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The Evolution and Trends of Tai Chi Research: A Bibliometric Visualization Study

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Abstract: This study systematically analyzes the literature in the field of Tai Chi research using bibliometric methods, aiming to identify research hotspots, development trends, and application scenarios. Through citation analysis, keyword co-occurrence analysis, and temporal analysis, the study explores the disciplinary layout, key themes, and emerging frontiers of Tai Chi research. The findings indicate that Tai Chi research primarily focuses on health interventions, psychological regulation, and cultural dissemination, with significant value in enhancing balance, managing chronic diseases, and facilitating cross-cultural communication. This study provides theoretical support for understanding the developmental trajectory of Tai Chi research and proposes new directions for its application in health sciences and cultural dissemination.

Keywords: Tai Chi, Evolution and Trends, Bibliometric Analysis, Visualization Study

1 Introduction

In recent years, with the continuous enhancement of global health awareness and the revival of traditional culture, Tai Chi, as a treasure of Chinese traditional culture, has increasingly attracted the attention of both academia and the public (Webster et al., 2015; Solloway et al., 2016). Tai Chi is not only a form of exercise but also a practical embodiment of philosophical thought in motion. It integrates traditional Chinese medical theories such as yin-yang balance and qi-blood regulation, while also offering significant benefits for physical fitness and psychological adjustment (Gaofeng, 2017). In recent years, with the strengthening of international cultural exchange and the development of modern communication technologies, Tai Chi has gradually become an important concept worldwide for promoting health and cultural exchange. Research indicates that Tai Chi not only has irreplaceable advantages in health and wellness but also integrates with the leisure tourism industry, driving its global spread and innovative development (Qiu, 2017). Additionally, international reviews highlight that Tai Chi helps improve balance, strengthen bones, and reduce pain, demonstrating its significant benefits for physical and mental health, making it a practice that blends tradition with practicality in modern society (Abdi, 2019).

Facing the rapid pace of modern society and the prevalence of lifestyle diseases, traditional forms of exercise such as Tai Chi offer a solution that integrates with modern health needs. Studies have shown that Tai Chi significantly improves balance in the elderly, prevents falls, improves chronic diseases such as hypertension, diabetes, and chronic obstructive pulmonary disease, and alleviates psychological stress (Zou et al., 2019; Grégoire et al., 2019).Especially in the management of chronic diseases and the regulation of mental health, the long-term

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intervention effects of Tai Chi have been widely recognized and have become an important part of many recognized health intervention programs (Wang et al., 2022; Guo et al., 2020). With the global spread of digital technologies and continuous advancements in data analysis methods, scholars have systematically studied the health effects, dissemination paths, and cultural archaeology of Tai Chi using emerging technologies such as big data and artificial intelligence (Zhang & LiNa, 2022).This scientific research method, through quantitative analysis of the number and distribution characteristics of the literature, has revealed the development dynamics, hot directions, and future trends in the field of Tai Chi research (You et al., 2021).In recent years, an increasing number of studies have focused on the role of Tai Chi in cross-cultural transmission, health interventions, and social impacts, leading to a trend of interdisciplinary research (Solloway et al., 2016; Yang et al., 2021).

Therefore, this study employs bibliometric tools to systematically organize and analyze research literature on Tai Chi from 2004 to 2024. Through data mining and visualization methods, it explores the research status and trends of Tai Chi on an international scale, providing a reference for future research and practice. The specific research questions are as follows:

- Analyze the core concepts in Tai Chi research literature published between 2004 and 2024, including authors, journals, and countries, identifying key scholars and institutions, highly cited papers, and international collaboration networks.
- Explore the main research hotspots of Tai Chi in health interventions, cultural dissemination, and social impacts, analyze the evolution of research themes across different phases, and investigate potential future development trends.

2 Data Sources and Methods

2.1 Data Sources

The data for this study are sourced from the Web of Science Core Collection database. This database covers a wide range of high-quality academic journals worldwide and is one of the essential tools for academic research and bibliometric analysis (Yan & Wang, 2023). The search period was set from January 1, 2004, to November 1, 2024, aiming to analyze the development and trends in the field of Tai Chi research.

To ensure the search results were relevant to the research topic, this paper employed a search strategy designed for Tai Chi (Fukuda & Tomiura, 2017). The search keywords used were (TS= (Tai Chi)) OR TS=(Taijiquan), yielding 223 related publications. These documents included journal articles, review papers, and conference abstracts, with the language restricted to English. During the data cleaning process, irrelevant documents and duplicate records were removed, resulting in a final dataset of 182 documents.

In the data process, the normalization of keywords is extremely important. For example, merging keywords with the same or similar meanings into a unified term helps avoid biases in statistics (Gündogdu & Saraçlar, 2017). Additionally, to ensure the accuracy and scientific rigor of the study, documents primarily focused on non-Tai Chi applications were excluded, even if they involved related fields, as they lacked direct discussion or theoretical contributions to Tai Chi. This rigorous screening process ensured the high quality of the final dataset and maintained a strong focus on the research topic.

From **Figure1**, this study focuses on analyzing annual publication growth trends, core authors and core partitions, country publication data, keyword co-occurrence relationships, and temporal trends. These analyses not only provide a systematic perspective on the development of the Tai Chi research field but also offer important references for future related studies (Yangshuo, L., 2013).

