Analysis of Open Access Paper Development in China and the United States Over the Past Decade: A Comparison Based on the InCites Database

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Abstract

【目的】This study aims to identify comparative differences between China and the United States regarding the quantity and impact of Open Access (OA) papers over the past decade, and to propose recommendations for the current development of Chinese OA papers to promote the advancement of open science.

【方法】Based on the InCites database, this study analyzes relevant indicators of China-US OA papers from 2013 to 2022, statistically examining the quantity, type, and disciplinary distribution of OA papers published by Chinese and American researchers, as well as citation-related impact indicators, employing bibliometric methods for comparative analysis.

【结果】The quantity and proportion of Chinese OA papers are basically on par with those of the United States; however, the distribution of types is less balanced than that of the US. In terms of disciplinary distribution, the number of OA papers in medicine and life sciences far exceeds that in other disciplines. Regarding impact, there exists a gap with the United States in both highly cited papers and the CNCI index.

【结论】The development of Chinese OA papers exhibits imbalance in both type and discipline. Going forward, China should establish Open Access platforms, implement strict quality control for OA papers, and improve relevant institutional frameworks.

Full Text

Analysis of Open Access Paper Development in China and the United States Over the Past Decade: A Comparative Study Based on the InCites Database

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Abstract:
[**Purpose**] This study aims to identify comparative differences between China and the United States in terms of open access (OA) paper volume and impact over the past decade, and to propose recommendations for the current development of China' s OA papers to advance open science. [**Methods**] Based on the InCites database, we analyzed relevant indicators of OA papers from China and the US between 2013 and 2022, including the quantity, types, and disciplinary distribution of OA papers published by researchers from both countries, as well as citation-based impact metrics. Comparative analysis was conducted using bibliometric methods. [**Findings**] While the number and proportion of Chinese OA papers have essentially caught up with those of the US, the distribution of OA types is less balanced than in the US. In terms of disciplinary distribution, OA papers in medicine and life sciences far exceed those in other fields. Regarding impact, China lags behind the US in both highly cited papers and CNCI index. [**Conclusions**] The development of OA papers in China is imbalanced in terms of types and disciplines. Future efforts should focus on building open access platforms, strictly controlling OA paper quality, and improving relevant institutional frameworks.

Keywords: Open Access; CNCI; Open Science; Sino-American Comparison; InCites Database

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Open Access (OA) is a publishing model adopted by the international academic and publishing communities to promote the broad dissemination of scientific research achievements. This model allows authors to directly publish articles via the internet and enables the public to freely read, download, and disseminate them. Since the rise of the open access movement, academic institutions worldwide have actively promoted open science development. In 2018, the cOAlition S launched the Plan S initiative for OA publishing of academic achievements in Europe. In August 2022, the White House Office of Science and Technology Policy released relevant documents requiring all research results funded by the federal government to be freely accessible to the public. These developments demonstrate that the role of open access in promoting academic exchange has been widely recognized by the academic community.

China' s open access model started relatively late, but open science has gradually gained attention from the Ministry of Education, Ministry of Science and Technology, and other departments in recent years. The National Natural Science Foundation of China (NSFC), as the country' s largest funding agency for OA papers, officially launched its open access repository in 2017 to promote the development of China' s open access movement. In December 2021, the Law of the People' s Republic of China on Science and Technology Progress explicitly proposed promoting open science development for the first time. In December 2022, the China Association for Science and Technology, in collaboration with the International Association of Scientific, Technical and Medical Publishers, jointly released the Chinese and English versions of the *China Open Access Publishing Development Report (2022)* on domestic and international platforms, marking another important initiative in China' s open science practice.

