gov/pubmed/37168339

Iskander, J. K., Wolicki, S. B., Leeb, R. T., & Siegel, P. Z. (2018). Successful scientific writing and publishing: A step-by-step approach. *Preventing Chronic Disease*, *15*, E79. doi: 10.5888/pcd15. 180085.

Katsnelson, A. (2022). Poor English skills? New AIs help researchers to write better. *Nature*, *609*(7925), 208–209. doi: 10.1038/d41586-022-02767-9.

Kennedy, M. S. (2018). Journal publishing: A review of the basics. *Seminars in Oncology Nursing*, *34*(4), 361–371. doi: 10.1016/j.soncn.2018.09.004.

Khalifa, A. A. (2022). Losing young researchers in the authorship battle, under-reported casualties. *Ethics, Medicine and Public Health*, *20*, 100735. doi: 10.1016/j.jemep.2021.100735.

Khlaif, Z. N., Mousa, A., Hattab, M. K., Itmazi, J., Hassan, A. A., Sanmugam, M., & Ayyoub, A. (2023). The potential and concerns of using AI in scientific research: ChatGPT performance evaluation. *JMIR Medical Education*, *9*, e47049. doi: 10.2196/47049.

Koga, S. (2023). The integration of large language models such as ChatGPT in scientific writing: Harnessing potential and addressing pitfalls. *Korean Journal of Radiology*, *24*(9), 924–925. doi: 10.3348/kjr.2023.0738.

Kunze, K. N., Jang, S. J., Fullerton, M. A., Vigdorchik, J. M., & Haddad, F. S. (2023). What's all the chatter about?. *The Bone and Joint Journal*, *105-B*(6), 587–589. doi: 10.1302/0301-620x.105b6.Bjj-2023-0156.

Lee, P. Y., Salim, H., Abdullah, A., & Teo, C. H. (2023). Use of ChatGPT in medical research and scientific writing. *Malaysian Family Physician*, *18*, 58. doi: 10.51866/cm0006.

Leopold, S. S., Haddad, F. S., Sandell, L. J., & Swiontkowski, M. (2023). Artificial intelligence applications and scholarly publication in orthopedic surgery. *Journal of Orthopaedic Research*, *41*(6), 1137–1138. doi: 10.1002/jor.25566.

Levin, G., Brezinov, Y., & Meyer, R. (2023). Exploring the use of ChatGPT in OBGYN: A bibliometric analysis of the first ChatGPT-related publications. *Archives of Gynecology and Obstetrics*, *308*(6), 1785–1789. doi: 10.1007/s00404-023-07081-x.

Luitse, D., & Denkena, W. (2021). The great transformer: Examining the role of large language models in the political economy of AI. *Big Data and Society*, *8*(2), 20539517211047734. doi: 10.1177/20539517211047734.

Macdonald, C., Adeloye, D., Sheikh, A., & Rudan, I. (2023). Can ChatGPT draft a research article? An example of population-level vaccine effectiveness analysis. *Journal of Global Health*, *13*, 01003. doi: 10.7189/jogh.13.01003.

Majovsky, M., Cerny, M., Kasal, M., Komarc, M., & Netuka, D. (2023). Artificial intelligence can generate fraudulent but authentic-looking scientific medical articles: Pandora's box has been opened. *Journal of Medical Internet Research*, *25*, e46924. doi: 10.2196/46924.

Marescotti, M. (2023). To ChatGPT or not to ChatGPT: The use of artificial intelligence in writing scientific papers. *Brain Communications*, *5*(6), fcad266. doi: 10.1093/braincomms/fcad266.

Mavrogenis, A. F., & Scarlat, M. M. (2023). Thoughts on artificial intelligence use in medical practice and in scientific writing. *International Orthopaedics*, *47*(9), 2139–2141. doi: 10.1007/s00264-023-05936-1.

Misra, D. P., & Chandwar, K. (2023). ChatGPT, artificial intelligence and scientific writing: What authors, peer reviewers and editors should know. *Journal of the Royal College of Physicians of Edinburgh*, *53*(2), 90–93. doi: 10.1177/14782715231181023.

O'Connor, S., & ChatGPT (2023). Open artificial intelligence platforms in nursing education: Tools for academic progress or abuse?. *Nurse Education in Practice*, *66*, 103537. doi: 10.1016/j.nepr.2022.103537.

Ocampo, T. S. C., Silva, T. P., Alencar-Palha, C., Haiter-Neto, F., & Oliveira, M. L. (2023). ChatGPT and scientific writing: A reflection on the ethical boundaries. *Imaging Science in Dentistry*, *53*(2), 175–176. doi: 10.5624/isd.20230085.

