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# Using artificial intelligence in academic writing and research: An essential productivity tool

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## ARTICLE INFO

## ABSTRACT

*Background:* Academic writing is an essential component of research, characterized by structured expression of ideas, data-driven arguments, and logical reasoning. However, it poses challenges such as handling vast amounts of information and complex ideas. The integration of Artificial Intelligence (AI) into academic writing has become increasingly important, offering solutions to these challenges. This review aims to explore specific domains where AI significantly supports academic writing.

*Methods:* A systematic review of literature from databases like PubMed, Embase, and Google Scholar, published since 2019, was conducted. Studies were included based on relevance to AI's application in academic writing and research, focusing on writing assistance, grammar improvement, structure optimization, and other related aspects.

*Results:* The search identified 24 studies through which six core domains were identified where AI helps academic writing and research: 1) facilitating idea generation and research design, 2) improving content and structuring, 3) supporting literature review and synthesis, 4) enhancing data management and analysis, 5) supporting editing, review, and publishing, and 6) assisting in communication, outreach, and ethical compliance. ChatGPT has shown substantial potential in these areas, though challenges like maintaining academic integrity and balancing AI use with human insight remain.

*Conclusion and recommendations:* AI significantly revolutionises academic writing and research across various domains. Recommendations include broader integration of AI tools in research workflows, emphasizing ethical and transparent use, providing adequate training for researchers, and maintaining a balance between AI utility and human insight. Ongoing research and development are essential to address emerging challenges and ethical considerations in AI's application in academia.

## Introduction

Academic writing is a key aspect of research and education, involving a structured method of expressing ideas. It is commonly used by researchers and educators in scholarly works to present data-driven arguments and logical reasoning. This form of writing helps readers to understand a topic thoroughly. It allows authors to deeply analyse concepts, leading to a well-explained theory or conclusion. Different fields use academic writing for various purposes. For example, scientists use it to explain their research and findings, while literary analysts use it to create fact-based critiques [1]. However, academic writing can be challenging, with difficulties varying depending on the writer and the field [2]. In academic writing, one must handle vast amounts of information, complex ideas, theories, and empirical data with understanding and clarity. This requires not only a deep understanding of the subject but also the ability to simplify complex ideas for the reader. Academic texts must meet high standards of accuracy, evidence, and logical structure. Every statement must be backed by credible evidence [3]. Additionally, mastering the formal tone and specific terminology of academic writing can be difficult, especially for beginners. Maintaining academic integrity through proper referencing and citing of sources is crucial, but it can be time-consuming and challenging, particularly for

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those who are not native English speakers [4].

The pressure to publish in academia, known as the "publish or perish" ethos, adds stress and can lead to burnout. Writers must balance being informative with keeping the reader engaged. They are also expected to bring originality and creativity to their work, which can be demanding under tight deadlines. Structural coherence, ensuring that ideas flow logically, is essential in academic writing, especially in long documents like theses or dissertations. This need for coherence must be balanced with effective time management, as academic writing often competes with other responsibilities [5]. The process of academic writing often involves revisions based on feedback from peers and advisors. This requires openness to criticism and the ability to integrate feedback effectively. When engaging in interdisciplinary research, writers face the challenge of combining different methodologies, terminologies, and concepts from various fields, adding complexity to their work [6]. Given these challenges, AI has become an invaluable tool in academic writing. AI-powered writing assistants help with grammar, structure, citations, and adherence to disciplinary standards. These tools are not just helpful but central to improving the efficiency and quality of academic writing. They enable writers to focus on the critical and innovative aspects of their research [7]. Therefore, while academic writing can be challenging, AI tools greatly aid in this process, enhancing research productivity and improving work efficiency. This review highlights the major ways in which AI tools can assist in academic writing, demonstrating their importance in advancing knowledge, supporting productivity, and contributing to academic discourse [8].

## Methods

A systematic review was undertaken to evaluate the role of Artificial Intelligence (AI) in enhancing academic writing and research. The methodology involved four key steps. The first step included literature search. A comprehensive search was conducted across databases such as PubMed, Embase, and Google Scholar. Keywords including "artificial intelligence," "academic writing," and "research" were used to find articles published in English since 2019. This search focused on identifying peer-reviewed articles, review papers, and empirical studies that explored AI's application in academic writing and research. The second step was defining inclusion and exclusion criteria to refine search. Studies were included if they directly addressed AI's application in enhancing specific aspects of academic writing and/or research, such as assistance in writing, grammar improvement, structure optimisation, plagiarism detection, or citation assistance. Studies were excluded if they were not directly related to academic writing or lacked empirical
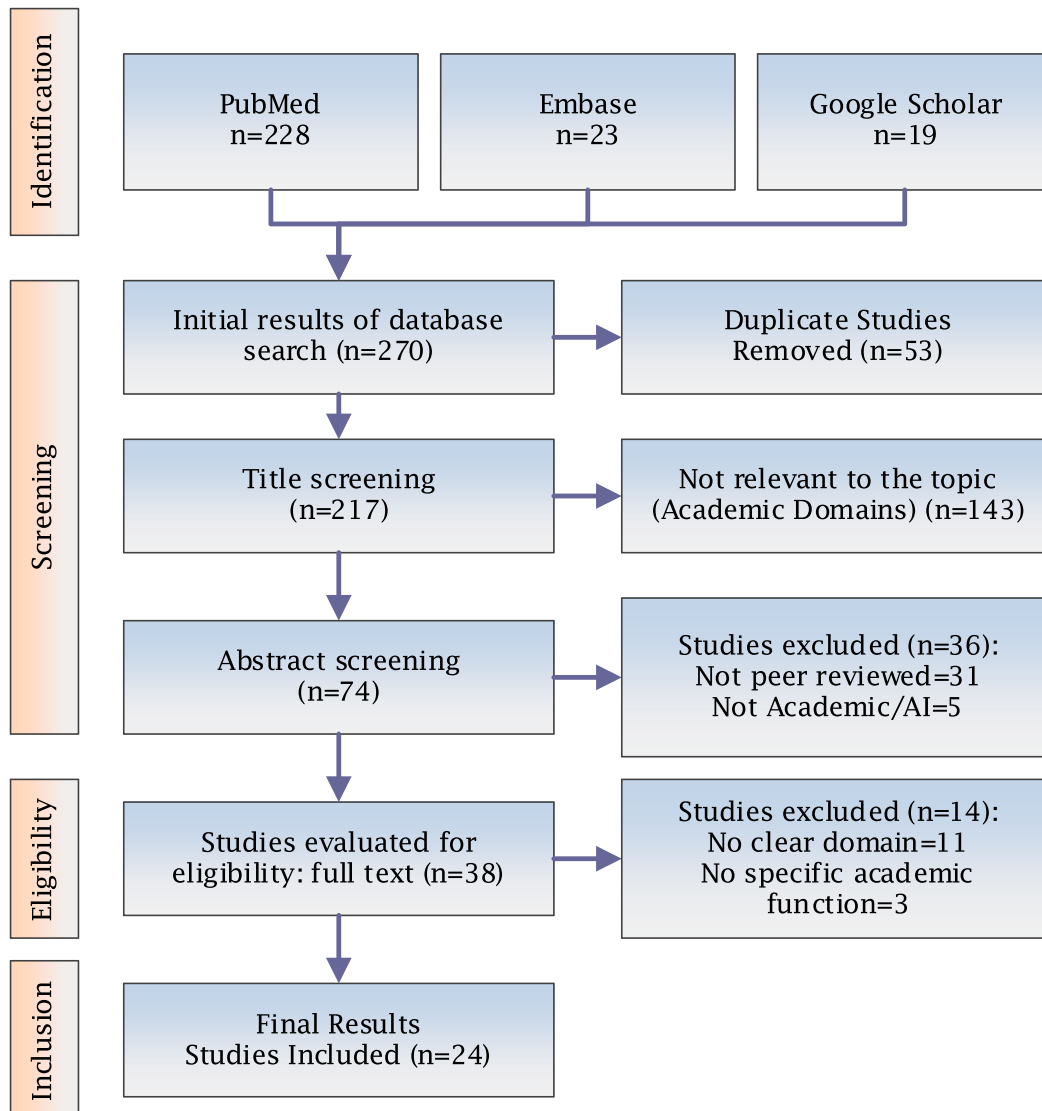