Open access has also received widespread attention from the academic community. Some scholars have conducted in-depth studies on the development of foreign open access movements at the government, societal, and industry levels. For instance, Cui Liyuan and Yu Linxi conducted an in-depth discussion on the motivations, principles, and implementation process of the EU' s Plan S initiative, arguing that China should also take active measures to participate [1,2]. Xie Ao et al. studied the open access agreement between Projekt DEAL and Springer Nature, and proposed recommendations for China' s open access academic publishing based on their findings [3]. Other scholars have conducted bibliometric research from the perspective of OA paper and journal development. For example, Liu Jiayu and Wei Mingkun measured impact metrics to explore the advantages of OA papers and journals and their influence on China' s academic publishing [4,5]. Yang Siluo et al. compared download and citation metrics of OA papers between China and the US using seven OA journals as samples [6]. Sun Shujun et al. analyzed OA data across different disciplines and institutions [7]. Additionally, some scholars have examined the role of research funding agencies in open access development from the perspective of research mechanisms. For instance, Sun Mengjia et al. compared the open access levels of papers funded by NSFC and three foreign science funding agencies (EPSRC, NSF, NIH) based on large-scale data from Unpaywall [8]. Cheng Weihong et al. investigated OA publication fees for SCI papers from major countries and found that Chinese OA paper publication is highly dependent on funding [9].

While the aforementioned scholars have studied open access from multiple angles—including foreign OA development trends, advantages of the OA model for papers and journals, and the current status of Chinese OA papers—several questions remain unclear. These include the overall status of Chinese OA papers published in international journals, the specific situation across disciplines, and what gaps still exist compared to the United States. In light of this, this study aims to analyze the trends in the quantity and impact of Chinese OA papers from 2013 to 2022. Relying on the InCites database, we examine the current status of OA papers in China and the US from both overall conditions and disciplinary development perspectives, with specific indicators including OA paper

volume, OA paper types, Category Normalized Citation Impact (CNCI), and other metrics. We hope that the analysis results will clarify the gaps between China and the US in OA paper publication volume, impact, and disciplinary distribution, and provide corresponding recommendations to improve the quality of Chinese OA papers and accelerate the development of China' s open access movement.

1.1 Data Sources

The InCites database aggregates data from the seven core index databases of Web of Science (WOS) over the past 30 years, offering diverse indicators and rich visualization capabilities. Adhering to principles of data availability and research feasibility, this study selected OA journal papers published between 2013 and 2022 with authors affiliated with mainland China and the United States as research subjects. We retrieved relevant paper information from the InCites database to analyze the development of OA papers in both countries.

The retrieval method for obtaining Chinese and US OA paper data from the InCites database was as follows: In the database, we selected regional entity types, set the dataset to InCites Dataset, defined the time span as 2013-2022, selected "All Open Access" as the open access type, chose "Citation Topics" as the research field classification system, and set the classification level to "Macro." Focusing on scientific and basic discipline fields, this study analyzed only the top eight fields excluding social sciences and arts/humanities, including: Medicine and Life Sciences, Chemistry, Physics, Agriculture and Environmental Sciences, Engineering and Mechanical Sciences, Electronic Engineering and Computer Science, Earth Sciences, and Mathematics. We selected "USA" and "CHINA MAINLAND" in the country/region field to download paper data for both countries. The downloaded information included OA paper volume, OA paper types and their proportions, number and proportion of highly cited OA papers, CNCI of OA papers, and other data.

1.2 Research Methods

This study analyzes the current status and differences of Chinese and US OA papers from two perspectives: paper indicator comparison and temporal disciplinary distribution. Four dimensions—OA paper volume and proportion, OA paper type distribution, highly cited OA papers, and OA paper CNCI index —were used to present the overall comparison of OA papers. Temporal disciplinary distribution was used to show the development of OA papers in various disciplines. Through the InCites database, we calculated OA paper indicators from the WOS core collection data for 2013-2022, and conducted a longitudinal trend analysis of OA papers published by Chinese and US researchers using the above indicator dimensions to obtain comparative results on OA paper volume and impact between the two countries. Due to the time lag in paper indexing, relevant indicator data for 2022 may have slight deviations, a situation that will not be elaborated upon in subsequent analysis.

