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Visual Analysis of Tennis Research in China Over the Past Two Decades Using CiteSpace

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ABSTRACT

Objective: To chart the overall landscape, core themes and evolutionary trajectory of tennis-related research in China over the past two decades, thereby furnishing a reference and source of inspiration for future scholarly inquiry.Methods: Using CiteSpace for scientometric visualization, we harvested tennis-themed articles included in CNKI from 2005 to 2025 and constructed knowledge maps that depict annual output trends, prolific authors, leading institutions and high-frequency keywords.Results: The annual publication volume exhibits a general decline and can be divided into four phases: 2005–2010 foundational accumulation, 2011–2014 performance-driven surge, 2015–2019 structural readjustment, and 2020–2025 low-level transformation. Guo Liya ranks first in individual output, while Beijing Sport University contributes the most at the institutional level.Conclusion: Despite the downward trend in quantity, tennis studies maintain high academic vitality. A systematic delineation of their developmental features and focal topics can supply data support and conceptual guidance for forthcoming project design, policy formulation and program reform.

1. Introduction

In December 2018, General Secretary Xi Jinping fully affirmed the leapfrog development of China's sport sector since the launch of reform and opening-up 40 years ago, stressing that "a strong sports nation underpins a strong China, and national prosperity energizes sports." The 13th Five-Year Plan for Sports Development further proposes making the building of a world-leading sports nation the overarching goal, so that sport can fully release its multiplicative value in advancing the Healthy China initiative, powering economic transformation, fostering national unity and upgrading cultural soft power (Zhu, Y, 2016). Tennis was born in Britain, popularized in the United States and introduced to China around the late nineteenth century; today it ranks second only to football in global participation and media attention(Tang Xin et al., 2021). At the Paris 2024 Olympic Games, Zheng Qinwen claimed China's first-ever women's singles gold medal, sparking

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nationwide enthusiasm(Wang Zhiyi, 2025).

Leveraging CiteSpace, this study conducts a bibliometric and visualization analysis of tennis-related articles published from 2005 to 2025 and included in CNKI. It offers a panoramic sketch of the field's intellectual landscape, evolutionary trajectory and thematic foci, reflects on present shortcomings and potential breakthroughs, and thus provides a roadmap for future scholarly inquiry(Yuaqing et al., 2025).

2. Data and methodology

2.1 Data source

The raw dataset was retrieved from the China National Knowledge Infrastructure (CNKI) academic repository. After an initial search that combined the subject term "sport" with the keyword "tennis," 789 records were returned. To guarantee proximity to the frontiers of scholarship over the past two decades, we restricted the sample to articles indexed in the Peking University Core Journals, removed conference papers, newspaper clippings and monographs, and conducted a manual cleaning round. The resulting corpus comprises 739 refereed research articles that serve as the refined database for this study.

2.2 Research Methods

All analyses were performed in CiteSpace 6.3.R1 (64-bit). The 739 cleaned records were exported in RefWorks format and renamed "download_x.txt." The time slice was set to 2005–2025 and the selection threshold per slice was fixed at k = 10 to ensure parsimonious networks while preserving salient nodes. Author-, institution- and keyword-based knowledge maps were then generated successively. This data-driven approach allows hotspots and emerging frontiers to be identified with minimal subjective interference, thereby enhancing objectivity and replicability.

3. Results and discussion

3.1 Annual publication output

Inspecting the yearly output of Chinese tennis studies between 2005 and 2025 provides an effective lens on the discipline's developmental dynamics. As shown in Figure 1, the overall trend is downward, with a mean of 37 articles per year; the nadir occurred in 2022. The steepest growth took place from 2006 to 2012, peaking in 2011–2012, coinciding with the fastest expansion of competitive tennis in China. A modest rebound is visible in 2024–2025. Because data collection began in January 2005, the apparent sharp drop at the left margin simply reflects the truncated interval.