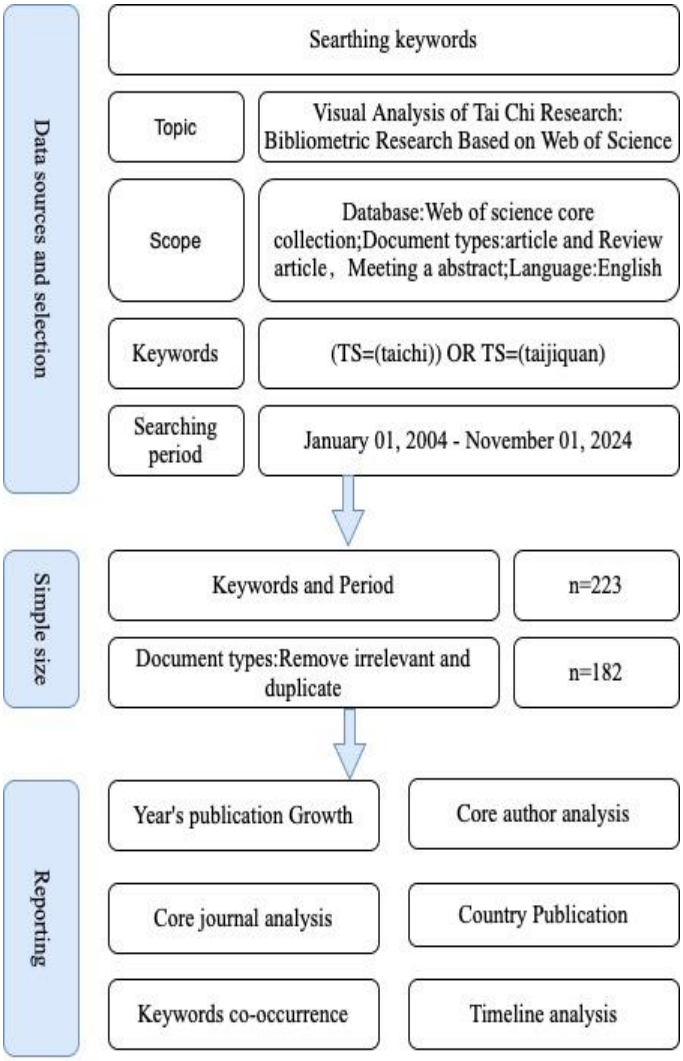

Figure 1 Workflow of Bibliometric Analysis on Tai Chi Research

2.2 Analysis Methods

This study utilizes bibliometric methods, employing Cite Space and VOS viewer software to analyze pre-processed literature data (Ding & Yang, 2020).Cite Space is a commonly used scientific literature analysis and visualization tool that can reveal the knowledge structure and development trends of research fields (Chen, C., 2018).It is particularly suitable for analyzing relationships such as keyword co-occurrence, author collaboration networks, and document co-citation in the literature, helping researchers intuitively understand the structure and development trends of academic fields (Khuan, H., Bakri, A., & Lusianawati, H., 2023).

3 Results Analysis

3.1 Descriptive Statistics

In the field of Tai Chi research, descriptive statistics provide critical foundational information to uncover the overall development characteristics of this are（Yang et al., 2021). By systematically analyzing publication volume, core authors, journal distribution, and inter-country research collaborations, the significant trends in Tai Chi research become apparent.

The time distribution of publication volumes over the past two decades shows a steady growth trend in Tai Chi research, particularly in the domains of health intervention, psychological regulation, and cultural dissemination. The identification of core authors and journals further clarifies the key academic contributors and the primary platforms for knowledge dissemination. Meanwhile, core country analyses reveal the focal areas of research within different nations and highlight the dynamics of international collaboration.

These descriptive statistics not only provide a data-driven basis for understanding the current state of Tai Chi research but also lay a solid foundation for subsequent keyword analysis and trend studies. This analysis underscores the field's steady expansion and its growing importance within both academic and practical applications.

3.1.1 Publication Volume Statistics

This study analyzed 182 papers sourced from 36 countries, 332 institutions, and 760 authors. These papers were published across 119 journals and cited 5,979 references from 3,013 distinct journals.

According to the distribution of publications over time in the field of Tai Chi research shown in **Figure 2**, the overall trend indicates a continuous increase in the volume of publications. Notably, after 2018, there was a significant rise in the number of publications. In 2020, the number of papers published reached 17; in 2021, it further increased to 20; and in 2022, it hit a historical high of 33. Although the number of publications in 2023 and 2024 declined slightly to 25 and 21, respectively, it remains at a relatively high level. This indicates that in recent years, Tai Chi research has gained widespread attention in academic circles and has become an important direction in the fields of cultural communication and health studies.