2.1.1 OA Paper Volume

This study counted the number of OA papers from China and the US included in the WOS core dataset from 2013 to 2022 (Figure 1 [Figure 1: see original paper]). From 2013 to 2022, China published 1.6591 million OA papers, while the US published 2.8158 million OA papers, accounting for 32.97% and 39.54% of the total papers from each country, respectively. The US had higher OA paper volume and proportion than China, but China' s OA paper volume grew faster than that of the US, and its proportion also increased rapidly.

2.1.2 OA Paper Type Distribution

Based on the classification standards of the InCites database, this study categorized OA papers into Gold, Hybrid, Bronze, and Green OA, and analyzed the type distribution of OA papers in both countries. Gold OA is currently the most widely used type, referring to papers published in fully OA journals where authors pay article processing charges to achieve open access. Hybrid OA refers to publishers that retain traditional subscription models while offering OA options to authors. Bronze OA, also known as free reading, refers to publishers proactively selecting certain papers as open resources without author fees, with the right to revoke open access at any time. Green OA refers to articles archived by authors on personal websites or in institutional repositories, including published articles, accepted articles, and submitted articles [10].

The distribution of Chinese OA paper types is shown in Figure 2 [Figure 2: see original paper]. It can be seen that Chinese researchers predominantly publish Gold OA papers. The proportion of Gold OA papers reached 45.15% in 2013 and increased year by year, exceeding 50% in 2015. In 2022, Gold OA reached its peak at 80.41%. Meanwhile, the proportions of other OA types continued to decline, with the gap between Gold OA and the other three types gradually widening. Overall, Hybrid OA papers had the lowest proportion, while Green and Bronze OA papers had similar proportions.

The distribution of US OA paper types is shown in Figure 3 [Figure 3: see original paper]. Unlike China, US OA papers are more evenly distributed across the four types. Before 2020, Green OA was dominant, with its volume remaining stable at around 100,000 papers. However, the proportion of Gold OA papers continued to rise, becoming mainstream after 2020. In 2021, the number of Gold OA papers was 123,300, reaching the highest proportion of 47.27% in 2022. Although the increase was modest, the proportion of Hybrid OA papers also rose, while Bronze and Green OA proportions showed an overall downward trend.

Comparing the OA paper type distribution between China and the US, in 2013, the number of Gold OA papers that dominated Chinese OA papers was only 72.54% of US Gold OA papers. By 2016, they were basically equal, and in 2017, Chinese Gold OA volume surpassed that of the US for the first time. However, it should also be noted that China' s open science started relatively

late, and the excessive proportion of Gold OA has led to a relatively singular type structure. The US has more policy provisions in this regard to safeguard open science development. For example, the US federal government stipulates that publicly funded research results must be converted to Green OA 12 months after publication .

2.1.3 Highly Cited Papers

Citation rate reflects the degree of attention and recognition a paper receives to some extent, so the number and proportion of highly cited papers can be used to reflect the overall quality of OA papers. The comparison of highly cited papers between China and the US is shown in Figure 4 [Figure 4: see original paper]. In 2013, China had 762 highly cited OA papers, which continued to increase, reaching a peak in 2020. The proportion of highly cited papers changed relatively smoothly, slightly decreasing after 2020 but generally remaining within the 0.5%-1.5% range. The US, however, had far higher numbers and proportions of highly cited papers than China. Although its growth rate was relatively low, the overall trend was stable and rising, also peaking in 2020. Between 2013 and 2020, the proportion of highly cited papers in the US showed a year-by-year decline, narrowing the gap between the two countries in terms of both number and proportion. However, the peak number of Chinese highly cited OA papers in 2020 was 3,575, only 58.13% of the US figure, indicating that the impact of Chinese OA papers still needs improvement.

2.1.4 Category Normalized Citation Impact

To eliminate the influence of different publication years and disciplinary fields on paper impact, this study used the Category Normalized Citation Impact (CNCI) indicator to compare and analyze Chinese and US OA papers, with results shown in Figure 5 [Figure 5: see original paper]. In 2013, the CNCI index for US OA papers was 1.77, rising to 1.78 in 2014, then declining year by year to 1.46, but still far above the global average. The CNCI index for Chinese OA papers showed an overall upward trend from 2013, reaching a peak of 1.28 in 2020, then beginning to decline, but never falling below the global average. It is clear that there remains a significant gap in impact between Chinese and US OA papers, with the difference in CNCI index ranging from 0.30 to 0.62, indicating substantial room for improvement in the impact of Chinese OA papers.