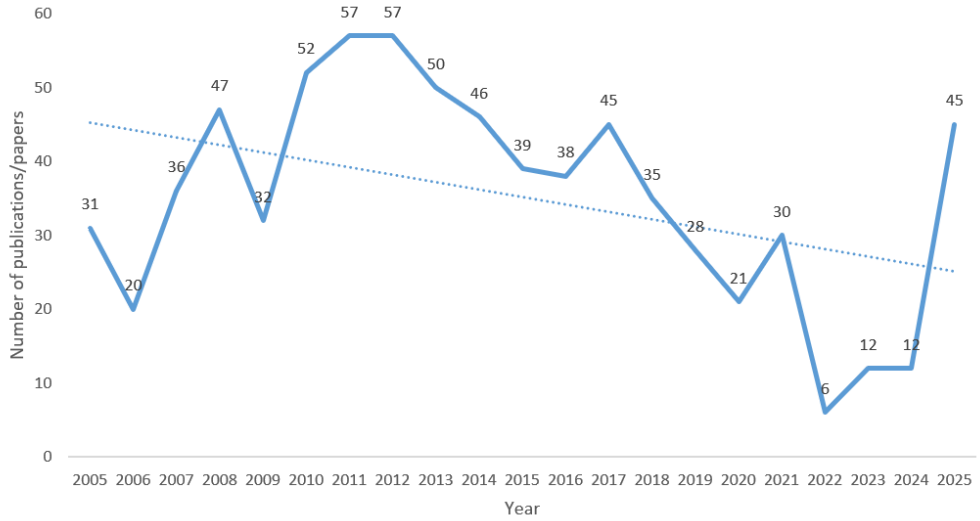

Figure 1: Trend in Annual Chinese Publications on Tennis Research (2005–2025)

3.2 Cooperative-network analysis

3.2.1 Author-level collaboration

In CiteSpace we selected "Author" as the sole node type, set the threshold to k = 10 and left all other parameters at their default values to generate the co-authorship map. Table 1 lists the 12 most prolific scholars extracted from the network; Guo Liya heads the ranking with nine articles.

Annual output is a key indicator of a field's visibility and momentum, reflecting both its growth rate and evolving research priorities(Mi Jun et al., 2024). In the map, node size scales with the number of articles published by each author, while the presence and thickness of ties indicate the intensity of collaboration. The author network contains 230 nodes and 86 edges, yielding a density of only 0.0033 (Fig. 2). Core authors are loosely connected, with most ties occurring within the same institution; no stable, tightly knit research team has yet emerged across organizations.(Hu, 2025b)

Table 1: Top 12 Chinese Authors in Tennis-Research Output (Past 20 Years)

Rank	Author Name	Number of Articles / Papers
1	Guo Liya	9
2	Shijun Liu	7
3	Qing Liu	6
4	Zhengyu Zhu	5
5	Hongwei Jiang	5
6	Xiaolin Tang	5
7	Zheng Chen	4
8	Zhihua Yu	4
9	Wei He	4
10	Chenglin Zhou	4
11	Jiancheng Zhang	4
12	Yong Chen	4

Source: CiteSpace 6.3.R1 (64-bit)