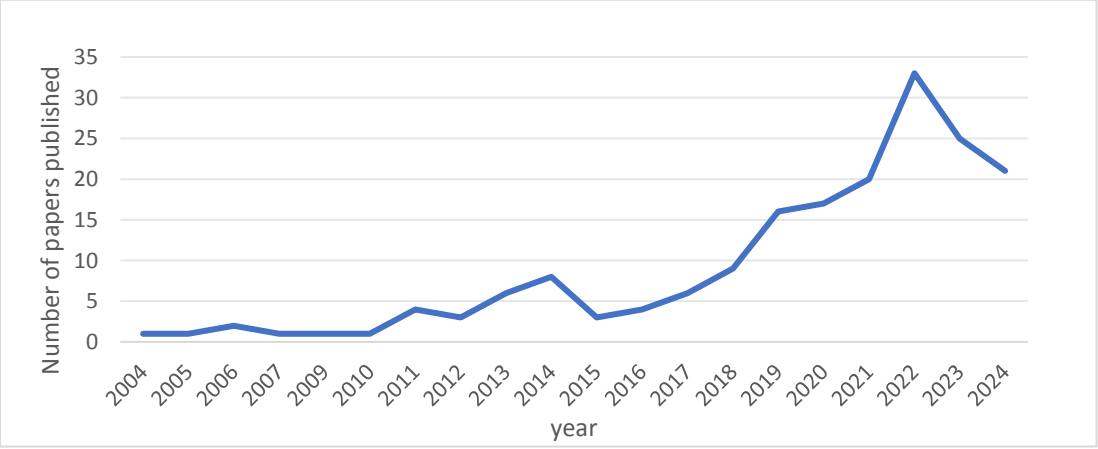

Figure 2 Annual Publication Trends of Tai Chi Research Papers (2004-2024)

3.1.2 Core Author Analysis

By analyzing the authors of the literature, it is possible to identify the representative scholars and core researchers in this field. In 1963, Derek J. de Solla Price proposed the famous Price's Law, which states that in a given scientific field, 50% of the papers are produced by the square root of the total number of authors in that field. This theory has garnered widespread attention from scholars for further development. For example, Egghe precisely calculated the relationship between Price's Law and Lotka's Law in his paper and mathematically demonstrated the applicability of this law (Egghe, 2005). Additionally, Nicholls empirically examined the validity of Price's square root law and explored its relationship with Lotka's Law (Nicholls, 1988).

$$\sum_{m+1}^{I} n(x) = \sqrt{N}$$

In the formula, n(x) represents the number of authors who have written xxx papers, and I=n max indicates the number of publications by the most prolific author in the field (i.e., the total number of papers by the most prolific author). Based on Cite Space statistics, n=4, N represents the total number of authors, and m represents the minimum number of publications required to be considered a core author. According to Price's Law, the minimum number of publications m for core authors in a given field is calculated as:

$$\mathbf{m=0.749x\sqrt{4}\approx 1.49}$$

Therefore, authors with a publication count of 2 or more (including 2) are identified as core authors in this field. A total of 49 core authors were identified, collectively contributing 121 papers, which accounts for 66.5% of the total publications, meeting the 50% threshold proposed by Price. Substituting these values into the formula also aligns with the calculations of Price's Law.

Thus, it can be concluded that a relatively stable group of authors has emerged in the field of Taijiquan research. Table 1 lists the high-productivity authors in this field, defined as those with at least four publications, showcasing their significant contributions to the development and dissemination of Taijiquan studies.

Table 1 Top Authors in the Field of Tai Chi Research

Rank	Author	Documents	Citations	Average Citation/Publication
1	Zou, Liye	4	67	16.75
2	Wang, Lin	4	40	10
3	Cherkashin, Ilia	4	28	7
4	Kruszewski, Artur	4	28	7
5	Ma, Xiujie	4	12	3
6	Soh, Kim Geok	4	12	3

The author with the highest publication volume is Professor Zou Liye from China, with 4 published papers and a total of 67 citations, resulting in an average citation per paper of 16.75. Ranking second is Professor Wang Lin, who also published 4 papers, with a total of 40 citations and an average citation rate of 10 per paper.

It is worth noting that both Cherkashin Ilia and Kruszewski Artur have published 4 papers each, with a total of 28 citations, averaging 7 citations per paper (Liang et al., 2023). In contrast, Ma Xiujie and Soh Kim Geok have relatively lower total citation counts, with 12 citations each, averaging 3 citations per paper (Ma et al., 2023), indicating that their research has comparatively limited influence in this field.

From the data analysis, it is evident that while Zou Liye and Wang Lin performed well in terms of publication volume and citation rate, there remains room for improvement in their average citation impact. Similarly, while the studies by Cherkashin Ilia and Kruszewski Artur exhibit moderate citation rates, their overall influence in the field is still relatively limited. These scholars have significant potential for growth in terms of improving the quality of their publications and increasing their academic impact in the future.

3.1.3 Core Journal Analysis

By analyzing journals, it is possible to identify the core journals in a specific field. Bradford's Law is an important tool in bibliometrics, used to analyze and recognize core journals in academic disciplines. Through Bradford's Law, we can determine which journals are core, secondary core, and peripheral in a particular field (Shenton & Hay-Gibson, 2011).

Bradford's Law (Naranan, 1970) describes the distribution characteristics of journals, which typically follow the pattern of 1: n: n^2. It indicates that the number of journals in each zone increases by a certain multiple. This distribution reflects a relatively uneven growth: the core zone contains the fewest journals, which publish the majority of the core literature in a given discipline. The number of journals in the secondary core zone is greater than that in the core zone, yet the volume of literature published is comparable. The number of journals in the peripheral zone further multiplies, while the volume of literature published remains equivalent to that of the core and secondary core zones.

According to the statistics generated by VOS viewer, the journal with the highest number of publications in this field is *Evidence-Based Complementary and Alternative Medicine*, with 8 papers published. Applying Bradford's Law, where $n^2 = 8$, we estimate $N \approx 2.83$. This calculation suggests that journals with 3 or more publications can be considered core journals in the field of Tai Chi research.