2.2 Disciplinary Analysis

According to the temporal changes in Chinese OA paper distribution by discipline (Figure 6 [Figure 6: see original paper]), the field of Medicine and Life Sciences grew from 24,100 papers in 2013 to 113,100 papers in 2022, showing the most significant increase. The fields of Electronic Engineering and Computer Science and Agriculture and Environmental Sciences also saw substantial growth, followed by Chemistry. Except for Chemistry, basic science fields such as Physics, Mathematics, and Earth Sciences showed relatively small increases

in OA paper volume over the past decade, while Engineering and Mechanical Sciences showed moderate growth. From the temporal changes in US OA paper distribution by discipline (Figure 7 [Figure 7: see original paper]), except for Medicine and Life Sciences, OA paper volumes in other disciplines remained very stable from 2013 to 2022.

2.2.1 Medicine and Life Sciences The gap in OA paper volume between China and the US in Medicine and Life Sciences has narrowed year by year since 2013, but China still has room to catch up. From 2013 to 2019, the CNCI index of US OA papers in this field was consistently higher than China' s. In 2020, China achieved a brief lead before falling back. Although remaining above the global average overall, the gap with the US has shown a widening trend. From 2013 to 2020, the percentage of highly cited papers in Chinese medical OA papers showed an overall upward trend, with the smallest gap with the US in 2020 at 0.63%. However, consistent with the CNCI trend, the decline in 2021 was significant, and the gap with the US widened again.

2.2.2 Chemistry From 2013 to 2022, China published 172,700 OA papers in Chemistry, while the US published 180,000. In 2013, the difference in OA paper volume between China and the US in this field was 5,700 papers. During 2013-2021, China' s OA paper volume continued to rise, surpassing the US for the first time in 2019 and maintaining the lead through 2022. The CNCI index of Chinese Chemistry OA papers changed relatively smoothly from 2013 to 2022, reaching a peak of 1.36 in 2016, then slightly declining but remaining above the global average. The US CNCI index declined throughout the period, and by 2021, the two sides were nearly equal with a gap of only 0.02. From 2013 to 2019, the percentage of highly cited papers in Chinese Chemistry OA papers was consistently lower than that of the US, but the upward trend was stable and continuously narrowed the gap. In 2020, China surpassed the US at 2.97%, and in 2021 maintained its high-position advantage, 0.16 percentage points higher than the US.

2.2.3 Physics From 2013 to 2022, US OA paper volume in Physics increased but with limited growth, while Chinese OA paper volume showed an overall upward trend with slight declines in 2020 and 2022, peaking at 16,400 papers in 2021. The gap with the US has continuously narrowed. Over the past decade, the CNCI index of Chinese Physics OA papers has been very stable, consistently maintained between 1.25 and 1.4, with the smallest gap with the US in 2021 at approximately 0.3. The proportion of highly cited Chinese Physics OA papers fluctuated from 2013 to 2022, but the overall trend was relatively stable, similar to the CNCI index, peaking at 1.75% in 2018, 0.44 percentage points lower than the US.

2.2.4 Agriculture and Environmental Sciences From 2013 to 2020, Chinese OA paper volume in Agriculture and Environmental Sciences was consis-

tently lower than that of the US, but showed an overall growth trend with higher growth rates than the US. The gap with the US decreased from 8,700 papers in 2013 to 1,000 papers in 2020, and China achieved a lead over the US in 2021. Over the past decade, both countries showed obvious downward trends in CNCI index and highly cited paper percentage in this field. The US CNCI index declined by 0.65, while China' s index fell from 1.36 in 2013 to 1.03 in 2022, a smaller decline but still slightly inferior to the US overall. The gap in highly cited percentage was more pronounced than in CNCI, with a difference of 0.21 percentage points between China and the US in 2022.