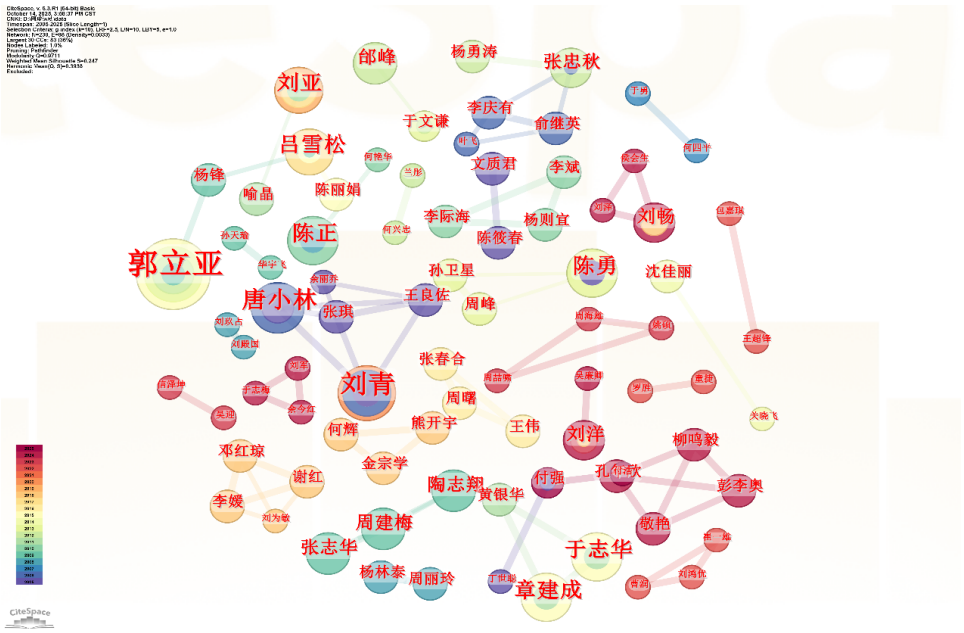

Figure 2: Knowledge Map of Chinese Tennis-Research Authors (2005–2025)

3.2.2 Institutional productivity and collaboration

The distribution and output of research institutions directly mirror the main disciplinary forces and their regional or national influence(Huang Jiafu & Wang Jinghao, 2022). Setting Node Types to “Institution” in CiteSpace (all other parameters unchanged) produced the institutional co-authorship network shown in Fig. 3, where nodes represent organizations and edges indicate joint publications. Extracting the top 12 producers gives Table 2; almost all are either dedicated sport universities or physical-education colleges within comprehensive universities(Hu, 2025e).

Elite sport universities function simultaneously as “experimental fields” and “power houses” for sports-science innovation. The network contains 195 nodes and 79 edges, yielding a low density of 0.0042. Sparse inter-institutional ties reveal that research is dominated by specialized sport academies operating largely in isolation; collaboration occurs mainly among colleagues within the same university, and substantial cross-organizational exchange is still missing(Hu, 2025c) .

Table 2: Top 12 Chinese Institutions in Tennis-Research Output (Past 20 Years)

Rank	Publishing Institution	Number of Articles / Papers
1	Beijing Sport University	31
2	College of Physical Education, Southwest University	17
3	Shanghai University of Sport	10
4	Chengdu Sport University	9
5	Shandong Sport University	7
6	School of Physical Education and Sport Training, Shanghai University of Sport	6
7	School of Kinesiology, Shanghai University of Sport	6
8		6

9	Nanjing Sport Institute	5
10	College of Physical Education, China University of Mining and Technology	5
11	College of Physical Education and Sport, Beijing Normal University	5
12	Department of Sport, Chengdu Sport University College of Physical Education, South-Central Minzu University	4

Source: CiteSpace 6.3.R1 (64-bit)