Table 2 Top 6 Journals by Publications and Citation Metrics

Rank	Source	Documents	Citations	Average Citation/Publication
1	Evidence-Based Complementary and Alternative Medicine	8	139	17.38
2	Archives Of Budo	5	35	7.00
3	International Journal of Environmental Research and Public Health	5	115	23.00
4	Medicine	5	2	0.40
5	Frontiers in Public Health	4	12	3.00
6	Psychiatria Danubina	4	1	0.25

From the data listed in Table 2, which displays the publication performance of the top six journals based on statistics from VOS viewer, the journal with the highest number of publications is **Evidence-Based Complementary and Alternative Medicine**, with a total of 8 papers. As a journal focusing on evidence-based and alternative medicine research, it covers a wide range of topics, particularly in the application of Tai Chi in health and medical research, thus demonstrating significant academic influence in the field. **International Journal of Environmental Research and Public Health** and **Archives of Budo** follow closely behind, each with 5 publications. The former has a total of 115 citations, achieving a high average citation per publication of 23.00, which indicates its research on public health and environmental health has received considerable recognition. The latter has 35 total citations and an average citation per publication of 7.00, reflecting a certain level of influence in the study of Tai Chi and martial arts culture.

The journal **Medicine** also has 5 publications, but with only 2 total citations and an average citation per publication of 0.40, suggesting limited impact in the field. Similarly, **Frontiers in Public Health** and **Psychiatria Danubina** have low average citation rates of 3.00 and 0.25 respectively, indicating relatively low attention and influence in related research.

Overall, **Evidence-Based Complementary and Alternative Medicine** and **International Journal of Environmental Research and Public Health** dominate research in this field. Their high total and average citation rates highlight the substantial academic value of their research outcomes. Moving forward, enhancing research quality and fostering deeper international academic collaboration will further advance studies in the fields of health and public health.

3.1.4 Core Country Analysis

In the bibliometric analysis of countries, to ensure the representativeness and stability of the data, only countries with more than five publications were included in the analysis. The relevant statistics are as follows:

Table 3 Top 10 Countries by Research Output and Impact

Rank	Source	Documents	Citations	Average Citation/Publication
1	China	131	1119	8.54
2	USA	23	322	14.00
3	Canada	7	89	12.71
4	South Korea	7	25	3.57
5	Australia	5	88	17.60
6	England	5	24	4.80
7	Germany	5	183	36.60
8	Japan	5	19	3.80
9	Malaysia	5	12	2.40
10	Poland	5	35	7.00

From Table 3, in terms of research output, China (Peoples R China) takes a clear lead with 131 publications, demonstrating its outstanding research wealth and resource investment in this field. The United States (USA) ranks second with 23 publications, reflecting its active involvement in the research. Other countries, such as Canada, South Korea, and Australia, have fewer publications but maintain a certain level of academic contribution.

In terms of citation count, China has a total of 1,119 citations. Although it has the highest publication volume, its average citation per paper is 8.54, indicating a relatively balanced research influence. The United States has a total of 322 citations, with an average citation rate of 14.00 per paper, reflecting strong academic impact. Notably, while Germany has fewer than five publications, its average citation rate reaches an impressive 36.60, highlighting the exceptional academic value and international recognition of its research contributions.

Additionally, Australia demonstrates notable academic impact with an average citation rate of 17.60. In contrast, countries like South Korea, Malaysia, and Japan exhibit relatively lower average citation rates of 3.57, 2.40, and 3.80, respectively, indicating a more limited influence of their research in the international academic community.

Figure 3 National Collaboration Network Map

Figure 3 shows the National Collaboration Network Map, where each node represents a country. The size and color of the nodes reflect the level of participation and activity of that country in research. The connecting lines between nodes indicate academic collaboration between different countries. The more numerous and thicker the lines, the closer the collaboration.

China (People's Republic of China) stands out as the most prominent node in this network, indicating its significant position and major contributions in the research field. China has collaboration links with multiple countries, particularly with the United States, Canada, and Germany. These connections highlight China's active role and increasing trend of internationalization in academic research.

The United States (USA) is also a key participant in this field, maintaining notable collaborative relationships with China, Germany, and India. The USA's international collaborations underscore its global academic influence, especially in partnerships with European and Asian countries, where it remains highly active.

Australia and Denmark appear as relatively independent nodes, indicating that their academic activities are primarily focused on collaborations with neighboring countries. Australia's collaboration network extends to Southeast Asia and Europe, showcasing a cross-regional cooperation trend. Canada's node reflects its links with China and Chile, participating in some intercontinental collaborative networks.

European countries such as Germany and France demonstrate strong academic collaboration, particularly with the United States and China, emphasizing their significant roles in international academic exchange.

This analysis reveals a dual-polar collaboration pattern centered around China and the United States in this research field. Additionally, an increasing number of countries are entering this field through regional and international collaborations. In the future, fostering deeper collaborations and enhancing academic exchanges will contribute to improving the research quality and impact in this domain.

3.*2 Keyword Analysis*

3.2.1 Keyword Co-occurrence Analysis

Figure 4 represents the analysis of the keyword co-occurrence network conducted through Cite Space. The merged network consists of 296 nodes and 1,083 links, indicating a relatively extensive academic discussion and close thematic connections within the research field. This reflects the strong co-occurrence relationships between keywords and the diversity and concentration of research content in the field.