2.2.5 Engineering and Mechanical Sciences Since 2013, China has consistently led the US in OA paper volume in Engineering and Mechanical Sciences. While China' s volume has grown steadily year by year, its advantage over the US has gradually expanded. In 2013, China' s OA paper volume was 3,000 papers, 500 more than the US, but by 2022, China's volume had climbed to 22,700 papers, 18,000 more than the US. However, the impact of Chinese Engineering and Mechanical Sciences OA papers lags behind that of the US. The CNCI index has shown a continuous downward trend since 2017. Although the gap with the US narrowed during this period, it remains below the global average. The highly cited percentage of Chinese OA papers in this field showed an upward trend after 2019, peaking at 1% in 2021, only 0.17 percentage points lower than the US, before slightly falling back.

2.2.6 Electronic Engineering and Computer Science From 2013 to 2019, Chinese OA paper volume in Electronic Engineering and Computer Science showed a clear upward trend, surpassing US volume for the first time in 2017 with a lead of 1,200 papers. China' s OA paper volume reached 30,100 papers in 2019, slightly decreased in 2020, and resumed its upward momentum in 2021. In 2013, the CNCI index of Chinese OA papers in this field differed from that of the US by 1.43, gradually increasing to 1.96 in 2015, then narrowing to a minimum gap of 0.31 in 2021. The gap in highly cited percentage between the two countries in this field was less pronounced than the CNCI gap. In 2013, China lagged behind the US by 0.77 percentage points, which narrowed to 0.12 percentage points by 2015, and in 2021, China' s highly cited percentage exceeded that of the US by 0.06 percentage points.

2.2.7 Earth Sciences Chinese OA paper volume in Earth Sciences grew continuously from 2,200 papers in 2013 to 12,300 papers in 2022, surpassing the US for the first time. US OA paper volume in this field remained relatively stable, similar to trends in US Physics and Chemistry OA papers, indicating that open science in basic science fields is relatively mature in the US. The CNCI index of Chinese OA papers in this field showed a downward trend but remained above the global average. Although still inferior to the US, the two countries were generally very close, with a maximum difference of only 0.29. Both countries showed downward trends in highly cited percentage for OA papers in this field,

with the maximum difference between China and the US being 0.78 percentage points.

2.2.8 Mathematics The difference in OA paper volume between China and the US in Mathematics was the smallest among all fields, and the volume was also the most stable. China' s peak occurred in 2021 with 6,400 papers, slightly declining in 2022. US OA paper volume in this field was similarly stable, with only a significant increase in 2021. The CNCI index of Chinese Mathematics OA papers exceeded the global average starting in 2015, surpassed the US in 2020, then declined again after 2021. The highly cited percentage of Chinese Mathematics OA papers led the US between 2015 and 2020, with a maximum difference of 1.03 percentage points, but was gradually surpassed by the US after 2021, though the gap remained minimal.

3.1 Conclusions

Through comparative analysis of the quantity, types, highly cited papers, CNCI index, and temporal disciplinary distribution of OA papers from China and the US between 2013 and 2022, this study reveals the current status and existing gaps in OA papers between the two countries. The research shows that while the number of OA papers published by Chinese researchers in international journals is lower than that of the US, its proportion is gradually showing a trend of catching up, indicating that the OA model is being increasingly accepted by Chinese researchers. Notably, China' s open science development lags behind that of the US, with OA paper type distribution overly concentrated in Gold OA and low proportions of other OA types—a trend that becomes more pronounced over time. In contrast, US OA papers show more balanced and diversified type distribution. In terms of paper impact, both the number and proportion of highly cited Chinese OA papers have increased over time, narrowing the gap with the US, though there remains considerable room for improvement. The CNCI index of Chinese OA papers has generally remained above the global average since 2013, while the US OA paper CNCI index has remained above 1.4 despite continuous decline, indicating that the impact of Chinese OA papers urgently needs improvement. Regarding disciplinary distribution, both countries have very high proportions of OA papers in Medicine and Life Sciences, far exceeding other disciplines. Additionally, China has seen the largest increase in OA papers in Electronic Engineering and Computer Science, with certain increases also observed in basic disciplines such as Earth Sciences and Mathematics.