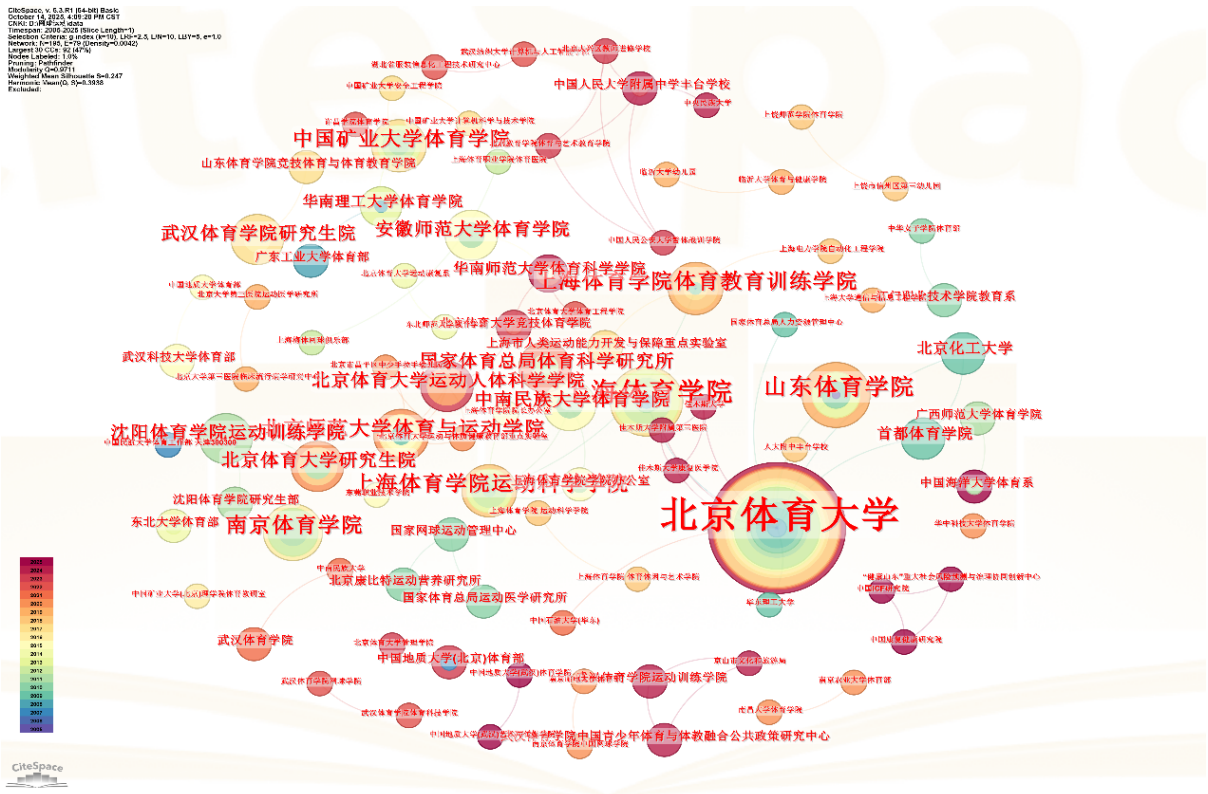

Figure 3:Knowledge Map of Chinese Tennis-Research Institutions (2005–2025)

3.3 Keyword analysis

3.3.1 Co-occurrence mapping

A keyword co-occurrence map allows scholars to quickly spot high-frequency terms and their evolutionary ties, thereby tracing the intellectual history of a field, identifying its core themes and forecasting future directions (Xie Penglei et al., 2024). With CiteSpace we set Node Types to “Keyword” and retained default parameters to generate the co-occurrence network shown in Fig. 4. Each node represents a keyword, node size scales with occurrence frequency, and edges indicate co-occurrence ties(Hu, Huang, et al., 2025). The map contains 264 nodes and 257 edges, giving a network density of 0.0074; the relatively dense connections signal a tightly knit structure.

Tables 3 and 4 list the top 10 keywords ranked by frequency and centrality. “Tennis”, “tennis sport”, “competitive sport”, “China” and “serve” head the frequency list. A centrality ≥ 0.1 is taken as the threshold for disciplinary salience; terms exceeding this value include tennis, China, sports talent and sports history. Overall, the thematic spotlight remains on competitive tennis in China and

the cultivation of athletic talent, especially reserve athletes(Hu, Zhang, Huang, Hu, et al., 2025).

Table 3: Top 10 Most Frequent Keywords in Chinese Tennis Research over the Past Two Decades

Rank	Frequency/Times	Keywords
1	253	Tennis
2	49	Tennis sport
3	47	Competitive sport
4	20	China
5	5	Serve
6	5	Techniques and tactics
7	5	Professionalization
8	4	Countermeasures
9	4	Women
10	4	Li Na

Source: CiteSpace 6.3.R1 (64-bit)

Table 4: Centrality Values of the Top 10 Keywords in Chinese Tennis Research over the Past Two Decades

Rank	Centrality Value	Keywords
1	0.66	Tennis
2	0.59	China
3	0.47	Sports talent
4	0.44	Sports History
5	0.42	Olympic Games
6	0.41	29th Edition
7	0.38	Ping Pong
8	0.19	Marketization
9	0.18	Table Tennis
10	0.18	Ping Pong

Source: CiteSpace 6.3.R1 (64-bit)

