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Bibliometric analysis of author count, funding, and citations in AI research

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ABSTRACT

The academic community places significant emphasis on publishing research in SCI and SSCI journals, which are known for their credibility, high quality, and strong reputations. Most research requires significant investment in human resources and equipment, making the acquisition of research funding crucial. Understanding the motivation behind authorship and its association with citation patterns in SCI and SSCI journals represents a significant research concern in bibliometric studies. This study identifies the relationship among author number, research funding, and citation count using content analysis techniques, including the chi-square and analysis of variance tests. Investment in AI research, development, and applications is increasing; thus, this study examines 4488 articles published in the field of artificial intelligence (AI) from Springer in 2018. The empirical results indicate that (1) the average number of authors is highest in Q1 journals, with non-single-author papers being more common than single-author papers and concentrated in higher rankings; (2) papers with research funding are more common than those without; (3) papers with citations are more frequent than those without; (4) the ranking of papers with research funding and citations is higher than that of other papers without funding; and (5) the average citation count of papers with research funding leads in Q1 and is higher than in other rankings. This study is the first attempt at highlighting papers in the field of AI from Springer. The results and important findings provide useful references for researchers, reviewers, publishers, and interested parties with different purposes for academic and technical publications with sustained success. This study uniquely integrates four dimensions—author count, research funding, journal ranking, and citation count—to offer novel insights into academic publishing performance in the AI field.

1. Introduction

Scientific research occupies a central position in a knowledge society, not only driving technological innovation but also promoting economic and social development. The knowledge created by universities and research institutions is crucial for science-based industries (Fleming et al., 2019; Poege et al., 2019), and considerable attention is given to the ways in which scientific knowledge is produced and the role of public funding in the process (Hausman, 2022). Public research funding is applied to stimulate innovation in the hope that the funds can effectively promote scientific progress and social return (Froumin & Lisyutkin, 2015; Oancea, 2019). However, attempts at evaluating the actual impact of research funding on research outcomes face many challenges, including the non-randomness of the funding process, the possibility that researchers may receive multiple grants simultaneously, and the difficulty of choosing appropriate measures for research output. Academic research is the cornerstone of societal and civilizational progress, and research published in trusted, high-quality journals and with a notable reputation in the science citation index (SCI) and social science citation index (SSCI) is highly valued. However, conducting research is both cumbersome and time-consuming, requiring the attention of top collaborating scholars and research funding support. As a

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result, research activities are typically costly. Adequate funding is essential for hiring professionals, expanding facilities, and enabling cross-disciplinary collaboration (Ebadi & Schiffauerova, 2016; Gulbrandsen & Smeby, 2005) to ensure sustainability.

Publishing research results in journals requires not only extensive and in-depth research work but also sufficient funding support to ensure that the research has quality and depth. Therefore, actively seeking diverse sources of research funding support becomes crucial, including academic institutions, government funding programs, and corporate co-sponsorships. Scholars must thus not only possess excellent research capabilities, but also the ability to accurately identify and apply for suitable funding by understanding the application requirements and standards of different funding institutions. The allocation of research funding usually depends on the importance of the research topic and field (Wu et al., 2015), and applying for research funding often requires meeting the relevant conditions and standards of different institutions or countries. Prominent sources of academic research funding include the European Research Council (ERC), the National Science Foundation (NSF) of the USA, the National Natural Science Foundation of China (NSFC), and Taiwan's Ministry of Science and Technology (MOST) project (Wu et al., 2015; Perianes-Rodríguez & Olmeda-Gómez, 2021). Financial support allows scholars to obtain the necessary resources, such as manpower, equipment purchases, and experimental materials, to ensure that the research proceeds smoothly and meets the expected standards. Since the establishment of the Web of Science (WoS) database in 2008, research on funding confirmation and bibliometrics has received widespread attention in academia, covering multiple fields, such as medicine, nanotechnology, and tribology (Huang & Huang, 2018). As we gradually enter a new era of development in artificial intelligence (AI), investment in AI research, development, and applications is increasing. AI technologies have found broad applications across diverse sectors, including business, management, healthcare, and defense (Asemi et al., 2021). Despite the popularity of the topic and the continuous increase in achievements, the research examining journal rankings from the perspective of publication quality remains relatively limited. This study aims to enhance the quality indicators of research and increase research capacity.

Although prior bibliometric studies have investigated individual relationships between variables such as research funding, author count, and citation count—typically focusing on paths such as funding → citations or collaboration → impact—most of these studies lack an integrated and layered analytical framework. Furthermore, few examine how these structural factors interact under the influence of journal rankings, particularly within a focused domain such as artificial intelligence (AI).

This study addresses this gap by employing a single-year (2018) × single-publisher (Springer) sampling strategy, enabling a uniform and controlled comparison. Unlike previous studies that span multiple publishers and years, resulting in dataset heterogeneity and diluted analytical focus, our design reduces noise and enhances the consistency of statistical interpretation.

To the best of our knowledge, this is the first bibliometric study that systematically integrates author number, funding support, citation behavior, and journal ranking into a layered, interaction-oriented framework using both chi-square and ANOVA methods. This focus on the AI domain, combined with methodological rigor, distinguishes our study from previous fragmented efforts and contributes new insights to the field.

During the research process, the authors handled large volumes of data and presented the findings with rigorous academic professionalism to ensure the accuracy and reliability of the results.

Additionally, they must monitor the extent to which their work is cited in the subsequent literature. Tracking research citations in the academic literature often requires tools such as Publish or Perish (POP). This study aims to explore whether journal articles have received research funding and whether they have been cited. We categorize the published papers into two groups: those with and without research funding support, and those with and without citations, and then organize them according to journal rankings. The objective of this study is to analyze the relationship between paper rankings and the number of authors, research funding support, and citation count, and examine the differences and impacts within journal rankings.

In recent years, content analysis methods such as descriptive statistics, the chi-square test, and analysis of variance (ANOVA) (Kassarjian, 1977) have been extensively applied in various studies across different fields. Roberti et al. (2015) conducted a quantitative and qualitative exploratory descriptive study to understand the development of clinical reasoning among undergraduate medical students. Kozikoglu (2017) utilized content analysis techniques to examine the challenges faced by novice teachers. Carlson et al. (2020) reported novel descriptive statistical data related to the United States Code, incorporating machine learning techniques for topic modeling. Additionally, Matos et al. (2021) developed and validated indicators for patient safety during intra-hospital transfers, emphasizing the importance of these indicators in enhancing nursing practice and patient safety. Overall, the use of content analysis techniques, especially descriptive statistics, has resulted in a better understanding of complex phenomena and the formulation of effective interventions. Descriptive statistics have also been applied to topics related to multicultural education, such as attitudes, cognitions, and educational practices (Köşker & Erdoğan, 2020).

The chi-square test was utilized to compare the news reporting differences on Indonesian migrant workers in Saudi Arabia between two media outlets: Detikcom and Sabq.org. The study identified significant differences in the portrayal of Indonesian migrant workers by these two sources (Yusuf & Ali, 2018). The chi-square test was used to analyze differences in the distribution of resource types at each stage in a systematic review of library guides from 18 English-speaking universities. It was found that there were statistically significant differences in the distribution of resource types during the search phase (Lee et al., 2021). Another study evaluated the content and quality of YouTube videos on zygomatic implants, utilizing a chi-square test to compare differences in information flow, accuracy, video quality, and precision across video content quality groups (low, medium, high). The results indicated that the quality of video content is crucial for providing effective and useful health information. This emphasizes the practicality of chi-square tests in assessing the quality of health information videos and highlights the need for improving health education content on YouTube (Yildirim & Kocaelli, 2023). Further, the chi-square test of independence was used to assess the associations between outbreak stages and message types (Alhassan & AlDossary, 2021).

Another widely recognized analytical approach involves the use of the well-known ANOVA test, which compares the means of multiple groups and determines whether there are statistically significant differences between them. In one study, a three-way ANOVA test was used to investigate the effects of biochar application ratios on soil water retention behavior. This study demonstrates the versatility and effectiveness of the ANOVA test in analyzing various content-related factors (Wong et al., 2017). The ANOVA technique was also used to evaluate the effects of various factors on the wear behavior of alumina–aluminum matrix composites. The study highlighted the importance of the ANOVA test in analyzing the tribological performance of composite materials (Rahman et al., 2019). Participants' profiles in each age group were compared through one-way ANOVAs and chi-square tests (Ballester-Arnal et al., 2023).

This study uniquely integrates four dimensions. Unlike studies spanning multiple fields or broader technology domains, this study adopts a focused approach, analyzing a uniform dataset from the field of AI published by Springer in 2018. It highlights the interaction between author number, funding support, journal ranking, and citation count—an integrated perspective rarely addressed in earlier efforts.

