Research Article

The Influence of an Artificial Intelligence Large Language Model (ChatGPT) on Orthopaedic Scientific Publishing: A Bibliometric Analysis

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Purpose: This study aimed to assess bibliometric trends in orthopaedic research before and after the public release of ChatGPT.

Methods: A bibliometric analysis was conducted using PubMed data from January 2021 to March 2025, encompassing articles from ten high-impact orthopaedic journals. Trends in daily publication frequency, number of co-authors per article, sentence length, and lexical diversity were compared between pre- and post-ChatGPT periods.

Results: A total of 19,380 articles were analysed. The mean number of publications per day increased significantly from 9.76 ± 6.79 to 12.02 ± 7.83 ($p < 0.001$). This difference remained significant after adjusting for monthly variation ($p < 0.001$). The mean number of authors per article rose from 5.9 ± 3.88 to 6.18 ± 4.04 ($p < 0.001$). Abstracts became slightly more concise, with the average sentence length decreasing from 14.95 ± 5.13 to 14.67 ± 5.04 ($p < 0.001$), while lexical diversity increased marginally (TTR: 0.5192 to 0.5233; $p < 0.001$).

Conclusion: Since the introduction of ChatGPT, orthopaedic publications have shown a measurable rise in daily output, enhanced collaborative authorship, and subtle changes in linguistic style. These findings suggest a potential influence of AI-assisted tools on the way scientific research is written and disseminated.

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Introduction

Artificial intelligence (AI) has rapidly evolved, influencing multiple aspects of scientific research, including data processing, writing, and publication trends.[1][2][3] ChatGPT, a state-of-the-art large language model (LLM) developed by OpenAI (California, USA) and released in November 2022, emerged as a transformative tool, quickly gaining widespread popularity for its ability to generate human-like text.[4]

Leveraging natural language processing (NLP) and deep learning (DL), ChatGPT processes vast amounts of data to generate coherent and contextually relevant responses.[5] Researchers continue to explore its potential in various medical fields, leading to an increasing number of publications across different specialities.[6][7]

From early-career researchers to senior academics, there is increasing interest in leveraging ChatGPT's capabilities to support scientific research and scholarly writing. Its potential to streamline literature reviews, assist in data interpretation, and enhance manuscript drafting is reshaping academic publishing, contributing to the evolving landscape of medical and healthcare research.

The introduction of LLMs such as ChatGPT has raised questions about their role in academic publishing, particularly regarding the volume and quality of publications, co-authorship trends, and language complexity.

Recent studies have explored the role of artificial intelligence in scientific publishing, highlighting both its benefits and challenges.[8][9] AI-powered tools, including large language models like ChatGPT, have demonstrated potential in automating literature reviews, drafting manuscripts, and analysing complex datasets.[10][11] Research by Fayed *et al*.[1] showed how AI is increasingly integrated into orthopaedic research, assisting in clinical decision-making. However, concerns regarding accuracy, bias, and ethical implications remain central to ongoing discussions in the scientific community.

Using artificial intelligence to write scientific papers raises concerns about plagiarism, compromised methodology, improper contextualisation of findings, and questions about intellectual contribution and scientific integrity.[12]

We hypothesised that the release of ChatGPT and similar AI tools would significantly influence the landscape of scientific publishing in orthopaedic research. We expected to observe an increase in

publication rates, shifts in keyword trends reflecting the growing integration of AI, and changes in authorship patterns. Furthermore, we anticipated a decline in linguistic complexity, as AI-generated texts often exhibit more structured and repetitive language patterns.

The aim of this study was to perform a bibliometric analysis of orthopaedic research articles published before and after the release of ChatGPT. By evaluating publication trends, keyword distributions, and linguistic characteristics, we sought to quantify the impact of AI on scientific communication. We believe these findings will contribute meaningfully to the ongoing discussion regarding the role of AI in academic publishing, highlighting both its potential benefits and the challenges it may pose to scientific integrity.

Design and methods

Study Design

A bibliometric review was conducted following the BIBLIO guideline for reporting bibliometric analyses of biomedical literature.[13] Data were retrieved from PubMed, focusing on high-impact orthopaedic journals identified by their International Standard Serial Numbers (ISSNs), including The Journal of Bone & Joint Surgery, The American Journal of Sports Medicine, The Journal of Arthroplasty, Knee Surgery, Sports Traumatology, Arthroscopy, Foot and Ankle International, European Spine Journal, Archives of Orthopaedic and Trauma Surgery, Clinical Orthopaedics and Related Research, International Orthopaedics, and Journal of Orthopaedic Research.

