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The rise of AI-driven language: A bibliometric analysis of ChatGPT-specific terms in scientific writing

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Abstract

The advent of artificial intelligence (AI), particularly ChatGPT, has introduced new dynamics in scientific writing, influencing both content and style. This study aims to analyze the frequency and trends of ChatGPT-specific terms in scientific literature. The study utilized a bibliometric analysis approach, leveraging the Scopus database to track the frequency of ChatGPT-specific keywords like "Intricate," "Harnessing," "Leverage," "Transformative," and "Revolutionize" from inception to June 17th, 2024. Two control terms, "Biology" and "Medicine," were also analyzed for comparison. The analysis revealed a significant rise in the usage of ChatGPT-specific terms in scientific writing, particularly in recent years. The relative publication frequency was measured by calculating the ratio of the number of publications from 2022 to 2024 to the total number of publications from the inception of the database to 2021. The analysis showed that "Intricate" had a high relative frequency of 0.741. Similarly, "Transformative" had a relative frequency of 0.613, while "Revolutionize" and "Leverage" followed closely with 0.589 and 0.578, respectively. In contrast, traditional terms like "Biology" and "Medicine" had much lower relative frequencies of 0.131 and 0.146, respectively. The increasing frequency of AI-specific terms suggests a shift in the linguistic landscape of scientific literature.

Keywords: Artificial intelligence, Bibliometric analysis, ChatGPT, Language trends, Scientific communication, Scientific writing.

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1. Introduction

Scientific writing is a pivotal component of scientific communication, encompassing a diverse range of documents including research papers, clinical trial reports, regulatory and educational materials [1, 2]. Over time, the language and terminology used in scientific and medical writing have evolved, reflecting changes in scientific knowledge, technological advancements, and shifts in societal attitudes towards health and disease [3, 4].

The advent of artificial intelligence (AI) and natural language processing (NLP) has significantly impacted the field of scientific writing [5, 6]. ChatGPT, developed by OpenAI, represents one of the most advanced language models to date, capable of generating human-like text based on vast datasets [7]. Its application in medical writing has the potential to streamline the creation of scientific content, enhance communication, and support evidence-based practice [8]. The language used in scientific writing must adhere to strict standards of clarity, accuracy, and professionalism [9]. Ensuring that AI-generated content meets these standards is essential for maintaining the integrity of scientific communication [10].

Bibliometric studies involve the quantitative analysis of academic literature to assess the impact, trends, and patterns within specific fields of research [11-13]. By examining metrics such as publication trends, bibliometric studies provide insights into the influence of particular keywords over time. These studies are invaluable for understanding the development of knowledge in various disciplines, identifying emerging areas of interest, and guiding research development.

The objectives of this study are to analyze the frequency and trends of ChatGPT-specific terms in scientific literature, comparing their usage with traditional scientific terms like "Biology" and "Medicine" to assess the impact of AI on scientific communication. The study aims to explore the implications of increased AI-driven language on the diversity and evolution of scientific writing, focusing on how tools like ChatGPT are shaping both the content and linguistic landscape of scientific discourse. Additionally, the research seeks to provide a quantitative basis for how AI is represented in scientific literature.

2. Methods

This study employed a bibliometric analysis to examine the frequency and trends of ChatGPT-specific keywords in the literature over time. The analysis utilized the Scopus database, known for its extensive coverage of scientific publications across various disciplines.

2.1. Search Strategy

The search strategy focused on article titles, abstracts, and keywords within the Scopus database. The search encompassed all available years up to June 17th, 2024, and included all languages and document types within journal sources. This broad approach ensured a thorough review of the literature across multiple domains and periods.

The search string used in this study for each keyword was as follows: "Intricate" was searched using the syntax `TITLE-ABS-KEY ( intricate )`, "Harnessing" with `TITLE-ABS-KEY ( harnessing )`, "Leverage" with `TITLE-ABS-KEY ( leverage )`, "Transformative" with `TITLE-ABS-KEY ( transformative )`, "Revolutionize" with `TITLE-ABS-KEY ( revolutionize )`, "Biology" with `TITLE-ABS-KEY ( biology )`, and "Medicine" with `TITLE-ABS-KEY ( medicine )`. These search strings were applied within the Scopus database to retrieve relevant publications based on the presence of these keywords in the title, abstract, or keywords section of the documents.

