

Bibliometric Analysis of Research on Traditional Chinese Exercise and Osteoarthritis

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Background: Osteoarthritis (OA) is a common disease in geriatric rehabilitation medicine caused by the progressive destruction of articular cartilage. Traditional Chinese exercise (TCE) is an important component of traditional sports in China and aims to stretch the musculoskeletal tract and relieve joint pain. Bibliometrics can help researchers find suitable partners and understand the research hotspots and trends in a certain field. However, there is still a lack of bibliometric analysis in the field of TCE and OA.

Methods: All the literature was obtained from the Web of Science Core Collection database. The last search was performed on July 28, 2023. The bibliometric indicators, such as publications, citations, and H-index, were recorded. Bibliometrix and CiteSpace were used for visualization analysis. In addition, randomized controlled trials were included to summarize the exercise prescription of TCE for OA.

Results: A total of 170 articles were included. The field of OA with TCE had great development potential and was in the rising period. The countries, institutions, and authors with the most publications were the United States, Tufts Medical Center, and Harvey WF, respectively. The most popular journal was *Osteoarthritis and Cartilage*. The recent burst keywords in this field were mainly “hip”, “pilot”, and “risk”. Tai Chi was the most studied TCE with the most detailed content of exercise prescription, followed by Baduanjin and Wuqinxi.

Conclusion: Our study provides a basis for researchers in this field to choose appropriate partner and academic journals. Moreover, pain, muscle strength, and quality of life management of elderly OA patients are research hotspots in this field. The intervention of hip OA risk through TCE is expected to become a research direction for emerging teams. The TCE prescription we summarized can better provide researchers with more treatment details.

Keywords: osteoarthritis, traditional Chinese exercise, traditional Chinese medicine, rehabilitation, bibliometrics

Introduction

Osteoarthritis (OA) is a common disease in geriatric rehabilitation medicine caused by the progressive destruction of articular cartilage.¹ The pathogenesis of this disease involves an imbalance of catabolism and anabolism in the articular cartilage matrix.² People with OA may experience joint pain, stiffness, swelling, deformity, and disability.³ The etiology of OA is still unknown, and its risk factors include joint degeneration and heredity, age, obesity, cumulative strain, joint trauma, and deformity.⁴ With the aging of the global population, OA has imposed a substantial economic burden on patients and society.⁵

Traditional Chinese exercise (TCE) is an important component of traditional sports in China. Based on the theory of traditional Chinese medicine (TCM), TCE aims to improve physical and mental cultivation and prevent and treat diseases.⁶ More importantly, TCE, such as Tai Chi, Baduanjin, Yijinjing, Wuqinxi, and Liuzijue, has shown beneficial effects on human health.^{7,8} For example, Tai Chi can reduce pain and increase quadriceps strength in patients with OA.⁹ In addition, it has been reported that Baduanjin helps to improve proprioception and balance function in elderly patients with OA.¹⁰ These findings suggest that TCE is a promising means of rehabilitation.

At present, most studies explain the potential mechanism of TCE treatment of OA from the bio-psycho-social model.^{11,12} TCE is an aerobic exercise in which OA patients are able to activate their agonist and antagonist muscles during activity, resulting in increased muscle strength and power control.^{13,14} In addition, through postural control and

the activation of mechanical stress, musculoskeletal proprioception at the joint is regulated, thereby improving body balance function and reducing pain.^{15,16} Importantly, effective TCE can reduce low-grade chronic inflammation in the development of OA.^{11,17,18} In addition, some studies have reported that TCE can help reduce anxiety, stress, and depression; improve mental health; and increase the social participation of OA patients.¹⁹

Bibliometrics is a literature research method that focuses on literature systems and bibliometric characteristics and can measure the contribution of individuals, institutions, or countries/regions to a specific field, which provides an important reference for researchers to find suitable partners.²⁰ Understanding the research hotspots and trends of a certain field via visualization tools, such as Bibliometrix and CiteSpace, can provide researchers with new research ideas and breakthroughs and is highly important for formulating scientific research planning.²¹ To date, bibliometrics has been applied in orthopedics, rehabilitation, psychiatry, endocrinology, and many other fields.^{22–24}

However, there is still a lack of bibliometric analysis in the field of TCE and OA. Therefore, we conducted a bibliometric analysis of relevant literature in the field of TCE and OA in the past 20 years (2003–2022) via Bibliometrix and CiteSpace, aiming to explore the research status, hotspots, and future development trends and to provide references for further research in this field.