Search Strategy

A structured bibliometric search was conducted in PubMed to identify articles published between January 2021 and March 2025 in ten high-impact orthopaedic journals, selected based on their ISSNs. Records were retrieved using automated queries stratified by journal and publication month, ensuring completeness and mitigating download limitations. All retrieved data, including abstracts and bibliographic metadata, were converted into a structured text format using the *easyPubMed* and *bibliometrix* packages in R.[14] To ensure data integrity, the retrieval process incorporated batch controls, duplicate checks, and verification of publication dates against inclusion criteria.

Group Definition

The dataset was stratified into two temporal groups based on the public release of ChatGPT (30 November 2022). Articles with an entry date (EDAT) on or before this date were classified as the pre-ChatGPT group (“Before”), while those indexed thereafter were included in the post-ChatGPT group (“After”). This classification was applied consistently across all analyses to assess temporal shifts in publication patterns, linguistic characteristics, and sentiment.

Data Processing and Analysis

All data processing and statistical analyses were conducted using R.[14] Following data retrieval, records were cleaned and structured for analysis. The number of authors per article was extracted from standardised metadata fields.

Abstracts were processed using natural language processing techniques to evaluate linguistic features. Lexical diversity was assessed using the Type-Token Ratio (TTR), and sentence complexity was estimated by calculating the average number of words per sentence.

Sentiment analysis was conducted using the syuzhet package in R, which applies a lexicon-based method validated for use in scientific texts. Each abstract received a continuous sentiment score reflecting its overall emotional tone, with higher values indicating more positive sentiment.[15]

Statistical Analysis

Descriptive statistics were reported as means and standard deviations. Comparisons between the pre- and post-ChatGPT periods were performed using Welch’s t-test for continuous variables, given the presence of unequal variances. In addition, a linear regression model was used to assess differences in daily publication rates, adjusting for monthly effects to account for seasonality. A two-sided p-value of less than 0.05 was considered indicative of statistical significance. All analyses were conducted using R. [14]

Results

Publication Trends

A total of 19,380 articles were included in the analysis, with 9,511 published before and 9,869 after the public release of ChatGPT. When adjusted for the number of days in each period, the mean number of publications per day increased significantly from 9.76 (± 6.79) in the pre-ChatGPT period to 12.02 (± 7.83) after the release ($p < 0.001$, Welch's t-test). This difference remained statistically significant after adjusting for seasonal variation using a linear model with monthly fixed effects, which estimated an adjusted increase of 2.046 publications per day ($p < 0.001$).

These findings suggest a measurable rise in publication activity in orthopaedic journals following the introduction of ChatGPT (Figure 1).