**Fig. 1.** PRISMA flowchart of study selection and inclusion process.

evidence or clear methodologies. Step three included data extraction and synthesis. Information was extracted from the identified studies regarding the study main AI focus, key findings, AI applications in academic writing or research, limitations, and recommendations. This data was then synthesised to identify domains where AI can support academic writing and research. The final step involved a detailed analysis of the extracted information to understand how AI can be used to support academic writing and research, the outcomes achieved, and potential areas for future application. This systematic approach was designed to rigorously assess the current state of AI in academic writing and identify avenues for further research and development.

## Results: the AI six academic domains

Searching PubMed, Embase, and Google Scholar, 270 papers were initially identified. After removing duplicates, 217 unique papers were identified. Applying the inclusion and exclusion criteria, 143 papers were excluded after title screening. Of the remaining 74 papers, only 38 studies were assessed for full-text eligibility after abstract screening. Finally, 24 studies, discussing the roles of AI in improving academic writing and research, were included in this review. Fig. 1 shows the study selection and inclusion processes.

Through careful examination and qualitative analysis, this review identified six core domains where AI significantly supports academic and research functions, each domain encompassing unique roles that collectively enhance the landscape of academic research and scholarship. The first domain, Idea Development and Research Design, demonstrates AI's prowess in supporting the generation of research ideas through brainstorming, spotting gaps in literature, and hypothesis suggestions. AI's adeptness in research planning, particularly in assisting study design, is a proof of its capability in shaping robust and thoughtful research methodologies [9,10]. The second domain, Content Development and Structuring, underscores AI's utility in crafting and organising academic content. AI facilitates writing assistance, encompassing text expansion, predictive text, and autocompletion, thereby enriching the writing process. Its role in structuring, through outlining and emotional tone analysis, and in integrating visual and multimedia elements like graphics and presentations, is pivotal in presenting research in a coherent and engaging manner [11–20]. In the third domain, Literature Review and Synthesis, AI's impact is evident in its ability to extract and analyse vast volumes of information, performing text extraction and semantic analysis. The synthesis of literature through AI, producing summary tables and comparative analyses, represents a revolutionary stride in automated literature synthesis, offering a comprehensive and nuanced perspective of existing research [9,10,18,20,21].

The fourth domain, Data Management and Analysis, highlights AI's proficiency in interpreting and managing data. Its capabilities in data interpretation, through detailed analysis and visualization, transform complex data sets into accessible insights. AI's role in dataset management, aiding in the creation and curation of datasets, underscores its importance in maintaining data integrity and facilitating efficient data analysis [22–27]. In the fifth domain, Editing, Review, and Publishing Support, AI emerges as a critical ally in refining academic writing, through proofreading, editing, and drafting abstracts. Its assistance in the publishing process, including managing peer review responses and manuscript tracking, is invaluable in the scholarly publication cycle [12, 13,15,18,20,21,25,28-31]. Finally, the sixth domain, Communication, Outreach, and Ethical Compliance, captures AI's role in disseminating research findings and ensuring ethical compliance. AI aids in tailoring content for diverse platforms, engaging audiences, and assuring research ethics, playing a crucial role in maintaining the integrity and outreach of academic research [9,11,15,16,20,25,28-33]. Table 1 shows the six domains where AI can support academic and research functions, Table 2 shows the analysis of the 24 included studies, and Table 3 shows the mapping the studies to the six AI academic domains. Fig. 2 shows the domains and functions while Fig. 3 shows AI contribution to the

**Table 1**

The six domains where AI can improve academic functions.

| SR | AI Academic Domain | AI Academic Functions |
|---|---|---|
| 1 | Idea Development and Research Design | Idea Generation (Brainstorming, Literature Gap Identification, Hypothesis Generation) Research Planning (Study Design Assistance) |
| 2 | Content Development and Structuring | Writing Assistance (Expanding Text, Predictive Text, and Autocompletion) Structuring (Outlining, Emotional Tone Analysis) Visual and Multimedia Integration (Graphics, Tables, Posters, Presentations) |
| 3 | Literature Review and Synthesis | Extracting and Analysing Information (Text Extraction, Semantic Analysis) Synthesising Literature (Summary Tables, Comparative Analysis, Automated Literature Synthesis) |
| 4 | Data Management and Analysis | Data Interpretation (Data Analysis Descriptions, Data Visualization) Dataset Management (Creating and Curating Datasets) |
| 5 | Editing, Review, and Publishing Support | Writing Refinement (Proofreading, Editing, Abstract and Summary Drafting) Publishing Assistance (Peer Review Responses, Manuscript Tracking, Letters to Editors, Peer Review Enhancement) |
| 6 | Communication, Outreach, and Ethical Compliance | Dissemination and Outreach (Content Tailoring, Social Media Engagement, Chatbots, Language Translation, Accessibility Features) Ethical and Integrity Assurance (Ethical Compliance, Plagiarism Detection, Research Ethics Risk Assessment) |

academic domains.