Methods

Search Strategy

The Web of Science and Scopus are the bibliometric tools used in most bibliometrics. However, in view of the need to obtain relevant information such as journal impact factor (JIF), JIF Quartile, and journal citation indicator (JCI) Quartile, we selected the Web of Science as the bibliometric tool for this study. All the literature data of this study were obtained from the Web of Science Core Collection database (Edition: Science Citation Index Expanded). The search terms included “Traditional Chinese exercise”, “Qigong”, “Tai Chi”, “Baduanjin”, “Yijinjing”, “Wuqinxi”, “Liuzijue”, and “Osteoarthritis”. The search period ranged from January 1, 2003, to December 23, 2022. The last search was performed on July 28, 2023. The specific search strategy is shown in [Table S1](#).

Bibliometric and Visualization Analysis

The number of publications, citations, H-index, JIF, JCI, and other relevant bibliometric indicators were recorded. R 4.1.3 was used to run Bibliometrix (<https://www.bibliometrix.org>). The options “Overview”, “Sources”, “Authors”, “Documents”, and “Social Structure” were selected to analyze the collaboration and keywords. “Overview” was an overview of the imported data, which helped us determine whether the imported data were consistent with the contents of the Web of Science Collection database. “Documents” could effectively extract and analyze keywords effectively. “Sources” and “Authors” analyzed the publication sources of imported articles, as well as the authors and their institutions. The “Social Structure” can be used to visually analyze the collaboration of authors, institutions and countries. All analysis principles were based on the data matrix contained in Bibliometrix itself, and the default system parameters were selected during the analysis. The analysis of bibliometric indicators and collaboration situations could help researchers choose target journals, find potential partners, and identify research hotspots and frontiers.

In addition, the data were imported into CiteSpace (version 6.1.3) to visualize the keyword Timeview map. Data extraction and analysis were carried out by two researchers independently. In the case of inconsistent results, a third researcher participated in the discussion and reached a unified result. In addition, randomized controlled trials (RCTs) were included, with the exception of pilot trials, secondary analysis, and protocols, which are used to summarize the relevant details of TCE treatment for OA, including treatment type, treatment frequency, and treatment duration.

Results

Literature Search

In the past 20 years, a total of 170 articles were included in the Web of Science Core Collection database (Edition: Science Citation Index Expanded), including 81 “articles” and 49 “review articles”, accounting for 76.47% of all the

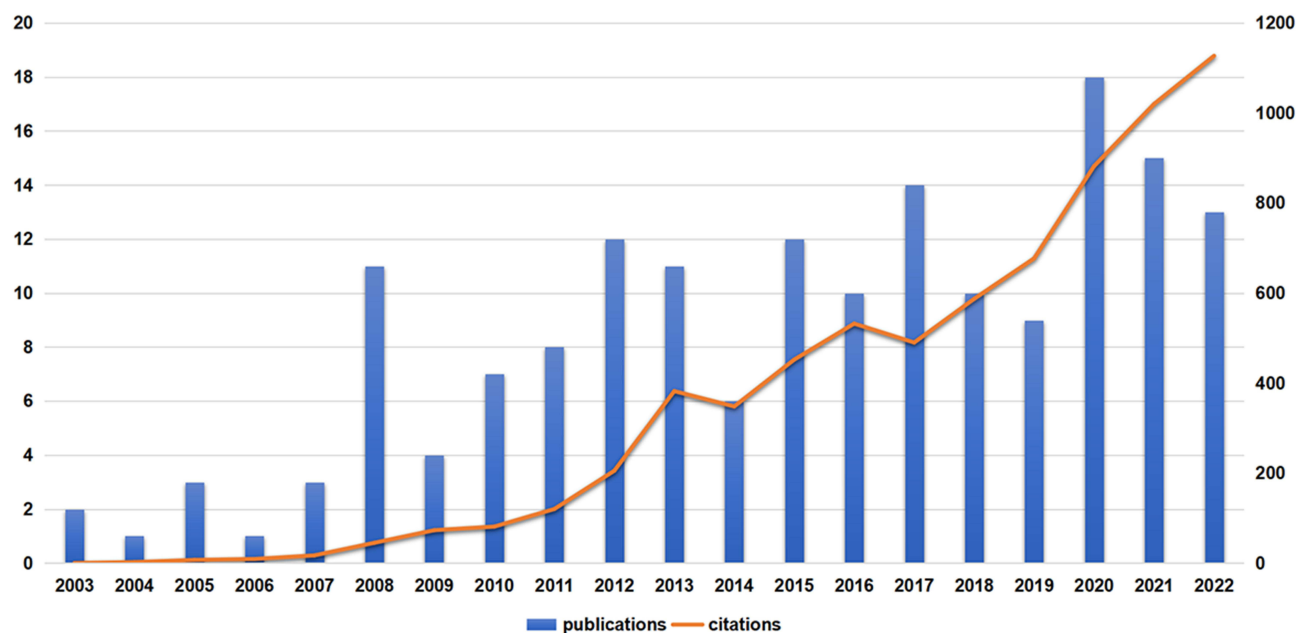


Figure 1 The situation of publications and citations in the field of TCE and OA.