2.2. Keywords Retrieval

At first, ChatGPT was asked to list the common keywords frequently used by ChatGPT. The response obtained was [ChatGPT tends to overuse certain words and phrases, particularly in formal, academic, and analytical contexts. These words often add a sense of complexity or sophistication to writing but can sometimes become redundant or unnecessary. For instance, descriptive adjectives such as intricate, robust, pivotal, paramount, and profound are frequently used to emphasize importance or depth. Similarly, words like significant, compelling, substantial, nuanced, and innovative are often included to highlight the uniqueness or value of a concept, sometimes excessively. In addition to adjectives, action-oriented words are commonly overused to indicate progress, transformation, or revolutionize. Examples include harnessing, facilitating, leveraging, encompassing, and bridging. These words often appear in discussions related to research, technology, and interdisciplinary studies. Similarly, terms like optimizing, mitigating, amplifying, curating, and elucidating frequently surface in scientific and business writing to describe improvements, reductions, or clarifications in a process or system. Beyond individual words, ChatGPT also tends to rely on recurring phrases that signal depth, complexity, or emphasis. Phrases like "It is worth noting that…," "A deeper understanding of…," and "Plays a crucial role in…" often introduce key points, even when simpler wording would suffice. Other frequently repeated expressions include "Sheds light on…," "The intersection of…," and "A holistic approach to…," which add an academic tone but may contribute to verbosity. Additionally, phrases such as "A comprehensive analysis of…," "An indispensable tool for…," and "At the forefront of…" are often used to stress relevance but can feel formulaic when overused.]

The analysis focused on five key terms frequently used by ChatGPT in scientific writing. These terms are, Intricate, Harnessing, Leverage, Transformative and Revolutionize. Two control terms were used as a control for comparison, comprising Biology and Medicine. This selection reflects a range of concepts and scientific disciplines in scientific research and practice.

2.3. Data Extraction and Analysis

Data extraction and analysis were performed on June 17th, 2024. For each keyword, the number of documents containing the term was recorded. A year-by-year frequency analysis was conducted to select keywords to track their usage over time.

3. Results

3.1. Dataset Characteristics

The dataset extracted for this bibliometric analysis was sourced from the Scopus database, utilizing a comprehensive search strategy that included keywords such as "Intricate," "Harnessing," "Leverage," "Transformative," "Revolutionize," "Biology," and "Medicine." These keywords were searched across article titles, abstracts, and keywords, with no restrictions on time frame, language, source type, or document type (Figure 1). The search was performed on June 17th, 2024. The wide-ranging scope of the search terms highlights the study's intent to capture a broad spectrum of scientific literature, especially in the fields of biology and medicine, where over two million records were identified under the keyword "Medicine" alone. After the initial screening, a total of 3,391,426 records were identified across all keywords.