## AI tools for academic writing and research

The area of academic writing and research is increasingly supported by a variety of AI tools, each tailored to meet specific needs. Tools like Zotero, Mendeley, and EndNote are indispensable for literature management, efficiently organizing research materials, generating citations, and seamlessly integrating with word processors. However, these tools don't extend support to text generation or writing assistance. For enhancing writing quality, Grammarly and OpenAI's ChatGPT are pivotal, offering AI-driven grammar checks, plagiarism detection, and text generation capabilities, which are crucial for crafting clear and original academic content. Yet, they lack in providing data analysis or reference management features. Turnitin and Copyscape stand out in the domain of plagiarism detection, employing extensive databases to verify the originality of academic works. However, their functionalities are limited to plagiarism checking and do not encompass text processing or data analysis. In the sphere of data analysis, Tableau makes a significant impact by transforming complex data into visually comprehensible formats. Despite its strengths in data visualization, Tableau does not offer AI-generated content capabilities. Specialized AI tools like ArXiv and Semantic Scholar revolutionize the way researchers access and summarize relevant academic papers, keeping them abreast of the latest developments in their fields through AI-driven mechanisms. For qualitative data analysis, NVivo, MAXQDA, Leximancer, Quirkos, ATLAS.ti, and Dedoose are prominent, offering features like automated coding, sentiment analysis, and pattern identification in voluminous text data. Additionally, Provalis Research and RapidMiner amalgamate AI with text analytics, facilitating sophisticated qualitative analysis. Each of these tools, with their distinct AI integrations and functionalities, are selected based on the unique requirements of the research project, highlighting the diverse applications of AI in academic research and writing. Table 4 shows a comparative analysis of the most famous AI tools for academic writing and research.

**Table 2**

Analysis of the 24 included studies.

| SN | Authors & Year | Title | Main Focus | Key Findings | AI Applications in Academic Writing | Limitations | Recommendations |
|---|---|---|---|---|---|---|---|
| 1 | Májovský et al., 2023 | Artificial Intelligence Can Generate Fraudulent but Authentic-Looking Scientific Medical Articles: Pandora's Box Has Been Opened | AI's potential in creating fraudulent scientific papers | AI can create convincing fraudulent articles with concerns in references | Raises questions about integrity in scientific research | Expert review needed to identify inaccuracies | Vigilance and better detection methods against AI misuse in research |
| 2 | Huang & Tan, 2023 | The role of ChatGPT in scientific communication: writing better scientific review articles | ChatGPT's role in enhancing efficiency and quality of scientific review articles | ChatGPT improves efficiency and quality in writing, with limitations in plagiarism and fabrication | Assists in developing outlines, details, and improving style | Generated text must be reviewed and edited to avoid plagiarism and fabrication | Careful and ethical use of ChatGPT in writing recommended |
| 3 | Dergaa et al., 2023 | From human writing to artificial intelligence generated text: examining the prospects and potential threats of ChatGPT in academic writing | The impact of ChatGPT on academic writing and research publications | ChatGPT enhances efficiency but raises authenticity concerns | Potential to enhance academic writing and research efficiency | Ethical considerations and importance of human intelligence in research | Comprehensive discussions on the use, threats, and limitations of AI tools |
| 4 | Currie et al., 2023 | ChatGPT in medical imaging higher education | AI's impact on academic integrity in medical imaging education | ChatGPT performed below average in complex tasks, better in basic tasks. Potential risks and benefits identified. | Limited use in student cheating, introduces errors, identified as AI-generated. | Use constrained by higher order taxonomies. | Enhanced learning environments, awareness of risks. |
| 5 | Eggmann et al., 2023 | Implications of large language models such as ChatGPT for dental medicine | LLMs in dental medicine | LLMs offer potential for clinical support, but with risks of misinformation. | Assist in clinical decision support, text summarization, efficient writing, multilingual communication. | Challenges in patient data confidentiality and cybersecurity. | Careful consideration of limitations and potential risks in dental medicine. |
| 6 | Švab et al., 2023 | New Challenges in Scientific Publications: Referencing, Artificial Intelligence and ChatGPT | AI's role in scientific writing and referencing | AI makes scientific writing easier and less time-consuming, leading to potential quality improvement. | Tools for searching, analysing, and writing scientific literature powered by AI. | Need for careful and ethical use of AI tools. | Enhancing and streamlining the scientific publishing process with AI. |
| 7 | Meyer et al., 2023 | ChatGPT and large language models in academia: opportunities and challenges | Opportunities and challenges of LLMs in academia | LLMs like ChatGPT can improve academic work efficiency but raise ethical concerns. | Improve academic work efficiency, but their fair use and inherent bias must be considered. | Caution regarding accuracy and bias. | Effective use of LLMs and chatbots in academia, quantifying bias, and ensuring accuracy. |
| 8 | Şendur et al., 2023 | ChatGPT from radiologists' perspective | ChatGPT's potential role in clinical decision support and academic writing | Highlights the potential roles of ChatGPT in clinical decision support and academic writing. | Potential use in clinical decision support and academic writing. | Intense criticism in the scientific community. | Familiarization with LLMs like ChatGPT in radiology. |
| 9 | Sharma et al., 2023 | ChatGPT in Plastic and Reconstructive Surgery | ChatGPT's use in plastic surgery | ChatGPT assists in creating academic literature and aiding research, with concerns in accuracy. | Assisting in manuscript preparation, healthcare communication, and education. | Accuracy concerns and data privacy implications. | Awareness of ChatGPT's shortcomings, potential for productivity improvement in surgery. |
| 10 | Giglio & Costa, 2023 | The use of artificial intelligence to improve the scientific writing of non-native English speakers | AI's role in aiding non-native English speakers in scientific writing | AI can significantly aid in improving the clarity, style, and coherence of scientific writing. | Assisting in manuscript preparation, especially for non-native English speakers. | Reliance on AI for language correction and writing improvement. | Enhancing communication of research by non-native English-speaking scientists. |
| 11 | Lee & Choi, 2023 | Utilising ChatGPT in clinical research related to anesthesiology: a comprehensive review of opportunities and limitations | ChatGPT's role in clinical research | ChatGPT can aid in identifying research topics and proofreading but has limitations due to AI hallucination symptoms and training data constraints. | Assisting in identifying research topics and proofreading English writing and scripts. | Limitations for widespread use in clinical research due to inaccuracies. | Caution in using ChatGPT for scientific writing in traditional journals. |
| 12 | Lubowitz, 2023 | Guidelines for the Use of Generative Artificial Intelligence Tools for Biomedical Journal Authors and Reviewers | Guidelines for AI use in scientific writing | Authors can use AI to improve writing but must ensure accuracy and originality. AI cannot be cited as an author. | Enhancing readability of authors' own writing. | Prohibition of AI use for creating or altering images or videos; AI use by reviewers. | Transparency in AI use, with guidelines for ethical use in manuscript writing. |