literature types. The total number of publications in the field of TCE and OA showed an upward trend, with the highest number published in 2020. The number of citations also increased annually and peaked in 2022 (Figure 1).

Characteristics of Literature Distribution

Country/Region

The number of publications by country/region was determined based on the statistical results of the Web of Science Core Collection database. In total, 31 countries/regions published related literature in this field, among which the United States ranked first with the most publications ($n=73$). The number of publications in the United States was much higher than that of other countries, accounting for 29.2% of the total number of publications, and it was 1.5 times that of the People's Republic of China, which ranked second. Canada had the highest average citation of 269.29, followed by Australia (average citation= 104.33) and the United States (average citation= 61.62) (Table 1). We further analyzed the annual publication volume of the top five countries/regions. Although South Korea published the first two articles in this field, the proportion of publications from the People's Republic of China gradually increased over the past five years (Figure 2A). In terms of country/region collaboration, the United States and the People's Republic of China had the closest collaboration (frequency =7), followed by the People's Republic of China and Canada (frequency = 5), Canada and Australia (frequency =3), and the United States and Canada (frequency =3) (Figure 2B and C). In addition, the

Table 1 Top 10 Countries/Regions in the Field of TCE and OA

Rank	Country/Region	Publications	Times Cited (Total)	Times Cited (Without Self-Citations)	Times Cited (Average per Item)
1	USA	73	4498	4390	61.62
2	Peoples R China	49	712	609	14.53
3	Canada	14	3770	3757	269.29
4	Australia	12	1252	1244	104.33
5	South Korea	8	413	408	51.63
6	England	6	367	365	61.17
7	Brazil	4	66	65	16.5
8	Taiwan	4	39	38	9.75
9	Italy	3	87	87	29
10	Japan	3	52	51	17.33