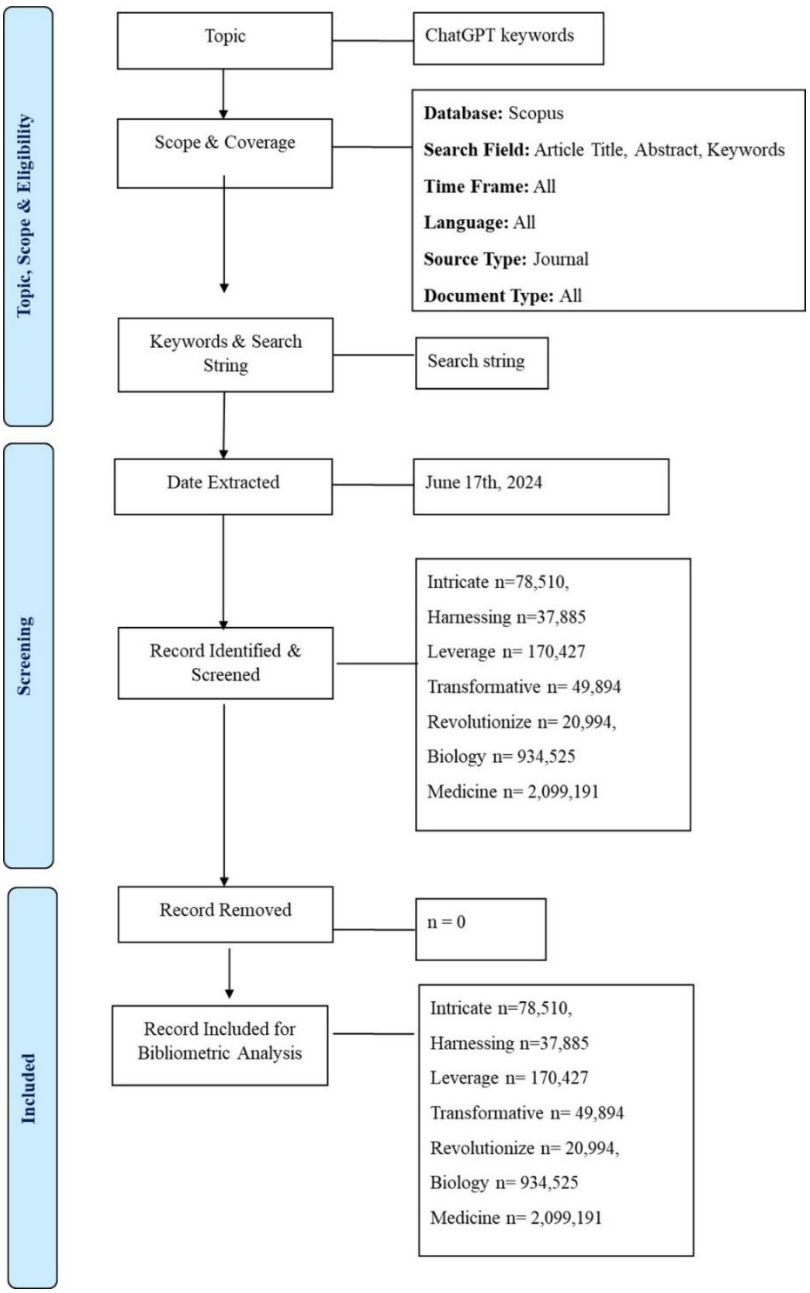

Figure 1.
Flowchart of Bibliometric Analysis Process.

The figure outlines the methodology used for the bibliometric analysis of ChatGPT-specific keywords in scientific literature. The process began with the selection of the topic, focusing on ChatGPT keywords. The search string was employed to extract data for specific keywords, including "Intricate," "Harnessing," "Leverage," "Transformative," and "Revolutionize," as well as control terms like "Biology," and "Medicine." The figure displays the number of records identified, screened, and included in the final analysis.

3.2. Trends in the Frequency of ChatGPT-Specific Terms in Scientific Writing

The results are presented through a combination of descriptive statistics, trend analyses, and visual representations as figures (Figure 2).