This paper has the following organizational structure: Section 2 reviews the related topics of author number, research funding, citation count, and average citation count; Section 3 provides a detailed introduction to the research data and methodology; Section 4 describes the experiment results and presents the discussion; finally, conclusions are drawn in Section 5.

2. Related work

The most direct measures of academic researchers' influence include the number of papers published, the number of citations, and the h-index (Rousseau, 2014; Vavryčuk, 2018). The h-index (Hirsch, 2005) has been widely applied and assesses the quality of a paper from multiple dimensions, such as author credentials, research funding support, citation situation, and citation count. The citation count can be divided into total citations and average citations. Since both can be calculated from each other, this study mainly focuses on average citations and explores the differences between different rankings. Many scholars use the h-index method in the publication process (Ashfaq et al., 2018; Bornmann, 2019; Chien et al., 2018; Liao et al., 2018; Patience et al., 2017; Ponce & Lozano, 2010; Smith et al., 2018; Yuen, 2018), exploring the impact and quality of journals (Bador & Lafouge, 2010; Kuan et al., 2013; Serenko & Dohan, 2011). However, few studies on funding support or citation count have used citation analysis to explore the relationships and differences between the number of authors, research funding support, citation count, and average citation count in relation to journal rankings.

While prior studies have explored single-variable relationships, such as "funding → citations," few have conducted integrated analyses involving the interaction among author number, funding, ranking, and citation count within the field of AI. This study fills that gap by employing both chi-square and ANOVA tests to identify statistically significant relationships, offering a deeper understanding of how structural factors affect academic impact.

2.1. Research on author number

Academic research integrates the resources, technology, and innovative thinking of researchers to promote the development of new knowledge and may receive research funding support (Morillo, 2016, 2019; Jeong et al., 2014). Paper authors can be divided into two groups: single authors and non-single authors, with the latter considered to enhance research efficiency (Aksnes et al., 2013; Fangmeng, 2016; Liu et al., 2021) through academic collaboration. This study focuses on the average number of authors (total number of paper authors/paper count) and single authors who conduct research independently, and then analyzes the differences in journal rankings.

2.2. Research on research funding

Research funding refers to financial support granted to teams through approved proposals submitted to relevant agencies (Wu et al., 2015; Huang & Huang, 2018; Grimpe, 2012; Shibayama, 2011). Securing research funding can upgrade research facilities, introduce new technologies, attract more research talent, and expand research collaboration. It not only promotes innovative research topics but also enhances the quality and outcomes of research (Blochet al., 2014; Bolli & Somogyi, 2011; Braun, 1998; Jowkar et al., 2011; Salter & Martin, 2001). Research funding plays a significant role in increasing the number of publications, enhancing citation counts, and expanding knowledge. Public funds are an important component in the promotion of high-quality scientific research and its outcomes and affirming their contribution to advancing scientific research and knowledge sharing (Heyard & Hottenrott, 2021).

Much work in the field of bibliometrics has investigated the impact of research funding on papers (Paul-Hus et al., 2016; Tang et al., 2017). Such research has involved tracking the research outcomes of funding agencies, funds, and economic support (Perianes-Rodríguez & Olmeda-Gómez, 2021; Boyack & Jordan, 2011; Saakyan, 2024; Galkina et al., 2018; Mejia & Kajikawa, 2018; Sussex et al., 2016; Lewison, 1994; Lyubarova et al., 2009); exploring the relationship between economic support and research impact (Harter & Hooten, 1992; Lewison & Dawson, 1998; Rigby, 2013; Zhao, 2010; Yan et al., 2018; Kokol & Vošner, 2018; Aagaard et al., 2021); identifying major funding countries (Wang et al., 2012); examining papers with the most citations (Giles & Councill, 2004); reviewing interactions between the public and private sectors (Morillo, 2016); and other topics worthy of attention (Álvarez-Bornstein et al., 2017).

2.3. Research on citation count

In academic works, citations symbolize the recognition of other researchers, where authors provide detailed information (such as author name, publication year, and title) pointing to the source. This not only highlights the contributions of the original author but also enhances the transparency and credibility of the research, affirming the work of predecessors and indicating that the research is based on existing knowledge, supporting one's viewpoints, enhancing persuasiveness, providing background, allowing readers to understand the research context, promoting academic exchange, sharing knowledge, avoiding plagiarism, and guarding academic integrity. Citations are the core of academic writing and are essential for research integrity, transparency, and knowledge sharing. Citations are widely used to measure the performance of academic research (Borgman, 2000; Ahmad et al., 2020; Waltman, 2016; Cole, 2000) and assess research productivity and impact.

The citation count (or citation number) refers to the total number of citations a paper receives and is commonly used as an indicator to measure a paper's impact. When a paper is widely cited, it signifies significant status and value in the field and is referenced by researchers in the same and related fields (Michalska-Smith & Allesina, 2017; Parmar et al., 2019). Citation count is considered an indicator of a researcher's influence, by proxy of the usefulness of their work to other researchers (Agarwal et al., 2016). The citation count of journal articles may influence the research topic and quality (Yang & Meho, 2006). Investigating citation counts as an indicator for evaluating the impact of academic research highlights its critical role in measuring research.

2.4. Research on average citation count

Citation rate refers to the frequency at which a paper is cited by other academic works. Citation analysis is a method used to analyze the research impact of published papers, considering the citation situation of a paper for a certain period (suggested to be more than 12 months) since its publication (Zhao et al., 2018; Katerattanakul et al., 2003). Research impact is reflected in a paper's number of citations within a discipline. This indicates research productivity and the work's promotion of international collaboration through research outcomes (Liu et al., 2021). Based on Huang and Huang's (2018) study, papers with a higher number of citations possess greater research impact typically.

Another study (Zhao et al., 2018) found that papers with research funding support tend to receive more citations, reflecting a positive correlation between research funding support and research impact. The academic community uses the two indicators to analyze the quality of papers: total citation count (Győrffy et al., 2018; Jani et al., 2020; Donthu et al., 2021; Verma et al., 2021) and average citation count (Hassanzadeh & Saber, 2020; Ho & Shekofteh, 2021; Donthu et al., 2021). Total citation count refers to the total number of citations for all papers published by a scholar or institution, while research on average citation count (total citation count/total number of papers) reflects the average number of citations per paper (Waltman, 2016).

3. Methodology

This section introduces the relevant data, covering the correlation analysis between the ranking and number of authors of journal papers, research funding support, and citation count. The collection and analysis of relevant data in the AI field in computer science reveal the interactions and impacts among these factors and explain the Theoretical Foundation and Conceptual Framework.

This study is grounded in bibliometric theory and the knowledge production framework, which emphasize the significance of structural factors such as author collaboration, research funding, and journal ranking in shaping academic performance (Moed, 2006; Bornmann & Daniel, 2008). Prior research has shown that papers with a greater number of authors and those that receive funding are more likely to be published in high-ranking journals and to receive more citations (Abramo & D'Angelo, 2011; Wang & Shapira, 2015).

Based on these foundations, our conceptual framework assumes that collaborative authorship and research funding act as driving forces that increase the visibility and academic value of research papers. Journal ranking, in turn, serves as a proxy for publication quality and scholarly impact. Thus, we propose a layered research structure centered on journal ranking, progressing through four key research questions that examine the relationships among author count, funding status, citation presence, and average citation count.

This conceptual structure provides a coherent analytical path and allows us to investigate both individual effects and interaction effects using appropriate statistical methods. It also helps to align our research questions with well-established theoretical principles in the field of scientometrics.

3.1. Research data source of the study

In the current popular field of AI research, journal publication is an important channel for knowledge dissemination. Many countries are actively investing in AI research in the fields of technology, education, and academia (Pan, 2016). This study collects data from international journals in the AI field in computer science in 2018, conducting data retrieval and data mining. The data on the ranking, number of authors, research funding support, and citation count of these papers will be organized and summarized.

Table 1 shows that a total of 133 journals were published by 32 publishers. Table 2 identifies the six publishers with the most publications. Springer leads with 36 journals, followed by Elsevier with 22, IEEE with 13, IOS Press with 7, and Wiley and World Scientific Publishing Co., Ltd., each publishing 6 journals. The six publishers together published 90 journals, accounting for 67.63 % (rounded to two decimal places) of the total. The top three publishers combined account for 53.38 % of the journal publications, with Springer publishing 36 journals, accounting for 27.07 %, clearly surpassing other publishers (Table 2). Thus, Springer is the most influential publisher in this field.