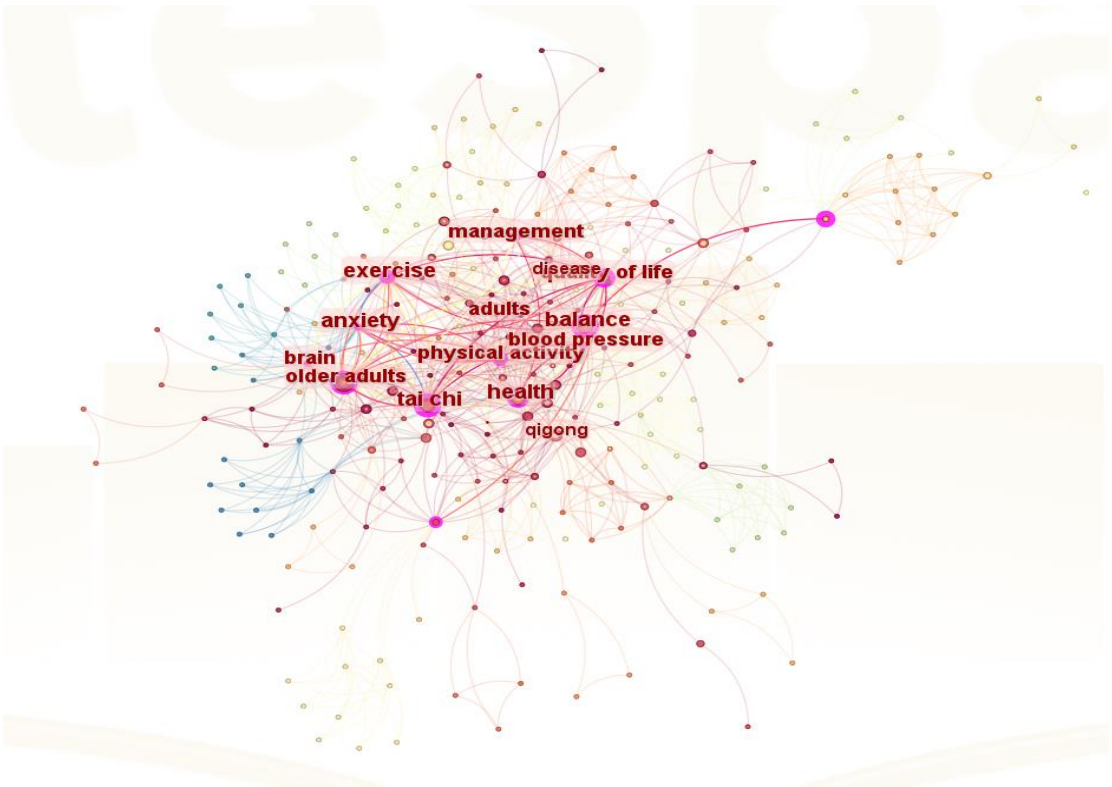

Figure 4 Keywords co-occurrences.

Table 4 Characteristics and Academic Significance of Key Keywords

Keyword Node	Node Characteristics	Academic Significance
Tai Chi	The most frequently occurring node, reflecting its widespread mention in research. It serves as a core keyword related to health, balance, and traditional culture, linking with other high-frequency keywords like "health" and "balance."	Tai Chi is not only a traditional martial art but also a significant health-promoting practice. Its cultural dissemination and health benefits make it a key area for interdisciplinary research.
Older Adults	Occupies an important position, showing strong associations with health and exercise, particularly with significant connections to "exercise" and "health."	The elderly population is a primary focus in Tai Chi research, with studies emphasizing the improvement of physical and mental health among older adults.
Exercise	A prominent theme in the field of physical activity, reflecting the popularity of Tai Chi as a form of exercise. Closely associated with "mental health" and "balance."	Tai Chi, as a low-intensity exercise, is not only suitable for older adults but also has substantial effects on overall health and psychological well-being.
Balance	A high-frequency keyword, especially linked with Tai Chi, showing that enhancing balance is a major benefit of Tai Chi practice.	Research highlights Tai Chi's significant impact on improving balance, preventing falls, and enhancing mobility, especially among older adults.
Health	Strongly associated with multiple themes, reflecting health as one of the primary application areas of Tai Chi, particularly in physical and mental health domains.	Tai Chi is widely studied as an effective intervention for cardiovascular health, stress relief, and immune system enhancement, making it an important tool for health promotion.
Mental Health	High frequency, indicating Tai Chi's importance in psychological regulation, with close links to "exercise" and "health."	Tai Chi combines physical movements, breathing, and psychological adjustment to effectively alleviate anxiety, depression, and improve mental states, making it a valuable mental health intervention.
Falls	Closely linked with "balance" and "older adults," demonstrating Tai Chi's role in fall prevention.	Studies confirm that Tai Chi can effectively reduce the risk of falls in older adults, establishing it as a crucial fall prevention strategy.
Flexibility	A prominent node related to physical activity, reflecting Tai Chi's role in improving physical flexibility and overall health.	Through stretching and gentle movements, Tai Chi improves flexibility and significantly enhances muscle and joint mobility.

continued

Rehabilitation	A strongly associated keyword, highlighting Tai Chi's application in rehabilitation, with close links to "health" and "exercise."	Tai Chi is increasingly used as a rehabilitation method for chronic diseases, postoperative recovery, and psychological rehabilitation.
Physical Activity	Strongly associated with "exercise" and "health," reflecting Tai Chi as a major focus in the study of physical activity.	Tai Chi is not only a form of physical activity but also a unique intervention that promotes sustained engagement in healthy behaviors.