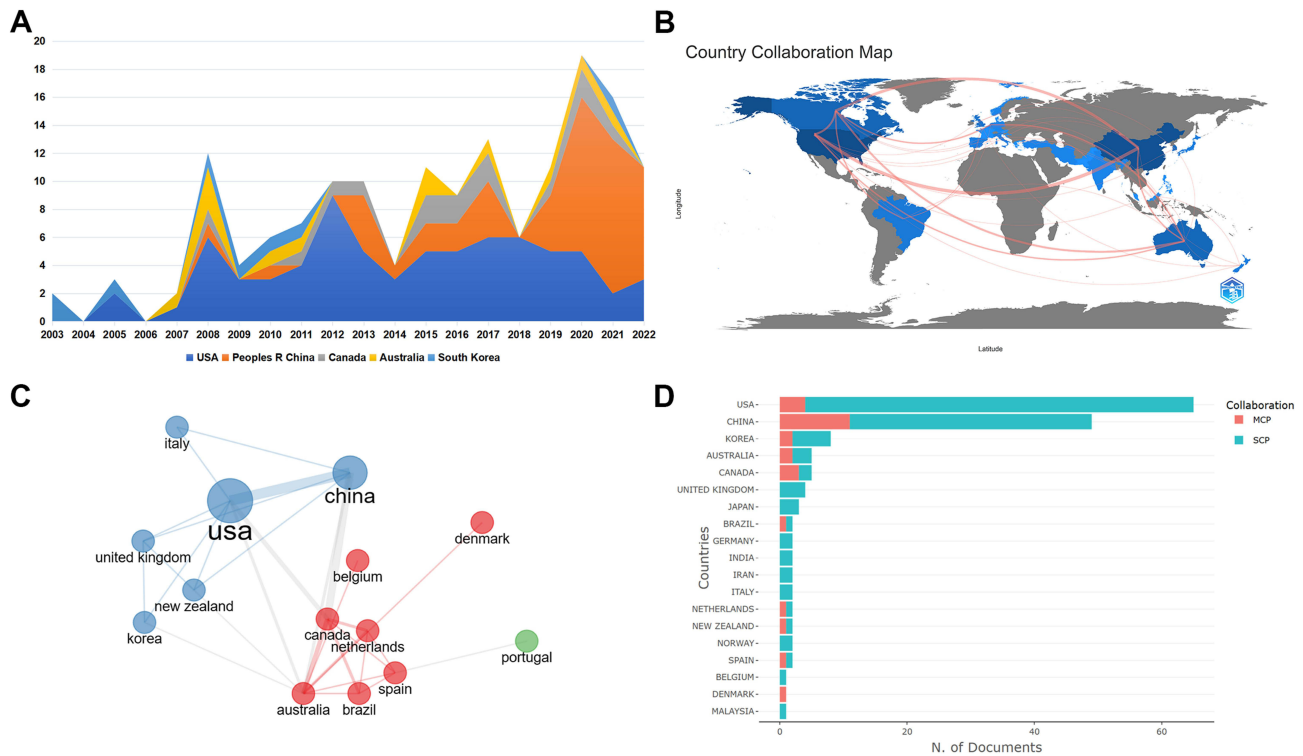


Figure 2 Country/region distribution characteristics of publications in the field of TCE and OA. **(A)** The annual proportion of publications in the top five countries/regions changed. **(B and C)** Map of collaboration between countries/regions. **(D)** The collaboration types of countries/regions.

People’s Republic of China has carried out the most international collaboration, while the United States has carried out the most domestic collaboration (Figure 2D).

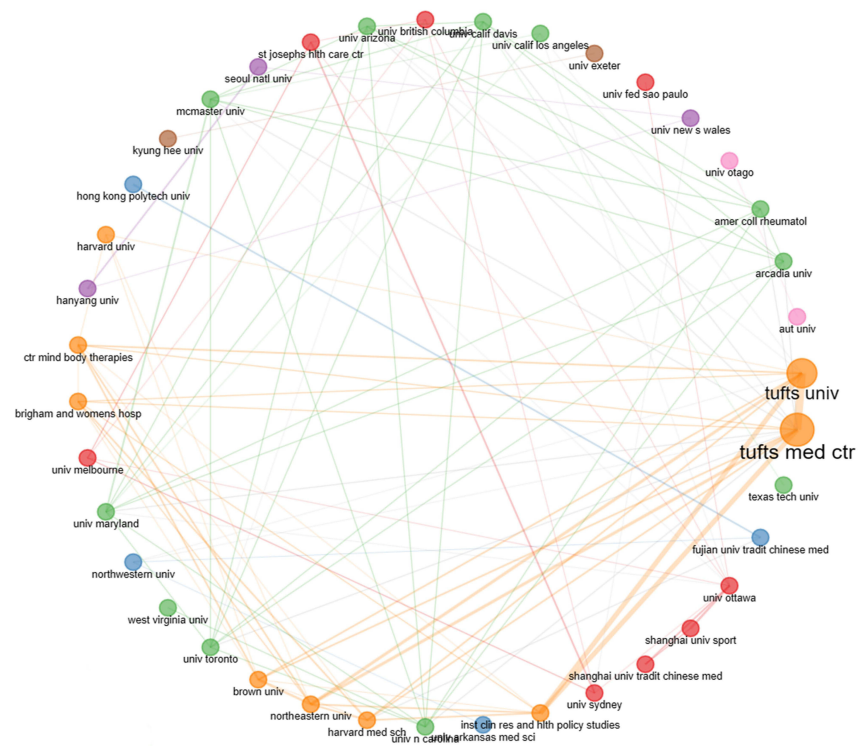
Institution

Of the 306 institutions, the three institutions with the highest number of articles were Tufts Medical Center (n= 25), Tufts University (n= 20), and Shanghai University of Sport (n= 11) (Table 2). The top 10 institutions were located only in the United States, the People’s Republic of China, and Canada; of these, 6 institutions were all in the United States, indicating the important contribution of the United States in the research on TCE and OA. In terms of institutional collaboration, Tufts Medical Center has the most collaboration with other institutions, Tufts University, University of Ottawa, Institute for Clinical Effectiveness and Health Policy, Northeastern University, Shanghai University of Sport, Harvard Medical School, and Shanghai University of Traditional Chinese Medicine (Figure 3A).