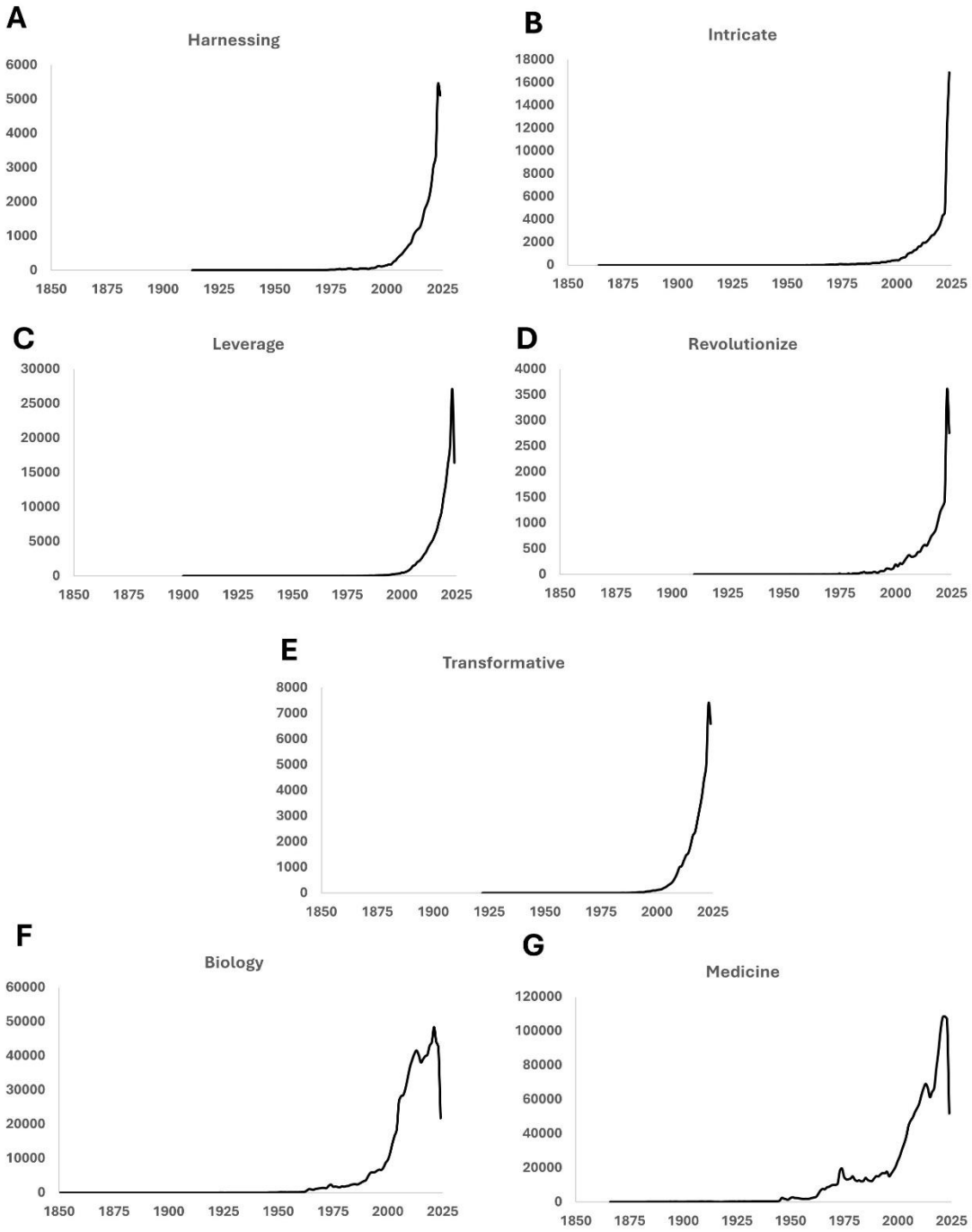

Figure 2.
Trends in the Frequency of ChatGPT-Specific Terms in Scientific Writing Over Time.

This figure illustrates the year-by-year number of publications of selected ChatGPT-specific terms: "Harnessing," "Intricate," "Leverage," "Revolutionize," and "Transformative," compared to control terms "Biology" and "Medicine." The data were extracted from the Scopus database and analyzed using R Studio with the Bibliometrix package. The figure highlights the significant rise in the usage of these terms, particularly in the last few years, reflecting the increasing influence of AI-driven language models in scientific discourse. The analysis includes data up to June 17th, 2024. The X-axis is the years and the Y-axis in the number of publications.

3.2.1. "Harnessing" Word Frequency

The frequency of the word "harnessing" in scientific writing indicates a significant rise in its usage over time. Initially appearing sporadically with just one occurrence in 1913, 1915, 1923, 1930, 1945, 1947, 1949, and 1950, the term remained relatively uncommon until the 1980s. From 1985 onwards, there was a small increase, reaching 51 occurrences in 1984. The

frequency continued to rise at a low pace, with notable jumps in the 2000s, peaking at 5,434 in 2023. It increased further to 5,113 in 2024, despite the included studies being only up to June 2024. This indicates an abrupt rise in this term in the last few years.

3.2.2. "Intricate" word frequency

The frequency of the word "intricate" in scientific writing reveals a marked increase over the past two years. The term appears sporadically from 1864 to 1947, with no or one occurrence in these years. A steady increase starts from 1950 onwards, reaching 88 occurrences in 1981. The frequency continues to rise throughout the 1980s and 1990s, surpassing 1,000 instances by 2007. There was a dramatic rise to 16,881 occurrences in 2024.

3.2.3. "Leverage" word frequency

The frequency of the word "leverage" in scientific writing showed a significant increase over the past few years. Starting with just one occurrence in 1900, the term remained infrequent until the mid-20th century. Usage began to rise in the 1970s, reaching 77 occurrences by 1985. The frequency continued to climb steadily, surpassing 1,000 instances by 2004. The trend saw an exponential increase in the 2010s, with 3,493 occurrences in 2011 and an abrupt peak at 27,128 in 2023. There is a further increase to 16,439 in 2024, despite only including studies up to June 2024.

3.2.4. "Revolutionize" word frequency

The frequency of the word "revolutionize" in scientific writing has shown a notable upward trend, particularly in recent years. From sporadic occurrences in the early 20th century, the term began to appear more consistently from the 1970s onward. There is a marked increase starting from the 2000s, with 120 occurrences in 1999 and climbing steadily to 877 by 2018. The term's usage surged in the early 2020s, peaking at 3,580 in 2023 and 2,755 in 2024. The increase in 2024 is notable as it includes studies only up to June 2024.