**Table 2** (*continued*)

| SN | Authors & Year | Title | Main Focus | Key Findings | AI Applications in Academic Writing | Limitations | Recommendations |
|----|----|----|----|----|----|----|----|
| 13 | Khlaif et al., 2023 | The Potential and Concerns of Using AI in Scientific Research: ChatGPT Performance Evaluation | Evaluating ChatGPT's performance in scientific research | ChatGPT can generate high-quality research but has minor impact on research framework and data analysis. | Enhancing human productivity in research and academic writing. | Concerns around ownership, integrity, and reliance on AI-generated text. | Focus on methodology and practical implications of research in the era of AI. |
| 14 | Salimi & Saheb, 2023 | Large Language Models in Ophthalmology Scientific Writing: Ethical Considerations Blurred Lines or Not at All? | Ethical considerations of LLMs in ophthalmology research | LLMs can guide researchers in various stages but pose significant ethical concerns. | Guiding researchers in various stages of research. | Ethical dilemmas related to scientific integrity. | Development of guidelines for ethical use in manuscript writing. |
| 15 | Sonntagbauer et al., 2023 | [Artificial intelligence: How will ChatGPT and other AI applications change our everyday medical practice?] | AI's potential impact on everyday medical practice | AI applications like ChatGPT could significantly change medical practice, with various applications and potential risks. | Diagnostics support system, medical documentation, and research support. | Risk of spreading inaccuracies and bias, need for regulation. | Evaluation of AI technology and assessment of opportunities and risks. |
| 16 | Shur et al., 2021 | Radiomics in Oncology: A Practical Guide | Applications of radiomics in oncology | Radiomics improves diagnosis, prognostication, and clinical decision support, with a guide for implementing a radiomic workflow. | Guide for radiomic workflow implementation in oncology. | Complex workflow, inadequate reporting, and poor reproducibility. | Familiarization with potential pitfalls to ensure meaningful conclusions in radiomics. |
| 17 | Ghorashi et al., 2023 | AI-Powered Chatbots in Medical Education: Potential Applications and Implications | Chatbots in medical education | Chatbots can enhance students' comprehension and retention, serve as tutors and medical references. | Use in learning, research, creation of memory aids, and as interactive tutors. | Dependence on chatbots and ensuring content adheres to medical science standards. | Use chatbots as assistive tools, ensure precision and adherence to scientific and ethical standards. |
| 18 | Giray, 2023 | Prompt Engineering with ChatGPT: A Guide for Academic Writers | The significance of prompt engineering for academic writers | Highlights the significance of prompt engineering in utilising language models for academic writing. | Enhancing academic writing process through effective prompt engineering. | Lack of familiarity with prompt engineering among writers and researchers. | Advocates for acquiring prompt engineering skills to effectively utilize language models. |
| 19 | Semrl et al., 2023 | AI language models in human reproduction research: exploring ChatGPT's potential to assist academic writing | AI's role in human reproduction research | ChatGPT can produce high-quality text and summarize information but has limited ability to interpret data and answer scientific questions. | Assisting in academic writing and summarising information. | Limited ability to interpret data and perform literature searches; risk of spreading misinformation. | Open discussions in reproductive medicine research to explore AI advantages and disadvantages. |
| 20 | Tang et al., 2023 | The importance of transparency: Declaring the use of generative artificial intelligence (AI) in academic writing | Transparency in declaring AI use in research writing | Emphasises the need for explicitly declaring the use of generative AI in manuscripts. | Encourages declaring generative AI tool usage in manuscripts. | Not all journals require explicit statements about generative AI use. | Recommends journals to include requirements for AI usage declarations in their guidelines. |
| 21 | Laios et al., 2023 | The Future of AI in Ovarian Cancer Research: The Large Language Models Perspective | AI's potential in ovarian cancer research | LLMs can condense results and optimize analysis time in ovarian cancer research. | Development of task-specific and domain-specific language models for ovarian cancer research. | Need for a bespoke, ovarian cancer-specific natural language model. | Focus on in-domain text for AI language models in ovarian cancer research. |
| 22 | Garg et al., 2023 | Exploring the role of ChatGPT in patient care (diagnosis and treatment) and medical research: A systematic review | ChatGPT's role in patient care and medical research | ChatGPT can be a clinical assistant and aid in research but has accuracy and bias concerns. | Assisting in patient treatment, research, and scholarly writing. | Accuracy, authorship, and bias issues in using ChatGPT. | Use ChatGPT cautiously in patient care and medical research. |
| 23 | Kocak et al., 2023 | CheckList for EvaluAtion of Radiomics research (CLEAR): a step-by-step reporting guideline for authors and reviewers endorsed by ESR and EuSoMII | Radiomics research reporting guidelines | Provides a checklist for planning, writing, and reviewing radiomic studies to ensure reproducibility. | As standardization tool providing minimum requirements for presenting clinical radiomics research. | Complex workflow and nuances in radiomics leading to poor reproducibility. | Use of CLEAR checklist as a guide for authors and reviewers to improve the radiomics literature. |
| 24 | Ingley & Pack, 2023 | Leveraging AI tools to develop the writer rather than the writing | AI's potential to improve scientific writing skills | AI tools, guided by second-language acquisition principles, can improve scientific writing. | Assisting scientists, especially non-native English speakers, in improving their writing skills. | Challenges in scientific writing for non-native English speakers. | Utilize AI tools in accordance with second-language acquisition principles for writing improvement. |