Pal, S., Bhattacharya, M., Islam, M. A., & Chakraborty, C. (2023). AI-enabled ChatGPT or llm: A new algorithm is required for plagiarism free scientific writing. *International Journal of Surgery*. doi:10.1097/JS9.0000000000000939.

Pittman, J., Stahre, M., Tomedi, L., & Wurster, J. (2017). Barriers and facilitators to scientific writing among applied epidemiologists. *Journal of Public Health Management and Practice*, *23*(3), 291–294. doi: 10.1097/PHH.0000000000000433.

Qasem, F. (2023). ChatGPT in scientific and academic research: Future fears and reassurances. *Library Hi Tech News*, *40*(3), 30–32. doi: 10.1108/lhtn-03-2023-0043.

Rozencwajg, S., & Kantor, E. (2023). Elevating scientific writing with ChatGPT: A guide for reviewers, editors. And authors. *Anaesthesia, Critical Care and Pain Medicine*, *42*(3), 101209. doi: 10.1016/j.accpm.2023.101209.

Sallam, M. (2023). ChatGPT utility in healthcare education, research, and practice: Systematic review on the promising perspectives and valid concerns. *Healthcare (Basel)*, *11*(6), 887. doi: 10.3390/healthcare11060887.

Salvagno, M., Taccone, F. S., & Gerli, A. G. (2023). Can artificial intelligence help for scientific writing?. *Critical Care*, *27*(1), 75. doi: 10.1186/s13054-023-04380-2.

Shafiee, A. (2023). Matters arising: Authors of research papers must cautiously use ChatGPT for scientific writing. *International Journal of Surgery*, *109*(9), 2853–2854. doi: 10.1097/JS9.0000000000000515.

Stokel-Walker, C. (2023). ChatGPT listed as author on research papers: Many scientists disapprove. *Nature*, *613*(7945), 620–621. doi: 10.1038/d41586-023-00107-z.

Svab, I., Klemenc-Ketis, Z., & Zupanic, S. (2023). New challenges in scientific publications: Referencing, artificial intelligence and ChatGPT. *Zdravstveno varstvo*, *62*(3), 109–112. doi: 10.2478/sjph-2023-0015.

Temsah, O., Khan, S. A., Chaiah, Y., Senjab, A., Alhasan, K., Jamal, A., . . . Al-Eyadhy, A. (2023). Overview of early ChatGPT's presence in medical literature: Insights from a hybrid literature review by ChatGPT and human experts. *Cureus*, *15*(4), e37281. doi: 10.7759/cureus.37281.

Thorp, H. H. (2023). ChatGPT is fun, but not an author. *Science*, *379*(6630), 313. doi: 10.1126/science.adg7879.

Tools such as ChatGPT threaten transparent science; here are our ground rules for their use (2023). Nature, *613*(7945), 612. doi: 10.1038/d41586-023-00191-1. available at, https://www.nature.com/articles/d41586-023-00191-1#:~:text=24%20January%202023-,Tools%20such%20as%20ChatGPT%20threaten%20transparent%20science%3B%20here%20are%20our,clear%20guidelines%20to%20avoid%20abuse.

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., . . . Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, *169*(7), 467–473. doi: 10.7326/M18-0850.

Verhoeven, F., Wendling, D., & Prati, C. (2023). ChatGPT: When artificial intelligence replaces the rheumatologist in medical writing. *Annals of the Rheumatic Diseases*, *82*(8), 1015–1017. doi: 10.1136/ard-2023-223936.

Wohlfarth, B., Streit, S. R., & Guttormsen, S. (2023). Artificial intelligence in scientific writing: A deuteragonistic role?. *Cureus*, *15*(9), e45513. doi: 10.7759/cureus.45513.

Wu, R. T., & Dang, R. R. (2023). ChatGPT in head and neck scientific writing: A precautionary anecdote. *American Journal of Otolaryngology*, *44*(6), 103980. doi: 10.1016/j.amjoto.2023.103980.

Xia, Z., & Wang, Q. (2023). The emergence of AI tools in scientific writing and research. *Biomaterials Translational*, *4*(1), 1–2. doi: 10.12336/biomatertransl.2023.01.001.

Yasin, Y. M., & Al-Hamad, A. (2023). Harnessing AI for enhancing scientific writing in nursing research: Prospects, pitfalls, and solutions. *Research in Nursing and Health*, *46*(4), 379–380. doi: 10.1002/nur.22326.

Zheng, H., & Zhan, H. (2023). ChatGPT in scientific writing: A cautionary tale. *The American Journal of Medicine*, *136*(8), 725–e726. doi: 10.1016/j.amjmed.2023.02.011.

Supplementary

The supplementary material for this article can be found online.

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