Also, the **Table 4** above explained the detail Analysis of Keyword Co-occurrence Relationships**.** The strong connection between "Tai Chi" and "Health" highlights the significant relevance of Tai Chi research to health promotion, particularly in enhancing physical and mental well-being. As a traditional exercise form, Tai Chi has been widely studied for its role in improving cardiovascular health and alleviating psychological stress through gentle movements and mental regulation. These characteristics position Tai Chi as a critical tool for health interventions. Additionally, the integration of "Qigong" with "Tai Chi" expands its application scope, demonstrating their synergistic effects on overall health and the improvement of qi and blood circulation.

The high-intensity association between the keywords "Balance" and "Older Adults" underscores the importance of improving balance as a key focus in Tai Chi research targeting elderly health. Studies emphasize how Tai Chi enhances physical stability in older adults, particularly in preventing falls and improving daily activity capabilities, establishing it as a safe and effective tool for balance training. Moreover, the connection between "Adults" and "Disease of Life" indicates the substantial potential of Tai Chi in addressing modern lifestyle diseases, such as obesity and cardiovascular conditions, making it an essential component of health management for the adult population.

The association of "Exercise" with "Anxiety" and "Brain" emphasizes the critical role of exercise interventions in psychological regulation and cognitive health. Specifically, Tai Chi has been shown to reduce anxiety and enhance cognitive function, with notable effects on brain neuroplasticity and the prevention of cognitive disorders. Furthermore, the link between "Physical Activity," "Blood Pressure," and "Management" reveals Tai Chi's value in managing hypertension and chronic diseases. Research demonstrates that through gentle movements and sustained practice, Tai Chi can effectively improve blood pressure levels and manage chronic health conditions, affirming its role as a comprehensive health intervention method.

3.2.2 Keyword Clustering Relationships

The **Figure 5** below shows the visual representation of the keyword clustering.

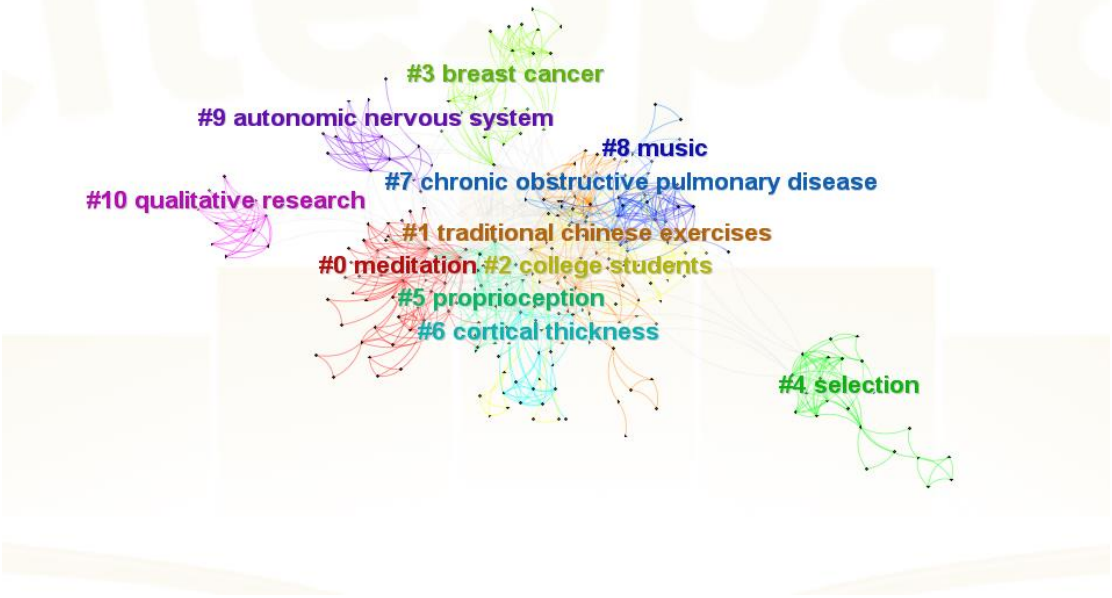

Figure 5 Keyword Clustering Visualization

Table 5 Keyword Clustering Analysis and Research Directions

Cluster Number	Topic Name	Keywords	Research Direction
#0	Meditation	long term meditation, meditation, stress	Research on the role of meditation in mental health, stress management, and cognitive function improvement, potentially involving Tai Chi as a form of meditation.
#1	Traditional Chinese Exercises	Tai Chi exercise, aerobic exercise, 24-style taijiquan exercise, qigong exercise, taichi exercise, home exercise program	Explore the effects of traditional exercises like Tai Chi and Qigong in health promotion, chronic disease management, and mind-body regulation.
#2	College Students	youth, academic stress, college students, university students	Study the mental health, stress coping, and exercise intervention effects among college students, and investigate the benefits of Tai Chi for younger populations.
#3	Breast Cancer	cervical cancer, cancer survivors, breast cancer, cancer, prostate cancer	Research exercise interventions for breast cancer patients, focusing on Tai Chi's role in cancer rehabilitation, psychological support, and quality of life improvement.

continued

#4	Selection	adaptive selection, selection, choice, strategy, decision making, option	Study the decision-making mechanisms in the selection of exercise forms, intervention strategies, and personalized health management.
#5	Proprioception	balance ability, improve balance, balance	Investigate how Tai Chi enhances proprioception through movement control and balance training, improving physical performance and stability.
#6	Cortical Thickness	cortical thickness, brain	Study the effects of Tai Chi on brain structure, particularly in improving brain function and cognitive ability through neuroplasticity.
#7	Chronic Obstructive Pulmonary Disease	copd - management, cardiorespiratory function, chronic obstructive pulmonary disease, cardiopulmonary endurance, cardiorespiratory fitness, copd	Research the impact of Tai Chi on lung function training, including improving respiratory capacity and enhancing the quality of life for chronic disease patients.
#8	Music	sound therapy, music therapy, melody, acoustic effects, harmony	Explore the synergistic effects of combining music and exercise interventions on physical and mental health.
#9	Autonomic Nervous System	heart rate variability, sympathetic, vagal tone, autonomic nervous system	Investigate how Tai Chi regulates the autonomic nervous system through rhythmic movements and breathing, promoting balance and calming effects.
#10	Qualitative Research	qualitative research, research methodology	Use qualitative research methods to explore the health benefits and cultural significance of Tai Chi, providing in-depth theoretical support.