**Table 3**
Mapping the 24 studies to the six AI academic domains.

| SN | Authors and Year | Domain 1: Idea Development and Research Design | Domain 2: Content Development and Structuring | Domain 3: Literature Review and Synthesis | Domain 4: Data Management and Analysis | Domain 5: Editing, Review, and Publishing Support | Domain 6: Communication, Outreach, and Ethical Compliance |
|---|---|---|---|---|---|---|---|
| 1 | Májovský et al., 2023 | – | Writing Assistance | – | – | – | Ethical and Integrity Assurance |
| 2 | Huang & Tan, 2023 | – | Writing Assistance | – | – | Writing Refinement | – |
| 3 | Dergaa et al., 2023 | Idea Generation | – | Extracting & Analysing Information | – | – | Ethical and Integrity Assurance |
| 4 | Currie et al., 2023 | – | – | – | Data Interpretation | – | – |
| 5 | Eggmann et al., 2023 | – | – | – | – | Writing Refinement | Ethical and Integrity Assurance |
| 6 | Švab et al., 2023 | – | – | Extracting & Analysing Information | – | Publishing Assistance | – |
| 7 | Meyer et al., 2023 | – | – | – | – | – | Ethical and Integrity Assurance |
| 8 | Şendur et al., 2023 | – | – | – | – | – | – |
| 9 | Sharma et al., 2023 | – | Writing Assistance, Visual and Multimedia Integration | – | – | Writing Refinement | Dissemination and Outreach |
| 10 | Giglio & Costa, 2023 | – | Writing Assistance | – | – | Writing Refinement | – |
| 11 | Lee & Choi, 2023 | – | Writing Assistance | – | – | – | – |
| 12 | Lubowitz, 2023 | – | – | – | – | Publishing Assistance | Ethical and Integrity Assurance |
| 13 | Khlaif et al., 2023 | – | Writing Assistance | Extracting & Analysing Information | – | Writing Refinement | Ethical and Integrity Assurance |
| 14 | Salimi & Saheb, 2023 | – | – | – | – | – | Ethical and Integrity Assurance |
| 15 | Sonntagbauer et al., 2023 | – | – | – | – | Writing Refinement | Dissemination and Outreach, Ethical and Integrity Assurance |
| 16 | Shur et al., 2021 | – | – | – | Data Interpretation | – | – |
| 17 | Ghorashi et al., 2023 | – | Writing Assistance | – | – | – | Dissemination and Outreach |
| 18 | Giray, 2023 | – | Writing Assistance | – | – | – | – |
| 19 | Semrl et al., 2023 | – | Writing Assistance | Extracting & Analysing Information | – | Writing Refinement | – |
| 20 | Tang et al., 2023 | – | – | – | – | Publishing Assistance | Ethical and Integrity Assurance |
| 21 | Laios et al., 2023 | – | – | – | Data Interpretation | – | – |
| 22 | Garg et al., 2023 | – | – | – | Data Interpretation | Writing Refinement | Dissemination and Outreach |
| 23 | Kocak et al., 2023 | – | – | – | Data Interpretation | – | – |
| 24 | Ingley & Pack, 2023 | – | Writing Assistance | – | – | – | – |

## Discussion and detailed analysis

### Domain 1: idea development and research design

In the dynamic field of academic and scientific research, the integration of AI in idea development and research design is proving to be transformative. Beginning with idea generation, AI algorithms significantly enrich brainstorming processes by providing insights derived from current trends, historical data, and cross-disciplinary studies [10]. For instance, AI might identify a gap in research related to the long-term impact of new insulin analogues on different age groups. This insight could steer the research team towards investigating how these insulin types affect elderly diabetic patients differently from younger ones, an area that might be underexplored [34]. Furthermore, AI's capability to identify gaps in literature is invaluable. Through advanced natural language processing, it can scrutinize thousands of documents, revealing overlooked or under-researched areas. In neurology, for example, AI might highlight the scant research on the long-term effects of certain

nootropic drugs [35]. Moreover, AI's role in hypothesis generation is pivotal. It utilises existing data to predict potential correlations or causal relationships, aiding in the formulation of robust hypotheses. For instance, in health research, AI can forecast the effectiveness of new treatments based on patient data trends. The impact of AI extends to Research Planning as well. It offers critical guidance in study design, recommending methodologies that align best with the research question. In studies examining the psychological impacts of virtual learning, AI might advocate for a mixed-method approach for comprehensive insights [36].