To ensure the representativeness and completeness of the data source, this study further examined the quartile distribution (Q1–Q4) of the journals from the six leading publishers and closely analyzed the publication profiles of the top three. Springer was ultimately selected as the primary data source due to its comprehensive journal coverage across all four quartiles (Q1 to Q4), which allows for a balanced representation of different levels of academic influence. This sampling strategy ensures the construction of a consistent and representative dataset for subsequent bibliometric analysis.

(1) **Springer publishing**: A total of 36 journals are distributed across 4 different levels, with 8 in Q1, 10 in Q2, 13 in Q3, and 5 in Q4. This distribution across Q1–Q4 journal rankings showcases the diversity in the field of academic publishing, making it a worthy research topic.

Table 1
A total of 133 journal rankings for Q1–Q4 in the AI field in computer science.

No	Publisher	Total	Q1	Q2	Q3	Q4
1	Springer	36	8	10	13	5
2	Elsevier	22	10	8	4	0
3	IEEE	13	10	2	0	1
4	IOS Press	7	1	1	1	4
5	Wiley	6	1	0	3	2
6	World Scientific Publishing Co. Pte. Ltd.	6	1	1	0	4
7	MIT	4	0	2	2	0
8	Pergamon-Elsevier Science Ltd.	4	2	2	0	0
9	Taylor & Francis Inc.	4	0	0	1	3
10	Acad	3	0	1	1	1
11	Cambridge	3	0	0	0	3
12	Institution Engineering Technology-IET	3	0	0	3	0
13	Assoc.	2	0	1	0	1
14	Tubitak Scientific & Technical Research Council Turkey	2	0	0	0	2
15	AI	1	0	0	1	0
16	Amer	1	0	0	1	0
17	Atlantis	1	0	1	0	0
18	Cariro	1	0	1	0	0
19	IEEE-Inst Electrical Electronics Engineers Inc.	1	0	0	0	1
20	Frontiers Media Sa	1	0	1	0	0
21	Inderscience Enterprises Ltd.	1	0	1	0	0
22	IGI Global	1	0	0	1	0
23	Kaunas Univ Technology	1	0	0	0	1
24	Old City Publishing Inc.	1	0	0	0	1
25	Pleiades Publishing Inc.	1	0	0	0	1
26	SAGE Publications Ltd.	1	0	0	0	1
27	SIAM Publications	1	0	1	0	0
28	Slovak Acad Sciences Inst Informatics	1	0	0	0	1
29	TSI Press	1	0	0	0	1
30	Univ. Suceava, Fac. Electrical Eng.	1	0	0	1	0
31	University of Zielona Gora Press	1	0	0	1	0
32	Zarka Private University	1	0	0	0	1
Total		133	33	33	33	34

Table 2
Distribution of top 6 journals by publisher in the AI field in computer science.

No.	Publish	Quantity	Present	Cumulative
1	Springer	36	27.07 %	27.07 %
2	Elsevier	22	15.54 %	43.61 %
3	IEEE	13	9.77 %	53.38 %
4	IOS Press	7	5.23 %	58.61 %
5	Wiley	6	4.51 %	63.12 %
6	World Scientific Publishing Co. Pte. Ltd.	6	4.51 %	67.63 %
Total		90		67.63 %

(2) **Elsevier publishing**: A total of 22 journals, with 10 in Q1, 8 in Q2, 4 in Q3, and none in Q4, are identified. This reflects the concentration of the journals of this publisher at the higher levels of Q1–Q3. The distribution characteristics hold unique value and focus in the field of academic publishing.

(3) **IEEE publishing**: A total of 13 journals, with 10 in Q1, indicating that the journals are mainly concentrated at the top academic level. There are 2 in Q2 and 1 in Q4, showing that IEEE also explores these levels. There are none in Q3, reflecting IEEE's publishing strategy preference of focusing on high-quality research and being more cautious about publishing in medium-quality journals.

The following outlines the distribution of journals across the Q1–Q4 levels:

(a) **Q1**: This group indicates the top journals that publish the most influential and innovative research results, reflecting the authoritative status of academic research.

(b) **Q2**: Also highly recognized in academic research, the research published is of good quality and innovativeness.
(c) **Q3**: Although less influential than Q1 and Q2, these journals still publish valuable research results.
(d) **Q4**: This group represents relatively emerging or specialized journals in the field, serving as an academic exchange platform within specific research areas.

With the above descriptions, we have three key points for Springer's selection of journals in the AI field. (1) In the exploration of academic research, journal ranking is an important key indicator for evaluating research outcomes. (2) Table 1 makes it clear that only Q1–Q4 levels exist in journals from Springer. (3) Table 2 also shows that Springer has the highest ratio (27.07 %) to cover the AI field journals. Thus, journals from Springer have better influence in this AI field. In this regard, this study focuses on the 36 journals published by Springer in the AI field in computer science in 2018 and analyzes the distribution of these journals' rankings. This study focuses on the ranking of journal papers, the number of authors, research funding support, and citation count. This analysis not only involves the composition scale of the papers' author teams but also examines the proportion of papers with research funding support and reflects the impact of papers through citation count, providing a multidimensional evaluation perspective. We focus on the research between journal paper rankings.

This study mainly uses papers from the AI field in computer science journals published by Springer in the 2018 WoS database to meaningfully verify the number of authors and research funding support for each paper. In order to obtain the citation count, the POP (6.48 version) tool is first used to ensure the accuracy of the citation count for each paper. Next, the research methodology is explained. Finally, the research questions of this study are described. Fig. 1 shows different questions trigged from various issues. To clarify the connections among the questions shown in Fig. 1, we designed the four main research questions (Questions I–IV) as a sequential and interrelated analytical structure. Each question builds upon the previous one, progressing from basic author metrics to funding influence, citation presence, and finally average citation count. All questions are organized around the core factor of journal ranking. This layered design ensures that each analytical stage provides insights that support the next, forming a coherent path to understand how various structural factors collectively shape academic performance and publication outcomes. Regarding the processing of data analysis, Fig. 2 shows a flowchart of the proposed research procedure in this study; two main parts are addressed, including data preprocessing and data analysis. In Fig. 2, the related processing flow is defined on the left side, and the corresponding methods used are identified on the right side. Fig. 2 provides a procedural overview of how research questions can be addressed through systematic data processing. The left side of the flowchart outlines the various stages of data preprocessing, including journal selection, variable identification (e.g., author counts, funding, citations), and dataset construction. These steps ensured the consistency and representativeness of the dataset, especially its alignment with the ranking of journals in the field of artificial intelligence (Q1–Q4).

3.2. Research methodology

To enhance the clarity and coherence between the study's goals and its technical methods, this section provides an overview of the three main analytical techniques used: descriptive statistics, chi-square tests, and ANOVA. Each method is carefully selected to correspond with specific research questions (Questions I–IV), as detailed in Table 3 Descriptive statistics are used to summarize and visualize fundamental patterns in the dataset, such as the distribution of author counts or citation presence. Chi-square tests are employed to examine the association between categorical variables, such as funding presence and journal ranking. ANOVA is applied to test for statistically significant differences in continuous variables—such as average citation count—across multiple journal ranking levels (Q1–Q4). This layered methodology ensures that each research hypothesis is evaluated using the most appropriate statistical tool, thereby strengthening the connection between analytical procedures and the research objectives.

This study employs three content analysis methods: descriptive statistics, the chi-square test, and the ANOVA test. Descriptive statistics aim to provide a basic overview of the research data, facilitating an understanding of the general characteristics of the dataset. The chi-square test is used to examine the association between variables, determining whether two categorical variables are significantly related. The ANOVA test is used to compare the differences between three or more samples, determining whether there are significant differences between different groups from question hypotheses. These hypotheses and methods together form the foundation of the analytical framework of this study, aiming to explore the relationship between journal paper ranking, the number of authors, research funding support, and citation count. The definition and application purpose of the analytical method will be described separately in the following sections.