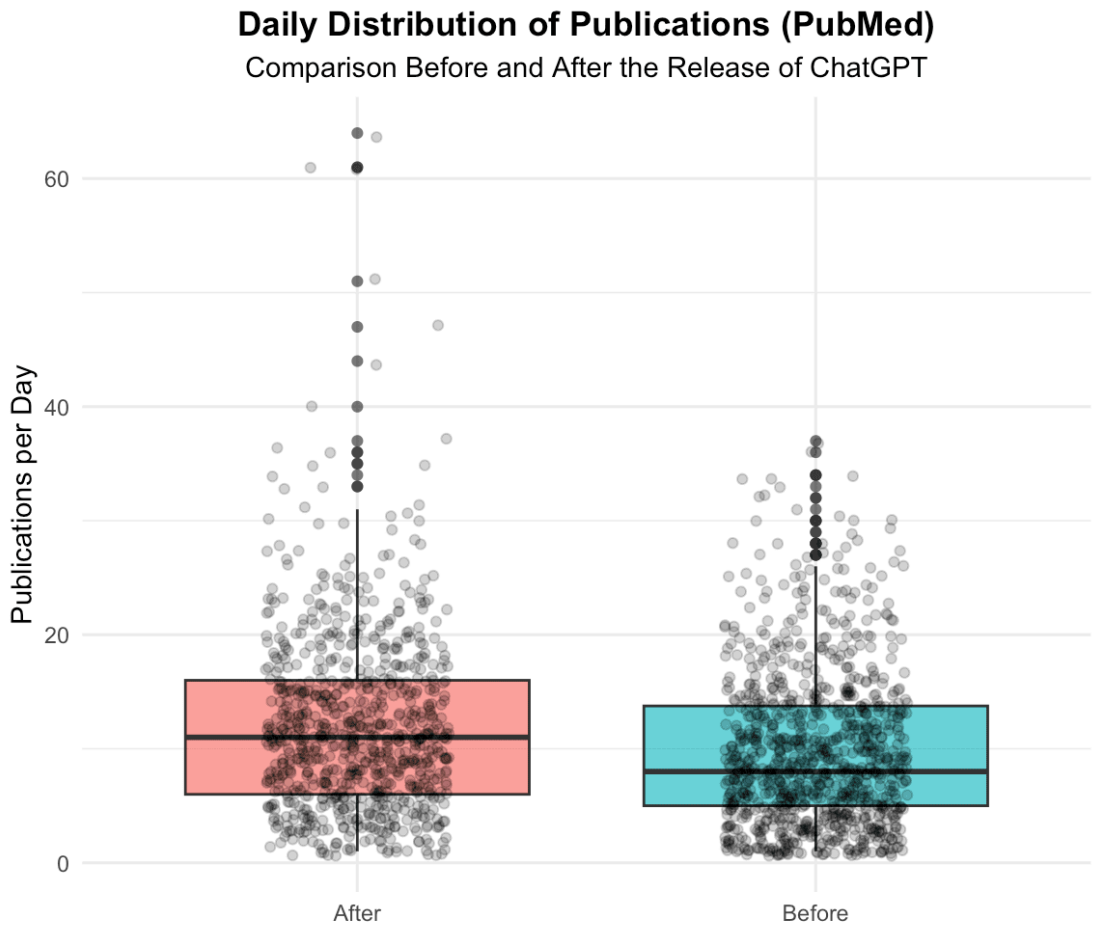

Figure 1. Boxplot showing the daily number of orthopaedic publications before and after the release of ChatGPT.

Authorship Patterns

The mean number of authors per article increased from 5.9 (± 3.88) in the pre-ChatGPT period to 6.18 (± 4.04) after its release. This difference was statistically significant (Welch's t-test: $t = 4.88$, $p < 0.001$). Figure 2 displays the proportional distribution of articles according to the number of authors, restricted to those with between one and ten contributors.

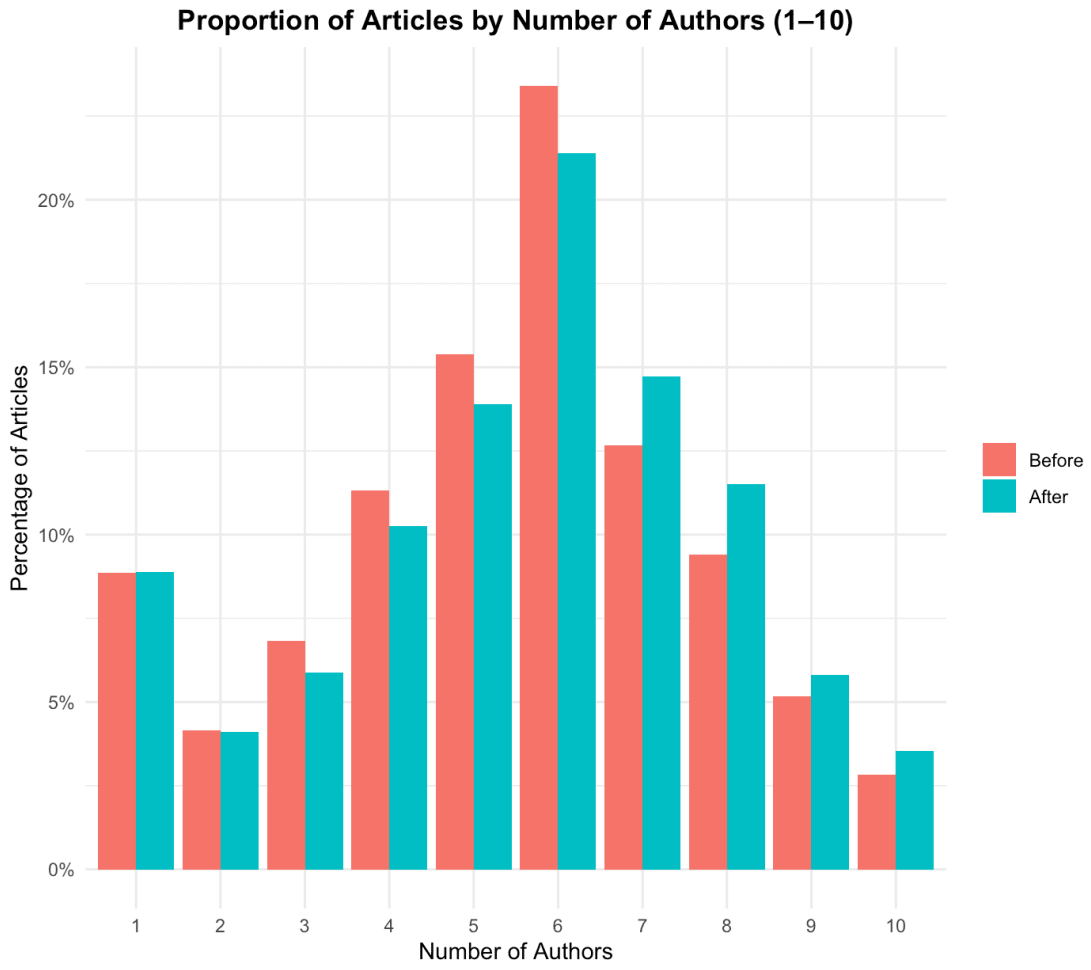

Figure 2. Bar chart showing the percentage of articles by number of authors, stratified by period.