AI also optimises experimental designs, suggesting appropriate sample sizes and statistical methods for more accurate results. For example, in behavioural economics, AI could propose experimental setups that accurately gauge consumer behaviour under varied economic conditions [37]. Additionally, in fields like epidemiology, AI tools aid in creating predictive models and simulations, facilitating the planning of studies around these models. This ensures that research is not only relevant but also anticipates future trends and scenarios [38].
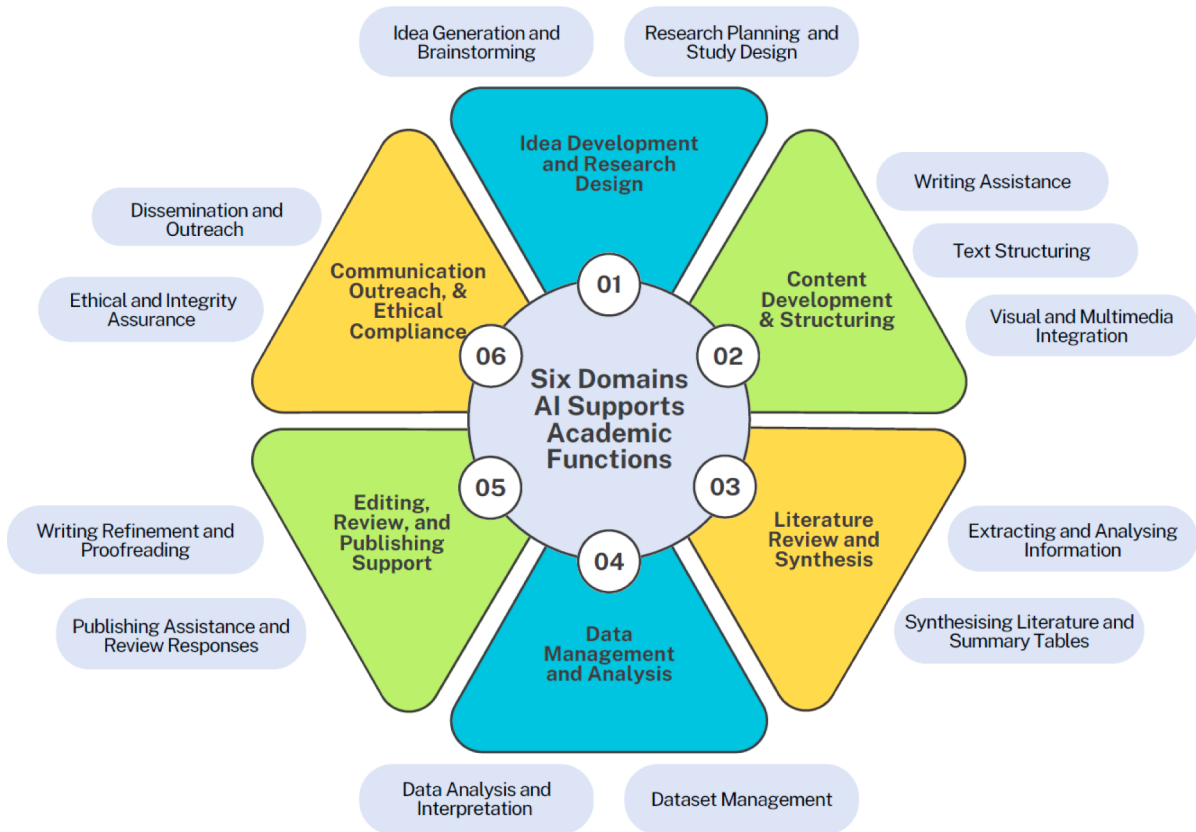
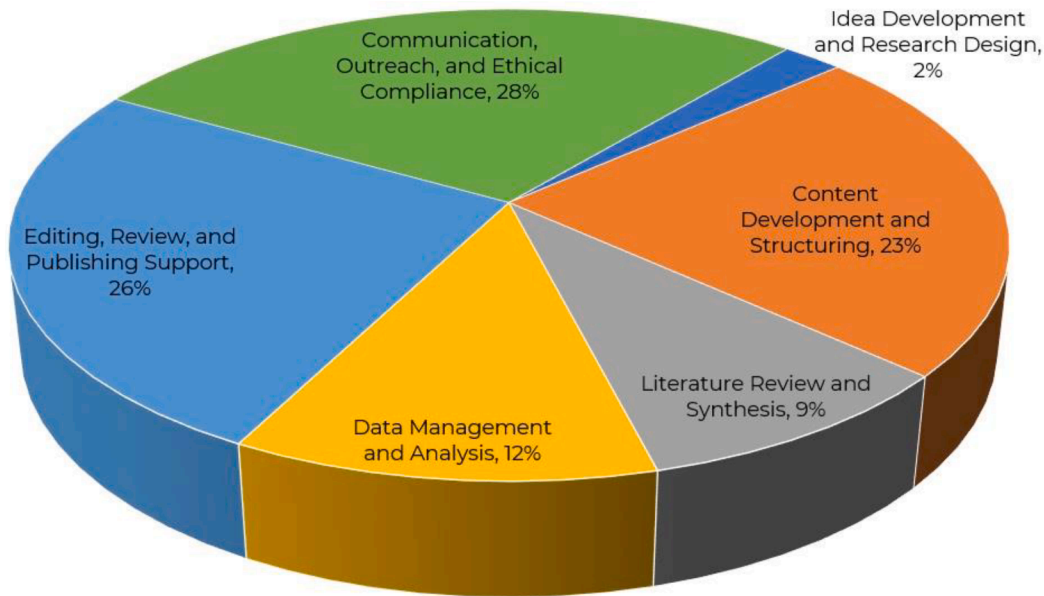**Fig. 2.** The six domains where AI can improve academic functions.



**Fig. 3.** AI potential contribution to academic domains.

However, despite the potential to enhance academic writing and research productivity, major ethical considerations are identified, such as the importance of human intelligence in research and the limitations that AI tools might enforce in guiding research ideas and design. AI tools could mislead the research and researchers to unintended areas or deviate from the target objective of the research. Accordingly, comprehensive discussions on the use, threats, and limitations of AI should be conducted before effectively relying on AI to support this specific area of developing ideas or designing research [9].

A case study from Editage Insights shows the integration of AI in academic research. It explores how AI tools enhance writing, data analysis, literature review, and research planning. The study emphasizes AI as a supportive mechanism, improving efficiency while maintaining the need for human creativity and critical thinking in research processes. This reflects AI's growing importance in optimizing academic workflows [39].

**Table 4**

Comparison of AI tools for academic writing and research.

| Feature/tool | Literature management | Writing assistance | Plagiarism detection | Data analysis | Specialized AI features |
|---|---|---|---|---|---|
| Zotero/Mendeley | Yes | No | No | No | No |
| EndNote | Yes | No | No | No | No |
| Grammarly | No | Yes | Yes | No | No |
| ChatGPT (OpenAI) | No | Yes | No | No | Yes |
| Turnitin | No | No | Yes | No | No |
| Copyscape | No | No | Yes | No | No |
| Tableau | No | No | No | Yes | No |
| ArXiv/Semantic Scholar | No | No | No | No | Yes |
| NVivo | No | No | No | No | Yes |
| MAXQDA | No | No | No | No | Yes |
| Leximancer | No | No | No | No | Yes |
| Quirkos | No | No | No | No | Yes |
| ATLAS.ti | No | No | No | No | Yes |
| Dedoose | No | No | No | No | Yes |
| Provalis Research | No | No | No | Yes | Yes |
| RapidMiner | No | No | No | Yes | Yes |

*Domain 2: content development and structuring*

In the second domain of Content Development and Structuring, AI plays a critical role in enhancing the quality and efficiency of creating and organising research content [13,14,16-18,20]. AI tools excel assisting the writing through in expanding text, offering predictive text capabilities, and providing autocompletion features, significantly aiding in the drafting process. For instance, AI tools such as ChatGPT can significantly improve the efficiency and quality of writing scientific review articles. This is particularly useful for expanding text, developing outlines, and enhancing writing style [12]. Moreover, AI tools can suggest extensions to preliminary findings and discussion sections, helping researchers articulate complex data in a more understandable manner. Predictive text capabilities are particularly useful in academic writing, where AI can anticipate and suggest technical terms streamlining the writing process [8]. However, caution should be considered about the potential misuse of AI in generating fraudulent scientific articles, highlighting the need for vigilance in maintaining academic integrity [11].

Structuring research content is another critical aspect where AI contributes significantly. AI can assist in outlining a document, ensuring logical flow and coherence. For example, in a public health policy document, AI can suggest an optimal structure that begins with an introduction to the health issue, followed by a review of existing policies, analysis of new data, and concluding with policy recommendations. Furthermore, AI's Emotional Tone Analysis is vital in tailoring the content's tone to the target audience [23]. In a grant proposal, AI can analyze the tone to ensure it is persuasive and compelling, increasing the chances of funding approval [28]. Visual and Multimedia Integration is where AI's impact is markedly innovative. AI can help integrate graphics, tables, posters, and presentations into research content, enhancing its visual appeal and comprehensibility. For example, AI can generate infographics that visually represent data trends, making complex information more accessible to a broader audience [15]. While AI tools streamline the content development process, it's essential to maintain transparency in AI usage to uphold the credibility and integrity of academic writing. This synergy between AI and research communications is becoming increasingly indispensable in the evolving landscape of healthcare and scientific research [19,31].