3.2.5. "Transformative" word frequency

The frequency of the word "transformative" in scientific writing reflects a significant increase over recent years. Initially rare, with only a few mentions in the 20th century, the term began to gain traction from the early 2000s. By 2023, "transformative" reached 7,369 occurrences, reflecting a peak usage in recent years. This high frequency continues into 2024 with 6,598 instances (until June 2024).

3.2.6. "Biology" word frequency

The frequency of the word "biology" in scientific writing shows a significant increase over the years. Starting with a count of only 1 in 1877, it gradually rises to 57 by 1935. A notable increase begins in the 1940s, with a sharp rise seen from 1950 onwards. The frequency surpasses 10,000 by 2001 and continues to increase, peaking at 48,409 in 2021. The count then slightly decreases, with 42,367 in 2023 and 21,821 in 2024.

3.2.7. "Medicine" word frequency

The frequency of the word "medicine" in scientific writing shows a substantial increase over the years. The term starts with minimal usage in the late 19th and early 20th centuries, with fewer than 100 occurrences per year until the 1940s. A steady rise begins in the 1960s, reaching over 1,000 instances by 2000. The frequency surpassed 10,000 instances in the late 1980s, peaking at 161,555 in 2015. Although there is a slight decrease afterward, the term remains prevalent, with 66,045 occurrences until June 2024.

3.3. The Relative Publication Frequency

The relative publication frequency for each keyword was calculated as the ratio of the number of publications from 2022 to 2024 to the total number of publications from inception to 2021. The data presented in Table 1 illustrate the evolving frequency of specific keywords in scientific literature, emphasizing a marked increase in the usage of terms closely associated with AI-driven language models like ChatGPT. For instance, terms such as "Intricate" and "Transformative" show a particularly high relative publication frequency, with ratios of 0.741139 and 0.613290, respectively. This suggests that these terms have become increasingly prevalent in recent scientific discourse, likely reflecting the growing influence of AI technologies in shaping both the language and content of scholarly articles. The increase in the use of terms like "Leverage" and "Revolutionize" further underscores the transformative effect of AI on scientific writing. With relative publication frequencies of 0.577567 and 0.589491, these terms encapsulate the wide usage of ChatGPT in scientific writing.

Table 1.
Summary of the Number of Publications and Relative Publication Frequency for Selected Keywords.

Term	Number of publications		The relative publication frequency
	2022-2024	From inception to 2021	
Harnessing	13883	24000	0.578458
Intricate	33415	45086	0.741139
Leverage	62394	108029	0.577567
Revolutionize	7786	13208	0.589491
Transformative	18966	30925	0.61329
Biology	108271	826246	0.13104
Medicine	266970	1831059	0.145801

The table presents the total number of publications for each keyword during two distinct periods: from 2022 to 2024 and from the inception of the database to 2021. Additionally, the relative publication frequency for each keyword is provided, calculated as the ratio of the number of publications from 2022 to 2024 to the total number of publications from inception to 2021.

Conversely, the terms "Biology" and "Medicine," while still widely used, show a much lower relative publication frequency of 0.131040 and 0.145801, respectively. This disparity highlights that while these foundational disciplines remain central to scientific research, the introduction of AI-related terminology has rapidly gained traction.

4. Discussion

Although there are limitations, ChatGPT serves as a valuable resource that enables scientists to concentrate on analyzing and interpreting literature reviews. By adopting such tools, researchers can enhance the efficiency and effectiveness of their work [14]. There are multiple concerns regarding the impact of ChatGPT on education, particularly in the context of academic writing [15]. These concerns include the potential to rely too heavily on AI-generated content, which may undermine their development of critical thinking and writing skills [15]. However, when used wisely and responsibly, ChatGPT has the potential to significantly enhance and transform academic research [16].

The results of this study emphasize the growing influence of AI-driven language models, particularly ChatGPT, in shaping the terminology and style of scientific writing. The significant increase in the frequency of terms such as "harnessing," "intricate," "leverage," "revolutionize," and "transformative" highlights a shift in the linguistic landscape of scientific discourse. This trend suggests that AI tools become more prevalent in research and writing.

Furthermore, the comparison between AI-specific terms and traditional scientific terms like "biology" and "medicine" reveals an interesting dynamic. While foundational disciplines remain central to scientific research, the relative frequency of AI-related terms has surged. This shift might be driven by the increasing adoption of AI in various research domains, where these models contribute not only to the methodology but also to the conceptual framework and terminology. The high frequency of terms like "transformative" and "revolutionize" might also reflect the broader impact of AI on scientific writing.