Textual Complexity

The mean number of words per sentence in abstracts decreased from 14.95 (± 5.13) before the release of ChatGPT to 14.67 (± 5.04) after. This difference was statistically significant (Welch's t-test: $t = -3.50$, $p < 0.001$). Figure 3 presents the density distribution of sentence length, normalised by the total number of abstracts in each period.

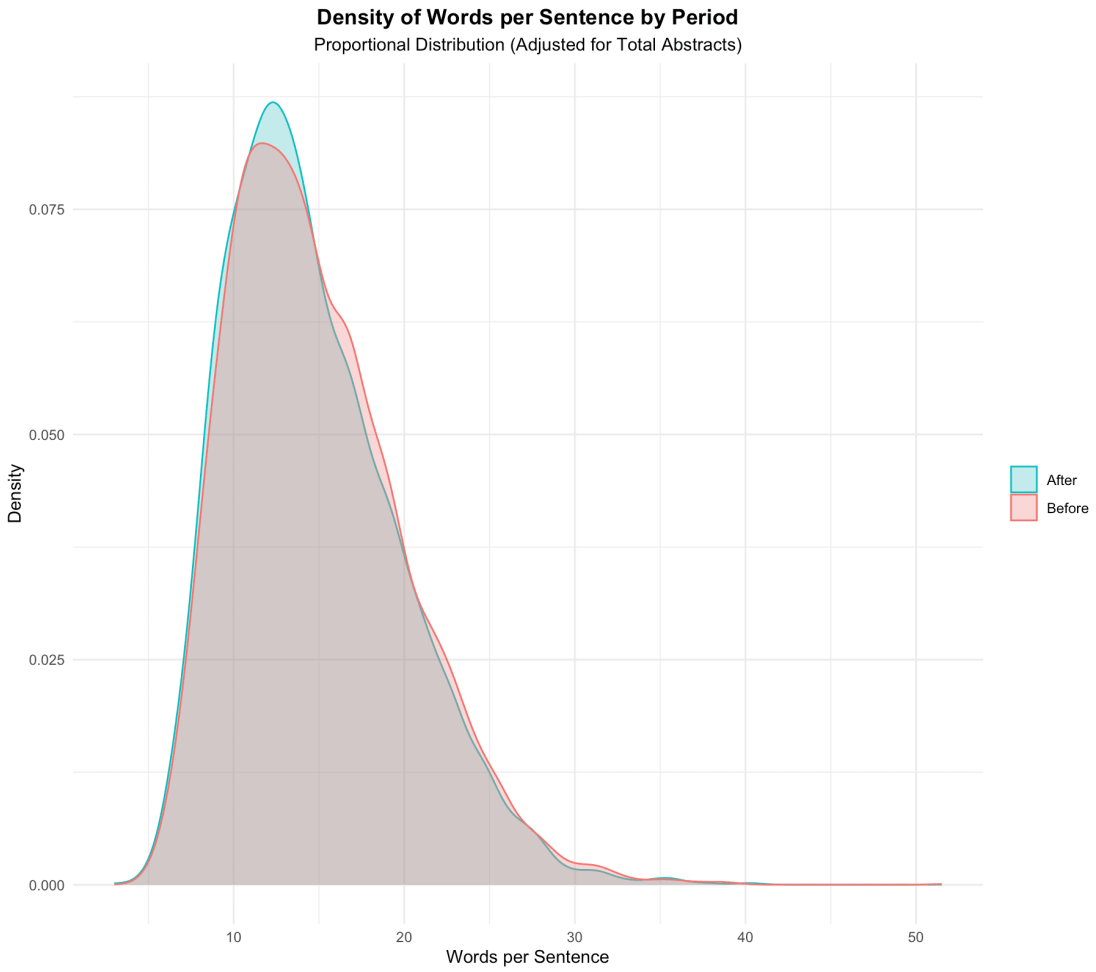

Figure 3. Density plot of the number of words per sentence in abstracts, stratified by period.

Lexical Diversity

Vocabulary diversity was evaluated using the Type-Token Ratio (TTR), calculated individually for each abstract. The mean TTR increased slightly from 0.5192 (± 0.06) in the pre-ChatGPT period to 0.5233 (± 0.06) after the release. This difference was statistically significant (Welch's t-test: $t = 3.86$, $p < 0.001$), suggesting an increase in lexical diversity. Figure 4 presents the density distribution of TTR values across both periods.