3.2.1. Research on descriptive statistics

Descriptive statistics involve significantly summarizing data to depict or outline the characteristics of a dataset. Descriptive statistics have been further applied in topics related to multicultural education, such as attitudes, cognitions, and educational practices (Köşker & Erdoğan, 2020). Statistical methods often include the calculation of mean, median, mode, and standard deviation to describe the central tendency and dispersion of the dataset. Statistical charts, such as bar graphs, are commonly used in descriptive statistics. Bar graphs are particularly suited for displaying the frequency or quantity of different categories (Anwyl-Irvine et al., 2021), allowing for a clear visual representation of category volume at a glance. They are employed to intuitively display the distribution and trends in data. Key features of this study, such as the number of authors, research funding, and citation counts, are presented

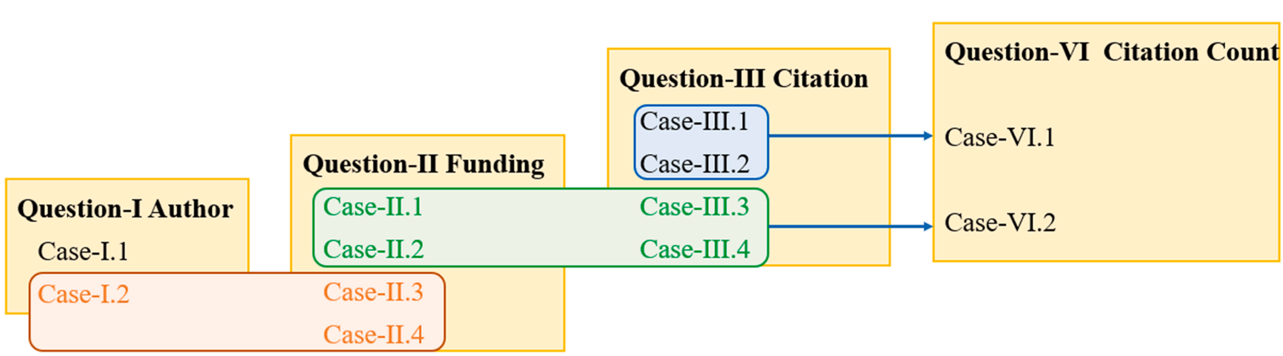

Fig. 1. Links to research on various issues. (Note: The four questions in Fig. 1 are sequentially related and form a layered analytical structure centered around journal ranking.).

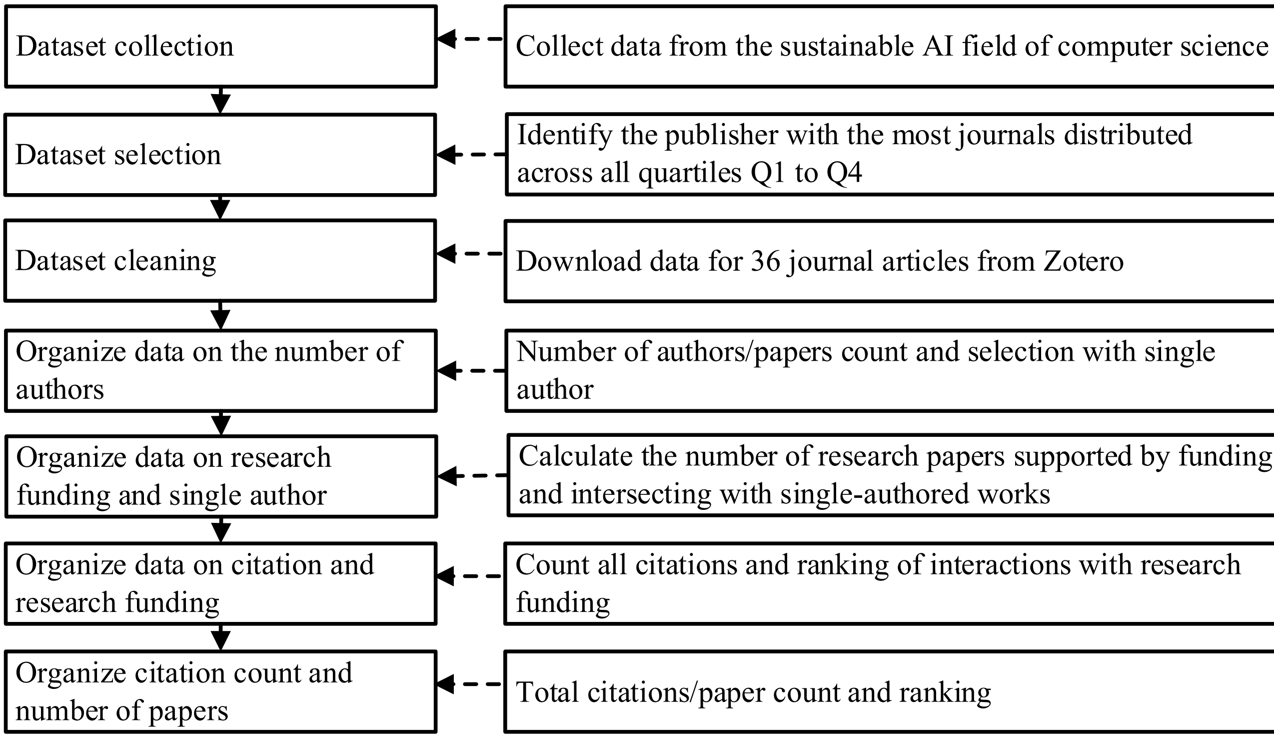

Fig. 2. Flowchart of the proposed research procedure in this study.

Table 3
Related testing methods and compiled key variables.

Question	Case	Method	Key variables
Question I	Case-I.1	ANOVA	number of authors, number of papers
	Case-I.2	Chi-Square	single author, non-single author
Question-II	Case-II.1	Chi-Square	research funding support, non-funding support
	Case-II.2	ANOVA	research funding support, ranking
	Case-II.3	Chi-Square	research funding and single author
	Case-II.4	ANOVA	research funding, single author paper, ranking
Question-III	Case-III.1	Chi-Square	cited paper, uncited paper
	Case-III.2	ANOVA	cited paper ranking
	Case-III.3	Chi-Square	cited paper, research funding
	Case-III.4	ANOVA	cited paper, research funding, ranking
Question-IV	Case-IV.1	ANOVA	citation count, number of papers
	Case-IV.2	ANOVA	citation count, research funding paper

using bar graphs.

This study uses descriptive statistics to present basic information, such as the number of authors (such as the average number of authors per paper), research funding ratio, number of citations, and journal classification (Q1–Q4). For example, when analyzing the average number of authors of papers in different journal rankings (Case-I.1), the type of authors (single author vs. non-single author) (Case-I.2), and the overall proportion of funded or unfunded papers (Case-II.1), they are all presented in the form of average values and proportion charts to help readers quickly grasp the research sample structure and main trends.

3.2.2. *Chi-square test technique*

Chi-square tests are statistical tools used to assess correlations between categorical data. For example, a correlation between respondents' locations, ages, and types of housing with their practices of waste sorting is significant (chi-square test, $p < 0.05$) (Fadhullah et al., 2022). The main applications include tests of goodness of fit and tests of independence. By calculating the deviation between observed and expected values, the chi-square test helps determine whether there is a substantial association between variables. For example, the chi-square test of independence was used to assess the associations between outbreak stages and message types (Alhassan & AlDossary, 2021). This study applies the test to explore correlations among different categories: (1) number of authors per paper and journal ranking; (2) papers with or without research funding support and journal ranking; (3) papers with research funding support and whether they are single-authored; (4) papers with or without citations and journal ranking; (5) papers that are cited and have research funding support; and (6) average citation count of papers with or without research funding support and journal ranking.

3.2.3. *ANOVA test technique*

The ANOVA test is a statistical method used to compare whether there are significant differences in the means of three or more groups. For example, studies have shown through ANOVA analysis that education level and gender play an important role in nursing staff's knowledge, practice, and attitude towards physical restraint (Lee et al., 2021). In addition, a statistical study was conducted on the variation analysis of digital abilities of higher education professors among different age groups in knowledge fields (Cabero-Almenara et al., 2021). In this study, we examine whether there is a correlation between some studies on application ranking (Q1–Q4) and number of authors, research funding, citations, and average citations.

3.3. *Research questions*

This study evaluates the correlation between the number of authors, research funding support, citation count, and average citation count. The four main research questions **(Questions I–IV)** with 12 meaningful hypotheses are defined as follows:

(1) **Question I:** What is the distribution of the average number of journal papers, single-author papers, and the ranking of journal papers (for the empirical results, please see Section 4.1)?
   (a) **Case I.1**: It is tested for the difference between average number of authors and journal paper ranking (see Section 4.1.1).
   (b) **Case I.2**: It is tested for the difference between single and non-single author count and journal paper ranking (see Section 4.1.2).
(2) **Question II**: What is the impact of research funding support, the number of authors, and the distribution of journal paper rankings (see Section 4.2)?
   (a) **Case II.1**: There are more research-funding-supported papers than non-funded papers (see Section 4.2.1).
   (b) **Case II.2**: Research-funding-supported papers have higher journal paper ranking proportions than non-funded papers (see Section 4.2.2).
   (c) **Case II.3**: Research-funding-supported papers have fewer single authors than non-single-author papers (see Section 4.2.3).
   (d) **Case II.4**: It is tested for the impact of journal ranking distribution for research-funding-supported papers that are single authored (see Section 4.2.4).
(3) **Question III**: What is the difference between citations, research funding support, and impact on ranking distribution (see Section 4.3)?
   (a) **Case III.1**: It is identified that cited papers are more numerous than uncited papers (see Section 4.3.1).
   (b) **Case III.2**: Cited papers have higher journal ranking proportions than uncited papers (see Section 4.3.2).
   (c) **Case III.3**: Papers with research funding grants are cited more often than those without research funding grants (see Section 4.3.3).
   (d) **Case III.4**: Journals with cited papers that have research funding grants have a higher proportion of high-ranking articles than those with cited papers without research funding grants (see Section 4.3.4).
(4) **Question IV**: What is the distribution of average citation counts and journal rankings for papers with and without research funding support (Section 4.4)?
   (a) **Case IV.1**: Difference in journal ranking distribution for average citation count (see Section 4.4.1).
   (b) **Case IV.2**: Differences in journal ranking distribution for average citation count of papers with research funding grants (see Section 4.4.2).