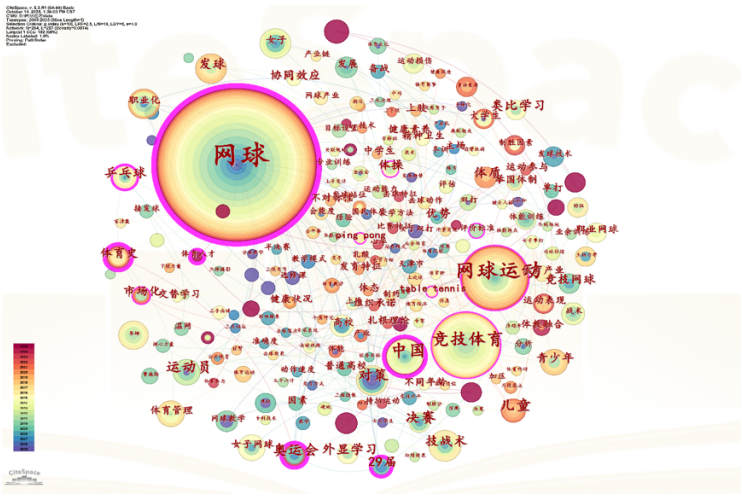

Figure 4:Knowledge Graph of Chinese Tennis Research Institutions over the Past Two Decades

3.3.2 Co-occurrence mapping

Based on network structure and clustering clarity, CiteSpace provides two key metrics for evaluating clustering quality: the modularity index (Q-value) and the mean silhouette score (S-value). These two parameters reflect the effectiveness of the clustering results(Xu Qi, 2025). The TTL algorithm is typically employed for keyword clustering. In this case, the clustering yields a modularity index Q = 0.8445 and a mean silhouette score S = 0.9795, both exceeding the thresholds of Q > 0.3 and S > 0.7, indicating that the keyword clustering structure is statistically significant, highly efficient, and persuasive(Zhang et al., 2025). By examining the keywords within each cluster, research hotspots and their distribution can be identified. As shown in Figure 5, the clustering labels are divided into 12 categories: #0 Tennis, #1 China, #2 Tactics, #3 Competitive Sports, #4 Strategies, #5 Physical Fitness, #6 Sports Industry, #7 Winning Factors, and so on. Smaller serial numbers in the cluster labels correspond to clusters containing more keywords(Hu, 2025d).

Figure 5: Cluster Map of Keywords in Chinese Tennis Research over the Past Two Decades

3.3.3 Keyword Bursts and Timeline Analysis

A keyword-burst map is generated by applying burst detection to the clustering results. Bursts reveal the rise and decline of keyword popularity, highlighting the periods in which a keyword received exceptionally high citation attention(Bai Sujie & Wang Wei, 2024). Using CiteSpace, 12 burst keywords were identified (Figure 6). Burst strength gauges the keyword's relative importance and level of interest within the field. Listed in chronological order of their burst onset, the terms "competitive sports," "tennis," "strategies," "children," and "serve" exhibit the highest intensities, indicating that these topics currently carry the greatest research value and are likely to shape future research trends(Yang et al., 2025).

To visualize the evolution of keywords across different periods, a timeline map was produced with CiteSpace. The timeline view emphasizes inter-cluster relationships and the historical span of

documents within each cluster(Chen Yue et al., 2015). Building on Figure 6, a temporal clustering analysis traces the year-by-year development of every cluster, offering a microscopic perspective on the core research themes in Chinese tennis studies. Figure 7 contains five clusters whose labels are drawn from the co-occurrence network(Deng et al., 2025). Keywords are arranged along the horizontal axis in chronological order; connecting lines and nodes expose co-occurrence ties and temporal trajectories, clearly depicting how research focus has shiftejd over time(Huang et al., 2025a).