A study by Mohamed Hammad found that AI tools significantly impacted the writing of scientific research, enhancing efficiency and quality. Similarly, Robert F. J. Pinzolits' study revealed AI's pivotal role in academia, particularly in improving learning and teaching through advanced AI tools and chatbots [40,41].

*Domain 3: literature review and synthesis*

In the domain of Literature Review and Synthesis, AI's integration is pivotal, enhancing the efficiency and depth of academic research. AI facilitates the extraction and analysis of information from existing literature, synthesising these findings into coherent overviews This role is invaluable, as AI tools process and analyse extensive data volumes, aiding in creating detailed and current literature reviews. While this integration streamlines research and ensures methodological soundness, careful monitoring is essential to maintain academic integrity and rigor [9,18,20,21]. For instance, AI's ability to perform text extraction and semantic analysis is crucial in handling the vast amounts of data present in scientific literature. AI tools, such as ChatGPT, has the capacity to analyse large sets of data and generate high-quality content, albeit with a need for careful oversight to prevent the production of fraudulent material. This capacity for data handling is essential in identifying trends, gaps, and emerging themes in each field [11].

Synthesising literature is another critical aspect where AI significantly contributes. AI can extract data and information elements, from abstracts and full text of studies, to create summary tables and perform comparative analyses, greatly aiding researchers in understanding and communicating complex information [42]. For example, AI tools such as ChatGPT can be instrumental in writing review articles, helping to develop comprehensive overviews of existing research [12]. Similarly, many potential benefits of AI in academic writing can be highlighted, including the efficient synthesis of literature, while also emphasising the need for ethical considerations and the maintenance of research authenticity [9]. However, it's important to approach the use of AI in literature synthesis with caution, especially in the area of academic integrity when it comes to the depth and accuracy of the synthesised content [23].

A case study from the "Nature Reviews Urology" titled "Artificial intelligence in academic writing: a paradigm-shifting technological advance" explored AI's transformative impact on academic writing. It highlighted AI's role in enhancing the efficiency and depth of literature review and synthesis in academic research [7].

*Domain 4: data management and analysis*

In the fourth domain of Data Management and Analysis, AI significantly enhances the handling and interpretation of complex datasets, pivotal for research integrity and success. It encompasses crucial aspects like Data Interpretation, where AI provides detailed analyses and visualizations, and Dataset Management, automating data curation for accuracy and accessibility. Essential in modern research, AI boosts efficiency, accuracy, and depth in data analysis. This not only streamlines research processes but also unlocks new discovery avenues by

offering profound insights and managing large-scale data. However, continual monitoring is necessary to maintain data integrity and ethical standards [23–27].

Data Interpretation, a critical component of this domain, involves AI's ability to provide detailed descriptions and visualizations of data. For instance, in the context of medical imaging education, AI tools can analyse and interpret complex data, providing insights that might not be immediately apparent through conventional analysis methods [23]. Similarly, in radiomics research, AI can extract and interpret intricate patterns from medical images, which is essential for accurate disease diagnosis and prognosis assessment [26]. AI's role in data interpretation is not only about handling large data volumes but also about providing nuanced insights that can lead to more informed decisions and discoveries [24].

Dataset Management, the other pillar of this domain, involves creating and curating datasets efficiently. This aspect is particularly important in fields like epidemiology, where managing extensive datasets is a routine task. AI can automate the process of data curation, ensuring data is accurate, up-to-date, and readily accessible for analysis [43]. For instance, AI tools can be used to compile and manage data for a systematic review, demonstrating how AI can streamline data management in complex research projects [25].

One case study, On the use of AI-based tools like ChatGPT to support management research, was presented by Emerald Insight and examined AI's integration in research, particularly in data classification, image analysis, and emotion analysis. It highlighted AI's significant role in systematic literature reviews, providing guidance on applying AI throughout the research process, and emphasizes the need for meticulous documentation to maintain research integrity and reliability [44]. Another case study was presented by Dida et al. (2023), where they examined the role of ChatGPT in enhancing the conversion of text to speech. The ChatGPT showed a superior performance of processing and converting text to speech, especially in big data [45].

*Domain 5: editing, review, and publishing support*

The fifth domain, Editing, Review, and Publishing Support, is integral to the research process, ensuring the clarity, coherence, and quality of academic output. This domain can be broadly categorised into Writing Refinement and Publishing Assistance, each playing a vital role in the journey from manuscript drafting to publication. Writing Refinement involves enhancing the textual quality of manuscripts, where AI tools are increasingly used for proofreading and editing. AI-driven software like ChatGPT, Grammarly, and Paperpal can correct grammatical errors and improve writing style, especially beneficial for non-native English speakers [13]. These tools help refine the language, making manuscripts clearer and more concise, which is crucial for conveying complex scientific ideas effectively. Additionally, AI can assist in drafting abstracts and summaries, ensuring that the key findings and implications of research are communicated succinctly and accurately [3,7].

Publishing Assistance encompasses a broader range of services facilitated by AI, including peer review responses, manuscript tracking, and enhancing peer review processes. For instance, it important that the authors disclosing the use of AI tools in their manuscripts, which highlights the growing role of AI in scientific writing and the need for transparency in its use [29]. Furthermore, AI can be instrumental in managing peer review responses, helping authors address reviewers' comments more efficiently and effectively, which is critical in the iterative process of manuscript revision and resubmission [31].

In the context of academic publishing, AI's impact is transformative. It not only streamlines the writing and editing process but also facilitates various aspects of the publishing workflow, from managing peer review feedback to tracking manuscript progress. This integration of AI in Editing, Review, and Publishing Support ensures that research outputs are not only of high quality but also align with the evolving standards and expectations of the academic community. However, it is crucial to use these tools ethically and transparently, maintaining the integrity and originality of scientific research [9,11,20,28-30,32,33].

The same case study titled "Artificial intelligence in academic writing: a paradigm-shifting technological advance" highlighted AI's role in enhancing manuscript quality, especially for non-native English speakers, and emphasizes AI's growing integration in editing and reviewing processes for research outputs [7].