Table 2 Top 10 Institutions in the Field of TCE and OA

Rank	Institution	Publications	Times Cited (Total)	Times Cited (Without Self-Citations)	Times Cited (Average Per Item)
1	Tufts Medical Center	25	1638	1616	65.52
2	Tufts University	20	627	607	31.35
3	Shanghai University of Sport	11	121	112	11
4	Fujian University of Traditional Chinese Medicine	9	187	180	20.78
5	Harvard University	8	276	268	34.5
6	University of Ottawa	8	2066	2058	258.25
7	University of North Carolina at Chapel Hill	7	1122	1121	160.29
8	University of Toronto	7	1759	1758	251.29
9	Harvard Medical School	6	204	200	34
10	Northeastern University	6	148	144	24.67

A



B

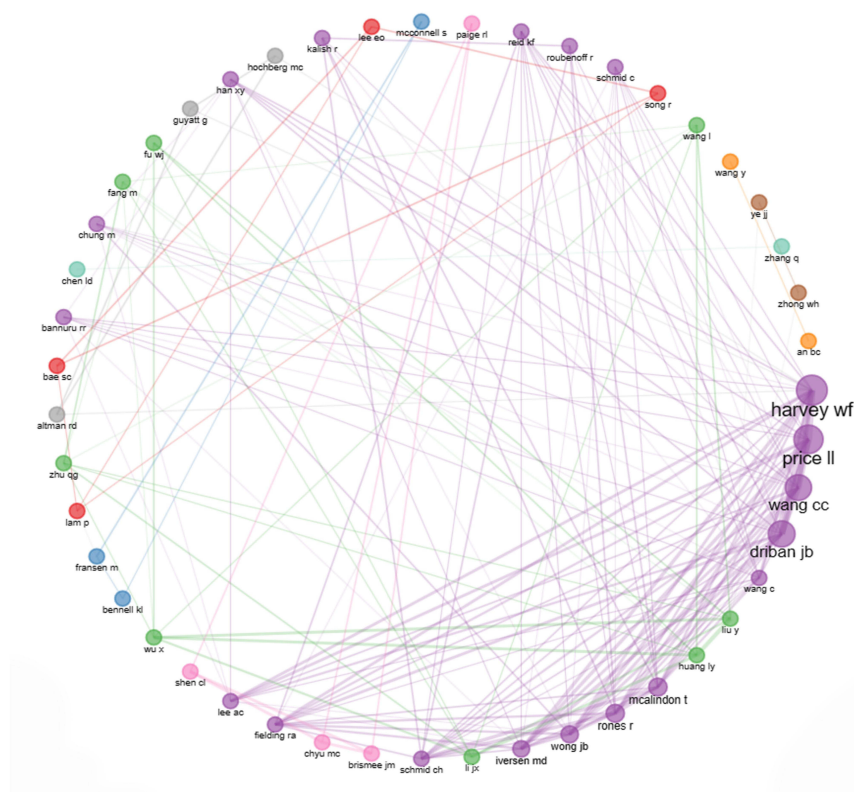


Figure 3 The institution and author distribution characteristics of publications in the field of TCE and OA. **(A)** Map of collaboration between institutions. **(B)** Map of collaboration between authors.

Author

A total of 712 authors were included. The top three authors were Harvey WF ($n=15$), Price LL ($n=14$), and Wang CC ($n=14$), with a total of 43 articles published (Table 3). Among them, Harvey WF was also the author with the highest

Table 3 Top 10 Authors in the Field of TCE and OA

Author	Publications	Times Cited (Total)	Times Cited (Without Self-Citations)	Times Cited (Average per Item)	H-Index
Harvey WF	15	1336	1323	89.07	9
Price LL	14	407	393	29.07	8
Wang CC	14	581	566	41.5	8
Driban JB	12	381	370	31.75	7
Wang C	10	56	56	5.6	3
Liu Y	9	150	145	16.67	5
Huang LY	8	112	107	14	5
Mcalindon T	8	351	345	43.88	4
Rones R	7	350	345	50	4
Wong JB	7	140	137	20	3

citations and average citations. In terms of author collaboration, the authors with the largest number of collaborations were Price LL, Harvey WF, Driban JB, and Wang CC (Figure 3B).

Journal

The included publications were published in 92 journals, and the top 10 journals published a total of 56 articles, among which *Osteoarthritis and Cartilage* published the most (n= 13) (Table 4). The journal with the highest JIF and JCI was *Annals of the Rheumatic Diseases*, which published 3 articles. The top 10 journals had higher JIF quartiles and JCI quartiles. According to the JCI quartile standard, all journals were Q2 and above, and more than seven journals reached Q1.