Questions, related tests, and key variables are summarized in Table 3 below. Table 3 summarizes how each research question and hypothesis is matched with the most appropriate analytical method based on the variable types and research objectives.

4. Experimental results and discussion

This experiment organizes research data, including the number of authors, whether research funding support was received, citation count, and ranking, into statistical summaries. The aim is to empirically understand the differences in journal rankings for issues, such as journal papers, number of authors, research funding support, and citation count. It is hoped that this will provide a more comprehensive perspective for academic research after implementing the content analysis techniques in the descriptive statistics, the chi-square test, and the ANOVA test.

4.1. Distribution of the average number of journal papers and single-author papers and the ranking of journal papers

This study aims to investigate the potential impact of the number of authors on journal rankings and understand the effect of author collaboration on enhancing the influence and academic value of papers by examining the ranking situations of single-authored and non-single-authored papers.

4.1.1. Difference between the average number of authors and journal paper rankings

This study examines 4488 papers with 15,080 authors, resulting in an average of 3.36 (15,080/4488) authors per paper (number of authors/paper count). Table 4 displays the average number of authors per journal ranking, with Q1 at 3.49, Q2 at 3.34, Q3 at 3.26, and Q4 at 3.02, indicating a decreasing trend from higher to lower rankings. Articles published in higher-ranked journals often involve more mature research and important topics and usually require more manpower. Collaborative research is more common, leading to a higher average number of authors for papers published in these journals. There is a significant difference ($P < 0.05$) in the average number of authors across different rankings, with higher-ranked papers typically written by research teams with greater academic influence. This phenomenon may reflect the active involvement and leadership of prominent scholars, as well as effective collaboration among team members, culminating in research that demonstrates strong potential, academic impact, and scholarly merit. Such outcomes may be associated with the so-called “Matthew Effect,” whereby high-profile topics tend to attract greater attention from reviewers and are more likely to be authored by well-established researchers.

4.1.2. Differences between single and non-single author counts and journal paper ranking

This study explores the distribution and ranking of single-authored and non-single-authored journal papers (Q1–Q4). Table 5 shows the distribution of single authors (single author/paper) in Q1: 6.10 %, Q2: 5.37 %, Q3: 9.20 %, and Q4: 15.75 %, and non-single authors (non-single author/paper) in Q1: 93.90 %, Q2: 94.63 %, Q3: 90.80 %, and Q4: 84.25 %. This indicates that the proportion of single-authored papers is less than that of non-single-authored papers, with a significant difference ($P = 0.000$, $P < 0.005$). This reflects that research collaborations can provide a broader range of knowledge and resources. Non-single-authored papers are concentrated in the higher rankings of Q1 and Q2, with Q1 journals ranking slightly lower than Q2 by 0.72 %, which also suggests differences in author collaboration models across different academic fields (Lindsey, 1980). The research results highlight the importance of academic collaboration in enhancing research quality and impact, especially in the competitive academic publishing environment.

Accordingly, Table 5 shows that there are 293 single-authored papers with the following journal ranking distribution (single author/total single author (Q1–Q4)): Q1: 25.60 % (75/293), Q2: 43.00 %, Q3: 24.57 %, and Q4: 6.83 % ($P = 0.000$, $P < 0.05$, with ** significant difference). Table 4 shows a total of 4195 non-single-authored papers with a significant distribution in journal rankings (non-single author/total non-single author (Q1–Q4)): Q1: 27.53 %, Q2: 52.97 %, Q3: 16.95 %, and Q4: 2.55 % ($P = 0.000$, $P < 0.05$, with ** significant difference).

The results indicate that both single-authored and non-single-authored papers are mainly concentrated in Q1 and Q2 rankings. This reflects that in the AI field, whether research has been conducted by an individual or team, high-quality work is easily accepted by high-ranking journals. However, the highest proportion of non-single-authored

Table 4
Average number of authors.

Item	Q1	Q2	Q3	Q4	Q1–Q4
Author	4291	7851	2555	383	15,080
Paper	1230	2348	783	127	4488
Author/Paper	3.49	3.34	3.26	3.02	3.36

Table 5
Distribution and ranking of single- and non-single-author papers.

Item	Q1	Q2	Q3	Q4	Q1–Q4
Single author	75	126	72	20	293
Non-single author	1155	2222	711	107	4195
Paper	1230	2348	783	127	4488
Single author/Paper	6.10 %	5.37 %	9.20 %	15.75 %	6.53 %
Non-single author/Paper	93.90 %	94.63 %	90.80 %	84.25 %	93.47
Single author/ Single author(Q1–Q4)	25.60 %	43.00 %	24.57 %	6.83 %	100.00 %
Non-single author/ Non-single author (Q1–Q4)	27.53 %	52.97 %	16.95 %	2.55 %	100.00 %

papers is in Q2 journals, which may indicate that collaborative research is more common in high-quality journals and receives high recognition. This emphasizes the importance of collaborative research in the AI field and the competitiveness of publishing research results in top journals.

4.2. Impact of research funding support, number of authors, and distribution of journal paper rankings

Research funding plays a key role in increasing the quantity and quality of research outcomes (Ebadi & Schiffauerova, 2016). This section explores four aspects: (1) the number of papers with and without research funding support, (2) the journal ranking situation of research-funding-supported papers, (3) the number of single-authored and non-single-authored papers with research funding support, and (4) the impact of journal ranking distribution on research-funding-supported papers that are single authored. These analyses aim to understand the impact of research funding support on enhancing the publication of academic research papers in higher-ranked journals.

4.2.1. Research-funding-supported papers are more numerous than non-funded papers

The results indicate that projects with research funding support tend to produce more papers (Huang & Huang, 2018). This finding can also be observed in the AI field, as shown in Table 6. In the AI field, papers with research funding support amount to 2639, accounting for 58.80 % (2639/4488), which is more than the 41.20 % (1849/4488) of papers without research funding support.

4.2.2. Research-funding-supported papers have a stronger presence in higher-rated journals than non-funded papers

Table 7 displays the journal rankings of papers that received research funding (funding/funding (Q1–Q4)). Q1: 28.72 %, Q2: 52.63 %, Q3: 16.07 %, and Q4: 2.58 %. In contrast, for the 1849 papers without research funding support (non-funding/non-funding (Q1–Q4)), the rankings are Q1: 25.53 %, Q2: 51.87 %, Q3: 19.42 %, and Q4: 3.18 %. Papers with research funding support are concentrated in Q1 and Q2 journals at 81.35 %, higher than the 77.4 % for papers without research funding support. This indicates that the proportion of papers published in high-ranking journals is significantly higher for those with research funding support compared to those without ($P = 0.006$, $P < 0.05$, with ** significant difference).

Table 6
Q1–Q4 results for funded/non-funded papers.

Item	Q1	Q2	Q3	Q4	Q1–Q4	Rate
Funding	758	1389	424	68	2639	58.80 %
Non-funding	472	959	359	59	1849	41.20 %
Paper	1230	2348	783	127	4488	100.00 %

Table 7
Q1–Q4 displays the journal rankings of papers that received research funding.

Item	Q1	Q2	Q3	Q4	Q1–Q4
Funding	758	1389	424	68	2639
Non-Funding	472	959	359	59	1849
Paper	1230	2348	783	127	4488
Funding Rate	28.72 %	52.63 %	16.07 %	2.58 %	100.00 %
Non-single Rate	25.53 %	51.87 %	19.42 %	3.18 %	100.00 %

4.2.3. There are fewer research-funding-supported papers with single authors than those with multiple authors

Among the 2639 papers with research funding support, Table 8 shows that non-single-author papers dominate, with an overwhelming proportion (funding and non-single author/funding) (96.02 %) far exceeding single-author papers (funding and single author/funding) (3.98 %). This suggests that most funded research is the result of team efforts, highlighting the significance of collaboration in academic work. Although there are fewer single authors, the ability to independently secure research funding and complete publication demonstrates strong capabilities in the research field. This also emphasizes the unique value of individual researchers' independence and innovativeness in scientific exploration.

