

Thirty years from 1992 to 2023: A bibliometric study of the Marathon Sports in China

Jiahui Wang^{1, a, *}, Peng Du^{1, b}

¹ School of Sports, Shenzhen University, Shenzhen, 518060, China.

^{a, *} wjh@szu.edu.cn, ^b wangjiaaab@icloud.com.

Abstract. This article uses triple analysis tools, namely Citespace, Vosviewer, and ArcGIS, to conduct a visual analysis of core literature published in the CNKI database from 1992 to 2023, focusing on the themes of "marathon" or "road running." The analysis generates visualizations such as keyword co-occurrence knowledge maps, keyword bursting maps, and heat maps of research institutions and regions. The objective is to explore the research hotspots, evolution, and frontiers of China's marathon studies based on the significance of sports, providing a systematic, vertical, and periodic overview of current China's marathon research. The study aims to fill the gap in the comprehensive, longitudinal overview of marathon research in China under a full cyclic historical development perspective. Additionally, it seeks to explore the dynamic development of marathon research in China throughout the entire cycle, contributing to a clear, systematic, and visual representation of marathon sports research. The findings are expected to offer valuable insights and references to promote the clarity, systematization, and visualization of marathon sports research in China.

Keywords: Marathon; Citespace; VOSviewer; Research review; Bibliometrics.

1. Introduction

A marathon, in the context of sports, was officially incorporated into the Olympic program in 1896[1]. The history of marathon development in China can be traced back to 1936 when Wang Zhenglin became China's first marathon athlete to participate in the Berlin Olympics[2]. By 1957, the first marathon race in New China was held in Nanjing [3]. As of 2019, China had hosted 1,828 marathon events, covering 70% of prefecture-level cities[4], with a total of 7.12 million participants [5]. Despite the impact of the COVID-19 pandemic in 2020, there were still 350 certified events recognized by the Chinese Athletics Association, and a total of 209 hybrid "online + offline" smart interactive marathon events were organized throughout the year, with over 10 million participants in various road races[6]. The post-pandemic era marked a significant milestone for the return of marathon events to society, with 133 registered events in the first half of 2023 alone. In terms of event quantity, the marathon trend has essentially returned to the pre-pandemic level [7].

Benefiting from the multi-pronged approach of sports development policies and the strong driving force of the marathon industry market, research on marathon running has long been a focal point in academic circles. A search using "marathon" or "road race" as keywords in the CNKI database's "Journal" category yielded 14,875 results (search date: June 12th, 2023). However, a comprehensive review of marathon running research literature published in core Chinese journals from 1992 to 2023 (as shown in Table 1) reveals two main characteristics. Firstly, the time span of the literature samples is limited to a specific period, such as studies covering the years 2010 to 2020 in the field of marathons[8]. Secondly, the literature samples are selected from specific domains, such as certain aspects of race management [9]. It is evident that no scholars have yet undertaken a comprehensive and vertical review of literature on the entire developmental cycle of China's marathon running from a holistic perspective.

Table. 1 Overview of Research Literature Review on Marathon Running in Chinese Core Journals

No.	Paper	Author	Journal	Year	Downloads
1	Visual analysis and international comparison of China's marathon research	Caijie Q, Bingyuan G, Xiaowei P.	Journal of Shenyang Institute of Physical Education	Sept. 16, 2021	1375
2	Visual Analysis of the Evolution of International Marathon Hot Topics Research—Based on the Application of Co-word Clustering Based on CiteSpace II Software	Xue H, Jiakun Zheng, Gangya S.	Journal of Southwest Normal University (Natural Science Edition)	Oct. 20, 2018	971
3	Knowledge graph analysis of marathon research in English journals	DingY, Bing S.	China Sports Technology	May. 15, 2018	1322
4	A review of the management process of some international marathons in China	Yan W.	Journal of Guangzhou Institute of Physical Education	Mar.28, 2013	870
5	A review of the theoretical research of women's marathon training in China	Qianfang J, Daqing L.	China Sports Technology	July.10, 2008	1463
6	Based on bibliometric analysis, the influence of different exercise patterns on bone density at home and abroad in the past 10 years was analyzed	Tao M, Jian L, Jiapeng J.	Chinese Tissue Engineering Research	Feb. 8, 2018	362

In view of this, this paper uses Citespace, Vosviewer and ArcGIS to visualize and analyze the core journals of "marathon" based on the meaning of sports published in CNKI database between 1992 and 2023, and generates keyword co-occurrence knowledge map, keyword emergence map, heat distribution map of research institutes and regions, etc. in order to sort out the current status, hotspots and trends of China's marathon research through the perspective of full-cycle and vertical research. The keyword co-occurrence knowledge map, keyword emergence map, heat distribution map of research institutions and regions, etc., are used to explore the current situation, hotspots and trends of the research on marathon based on the significance of sports in China, in order to sort out the current research on marathon based on the significance of sports in China through the perspective of full-cycle and vertical research, and to make up for the lack of a comprehensive review of marathon based on the significance of sports in China in the post-epidemic era, with a view to exploring the development of the field of marathon in China. We hope to explore the development dynamics of marathon research in China, and provide useful reference for promoting the clarity, systematization and visualization of marathon research.