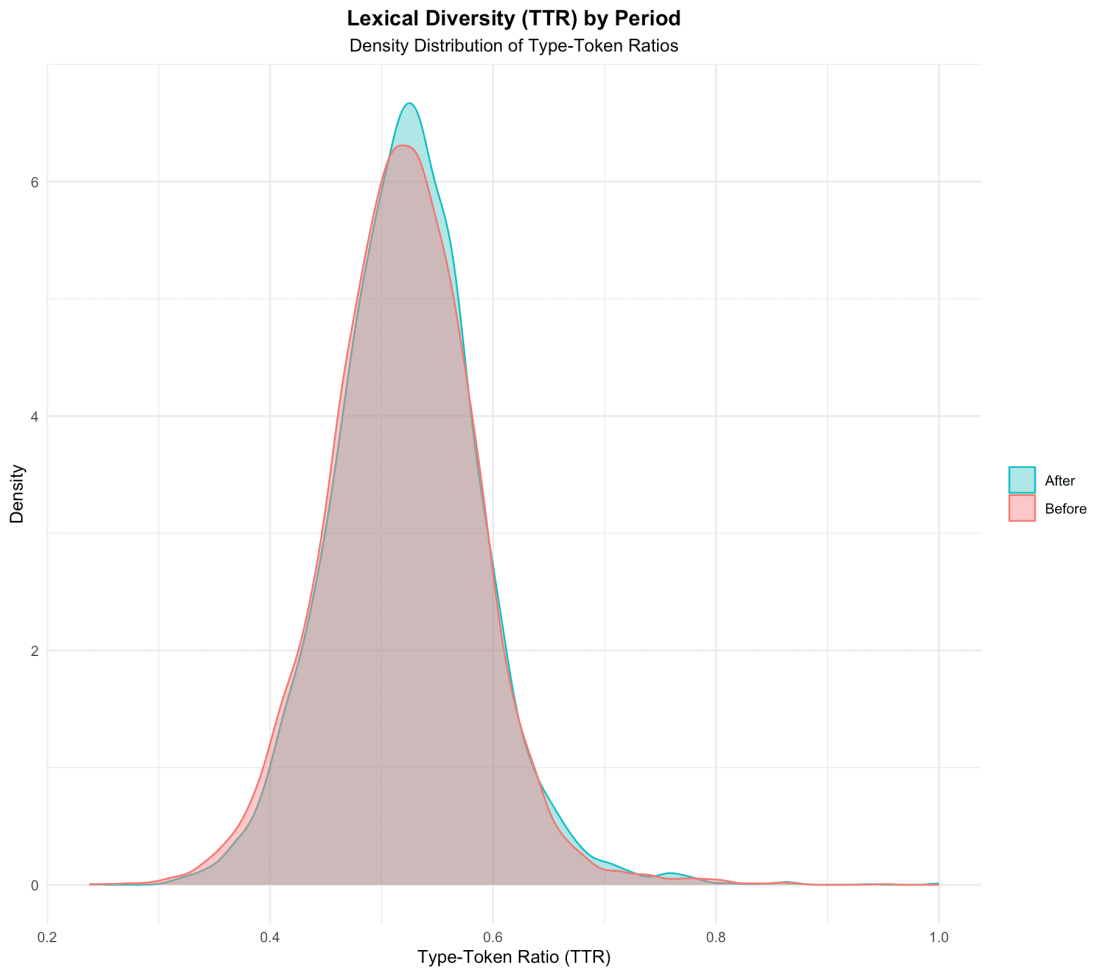

Figure 4. Density plot showing the distribution of Type-Token Ratios (TTR) in abstracts, stratified by period.

Sentiment Analysis

The mean sentiment score increased from 3.26 (± 3.26) in the pre-ChatGPT period to 3.46 (± 3.39) after the release. This difference was statistically significant (Welch's t-test: $t = 3.79$, $p < 0.001$), indicating a shift towards a more positive tone in abstracts over time. To facilitate interpretation, sentiment scores were categorised as positive, negative, or neutral. Figure 5 presents the proportional distribution of abstracts across these sentiment categories for each period.