Keywords

The top 10 keywords were “pain” (frequency= 51), “management” (frequency= 40), “older adults” (frequency= 38), “tai-chi” (frequency= 37), “hip” (frequency= 35), “randomized controlled trial” (frequency= 29), “quality of life” (frequency = 28),

Table 4 Top 10 Journals in the Field of TCE and OA

Rank	Journal	Publications	JIF	JCI	JIF Quartile	JCI Quartile
1	Osteoarthritis and Cartilage	13	7.0	1.96	ORTHOPEDICS Q1 RHEUMATOLOGY Q1	ORTHOPEDICS Q1 RHEUMATOLOGY Q1
2	Medicine & Science in Sports & Exercise	9	5.4	1.76	SPORT SCIENCES Q1	SPORT SCIENCES Q1
3	Medicine	7	1.6	0.38	MEDICINE, GENERAL & INTERNAL Q3	MEDICINE, GENERAL & INTERNAL Q2
4	Clinical Rehabilitation	5	3.0	1.12	REHABILITATION Q1	REHABILITATION Q1
5	Arthritis Care & Research	4	4.7	1.49	RHEUMATOLOGY Q2	RHEUMATOLOGY Q1
6	Arthritis & Rheumatology	4	13.3	3.31	RHEUMATOLOGY Q1	RHEUMATOLOGY Q1
7	Frontiers in Medicine	4	3.9	0.84	MEDICINE, GENERAL & INTERNAL Q2	MEDICINE, GENERAL & INTERNAL Q1
8	Journal of Alternative and Complementary Medicine	4	2.6	0.62	MEDICINE, GENERAL & INTERNAL Q3	MEDICINE, GENERAL & INTERNAL Q2
9	American Family Physician	3	4.0	1.8	MEDICINE, GENERAL & INTERNAL Q3 PRIMARY	MEDICINE, GENERAL & INTERNAL Q1 PRIMARY
10	Annals of the Rheumatic Diseases	3	27.4	4.91	HEALTH CARE Q1 REHABILITATION Q1	HEALTH CARE Q1 REHABILITATION Q1

Abbreviations: JCI, journal citation indicator; JIF, journal impact factor.

“exercise” (frequency= 25), “arthritis” (frequency= 20), and “muscle strength” (frequency= 20) (Figures 4A and S1). In the past 20 years, the keywords used in related literature in this field have also changed (Figures 4B and S2). Using the Trend Topics function to analyze the burst keywords, we found that the recent burst keywords in this field were mainly “hip”, “pilot”, and “risk” (Figure 4C). In particular, “risk” and “WOMAC” have been hot words in this field for 10 years and broke out in 2020 and 2019, respectively.

TCE Prescriptions

We further summarized the TCE prescriptions used in RCTs in this field, including TCE type, frequency, duration, and efficacy ([Table 5](#)). Tai Chi was the most studied TCE and had the most detailed content related to exercise prescription. [Table S2](#) shows the details of each study.