4.2.4. Impact of journal ranking distribution for research-funding-supported papers with single authors

Table 9 shows the distribution of rankings for single-authored papers with and without research funding. For papers with research funding support, the distribution (single and funding/single author) is Q1: 42.67 %, Q2: 38.10 %, Q3: 23.61 %, and Q4: 40.00 %; for papers without research funding support, the distribution (single and non-funding/ single author) is Q1: 57.33 %, Q2: 61.90 %, Q3: 76.39 %, and Q4: 60.00 %.

Table 9 displays a total of 105 papers that received research funding and were independently conducted, with rankings distributed as follows (single and funding/single and funding (Q1–Q4)): Q1: 30.48 %, Q2: 45.71 %, Q3: 16.19 %, and Q4: 7.62 %. The distribution trend for Q1 and Q2 combined is 76.19 %, following the order of Q2 > Q1 > Q3 > Q4, from highest to lowest ($P = 0.008$, $P < 0.05$, with ** significant difference), mainly concentrated in higher rankings.

Publications reporting research undertaken without research funding support totaled 188 papers. These articles were accepted by international journals, indicating that the research topics and results have unique features, are truly outstanding, and have high research impact. Table 9 shows the distribution of rankings as follows (single and non-funding/single and non-funding (Q1–Q4)): Q1: 22.87 %, Q2: 41.49 %, Q3: 29.26 %, and Q4: 6.38 % ($P < 0.05$), showing the trend Q2 > Q3 > Q1 > Q4. Despite their lack of research funding support, the research topics covered in these papers make important academic contributions, reflecting the authors' strong research capabilities. This indicates that even in situations with limited funding, journals recognize the importance and innovativeness of individual researchers' work, demonstrating their exceptional research abilities.

4.3. Relationship between citations, research funding support, and impact on the ranking distribution

This section explores paper citation: (1) the number of cited papers,

Table 8
Distribution of funded papers between single-author and non-single-author papers.

Item	Paper	Rate
Funding & Single author	105	3.98 %
Funding & Non-single author	2534	96.02 %
Funding	2639	100.00 %

Table 9
Single-author papers with funding/non-funding.

Item	Q1	Q2	Q3	Q4	Q1–Q4
Single & Funding	32	48	17	8	105
Single & Non-funding	43	78	55	12	188
Single author	75	126	72	20	293
Single & Funding/Single author	42.67 %	38.10 %	23.61 %	40.00 %	100.00 %
Single & Non-funding/ Single author	57.33 %	61.90 %	76.39 %	60.00 %	100.00 %
Single & Funding/Single & Funding (Q1–Q4)	30.48 %	45.71 %	16.19 %	7.62 %	100.00 %
Single & Non-funding/ Single & Non-funding (Q1–Q4)	22.87 %	41.49 %	29.26 %	6.38 %	100.00 %

(2) the journal ranking distribution of cited papers, (3) the number of cited papers with research funding support, and (4) the journal ranking distribution of cited papers with research funding support. The aim of the analysis is to understand the impact of citations and research funding support on enhancing the publication of academic research papers in journals.

4.3.1. *Cited papers more numerous than uncited papers*

This section aims to explore the citation counts of the examined papers. Table 10 shows that 86.61 % (3887/4488) of papers were cited, and 13.39 % (601/4488) were uncited. Table 11 shows the citation status of papers from Q1 to Q4. Cited papers are distributed as follows (citation /paper): Q1: 90.49 %, Q2: 86.58 %, Q3: 83.27 %, and Q4: 70.08 %; uncited papers are distributed (non-citation/paper) as Q1: 9.51 % (117/1230), Q2: 13.42 %, Q3: 16.73 %, and Q4: 29.92 %. The proportion of uncited papers follows the trend Q1 < Q2 < Q3 < Q4, indicating that cited papers are more numerous than uncited papers.

4.3.2. *Cited papers have higher journal rankings than uncited papers*

The proportion of cited paper rankings is the following (citation/ paper (Q1–Q4)): Q1: 24.80 %, Q2: 45.30 %, Q3: 14.53 %, and Q4: 1.98 %. Table 12 shows the proportion of papers not cited as the following results (non-citation/paper (Q1–Q4)): Q1: 2.61 %, Q2: 7.02 %, Q3: 2.92 %, and Q4: 0.84 %. Cited papers have higher journal rankings than uncited papers, with 70.10 % concentrated in the high-ranking Q1 and Q2 levels.

Furthermore, Table 12 shows the distribution of Q1–Q4 for 3887 cited papers as follows (citation/citation(Q1–Q4)): Q1: 28.63 %, Q2: 52.30 %, Q3: 16.77 %, and Q4: 2.3 %. A total of 80.93 % are widely cited in Q1 and Q2 journals, following the trend Q2 > Q1 > Q3 > Q4, with only 19.07 % in other rankings ($P < 0.05$), showing a significant gap ($P = 0.000$, $P < 0.005$). This emphasizes that papers published in high-ranking journals are more likely to receive attention and citations from the academic community.

4.3.3. *Papers with research funding grants are cited more often than those without research funding grants*

Cited papers are more numerous than uncited papers (see Section 4.3.1), and papers with research funding support are more numerous than those without (see Section 4.2.1). Undoubtedly, Table 13 presents cited papers, with 60.05 % (citation and funding/total citation) receiving research funding compared to 39.95 % (citation and non-funding/total citation) without research funding, showing a difference of 20.10 %. The majority of the cited papers received research funding support.

Table 10
Results of cited and non-cited papers.

Item	Citation	Non-citation	Total
Paper	3887	601	4488
Rate	86.61 %	13.39 %	100 %

Table 11
Cited and non-cited papers in Q1–Q4.

Item	Q1	Q2	Q3	Q4
Citation	1113	2033	652	89
Non-citation	117	315	131	38
Paper	1230	2348	783	127
Citation /Paper	90.49 %	86.58 %	83.27 %	70.08 %
Non-Citation/Paper	9.51 %	13.42 %	16.73 %	29.92 %

Table 12
Distribution of cited and non-cited papers in Q1–Q4.

Item	Q1	Q2	Q3	Q4	Q1–Q4
Citation	1113	2033	652	89	3887
Non-citation	117	315	131	38	601
Paper	1230	2348	783	127	4488
Citation/Paper (Q1–Q4)	24.80 %	45.30 %	14.53 %	1.98 %	86.61 %
Non-Citation/Paper (Q1–Q4)	2.61 %	7.02 %	2.92 %	0.84 %	13.39 %
Citation/Citation (Q1–Q4)	28.63 %	52.3 %	16.77 %	2.3 %	100.00 %

Table 13
Citation results for funded/non-funded papers.

Item	Funding	Non-funding	Total
Citation	2334	1553	3887
Rate	60.05 %	39.95 %	100.00 %

Table 14 shows the proportions of cited papers with research funding support as follows (citation and funding/citation): Q1: 61.46 %, Q2: 60.40 %, Q3: 56.45 %, and Q4: 60.65 %; and for cited papers without research funding support (citation and non-funding/citation): Q1: 38.54 %, Q2: 39.60 %, Q3: 43.55 %, and Q4: 39.55 %. The results show that cited papers with research funding support are more numerous than those without. The higher proportion of cited papers with research funding support may reflect the important role of research funding in enhancing research quality and impact.

4.3.4. *Journals with cited papers with research funding grants have a higher proportion of high-ranking articles than those with cited papers without research funding grants*

Table 14 illustrates the proportion of journal rankings for cited papers with research funding support as follows (citation and funding/ citation (Q1–Q4)): Q1: 17.60 %, Q2: 31.60 %, Q3: 9.47 %, and Q4: 1.39 %; for cited papers without research funding support, the proportions are as follows (citation and non-funding/citation (Q1–Q4)): Q1: 11.04 %, Q2: 20.71 %, Q3: 7.31 %, and Q4: 0.88 %. Cited papers with research

Table 14
Citation results for Q1–Q4 funded/non-funded papers.