3.2 Recommendations

Given the existing gaps in open science development between China and the US, it is necessary for the Chinese scientific community to enhance recognition of the OA model, improve OA paper quality, and reduce the outflow of research funds to "predatory" international journals. Based on the above comparative analysis, this study proposes the following recommendations.

Build open access platforms to accelerate OA model development. The OA model for paper publishing facilitates the free dissemination of scientific and technological achievements and enhances public utilization of scientific research, representing the general trend of scientific achievement publishing. China' s OA movement started late and its development has been somewhat lagging. Currently, China' s large-scale open access platform, COAJ, still faces problems after more than a decade of development, such as a small number of included journals and low international recognition [11]. Traditional platforms such as repositories, databases, and portals built with participation from universities, research funding agencies, and other institutions suffer from low resource utilization in the implementation of open access for research papers [12]. China should take action to build a national-level large-scale Green OA platform to promote recognition of the open access model domestically. By establishing a unified Green OA platform, operational costs can be reduced, scattered open access resources can be integrated at lower cost, and the usability and compatibility of OA platforms can be better optimized and guaranteed. A unified platform can facilitate researchers' publication, access, and use of content through international standard compliance, improved response speed, open OA hosting services, and support for cross-platform access, thereby promoting international cooperation and exchange, helping researchers participate in global OA initiatives and policies, and accelerating the development of the OA model in China.

Strictly control paper quality to improve OA paper recognition. The large gaps in OA paper proportions across disciplines in China and the unbalanced types of published OA papers indicate that open access still has considerable room for promotion domestically. To enhance its recognition, we must first improve understanding of the OA model among researchers in different disciplines and publishing institutions of different types. Second, OA paper quality should be enhanced through more rigorous peer review mechanisms, more transparent review processes, more thorough paper data disclosure mechanisms, and more comprehensive social supervision mechanisms. This can strengthen OA journal construction while expanding publication pathways for researchers without affecting their achievement quality and research integrity. Finally, a reasonable scientific achievement evaluation system and an early warning mechanism for poor-quality journals should be established to encourage researchers to choose high-quality OA journals or platforms for paper publication, and to encourage universities, research institutions, and libraries to lead the establishment of academic supervision systems that regularly publish and update lists of OA journals not recommended for submission, thereby circumventing some current drawbacks of OA publishing.

Improve open access policies and expand OA model funding sources. In recent years, science funding agencies have become one of the main participants in the "open science" movement [13]. Compared with the US, Chinese OA papers rely more heavily on funding from the National Natural Science Foundation. Therefore, to promote high-quality OA development in China and

reduce the financial pressure on researchers to publish OA papers, optimization of the funding structure is essential. Support from science funding agencies and assistance from research institutions are key factors in funding structure optimization. Additionally, operational models such as transformative agreements and institutional payments from relevant agencies are conducive to the sustainable operation of OA journals while ensuring quality. Therefore, establishing more systematic and standardized open access publishing policies and optimizing funding structures are beneficial for building a sustainable open access operational model, ensuring the sustainable development of the OA model. These are also effective measures for enhancing the international impact of Chinese OA papers and further accelerating the development of China' s open science.

Compared with traditional publishing models, the open access model offers advantages such as shorter review cycles and broader achievement dissemination, representing an important measure for achieving "academic sharing" in the digital age. Through comparison of international journal OA papers published by researchers from China and the US, this study provides a clear demonstration of current gaps between the two countries. However, this study only focuses on journals included in the InCites database. Due to limitations in journal information disclosure and platform data volume, the research results may have certain limitations. Future research could attempt statistical analysis based on full-text search engines or by integrating multiple databases to more comprehensively and objectively grasp the current status of Chinese OA papers and promote the sustainable development of the open access movement in China.

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Note: Figure translations are in progress. See original paper for figures.