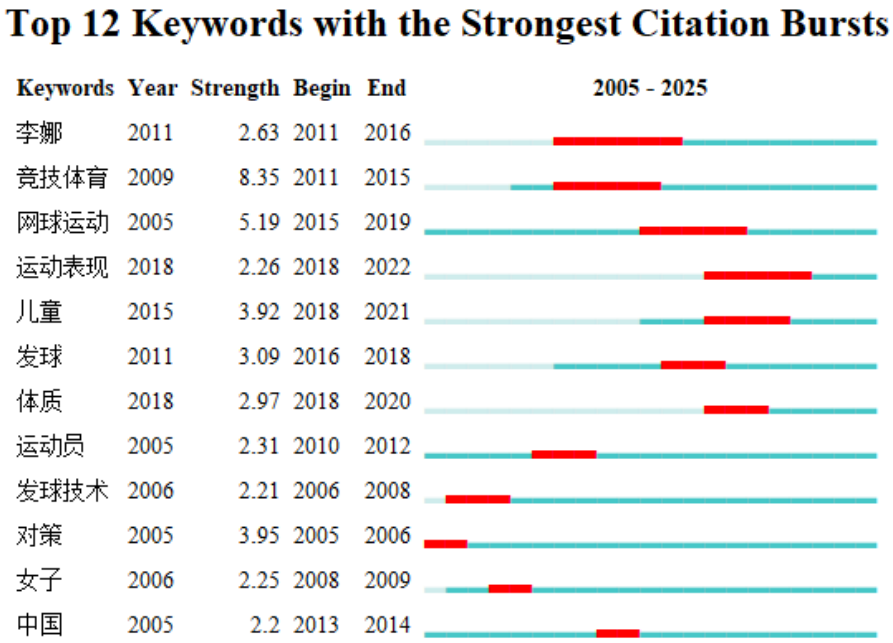

Figure 6:Top 12 Burst Keywords in Chinese Tennis Research over the Past Two Decades