2. Data and Method

2.1 Data

Based on the consideration of the quality of the literature[10], the Chinese data were obtained from the China Academic Journal Network Publishing Database (CNKI), with the search subject of "marathon" or "road running", the source category of "core journals", "CSSCI, CSCD", and the literature type of "journal articles", CSSCI, CSCD", the type of literature was journal articles, and the search time was June 12, 2023.

Meanwhile, to ensure the accuracy of the literature, the researchers will proofread, de-weight and errata the results of the literature search, and exclude news reports, conference notices, monographs, art appreciation, military battles, engineering machinery, and other non-sporting marathon research literature data. The database search and literature screening process is detailed in Table 2.

Table. 2 Database search and literature selection results

Classify		Data Retrieval Results
Database		CNKI
Search Criteria	Topic	“Marathon”or“Road run”
	Source Category	“Core journals, CSSCI, CSCD”
	Document Type	Article
	Time Span	Unlimited
Number of Articles Initially Searched		641
Literature Screening and Refining Results		446

2.2 Method

CiteSpace is a scientific measurement and knowledge visualization software developed based on Java operating environment. The software is mainly based on the theory of co-citation analysis (co-ciation) and the pathfinder network algorithm (pathFinder), etc., to implement the metrological analysis of the literature in specific research fields, in order to explore the key paths of the evolution of the subject areas and their knowledge inflection points, and to draw visual maps to excavate the potential power mechanism of the evolution of the discipline and the process of the changes in the frontiers of the discipline's development [11]. The aim is to draw a visual map of marathon research with the help of CiteSpace software tools, such as "keyword clustering, keyword emergence", etc. At the same time, we use comparative analysis and logical reasoning to clarify the tendency of China's marathon research.

VOSviewer is developed by Nees Jan Van Eck and Ludo Waltman of Leiden University [12], and VOSviewer has more advantages than Citespace in keyword visualization mapping. Therefore, in this paper, VOSviewer will be used to visualize the keywords of the sample literature in order to reveal the hotspots of interest in the field.

ArcGIS is a special software for geographic information system (GIS) developed by ESRI, which has become an important tool for research related to recreational tourism and geographic information mapping because of its multiple functions such as editing, analysis, statistics, etc.[13] In this paper, we take the major marathon research institutions and regional heat maps in China as the entry point of the demand, and draw the visual mapping with the help of this tool.

3. Descriptive statistical analysis of literature

3.1 Distribution of literature by year of publication

This study finally included 446 Chinese-language literature, the first core journal literature on marathon based on the significance of sports published by CNKI was seen in 1992, and the annual number of publications is shown in Figure 1.As shown in the figure, the overall China's research on marathon with the significance of sports has shown a long-term gradual growth and then declined back to the trend of publications. Among them, the number of Chinese literature issuances has grown significantly since 1992-2017, from 8 annual literature issuances at the beginning of the study to 54, reaching the peak of China's marathon sports research issuances. From then to 2019, the annual number of publications briefly dropped back to 37, and then declined progressively in 2020 after a rapid upward trend of publications again. It can be seen that the China's research on marathon sports started late; secondly, up to 2020, the China's research on marathon sports has

shown a long-term upward trend and good development, but after 2020, affected by the COVID-19 disease, the research has been hindered and showed a downward trend.