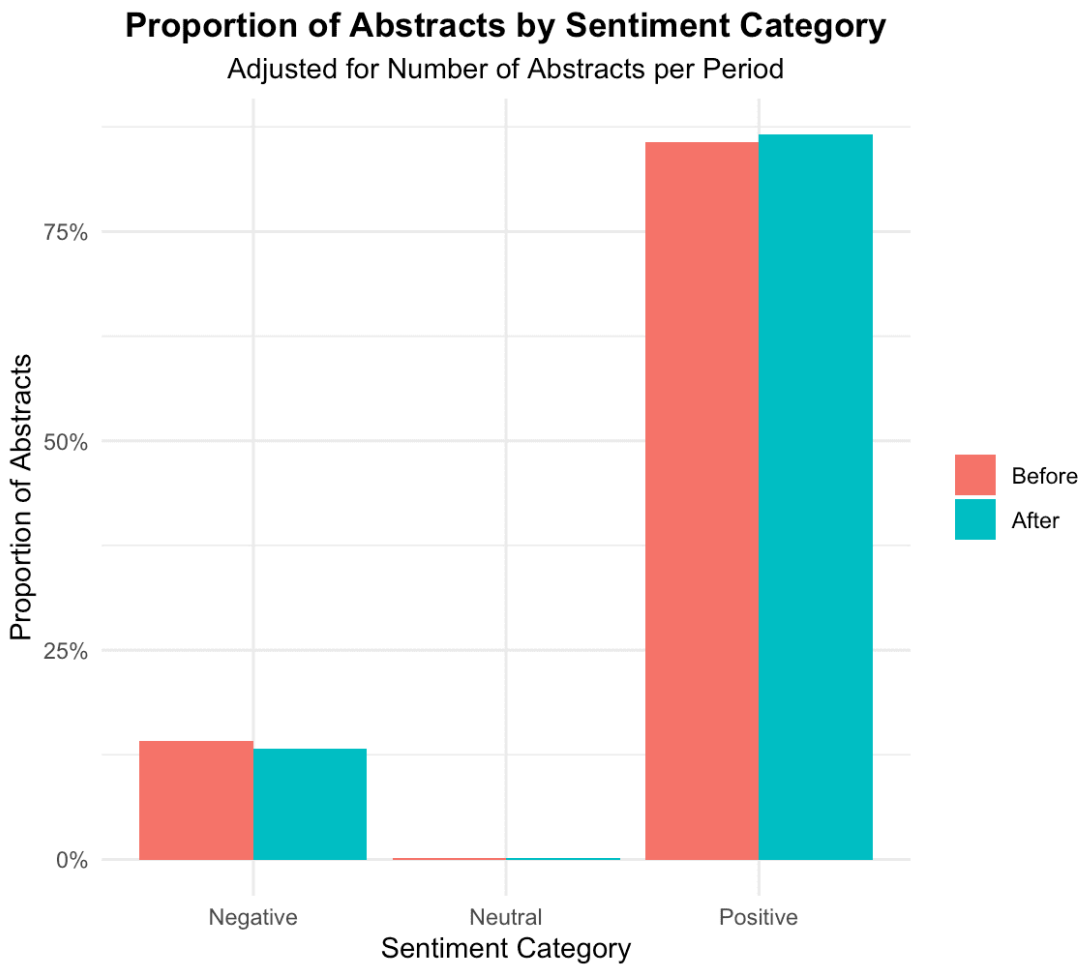

Figure 5. Bar chart showing the proportion of abstracts by sentiment category (positive, neutral, negative), stratified by period.

Discussion

This study examined whether the release of ChatGPT was associated with changes in orthopaedic scientific publishing. Our findings revealed a statistically significant increase in the number of articles published per day following its introduction (Welch's t-test, $p < 0.001$).

While causality cannot be established from bibliometric data alone, this trend suggests a potential association between the availability of large language models and increased research productivity. It is plausible that researchers have begun incorporating AI-based tools such as ChatGPT into their writing workflows to enhance efficiency in drafting, editing, or translating scientific content. Such practices may

lower the time and effort required to prepare manuscripts, thereby contributing to the observed rise in publication output.

The observed increase in the average number of authors per article—from 5.9 to 6.18 ($p < 0.001$)—may reflect broader shifts in research collaboration dynamics. While the integration of AI tools like ChatGPT could streamline manuscript preparation, facilitating contributions from multiple authors, it is also plausible that the post-pandemic acceleration of digital connectivity has played a significant role.

The widespread adoption of virtual communication platforms has lowered barriers to collaboration, enabling researchers from diverse locations to co-author work more readily[16]. This trend aligns with findings that highlight a surge in digital collaboration and co-authorship patterns following the COVID-19 pandemic.

Furthermore, Fayed et al.[1] discuss how the integration of AI in orthopaedics often necessitates interdisciplinary collaboration, involving experts in machine learning, data science, and clinical practice. Such collaborations inherently increase the number of co-authors on publications, reflecting the multifaceted nature of AI-driven research in the field.[1]

Our analysis identified a modest but statistically significant simplification in the linguistic structure of orthopaedic abstracts following the release of ChatGPT. The mean number of words per sentence decreased from 14.95 to 14.67 ($p < 0.001$), indicating a tendency towards more concise expression. In parallel, lexical diversity—as measured by the type-token ratio (TTR)—increased slightly from 0.51 to 0.52 ($p < 0.001$). These changes may reflect the influence of large language models, which are designed to generate fluent, grammatically accurate, and easily readable text, often prioritising clarity and directness.