Additionally, the Table 5 shows the detailed description of crossovers and associations between Keyword Clusters:

The crossover between Meditation (#0) and Traditional Chinese Exercises (#1) lies in the comprehensive interventions for mental and physical health, particularly highlighted by the co-occurrence of keywords such as “Stress” and “Health.” The integration of meditation and Tai Chi in clinical studies for stress and anxiety relief is steadily increasing, especially among chronic disease patients and the elderly, where it has shown significant effects. Both clusters demonstrate synergistic roles in improving mental health (e.g., alleviating anxiety and depression) and enhancing physical flexibility and balance.

The association between Breast Cancer (#3) and Autonomic Nervous System (#9) reflects the potential of psychological interventions and neural regulation in cancer rehabilitation.

Regulating the autonomic nervous system through Tai Chi and meditation to reduce stress levels and improve immune function in cancer patients has become a key research focus. The co-occurrence of autonomic nervous system keywords (e.g., "Sympathetic" and "Vagal Tone") with breast cancer-related terms (e.g., "Quality of Life") highlights the growing importance of emotional regulation and quality-of-life improvements in cancer recovery.

Music (#8) has close connections with mental health and exercise science, reflecting the multifunctionality of music therapy. The combination of music and meditation creates a more holistic approach to mental health interventions, effectively alleviating anxiety and emotional disorders. Studies have shown that incorporating music into exercise interventions enhances participants' adherence, particularly by improving the exercise experience through rhythm and melody.

The crossover between Proprioception (#5) and Selection (#4) is evident in the optimization of exercise interventions and health decision-making. Research shows that users tend to prioritize health intervention options (e.g., exercise types) that improve balance and stability. Studies on selective mechanisms (e.g., "Decision Making" and "Adaptive Selection") provide theoretical support for designing personalized exercise programs.

3.2.3 Keyword Temporal Trends

The timeline in **Figure 6** spans from 2011 to 2024. Through the distribution along the timeline, the changes in activity and development trends of different keywords and research themes can be observed intuitively. The nodes represent different keywords, while the connections indicate associations and co-occurrences between keywords. This information allows for an analysis of the evolution of research hotspots as well as the intersections and collaborations between themes.

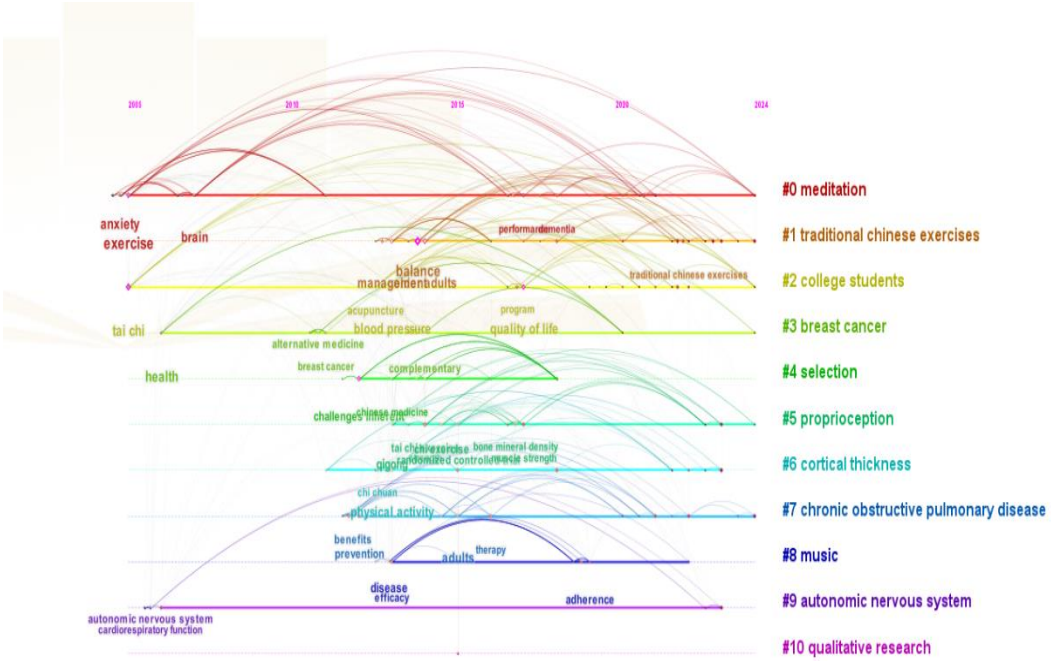

Figure 6 Keyword Timeline Visualization

From the perspective of time span, research on various themes exhibits distinct phases and progressive development:

Foundational Stage of Traditional Themes (2011–2015): During this period, keywords such as "Tai Chi" and "Health" dominated the research landscape, with studies focusing on the effects of Tai Chi as a traditional exercise on physical health and chronic disease management. Concurrently, research on "Proprioception" centered on balance and motor rehabilitation, particularly interventions targeting the elderly and patients recovering from illness.