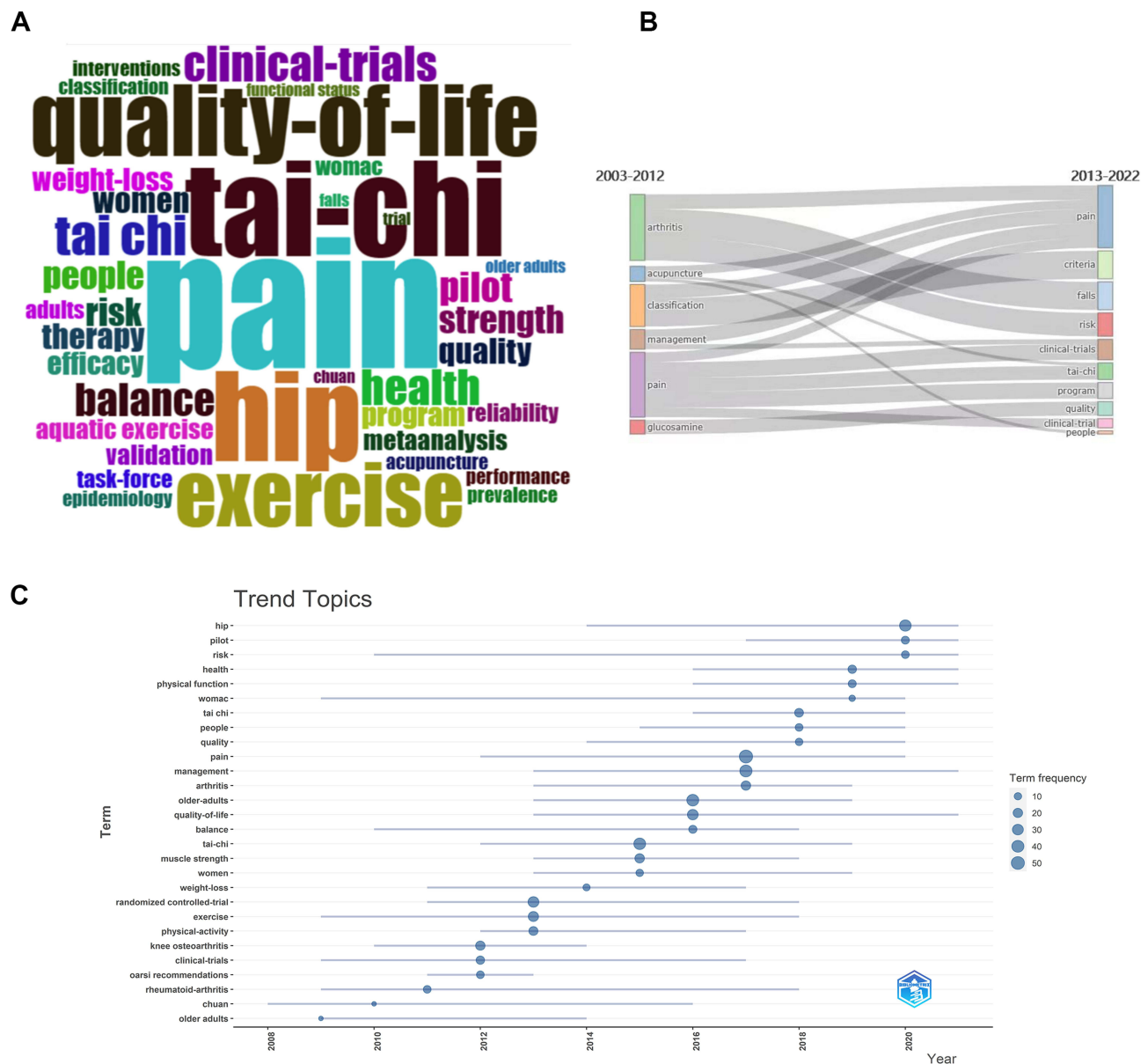


Figure 4 Keyword analysis in the field of TCE and OA. **(A)** WordCloud of the top 50 keywords. **(B)** The evolution of the main keywords in the past 20 years. **(C)** Trend topics of the keywords.

Table 5 Exercise Prescription of TCE for OA

TCE Type	Frequency	Duration	Disease	Efficacy
Tai Chi	2 to 5 times a week	10, 12, or 24 weeks	KOA, symptomatic tibiofemoral OA, Hip OA, primary TKA for end-stage KOA	Relieve pain, improve muscle strength, improve balance and motor function, improve proprioception, improve quality of life, and promote mental health ^{18,25–39}
Baduanjin	3 or 5 times a week	8 or 12 weeks	KOA	Relieve pain, improve muscle strength, improve proprioceptive sensation, adjust posture control ^{10,18,40,41}
Wuqinxi	4 times a week	24 weeks	KOA	Increase muscle strength, relieve pain and improve balance ⁴²
External Qigong	5 or 6 times every 3 weeks	3 weeks	KOA	Relieve pain and improve negative mood ⁴³

Abbreviations: KOA, knee osteoarthritis; OA, osteoarthritis; TCE, traditional Chinese exercise; TKA, total knee arthroplasty.

Discussion

With the trend of global aging, the incidence of OA is gradually increasing. The rehabilitation of OA through TCE has gradually attracted the attention of clinicians. Our study conducted a qualitative and quantitative analysis of the literature in the field of TCE and OA over the past 20 years through bibliometric methods and described the development trends in this field.

From 2003 to 2022, the number of literature published in this field has increased annually, which means that researchers at home and abroad have gradually paid attention to the prevention and treatment of OA by TCE. Since the South Korean research team published two studies on TCE for the treatment of OA in 2003, related research has gradually progressed through other countries.^{38,44} To date, the United States has made the largest contribution to the field. This is mainly because the United States attaches great importance to the prevention and standardized management of diseases in elderly individuals. Additionally, this may also be related to the leading economic level and superior scientific research conditions in the United States.

The Tufts Medical Center is the most influential institution in the field and has the highest number of publications and collaborations. Harvey WF is the most influential researcher in this field and published the “2019 American College of Rheumatology/Arthritis Foundation Guideline for the Management of Osteoarthritis of the Hand, Hip, and Knee”, which is the most frequently cited article, with a total of 1923 citations. This guideline strongly recommends tai chi practice in patients with knee and/or hip OA, emphasizing the important role of TCE in the prevention and treatment of OA.⁴⁵

The analysis of countries, institutions and authors can help researchers find more suitable partners in the field. Scientific research collaboration between authors from different institutions and countries/regions can promote the effective publication of research and the rapid promotion of research findings. For example, the United States and the People’s Republic of China carry out more collaboration in this field, which further promotes the progress of the People’s Republic of China and the United States in this field.