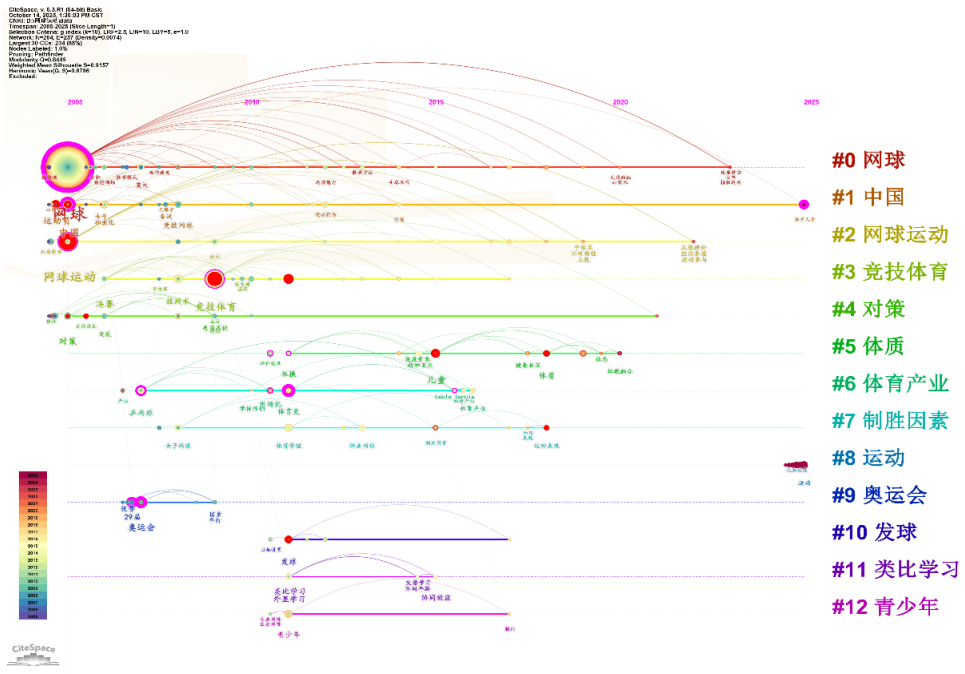

Figure 7:Timeline Map of Chinese Tennis Research over the Past Two Decades

4. Discussion

4.1 Output, authorship and institutional patterns

Between 2005 and 2017 Chinese tennis science experienced a fluctuating upswing. Three mutually reinforcing drivers were at work. First, competitive breakthroughs—ranging from the 2004 Olympic gold to Li Na's 2014 Grand Slam—repeatedly fuelled academic enthusiasm. Second, the popular base expanded to an estimated 10.2 million players, furnishing scholars with abundant empirical material. Third, the establishment of systematic training models generated a steady stream of research questions. Consequently, publications on tennis training and related topics surged(Zhang Zhishang et al., 2015). After the Beijing Games, authorities consolidated lessons learned and issued the "2009–2016 Tennis Olympic Glory Plan", which demanded that "scientific development guide the project, global vision and strategic thinking be adopted, and the sport's trajectory be correctly understood" (Sun, J. F, 2013). The plan further aligned research priorities with practical preparation, sustaining the growth momentum. Output peaked at 45 papers in 2017, but then entered a downward phase averaging 20.6 articles per year through 2024. The 2017 inflection coincided with the waning of competitive hot topics and the fragility of existing research structures; the 2022 nadir of only six articles reflects the combined shock of the pandemic, reallocation of research resources and a broader contraction of the academic ecosystem. At the micro level collaboration remains thin. Guo Liya (Southwest University, nine papers) and Liu Shijun (second in volume) each co-authored with only one colleague, focusing on physical training, serving technique and professionalisation, respectively. A marginal exception is the small Chengdu Sport University cluster formed by Liu Qing, Zhang Qi, Tang Xiaolin and Wang Liangzuo, whose work centres on competitive tennis, professionalisation and policy countermeasures. Institutionally, Beijing Sport University dominates with 31 articles and maintains an extensive peripheral network that includes East China University of Science and Technology, China University of Petroleum (East China), Shanghai University of Sport and several medical and rehabilitation units. By contrast, the second-ranked Southwest University (17 articles) has no external ties, while third-ranked Shanghai University of Sport (ten articles) collaborates only with the Shanghai Laboratory of Human Motor Ability Development and South-Central Minzu University(Hu, Zhang, Huang, & Jin, 2025). Overall, the field exhibits a dual pattern: isolated productivity and selective alliance. Research is concentrated in "tennis", "competitive sport", "elite tennis", "countermeasures" and "development", but institutions are geographically scattered and inter-regional links are weak. Most universities have yet to embed themselves in any collaborative web. Future progress will require deeper multi-institutional, multi-regional, multi-disciplinary and international partnerships(Hu & Huang, 2025a).

4.2 Research Hotspots

Co-occurrence analysis of keywords reveals that Chinese tennis research concentrates on "tennis," "tennis sport," "China," "competitive sport," and "professionalization." The advance of competitive sport in China has propelled tennis forward while enriching the teaching system and injecting new vitality into elite sport (Peng Guoqiang, 2024). Centrality indices show that "tennis," "sports history," "China," and "sports talent" carry the greatest weight, indicating that deeper exploration of tennis development, problems, and solutions is still needed (Wang Yuanyuan, 2024). Amid a fluid domestic environment, future tennis instruction in primary, secondary, and tertiary education must continually innovate teaching models, philosophies, and methods to cultivate competitive reserve athletes (Gong Lina, 2025; Zhang Yihang, 2021).The Outline for Building a Leading Sports Nation stipulates that China should establish a modern system in which government,

society, and the market collaborate, and that sports governance systems and capacity should be modernized. Within this framework, integrating resources from sports schools and social clubs to jointly nurture competitive reserve athletes has become a key pathway for advancing tennis and other sports(Lu Wenyun, 2020).Notably, “table tennis” ranks seventh and ninth in centrality, indicating its high reference value for tennis in training, teaching, and tactics; future cross-integration with table tennis could provide new momentum for tennis development (Jiang Yanyan, 2012). Studies continue to explore tennis athletes’ development; as reserve talent for competitive sport, they include males, females, professionals, club players, and elite athletes. Being an individual sport, tennis has unique rules in competition, promotion, and development; generational succession of tennis players is fundamentally driven by the synergy of professionalization, media dissemination, and sports sponsorship systems (Yin Shulai & Jiang Hongwei, 2020).Reserve-talent training should systematize the “all-round development” philosophy to form a synchronized, monitorable training-guidance system(Xia Jing & Li Zan, 2025); innovate a vertical “pyramid” talent-development model and continuously broaden and deepen its pathways (Li Xiuhong et al., 2020); promote complementarity and integration of multiple training models and establish a mutually supportive and reciprocal “harmonious coexistence” system (Sun Ping & Li Chengliang, 2024); and advance school–sport integration in both breadth and depth while improving coaches’ comprehensive qualities to build high-quality mentoring teams (Yang Chengbo et al., 2020). Keyword induction shows that the evolution of research hotspots reflects the continuous development and change of Chinese tennis studies over the past two decades.