Interdisciplinary Integration Stage (2016–2020): This phase witnessed the emergence of keywords such as "Music Therapy" and "Cortical Thickness," signaling a shift towards the integration of neuroscience, psychology, and exercise science. For instance, the keyword "Neuroplasticity" highlights the growing interest in the application of long-term exercise interventions to improve cognitive function and address neurodegenerative diseases.

Technology-Driven Innovation Stage (2021–2024): New keywords such as "Autonomic Nervous System" and "Digital Methods" suggest that health intervention research is advancing toward a technology-driven and diversified direction. The emergence of wearable devices, data monitoring, and artificial intelligence in health intervention studies marks a significant innovation. These advancements are shaping new modes of health management that are data-driven and technologically enhanced.

This temporal analysis illustrates the evolution of Tai Chi research from foundational studies on traditional health benefits to interdisciplinary applications and technology-driven innovations, reflecting the expanding scope and depth of this research field.

4 Discussion and Implications

4.1 Discussion

This study employs bibliometric methods combined with visualization tools such as Cite Space and VOS viewer to comprehensively reveal research trends in Tai Chi across domains such as health intervention, cultural dissemination, and social impact. These analyses not only map the academic development trajectory of Tai Chi on a global scale but also provide a systematic theoretical framework for future research. In terms of research content, the significant associations of Tai Chi with health promotion, chronic disease management, and psychological regulation highlight its modern value as a traditional form of exercise (Wang, Collet, & Lau, 2004). Moreover, the role of Tai Chi in cross-cultural communication reflects both its growing influence and the challenges it faces in its global promotion (Lin, 2016).

The analysis of core authors and institutions reveals that leading scholars and research teams have played crucial roles in advancing Tai Chi's health benefits and promoting its international adoption. Their studies have not only established the scientific foundation for Tai Chi's health interventions but have also driven its global recognition and application. By examining these researchers' achievements, this study extracts their methodologies and innovative approaches, providing clear directions for subsequent academic efforts. Moreover, these insights enable new researchers to integrate swiftly into the field and conduct innovative studies.

The keyword analysis further reveals the current hot topics in Tai Chi research, encompassing themes such as "health promotion," "balance improvement," "psychological health intervention," and "cultural dissemination." The frequent appearance of these keywords reflects the mainstream research directions in the field, particularly highlighting the value of Tai Chi in managing chronic diseases and promoting health in older adults (Yang, Desai, Esfahani, Sokolovskaya, & Bartlett, 2021). Additionally, studies on Tai Chi in the field of mental health demonstrate its unique advantages in alleviating anxiety, improving depression, and enhancing quality of life (Wang et al., 2014). The trends in research hotspots further indicate that, with technological advancements and changing global health needs, future research may expand to explore the role of Tai Chi in addressing neurodegenerative diseases (Jiang et al., 2022).

These studies collectively highlight the theoretical contributions and practical value of Tai Chi in addressing chronic disease, promoting psychological well-being, and fostering cultural exchange. The innovative elements of highly cited literature delineate the evolution of Tai Chi research from theory to practice and its significance in guiding subsequent studies. These high-impact studies not only offer foundational research frameworks but also lay the groundwork for interdisciplinary exploration in the future.

4.2 Implications

This study, through bibliometric analysis, reveals the knowledge structure and development trends in the field of Tai Chi research, providing direction for future studies. Visualization techniques assist in identifying key authors and research hotspots, offering new perspectives for comprehensive exploration in this domain (You, Min, Tang, Chen, & X., 2021).

The interdisciplinary nature of Tai Chi highlights the necessity of integrating health sciences, psychology, and cultural communication research, particularly regarding its roles in health promotion, psychological regulation, and cross-cultural dissemination. Combining

neuroscience and digital technology, future research could further explore the mechanisms of Tai Chi in improving cognitive functions and mitigating the impact of chronic diseases. The application of big data and artificial intelligence brings new opportunities to Tai Chi research, enabling precise monitoring and dynamic optimization, while the integration of traditional culture and technology requires ensuring both innovation and sustainability (Liang et al., 2018).

5 Conclusion

Through a systematic review and bibliometric analysis of Tai Chi research literature from 2004 to 2024, this study reveals the current state and developmental trends of Tai Chi in the fields of health intervention, psychological regulation, and cultural dissemination. The findings indicate that Tai Chi demonstrates significant effects in improving balance, preventing falls, managing chronic diseases such as hypertension and diabetes, and alleviating psychological stress. Notably, its unique value in elderly health management and chronic disease intervention has been increasingly recognized. Moreover, Tai Chi's role in addressing anxiety, depression, and enhancing cognitive function within the realm of mental health has garnered widespread attention. Research combined with neuroscience is providing new scientific evidence to uncover the underlying mechanisms driving these benefits.

Additionally, as a symbol of traditional Chinese culture, Tai Chi holds significant importance in international dissemination. In recent years, Tai Chi has not only advanced global health initiatives through cross-cultural communication but has also served as a vital platform for showcasing China's cultural soft power. Furthermore, the integration of modern technologies such as big data and artificial intelligence has brought new opportunities to Tai Chi research, driving the personalization of health management and offering innovative support for its global promotion. Future studies should continue to explore Tai Chi's potential in health promotion, cognitive function enhancement, and cultural exploration, fostering the integration of traditional culture with modern technology to further its development and impact.

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