Item	Q1	Q2	Q3	Q4
Citation & Funding	684	1228	368	54
Citation & Non-funding	429	805	284	35
Citation	1113	2033	652	89
Citation & Funding/Citation	61.46 %	60.40 %	56.45 %	60.65 %
Citation & Non-Funding/Citation	38.54 %	39.60 %	43.55 %	39.55 %
Citation & Funding/Citation (Q1–Q4)	17.60 %	31.60 %	9.47 %	1.39 %
Citation & Non-Funding/Citation (Q1–Q4)	11.04 %	20.71 %	7.31 %	0.88 %
Citation & Funding/ Citation & Funding (Q1–Q4)	29.31 %	52.61 %	15.77 %	2.31 %

funding support are more numerous across Q1–Q4.

Table 14 shows the proportion of journal rankings for cited papers with research funding support (citation and funding/citation and funding (Q1–Q4)) as Q1: 29.31 %, Q2: 52.61 %, Q3: 15.77 %, and Q4: 2.31 %. A total of 81.92 % are distributed in the high-ranking Q1 and Q2, following the trend Q2 > Q1 > Q3 > Q4 ($P < 0.05$). There is thus a positive relationship between cited papers and research funding support. The statistical analysis results show a significant difference in whether papers are cited across different journal rankings ($P = 0.000$, $P < 0.005$), indicating a close correlation between journal rankings and paper citations.

4.4. Distribution of average citation count and journal rankings for papers with and without research funding support

The average citation count (total citations/paper count) helps us understand the impact and importance of academic research outcomes. It not only reflects the degree of recognition of research in the academic community but is also often used as a measure or indicator to assess the impact of academic achievements.

4.4.1. Difference in journal ranking distribution for average citation count

The total average citation count for journal papers in this study is 9.73 (43,649/4488). Table 15 shows that the average citation count for papers receiving research funding is 9.92 (26,180/2639), slightly higher by 0.47 than those without research funding support, which have an average of 9.45.

Table 16 shows that the average citation counts by journal ranking (citation count/paper) is Q1: 12.45, Q2: 10.05, Q3: 5.27, and Q4: 4.79. The average citation counts for higher-ranked Q1 and Q2 is 2.72 and 0.32 higher than the overall average, respectively, with Q1 leading other rankings. The average citation count follows the trend Q1 > Q2 > Q3 > Q4, indicating that scholars prefer to cite papers from higher-ranked journals, which are more likely to be recognized by the research community, showing an emphasis on quality outcomes with greater academic impact. This study thus confirms a positive correlation between journal ranking and average citation counts.

4.4.2. Differences in journal ranking distribution for the average citation count of papers with research funding grants

The average citation count for papers with research funding support in each ranking is as follows (citation count (funding)/paper): Q1: 8.21, Q2: 5.69, Q3: 3.00, and Q4: 3.00. Table 17 shows that for papers without research funding support, the average citation counts (citation count (non-funding)/paper) are Q1: 4.24, Q2: 4.36, Q3: 2.27, and Q4: 1.79. The gap between the two is Q1: 3.97, Q2: 1.33, Q3: 0.73, and Q4: 1.21, showing that papers with research funding support have higher average citation counts, with a significant difference ($P < 0.05$). However, apart from the gap of 3.97 in Q1, the difference in other rankings is only between 0.73 and 1.33, indicating that even papers without research funding support are still highly cited in the AI field.

Table 17 shows the average citation counts for cited papers with research funding support (citation count (funding)/paper (citation and funding)) are Q1: 14.76, Q2: 10.88, Q3: 6.38, and Q4: 7.06, with Q1 being the highest, followed closely by Q2, showing the trend Q1 > Q2 > Q3 > Q4, highlighting the significant impact of research funding support.

Table 15
Results of average citation counts with funding/non-funding.

Item	Total	Funding	Non-Funding
Citation count	43,649	26,180	17,649
Paper	4488	2639	1849
Citation count/Paper	9.73	9.92	9.45

Table 16
Results of ranking by average citation counts.

Item	Q1	Q2	Q3	Q4
Citation count	15,314	23,600	4127	608
Paper	1230	2348	783	127
Average Citation count	12.45	10.05	5.27	4.79

Table 17
Results of average citation counts with funding in Q1–Q4.

Item	Q1	Q2	Q3	Q4
Citation count (Funding)	10,094	13,356	2349	381
Citation count (Non-Funding)	5220	10,244	1778	227
Paper	1230	2348	783	127
Paper (Citation & Funding)	684	1228	368	54
Citation count (Funding)/paper	8.21	5.69	3.00	3.00
Citation count (Non-funding)/paper	4.24	4.36	2.77	1.79
Citation count (Funding)/ Paper (Citation & Funding)	14.76	10.88	6.38	7.06

4.5. Summary of empirical results

The experiments presented in Section 4 are summarized in Table 18, with a brief description below.

(1) The average number of authors decreases in higher-ranked journals, with multi-author papers being more common than single-author papers.
(2) Research-funding-supported papers with single-author papers have a high proportion of higher-ranked journals.
(3) The number of cited papers is higher, mainly concentrated in higher-ranked Q1 and Q2 journals. Among these papers, the proportion of research funding support is higher, and their journal rankings are also higher.
(4) The average citation count and the highest journal ranking both show that papers with funding support have higher values, but the gap with papers without research funding support is not large.

4.6. Discussion and research findings

This section discusses the issues that emerge from the above results, including the number of authors, research funding, citation counts, and average citation counts, with the following five key points:

(1) The number of authors

This study shows that papers in Q1 journals have a higher average number of authors, indicating the complexity of research and the need for extensive professional knowledge and highlighting the importance of research collaboration. Collaboration helps enhance research and is seen as a driving force for academic progress. It also provides important reference material for development trends in academic research.

The proportion of single-author papers in Q2 is higher than in Q1, showing that independent research in the AI field has high quality and impact. With rapid technological advancement and expanding scope for applications, high-quality and influential research increasingly relies on teamwork. The high proportion of non-single-author papers in Q2 journals emphasizes the widespread recognition of collaborative research, indicating that it plays a key role in advancing AI scientific research.

(2) Research funding and single authors

In the rapidly developing field of AI, papers with research funding support exceed those without and are concentrated in Q1 and Q2 journals; non-single-author papers with research funding support are

Table 18
Summary of research results.

Question	Case	Significant or not	*P*-value	Results
Question-I	Case-I.1	Significant	$P = 0.000^{***}$	The average number of authors per paper follows a descending order from Q1 to Q4.
	Case-I.2	Significant	$P = 0.000^{***}$	Q4 > Q3 > Q1 > Q2, non-single-author papers are more numerous than single-author papers.
Question-II	Case-II.1	Significant	$P = 0.006^{**}$	Funded paper > non-funded paper
	Case-II.2	Significant	$P = 0.006^{**}$	The ranking of journals with research funding is Q1 > Q2 > Q3 > Q4.
	Case-II.3	Significant	$P = 0.008^{**}$	Among papers that received research funding, non-single author publications were more prevalent than single-author papers.
	Case-II.4	Significant	$P = 0.008^{**}$	Papers with research funding and a single author have a ranking distribution of Q2 > Q1 > Q3 > Q4, mainly concentrated in higher rankings.
Question-III	Case-III.1	Significant	$P = 0.000^{***}$	Cited paper > non-cited paper
	Case-III.2	Significant	$P = 0.000^{***}$	The journal rankings of cited papers predominantly cluster in the top Q1 and Q2 tiers, surpassing those of uncited papers, with a ranking order of Q2 > Q1 > Q3 > Q4.
	Case-III.3	Significant	$P = 0.003^{**}$	The number of cited papers supported by research funding is greater than that of papers without research funding.
	Case-III.4	Significant	$P = 0.003^{**}$	Cited papers and journals receiving research funding are ranked predominantly in the Q1 and Q2 tiers, with a ranking order of Q2 > Q1 > Q3 > Q4.
Question-IV	Case-IV.1	Non-significant	$P = 0.852$	The average number of citations ranked shows the trend of Q1 > Q2 > Q3 > Q4.
	Case-IV.2	Significant	$P = 0.000^{***}$	Funded papers have a higher average citation count than unfunded ones, with journal rankings from Q1 to Q4.

dominant, highlighting the importance of teamwork in research; similarly, single-author papers with research funding support are also concentrated in Q1 and Q2 journals. This shows that even individual researchers can receive high recognition as long as their research is highly innovative and contributing. This also highlights the exceptional abilities of individual researchers in the field, reflecting the academic emphasis on high-quality research outcomes, regardless of whether the research is conducted individually or by a team.

Single-author papers without research funding support are still accepted by academic journals, even in situations with limited funding. This points to the importance and innovativeness of individual researchers' research topics, with unique contributions and high research capabilities.