While the increased clarity can enhance accessibility, there is also a risk of homogenisation in scientific writing. If many researchers begin relying on the same AI tools, there may be an unintentional convergence in tone and phrasing, leading to a loss of individual authorial voice. Alkaissi and McFarlane have warned that the standardised output of ChatGPT, although fluent, may lack the depth or nuance of expert-crafted narratives.[17]

Another notable finding was the significant increase in positive sentiment observed in abstracts. Mean sentiment scores rose from 3.26 to 3.46 ($p < 0.001$) in the post-ChatGPT period. Although scientific writing is expected to maintain a neutral tone, our analysis suggests a subtle shift towards more positively framed language. This may be partly attributable to the generative tendencies of LLMs, such as

ChatGPT, which often default to polite, affirmative, and constructive phrasing unless explicitly instructed otherwise.

Challenges and Ethical Considerations

Despite its advantages, AI is not infallible. One study highlights inconsistencies in AI-generated academic articles, underscoring the need for human oversight in verifying outputs.[18] Furthermore, the reliance on proprietary AI systems could lead to restricted access to scientific knowledge, as concerns about paywalled AI-generated research platforms grow. If AI-driven research tools become monetised, there is a risk that only well-funded institutions will benefit from these advancements, limiting open science initiatives.[6][19][20]

While the integration of AI tools into scientific workflows shows promise, it is important to recognise their current limitations. ChatGPT and similar models are known to generate factual inaccuracies, including fabricated references and misrepresented data trends. Farhat et al. demonstrated that such tools may produce plausible-sounding but incorrect scientific content, particularly when applied to data interpretation or citation generation.[21] Although LLMs can assist in refining the clarity and structure of text, their output still requires careful human oversight.

Nevertheless, these shortcomings may diminish over time. As statistical architectures become more sophisticated and training datasets expand, the accuracy and reliability of AI-generated content are likely to improve. The trajectory of model refinement suggests that future versions may offer enhanced factual precision, potentially increasing their utility in academic writing without compromising scientific integrity.

Additionally, Kim *et al.* examined the role of ChatGPT in medical education and its performance in standardised assessments, highlighting both its strengths and limitations.[19] While AI demonstrates promising applications in synthesising information and assisting in academic tasks, concerns remain regarding plagiarism, reliability, and disparities in educational access.

Dave *et al.* further highlight the ethical concerns surrounding AI-generated scientific content, particularly in relation to plagiarism and transparency in authorship, reinforcing the need for rigorous validation and oversight.[6] These findings align with our observations that AI, despite improving research efficiency, raises ethical concerns regarding transparency and the risk of diminishing critical evaluation in scientific writing. As AI tools become increasingly integrated into academia, it is crucial to

establish clear guidelines to mitigate these risks and ensure their responsible use in research and publishing.

Maintaining Scientific Integrity in AI-Assisted Research

While qualitative research exhibits greater resistance to AI, fearing the loss of human interpretation, other fields appear to adopt these tools more flexibly, particularly for enhancing writing and data analysis. In both cases, there is a clear need for well-defined guidelines to ensure that AI serves as a valuable aid to research without compromising originality and academic rigour. The risks of AI-generated errors, including data misinterpretation and fabricated references, must be mitigated through structured human-AI collaboration.

Similarly, Alkaissi *et al.* demonstrated that ChatGPT can generate artificial hallucinations, where factually incorrect statements and fabricated references are confidently presented as accurate. Their findings highlight the potential risks of unchecked AI-generated content, particularly in scientific writing, where misinformation could propagate if not rigorously verified.[17]

In 2023, Cheng et al. found that AI-generated scientific abstracts were of significantly lower quality than those written by human authors, with some containing incorrect conclusions—highlighting the importance of human oversight in AI-assisted research.[22] While these findings underscore the limitations of earlier language models, the rapid pace of AI development suggests that such tools may already have improved. As AI systems continue to evolve, distinguishing between human- and AI-generated manuscripts could become increasingly difficult, raising important questions about authorship attribution, academic integrity, and the evolving role of human researchers in scientific writing.

The phenomenon of AI-generated inaccuracies aligns with our observation that while AI-assisted tools may improve efficiency, they also pose challenges to the integrity of scientific communication. This underscores the urgent need for robust validation frameworks to ensure that AI-generated texts uphold the highest standards of academic reliability and transparency.

Democratisation of Research Through AI

One of the major advantages of AI in publishing is its ability to bridge the gap between well-funded research institutions and smaller hospitals or under-resourced research teams. By providing automated support in data analysis and manuscript preparation, AI can empower researchers who lack access to

extensive academic infrastructure. This democratisation of research tools allows clinicians and scientists from diverse backgrounds to engage in academic publishing without the same level of institutional resources traditionally required.