4.3 Research Trends

Tennis has undergone a protracted developmental journey. Cluster, burst, and timeline analyses of keywords allow us to chart the evolution of hotspots and forecast future directions (Zhou Chi & Huang Wenying) . Overall, studies cluster around China, tennis sport, tactics, countermeasures, children, and the sports industry(Hu & Huang, 2025b). The broader development of Chinese sport has opened new avenues for tennis research, including its own growth and constraints, as well as the expansion of the sports and tennis industries(Liu Yanwu, 2025).

Four phases can be distinguished. 2005–2010: Foundational accumulation. Emphasis lay on tennis, countermeasures, serving techniques, women’s tennis, and the sports industry. The importation of foreign theories, coupled with the 1995 Sports Industry Development Outline (1995–2010), the National Fitness Plan, and the Olympic Glory Plan (1994–2000), ushered in categorical sports governance (Xun Changdian et al., 2025). China’s tennis progress showcased the strengths of the national system (Zhang Yan et al., 2025). From 2003 the Tennis Administration Center shifted from “management” to “service,” integrating human, material, and financial resources to create a resource platform that combined administrative and market instruments to prepare for successive Olympic cycles (Liang Gaoliang & Chen Yong, 2019). 2011–2014: Competitive explosion. Research focused on Li Na, competitive sport, and athletes. Li Na’s 2011 Roland-Garros triumph triggered “tennis fever” (Jiang Fusheng & Liu Ya, 2011), the tennis population exceeded 10 million, and the spread of university tennis courses propelled the field (Shen Ye, 2019). 2015–2019: Adjustment. Attention shifted to children, performance, and governance structures. Children and adolescents are the core base for competitive reserve talent (Hu, 2025a). Continuously perfecting the youth training system is essential to supply Olympians. A mature training system requires both competitive validation and the test of time (Chen Lijuan et al., 2017). China must absorb international best practices, integrate them with national realities, and forge an innovative, distinctly Chinese talent model(Liu Bo et al., 2023). Only by expanding the

youth talent pool can the national team secure long-term competitiveness and produce icons on the level of Kei Nishikori or Li Na(Hua Xiao, 2019). The 14th Five-Year Sport Development Plan explicitly calls for deepening school–sport integration, supporting youth sports organizations, and consolidating reserve talent pipelines (Zhu Yan et al., 2022). 2020–2025: Low-level transformation. Studies foreground match characteristics, athlete heart-rate, Chinese sports talent, theory, and countermeasures(Huang et al., 2025c). The 2020 Healthy China 2030 Outline provides new conceptual guidance by embedding sport within a broader health framework and linking it to medicine, public health, and social services (Huang et al., 2025b).This shift directs public attention beyond elite medals and fosters a pluralistic, life-oriented sports ecosystem (Chen Jingcheng, 2021; Zhao, H. Y., & Li, R. R, 2021).

Thirty years of the Olympic Glory Plan have yielded remarkable Olympic success and a distinctly Chinese path to becoming a sports power (Shao Kai & Du Jiang, 2025). By 2025 tennis has matured; Zheng Qinwen's 2024 Paris Olympic women's singles gold benefited directly from the plan. The sports industry—described as a sunrise, green, and happiness industry—shoulders the strategic mission of realizing a strong sports nation and Healthy China (Huang, Haiyan, 2018). Continuous reform has expanded the tennis fan base, amateur events, and competitive tennis Zheng Sen & Xu Jian, 2019). To sustain output, China must balance grassroots and elite structures across industrialization, cultural soft power, reserve talent, teaching, and training (Dong Guangwu et al., 2024).

5. Conclusion

Over the past two decades, the output of tennis-related research in China has shown an overall downward trend. Academic capacity is concentrated in sports-oriented universities, yet both authors and institutions are scattered, resulting in low levels of close collaboration; cross-institutional communication and cooperation urgently need to be strengthened. Future research hotspots are likely to concentrate on the industrialization of tennis, the optimization of tennis teaching, the enhancement of competitive tennis, the integration of elite sports, and the cultivation of sports talent.

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