However, while the findings are compelling, they also raise questions about the long-term implications of AI's influence on scientific writing. The increasing reliance on AI-generated content could lead to homogenization in language use, potentially stifling creativity and diversity in scientific expression. Additionally, as AI models like ChatGPT continue to evolve, it will be essential to monitor how they affect the quality and integrity of scientific communication. Future research should explore these aspects in greater depth, examining not only the frequency of specific terms but also the broader impact of AI on the structure, tone, and content of scientific literature. Given the potential applications and implications of ChatGPT, it is essential for the academic and scientific community to develop clear guidelines for the responsible use of large language models, particularly ChatGPT, in research and publishing [17].

While traditional medical and biological sciences may encounter opposition due to strict language and regulatory rules, AI-generated terminology may differ from one discipline to another. Future studies examining term adoption across other scientific domains should help to reveal differences in how artificial intelligence affects academic writing.

Generative AI is expected to affect language education with some ethical concerns [18]. This includes substantial moral worries, including confidentiality and data protection, possible prejudices and concealed ideologies in the results, openness and responsibility, reliance and independence on AI-generated data [18]. When including ChatGPT and other AI-powered tools into language applications and beyond, one has to take into account privacy, lowering bias, preserving authenticity, and supporting academic integrity [19]. Large language models are fast being applied to automate content generation, feedback delivery, and grading as well as content development. Although a thorough scoping review of 118 studies showed 53 application scenarios arranged into nine key areas, it also exposed challenges like inadequate technical preparedness, transparency problems, and ethical questions. The authors advise using open-sourced technologies, modern models, and a human-centred approach to upgrade innovations so that ethical AI integration in education may be guaranteed [20].

One of the key strengths of this study is its innovative approach to examining the impact of AI-driven language models like ChatGPT on scientific writing through a bibliometric analysis. By focusing on the frequency of specific keywords associated with AI and comparing them with traditional scientific terms, the study provides a novel perspective on the evolving linguistic trends in scientific literature. This approach allows for a quantifiable assessment of how AI technologies are influencing not just the content but also the language of scientific discourse. Additionally, the use of a large and diverse dataset from the Scopus database ensures that the findings are robust and reflective of broader trends across various scientific disciplines.

However, the study also has several limitations that need to be considered. The reliance on keyword frequency as the primary metric may not fully capture the instances of how AI is influencing scientific writing. For instance, while frequency counts provide insight into the prevalence of certain terms, they do not account for the context in which these terms are used or how they might be shaping the interpretation of scientific content. Moreover, the dataset, although extensive, may not be entirely comprehensive, potentially excluding relevant publications or newer trends that have not yet been fully represented in the literature. Finally, the study does not address the potential qualitative changes in scientific writing that AI might induce, such as shifts in tone, style, or the complexity of language, which could also significantly impact scientific communication. This study mostly covers numeric changes in the use of ChatGPT-specific phrases without examining their contextual appropriateness or meaning. Further research is needed to use sentiment analysis or qualitative content analysis to determine if artificial intelligence-generated content influences the significant scientific worth of these terms.

Future work should aim to build on the findings of this study by exploring the qualitative aspects of AI's influence on scientific writing, such as changes in writing style, tone, and the complexity of language. This could involve conducting a more detailed content analysis to understand how AI-driven language models are shaping the narrative structures of scientific documents. Additionally, expanding the dataset to include more recent publications and emerging fields could provide a more comprehensive view of these trends. Content analysis would help future research to explore more the ways artificial intelligence shapes originality, language tone, and narrative structures. Expanding the dataset to include other kinds of articles and new domains might assist in making the conclusions much more solid.

5. Conclusion

This bibliometric analysis highlights the significant influence of AI-driven language models, particularly ChatGPT, on the terminology and style of scientific writing. The marked increase in the frequency of terms such as "harnessing," "intricate," "leverage," "revolutionize," and "transformative" underscores the impact of AI technologies on the language used in scholarly discourse. However, this trend also raises concerns about the potential for homogenization in scientific expression, as AI-generated content could lead to a reduction in linguistic diversity and creativity. As AI models like ChatGPT continue to evolve, their influence on the structure, tone, and content of scientific writing should be examined to ensure that they enhance rather than detract from the clarity and precision of scientific discourse. The study's approach provides a novel perspective on the evolving linguistic trends in scientific literature, but future research should explore the qualitative changes in writing style and tone brought about by AI, as well as the broader implications for scientific communication.

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