*Domain 6: communication, outreach, and ethical compliance*

The sixth domain, focusing on Communication, Outreach, and Ethical Compliance, plays a critical role in both spreading research findings and upholding ethical standards in today's digital world. It covers two key areas: Dissemination and Outreach, and Ethical and Integrity Assurance. These areas tackle distinct challenges faced in modern research environments. This domain emphasises the need for effective communication of research to a varied audience, maintaining a commitment to ethical principles. AI tools are instrumental in this domain, enhancing outreach and ensuring ethical conduct in research. Nonetheless, it's essential to strike a balance between utilising these sophisticated tools and ensuring transparency, ethical responsibility, and the preservation of the human aspect in scientific discourse and decision-making [9,11,15,16,20,25,28-33].

Dissemination and Outreach involve leveraging AI to tailor content for different audiences and platforms, enhancing social media engagement, and facilitating language translation and accessibility. For instance, AI chatbots can be programmed to interact with diverse audiences, making complex scientific concepts more accessible, such as in medical education [16]. This aspect of AI is particularly valuable in reaching a broader audience, including non-specialists, through platforms like social media, blogs, or webinars. Moreover, AI's capability in language translation breaks down linguistic barriers, making research globally accessible and fostering international collaboration [18,32,33].

Ethical and Integrity Assurance focuses on maintaining the ethical use of AI tools in research. This includes ensuring ethical compliance, detecting plagiarism, and assessing research ethics risks. For example, the ethical implications of AI tools like LLMs in academia must be critically evaluated to maintain scientific integrity [32]. This involves transparent disclosure of AI usage in research publications to preserve the authenticity and credibility of scientific work [31]. Moreover, AI tools can assist in plagiarism detection, an essential aspect of academic integrity, ensuring that the research is original and appropriately credited [12,32].

A case study, Integrating Ethics in AI Development, was presented by BMC Medical Ethics examined ethical challenges in AI healthcare development. Part of the Swiss "EXPLaiN" program, it uses interviews with diverse AI experts to explore practical ethical issues, emphasizing the need for purposeful AI development and application in healthcare [46].

*Role of AI in interdisciplinary research*

AI holds immense potential to revolutionise and streamline interdisciplinary research, acting as a bridge between diverse fields. Its advanced data analysis capabilities enable it to uncover patterns and correlations that might be invisible to human researchers, thereby fostering new insights and theories. AI can process and synthesize vast amounts of information from different disciplines, helping researchers in one field to utilize findings from another, leading to innovative solutions [37]. For instance, AI's ability to analyze complex biological data can aid advancements in medical research by integrating findings from genetics, bioinformatics, and pharmacology. Additionally, AI-driven tools encourage collaborative research by providing platforms for sharing data and insights, breaking down silos that often exist between disciplines. This interconnected approach can lead to groundbreaking

discoveries, as AI's comprehensive analysis can reveal novel applications of existing knowledge, potentially leading to breakthroughs in areas like sustainable energy, healthcare, and materials science. AI's role in interdisciplinary research is not just a facilitator of data analysis, but also a catalyst for creative problem-solving and idea generation across boundaries [47,48]. Moreover, the position paper of the Philippine Association of Medical Journal Editors on the ethical use of AI in publication focused on accuracy, transparency, authorship, bias, and maintaining peer review integrity. Guidelines emphasised AI's supportive role in research and publishing, ensuring reliability and accountability in AI-assisted scientific literature [49].

## Conclusion and recommendations

Artificial Intelligence (AI) represents and essential productivity tool which substantially revolutionises academic writing and research across six domains, as identified in this review. These include Idea Development and Research Design, Content Development and Structuring, Literature Review and Synthesis, Data Management and Analysis, Editing, Review, and Publishing Support, and Communication, Outreach, and Ethical Compliance. AI transforms idea development and research design by providing valuable insights and optimising methodologies. It enhances content quality through writing assistance and emotional tone analysis. In literature review and data management, AI's ability to process large data sets ensures comprehensive analysis and integrity. AI also streamlines the publishing process and supports ethical compliance in research dissemination.

Given these findings, several key recommendations emerge. Firstly, it is imperative for academic institutions and researchers to integrate AI tools more comprehensively into their research workflows to fully exploit their benefits. This integration should not only be widespread but also deep, ensuring that all facets of academic work are touched by AI's transformative capabilities. Secondly, the ethical and transparent use of AI is paramount. Researchers must commit to using these tools in a manner that upholds the integrity and originality of their work, avoiding any misuse that could undermine academic standards. Thirdly, there is a pressing need for adequate training and adaptation periods. These are essential for researchers to become proficient in effectively utilising AI tools, thereby maximising their potential in academic work. Furthermore, a careful balance must be achieved between the utilization of AI and human insight, especially in areas like idea generation and research design. This balance is crucial to ensure that while AI brings efficiency and analytical power, the creativity and critical thinking inherent in human intelligence are not overshadowed. Lastly, the landscape of AI in academia is ever-evolving, necessitating continued research and development. This ongoing exploration is vital to refine these tools, address emerging challenges, and consider ethical implications, ensuring that AI remains a dynamic and beneficial force in academic research and writing.

Future research directions include developing advanced AI tools for hypothesis formulation and predictive analysis, establishing ethical frameworks for AI use, exploring optimal human-AI collaboration models, investigating AI's role in interdisciplinary research, enhancing AI's impact on data management, analysis, editing, review, and publishing processes, and examining AI's influence on communication and outreach. Ongoing exploration is vital to address challenges, refine tools, and ensure ethical AI application in academia.

## Declaration on the use of AI in the writing process

The authors of this manuscript declare that in the writing process of this work, no generative artificial intelligence (AI) or AI-assisted technologies were used to generate content, ideas, or theories. We utilised AI solely for the purpose of enhancing readability and refining language. This use was under strict human oversight and control. After the application of AI technologies, the authors carefully reviewed and edited the manuscript to ensure its accuracy and coherence. The authors understand the potential of AI to generate content that may sound authoritative yet might be incorrect, incomplete, or biased. Considering this, the authors ensured that the manuscript was thoroughly revised by human eyes and judgment. In line with Elsevier's Authorship Policy, the authors confirm that no AI or AI-assisted technologies have been listed as an author or co-author of this manuscript. The authors fully comprehend that authorship comes with responsibilities and tasks that can only be attributed to and performed by humans, and authors have adhered to these guidelines in the preparation of this manuscript.

## CRediT authorship contribution statement

**Mohamed Khalifa:** Writing – review & editing, Writing – original draft, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Mona Albadawy:** Writing – original draft, Methodology, Formal analysis, Conceptualization.

## Declaration of competing interest

The authors declare no conflicting interests to declare, regarding the publication of this manuscript.

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