Despite ongoing concerns, AI holds promise for democratising scientific research by assisting individuals in resource-limited settings. As highlighted by Granjeiro et al., tools such as ChatGPT and Grammarly can help non-native English speakers and early-career researchers overcome linguistic barriers, improve the clarity and coherence of their manuscripts, and increase their visibility within the global academic community.[8]

For these benefits to be equitably distributed, however, access to AI tools and training must be widened. Supporting infrastructure, open-source alternatives, and targeted capacity-building initiatives can all contribute to a more inclusive research ecosystem.

Implications for Journals and Peer Review

The proliferation of AI-generated content compels journals to refine their editorial workflows in a constructive and integrative manner. Rather than solely focusing on AI detection or restriction, editorial teams may increasingly harness AI tools to assist in the standardisation and quality control of submissions. For instance, AI can be applied to automatically verify whether manuscripts comply with established reporting guidelines and checklists, ensuring that authors have completed all required sections and methodological disclosures before peer review begins.

Moreover, artificial intelligence has the potential to enhance the peer review process itself. In the future, a dual-layered system may emerge wherein AI performs a parallel review—focusing on structural, statistical, and compliance aspects—alongside traditional human peer review, which continues to evaluate conceptual, scientific, and interpretative quality. This complementary model could improve the efficiency, rigour, and consistency of manuscript evaluation while preserving the irreplaceable insight provided by expert reviewers. To achieve this, journals will need to develop clear frameworks that outline the role of AI in editorial decision-making and ensure transparency and accountability throughout the process.

AI and the Future of Scientific Publishing

The increasing integration of AI in academia suggests a future where scientific research is no longer centred on human-driven analysis and interpretation. Instead of reading and synthesising literature,

researchers may simply upload raw data, allowing AI to perform statistical analyses, identify patterns, compare findings with existing guidelines, and generate comprehensive reports. In this scenario, the role of the orthopaedic surgeon as a researcher could shift towards data curation and clinical validation, ensuring that AI-generated insights align with real-world practice.

While this transformation could enhance efficiency and streamline scientific production, it raises ethical and methodological concerns regarding transparency, potential algorithmic bias, and the diminishing role of human critical thinking in evaluating medical evidence. Additionally, as AI-driven research platforms grow, there is a risk that access to scientific data may become restricted, with proprietary databases limiting the availability of findings to exclusive research networks or commercial entities. What is now open-access knowledge could, in the future, be locked behind paywalls, creating disparities in who can access and contribute to medical advancements.

A recent development in this context is the launch of the FAIR^2 data management framework (Findable, Accessible, Interoperable, Reusable, and AI-Ready) by Frontiers.[23] This system encourages researchers to upload structured datasets enriched with metadata, facilitating AI-driven analyses and enabling direct citation of datasets. By promoting transparency and reproducibility, FAIR^2 aims to enhance the integrity of AI-assisted research and ensure that data remains a citable and integral component of scientific communication.

Strengths

This study is one of the first large-scale, orthopaedics-focused evaluations of AI's impact on scientific writing. By applying natural language processing techniques to a robust dataset spanning multiple decades and journals, we were able to quantify subtle but important shifts in collaboration, writing style, lexical diversity, and sentiment. Focusing on high-impact journals ensured that the observed trends reflect key changes within influential research outputs.

Limitations

Several limitations must be acknowledged. Our analysis focused exclusively on titles and abstracts, limiting insight into full-text evolution. We used a restricted list of journals, which may not capture trends in all orthopaedic publications. Finally, our study is correlational and cannot definitively attribute the observed changes solely to ChatGPT or AI adoption.

Conclusion

Since the public release of ChatGPT, orthopaedic journals have exhibited a measurable rise in daily publication output, modest increases in co-authorship, and subtle changes in the linguistic style and sentiment of abstracts. Although bibliometric data cannot establish causality, these associations are compatible with the growing uptake of AI-assisted tools for drafting, editing, and translation, and they may also be influenced by concurrent editorial or field-level factors.

It remains essential for the research community to address the ethical and practical implications of AI use, promoting transparent author disclosures and clear editorial guidance. Future work should examine specific pathways by which AI affects manuscript preparation and review, and evaluate policies that maintain scientific quality while enabling responsible, productive use of these tools.

Statements and Declarations

Conflicts of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online.

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Ethical Approval

This study was conducted using publicly available bibliometric data and did not involve human participants or require ethical approval.

Authors' Contributions

All authors contributed to the conception, analysis, interpretation, and drafting of this manuscript.

Availability of Data and Materials

The dataset used in this study was derived from PubMed-indexed journals and is available upon reasonable request.

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Declarations

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