Through journal analysis, the relevant bibliometric indicators of the published journals, such as JIF and JCI, can not only reflect the academic level of the article and the recognition of scholars in the research field but also help researchers in the field find appropriate journals to present their research results.⁴⁶ In the field of TCE and OA, the JCR (JIF) partition of more than 7 journals reached Q1, among which the journal with the largest number of publications was *Osteoarthritis and Cartilage*. The journal with the highest impact factor was *Annals of the Rheumatic Diseases*, for which the JIF and JCI were 27.4 and 4.91, respectively. According to our analysis of journal types and bibliometric indicators, the overall development level of this field is relatively high.

Keyword analysis can reveal the research hotspots in the field, the academic topics of interest, and future research trends because keywords are highly condensed into the content of the literature.⁴⁷ Through high-frequency keyword analysis, we found that pain, muscle strength, and quality of life management of elderly OA patients are the research hotspots in this field. More importantly, identifying research hotspots can enhance the depth of related research and broaden the research ideas. Tai Chi is the main type of TCE for OA, and the most

popular research method is randomized control. This is not surprising because the main purpose of TCE is to delay the progression of OA and improve daily living activities. In addition, the most effective and credible method for performing clinical trials is RCTs. These findings can help research teams in the field optimize research methods, including the selection of TCE types, the designation of clinical study protocols, and the evaluation of osteoarthritis parameters.

The keyword visualization results of Bibliometrix and CiteSpace show that with the passage of time and the conquering of key issues, the related research hotspots also change. However, regardless of how the keywords evolve, researchers in this field always focus on pain management. In particular, after several years of development, the management content and methods are gradually refined to include risk factors, assessment methods, and management procedures, with increased attention given to improving the quality of life of patients and the reliability of clinical trial protocols.

Through Trend Topics function analysis, the research frontiers in this field can be identified, which can help the research team determine future research ideas. We further found that interventions for hip OA risk through TCE will be a research hotspot in the future. Indeed, the hip, as one of the most common sites of OA, has gradually attracted the attention of researchers.^{48,49} The balance and gait of patients with mild to moderate hip OA will change, and long-term weight bearing will aggravate the development of the disease.⁵⁰ Ultimately, function can be restored only by hip replacement.⁵¹ Fortunately, the onset and progression of hip OA can be delayed through effective risk management.⁵² More importantly, TCE, as a noninvasive intervention, is beneficial for functional recovery, regardless of whether the patient ultimately receives surgery.⁵³ These findings are very useful for emerging teams, especially in the case of inadequate team research foundation, and reference to the research frontier in the field can help them quickly establish a research foundation and provide reference information for future research. Importantly, the TCE prescription we summarized can better provide researchers with more treatment details.

This study has several limitations. First, due to the limitations of visualization tools, our study only searched a single database. If the Chinese database was included, the results might have changed. Although the Web of Science Core Collection is an internationally well-known citation database widely recognized and used by academia, there is still publication bias due to the literature omissions. Second, our search strategy cannot fully cover all the literature in this field, which is also an inevitable limitation of bibliometrics. Finally, due to the short duration and limited citations of the published literature in recent years, this may lead to bias in the results; therefore, it is necessary to carry out new metrological researches on this topic in the future.

Conclusions

In summary, researchers have gradually focused on the prevention and treatment of OA with TCE. This field has great development potential and is currently in the rising period. Our study provides a basis for researchers in this field to choose appropriate partners and academic journals. The United States has contributed the most to this field. The Tufts Medical Center is the most influential institution, and the Harvey WF is the most influential researcher. The journal with the largest number of publications is *Osteoarthritis and Cartilage*. Pain, muscle strength, and quality of life management of elderly OA patients are the research hotspots in this field. Tai Chi is the main type of TCE for OA, and the most popular research method is randomized control. The intervention of hip OA risk through TCE is expected to become a research direction for emerging teams. Importantly, the TCE prescription we summarized can better provide researchers with more treatment details.

Abbreviations

JCI, journal citation indicator; JIF, journal impact factors; KOA, knee osteoarthritis; OA, osteoarthritis; RCTs, randomized controlled trials; TCE, traditional Chinese exercise; TCM, traditional Chinese medicine; TKA, total knee arthroplasty.

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Disclosure

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