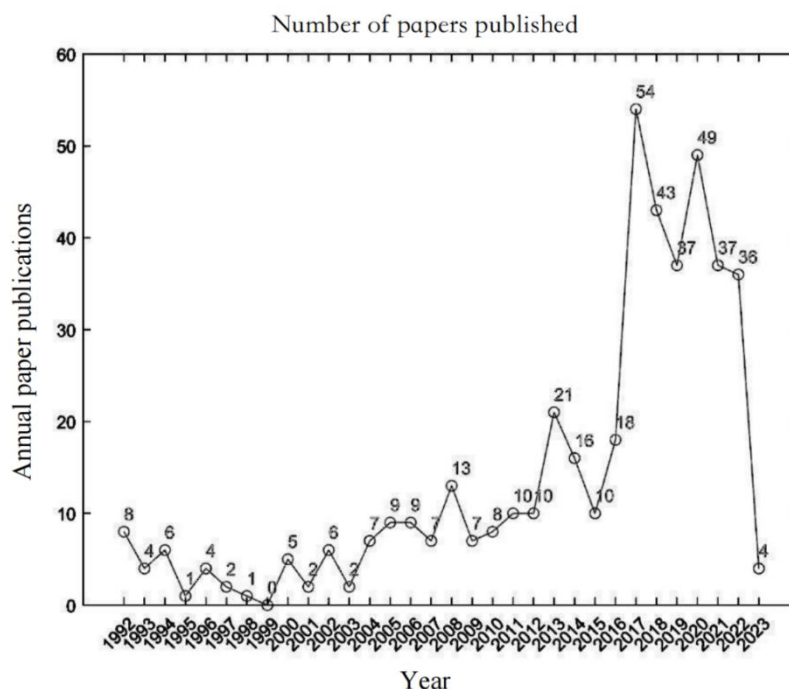


Fig. 1 CNKI marathon research literature publication year and publication volume

3.2 Study authors and collaborations

Based on the CNKI literature data, the relationship mapping of China's researchers of marathon based on the significance of sports is drawn, and the key data are intercepted to retain the top ten core authors in the rankings and analyze their research contents.

In the China's core papers, the top ten authors in terms of research publications are Jianping Ding, Xiaolin Zhang, Wangang Lv, Xiaozhong Zheng, Zheng Zhu, Hui Zhang, Zhichun He, Lin Wang, Fangqian Jiao and Feng Zhai. Among them, Jianping Ding has accumulated 6 publications from 2019 to 2023, and his research direction belongs to the category of sports human science, which usually uses MRI (magnetic resonance imaging) T2* mapping relaxation time to quantitatively analyze the changes in the composition of tissue within the knee cartilage, in order to more sensitively assess the changes in the composition of the knee cartilage before and after a half-marathon in amateur marathon runners or road runners. compositional changes in knee cartilage [14].

Xiaolin Zhang has accumulated 5 articles from 2016 to 2023, and her research direction belongs to the category of sports humanities and sociology, and her research takes marathon race culture as an entry point, covering the value of the event, the traceability and revelation of the race culture, the comparison of the race culture, the strategy of the race problem dissolution, and the historical evolution of women's participation in marathon based on the feminist perspective [15]. Wangang Lv has accumulated 5 articles from 2017 to 2023, and his research direction is humanities and sociology of sports, and his research mostly draws on literature, logical analysis and other methods to sort out and summarize the supply-side structural reform and development of the marathon sports industry [16], the mode and mechanism of preventing the risk of sudden death [17], the physiological adaptation of marathon to the heart and the potential risk of marathon [18], the role mechanism and development of digitalization of the sports industry [19], and the path of coordinated governmental governance of event risks [20]. Xiaozhong Zheng has accumulated 5 articles since the beginning of 2019 until 2023, and his research focuses on discussing the effects of half-marathon exercise on the biochemical components of the thigh musculature [21], patellar tendon morphology [22], and articular cartilage [23] occurring in male amateur marathon runners

during the exercise process with the help of MRI technology and DTI technology. Zheng Zhu has accumulated four publications since the beginning of 2007 until 2023, and all four articles were published in 2007. The research direction is sports human science, usually using acupuncture as an intervention, with the help of dynamic observation methods, to study the effect of acupuncture on the recovery of immune function after half marathon [24] in middle-distance runners. Hui Zhang has accumulated 4 publications since the beginning of 2020 until 2023. Most of the studies started with the marathon race culture as the core to gain insights into the event participants' urban residents' happiness index [25], event attractiveness perception [26], city brand cognition [27], and city integration evaluation [28]. Zhichun He, with a cumulative publication volume of 4 articles from 2014 to 2023, focused his research on analyzing marathon participants' post-race medical consultations, exploring their influencing factors and their correlations [29-31], and then proposing strategies to optimize race protection. Lin Wang has accumulated 4 articles from 2010 to 2023, and his research focuses on analyzing the pre-event training arrangement and content of outstanding athletes, in order to provide theories and data for reference [32-34].

Fangqian Jiao has accumulated a total of 4 publications from 2008 to 2023, and her research direction is mainly on the training load, training cycle, and training pattern of Chinese female marathon runners [35]. Zhai Feng has accumulated 4 articles from 2002 to 2023, and his research direction is mainly on the plateau training [36] model of excellent marathon runners.