Overall, these findings emphasize the key role of research funding support in promoting the production of high-quality research outcomes while also acknowledging the unique role and contribution of individual authors to scientific exploration. This suggests that the academic community and funding agencies should continue to support and encourage innovative research by independent researchers while also affirming the importance of teamwork in addressing complex scientific problems.

(3) Citations for papers with and without research funding

The results reveal a significant correlation between funding and paper citations, with non-single-author papers with research funding support often receiving more citations than single-author papers (Paul-Hus et al., 2016); papers with larger funding amounts have more citations than those with smaller amounts (Boyack, 2004). Wang and Shapira (2015) found that funded papers have greater impact in terms of citations and rankings. The proportion of paper citations is closely related to journal rankings, especially with Q1 journal papers having the highest citation proportion, indicating that higher-ranked papers are more likely to attract researchers' attention. This study found that Q1 and Q2 journal papers account for the majority of total citations, highlighting researchers' preference for high-quality research and confirming the importance of such research for academic development.

Cited papers with research funding support are more numerous than those without, with Q1 and Q2 leading other rankings, greatly increasing the opportunity to enhance paper quality and academic research attention. This emphasizes the positive role of research funding support in promoting academic influence and suggests that researchers should consider the potential impact of funding when choosing publication platforms, highlighting the importance of support for innovative and high-quality research. The trend Q2 > Q1 > Q3 > Q4 indicates the difficulty and high standards of publishing in Q1 journals. If a paper is included in a Q1 journal, it is highly recognized by academia and has a very high impact.

(4) Average citation count for papers with and without research funding

Papers with research funding support typically have higher average citation counts than those without funding support. This finding was also observed in this study, especially in the performance of Q1 journals, highlighting the important role of research funding in enhancing paper quality and academic visibility. Additionally, high-quality research without funding support still receives high citation counts, reflecting the academic community's high regard for research quality. Research funding not only provides necessary resources but also plays a key role in increasing academic attention to papers.

This study explores factors involved in papers' impact levels and provides researchers with a focus on influencing factors and strengthening the goal of enhancing research quality.

This study explores the factors that influence the impact levels of academic papers, aiming to help researchers identify key contributors to research visibility and quality. The analysis was based on a series of hypothesis-driven comparisons within a structured and layered framework. Although several statistical tests were performed, no formal correction for multiple comparisons was applied due to considerations of the limited number of tests.

While p-values were reported to assess statistical significance, corresponding effect sizes were not included in this version due to data constraints.

5. Conclusions

In order to integrate the study results and the gaps in this research, we address the importance and integration of the experimental results, research findings, research contributions, research limitations, and subsequent research in this section.

5.1. Importance and integration of experimental results

This study examines 4488 papers published in the AI field in 36 journals from Springer in 2018, focusing on the average number of authors, the proportion of single-authored papers, funding support, and citation patterns. In top-tier Q1 papers, the average number of authors is higher than in other ranks, and multi-authored papers are more common than single-authored ones; papers with funding support surpass those without and are mainly published in Q1- and Q2-level journals. Among funded papers, the number of multi-authored works exceeds that of single-authored ones, especially in Q1- and Q2-level journals; cited papers outnumber uncited ones, and the proportion of papers with funding support is higher than those without, particularly in Q1-level journals, where papers with funding support have the highest citation rate; in terms of citation count, papers with research funding support outperform those without, especially in Q1-level journals, where their performance is even more prominent.

5.2. Research findings

This study highlights the crucial role of academic collaboration and journal ranking in influencing the quality of research papers. Higher-ranked journals have a greater average number of authors, and across all rankings, multi-authored papers are more common than single-authored ones, underscoring the importance of academic collaboration in enhancing the quality of research outcomes. Papers reporting on funded research often adopt a team collaboration model, highlighting the crucial role of academic collaboration in driving innovation. However, single-author studies also demonstrate unique innovation and impact, especially when they receive research funding, as their research outcomes are recognized in high-ranking journals. This not only supports the conduct of high-quality research but also promotes academic collaboration and exchange, playing an important role in advancing academic research in the AI field. Cited papers highlight the importance of high-ranking journals in enhancing academic influence. Papers that receive research funding support are more likely to be recognized by Q1 journals and have a higher citation rate than those without funding. These findings emphasize the critical role of research funding in promoting the publication of academic results and increasing academic value. Papers with research funding support have a significantly higher average citation count than those without, especially in Q1 journals, highlighting the importance of research funding in enhancing academic impact. Furthermore, high-quality research can still be recognized by top-tier journals even without funding support, showing the academic community's emphasis on innovation and research quality. These results provide important guidance for researchers, academic institutions, and funding agencies in scientific innovation and resource allocation, emphasizing the crucial role of research funding and journal ranking in promoting academic achievements and increasing academic value. Finally, higher-ranked journals often publish research that is more complex, resource-intensive, and collaborative in nature, which typically involves larger research teams and greater funding support and tends to receive more academic attention and citations. Therefore, analyzing these variables in relation to journal ranking within the AI field provides valuable insights into the structure and impact of scholarly output.

5.3. Research contributions

This study contributes to the field by integrating four key bibliometric indicators—author number, funding support, journal ranking, and citation count—into a unified analysis within the AI domain. This approach differs from previous studies that often analyzed these factors in isolation or across broader, less focused datasets. It reveals that top-ranked journals, such as those in the Q1 category, typically feature papers with a higher average number of authors and a greater prevalence of collaborative authorship compared to solo-authored works. Moreover, there are significantly more papers that receive research funding than those without, especially in Q1- and Q2-tier journals. Among these funded papers, collaborative efforts far exceed solo-authored papers, particularly in higher-tier journals. Additionally, we observed that papers with a higher number of citations are often those that have received research funding, with the highest citation rates found in Q1 journals. Overall, funded papers demonstrate superior citation performance, particularly in higher-ranked journals, underscoring the importance of research funding in enhancing academic impact.

These findings highlight the significance of academic collaboration and journal rankings in enhancing the quality of research papers. High-ranking journals typically feature more co-authored papers than single-authored ones. This highlights the vital role of teamwork in achieving high-quality research outcomes. Research funding plays a pivotal role in facilitating the publication of high-quality research findings and elevating academic value. Papers with a higher number of citations underscore the importance of high-ranking journals in amplifying academic influence. Papers that receive research funding are more likely to be recognized by top-tier journals and exhibit a higher citation rate compared to those without funding. These results offer crucial guidance for researchers, academic institutions, and funding bodies in the realms of scientific innovation and resource allocation, emphasizing the key role of research funding and journal rankings in fostering academic achievements and enhancing academic value.

5.4. Research limitations

The data for this study are confined to 36 journals in the AI domain from 2018. Thus, the limitations of this research relate to the period and the number of journals. Several of these limitations are defined and outlined below:

(1) Temporal Limitation: The results of this study are confined to the year 2018.
(2) Publisher Limitation: This research focuses exclusively on Springer, excluding other publishers.
(3) Domain Limitation: This study primarily focuses on papers published in the AI field within computer science and does not include exchanges with other significant domains.
(4) We further note that conducting multiple statistical tests without correction may increase the risk of type I error. While our comparisons were pre-planned and focused, future exploratory studies with broader hypothesis testing should apply appropriate correction methods to enhance statistical rigor.
(5) Although this study involves multiple statistical analyses, effect size measures were not reported due to constraints in data and analytical methods. Future research with access to more complete datasets or more advanced statistical tools is encouraged to include effect size estimates in order to more clearly illustrate the practical significance of variable relationships.

5.5. Future research

The results of this study suggest that researchers should consider the potential benefits of research funding when choosing publication platforms, emphasizing the importance of pursuing high-quality journals that provide valuable strategies and insights for academic research. Future research can further explore the field of sustainable AI. (Sustainable AI refers to the development and deployment of artificial intelligence technologies in a way that minimizes environmental impact and maximizes long-term sustainability. This involves reducing energy consumption, minimizing waste, and promoting ethical practices throughout the AI lifecycle. It also encompasses using AI to address environmental challenges and promote sustainability in other sectors (Pachot & Patissier, 2022; Tabbakh et al., 2024; Lu & Liao, 2025).) Future studies can also explore the impact of international collaborations on journal papers and the contribution of different author ranks to research outcomes, promoting the diverse development of academic research. This study will inspire more outstanding academic research and international collaborations, collectively advancing scientific progress and fostering knowledge innovation.

Data availability statement

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

CRediT authorship contribution statement

Wei-Chao Lin: Writing – review & editing, Resources, Methodology, Conceptualization. **Huei-Hua Tsao:** Writing – original draft, Software, Data curation. **You-Shyang Chen:** Writing – review & editing, Validation, Resources, Methodology. **Chien-Lung Hsu:** Conceptualization.

Declaration of competing interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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