Table. 3 Authors of the Top Ten Studies in Terms of Publications

No.	Author	Number of Published	Research Directions	Year of First Publication	Article	Journal
1	Pingjian D.	6	Human Movement Science	2019	Quantitative study of MRI T2* value of knee cartilage before and after half marathon runners in amateur marathon runners	Chinese Journal of Radiology
2	Xiaolin Z.	5	Humane and Sociological Science of Sports	2016	Analysis of the value of the "hot" phenomenon of marathon events in China	Journal of Shenyang Institute of Physical Education
3	Wangan g L.	5	Humane and Sociological Science of Sports	2017	Supply-side structural reform and sports industry development: reflections triggered by urban "marathon fever"	Journal of Shandong Institute of Physical Education
4	Xiaozhong Z.	5	Human Movement Science	2019	Quantitative study of MRI T2* value of knee cartilage before and after half marathon runners in amateur marathon runners	Chinese Journal of Radiology
5	Zheng Z.	4	Human Movement Science	2007	Changes in spontaneous cytokine gene expression of Th1 and Th2 characteristics of acupuncture intervention 4 h after	Journal of Guangzhou Institute of Physical Education

No.	Author	Number of Published	Research Directions	Year of First Publication	Article	Journal
					the half-marathon	
6	Hui Z.	4	Humane and Sociological Science of Sports	2020	The relationship between marathon culture and the happiness index of city residents: based on a survey of local event participants	China Sports Technology
7	Zhichun H.	4	Human Movement Science	2014	Analysis of medical visits of participants in the Shanghai 2013 International Marathon	Chinese Public Health
8	Lin W.	4	Theories of Sport Training	2010	Study of pre-race training for the World Championships in Berlin	Journal of Beijing Sport University
9	Fangqian J.	4	Theories of Sport Training	2008	A review of the theoretical research of women's marathon training in China	China Sports Technology
10	Feng Z.	4	Theories of Sport Training	2002	A study of plateau training for outstanding female marathon runner Ren Xiujuan	Sports Science

The same operation as above, the top ten research authors' collaborative relationship structure network is plotted (see Figure 2 for details). It can be seen that the top ten collaborative research authors are basically the same as the top ten research authors in terms of the number of publications. In addition to Zhang Xiaolin and Zhai Feng, who are mostly independent research authors, the other eight research authors have formed small research cooperative groups with other scholars, and the small research cooperative groups show a discrete distribution pattern. This indicates that scholars in the field of marathon research in China have not yet formed a close cooperative relationship, and have not yet formed a research team of a certain size.



Fig. 2 The map of the cooperative relationship between the top ten research authors in China's marathon sports

3.3 Research Institutions and Partnerships

The top ten marathon sport research institutions in China (as shown in Table 4). From this, it can be seen that at present, China's marathon sports research institutions are mainly Beijing Sport University, College of Physical Education of Northeast Normal University, College of Sports Science, Nanjing Normal University, the Department of Physical Education of Tsinghua University, the College of Sports Industry and Leisure of Nanjing Sports Institute, the Department of Radiology of Hangzhou Normal University Hospital, the Institute of Sports Science of the State General Administration of Sports, the College of Sports Science of the Shanghai Institute of Physical Education, the Shanghai Institute of Sport, and the State General Administration of Sports Sports Culture Development Center.

The dissertation output of Beijing Sport University in marathon sports research mainly focuses on the field of sports training, such as the training load arrangement and training cycle arrangement of excellent athletes, the review of training theory research, the improvement of middle-distance runners' athletic ability by plateau training and nutritional monitoring and the characterization of the speed change of the marathon World Championships, etc. In 2018, some scholars attempted to carry out a qualitative research on the interaction between China's amateur marathon runners and the social interaction qualitative research [37], which makes the institutional dissertation output of Beijing Sport University jump out of the monolithic research category with athletic training as the main body, and promotes the multi-perspective perspective within the institution to cut into the study of marathon sports.

The overall research tendency of the College of Physical Education of Northeast Normal University is in the direction of humanities and sociology of sports, dedicated to the study of the culture of marathon sports, including its generative mechanism, cultural analysis, as well as the path of marathon athletes' professional development under the synergy of multiple subjects [38], and so on.

The College of Sports Science, Nanjing Normal University takes marathon events as the main body, and conducts qualitative research on event review, event participants' consumption preference [39], event brand cognition [40], event governance logic and regulatory optimization strategy [41], and so on.

The research perspectives of the Department of Physical Education and Sport at Tsinghua University are significantly diversified, and the research content involves two major categories: humanities and sociology of sport and sports human science. The research based on the field of humanities and sociology is mainly about the value of marathon events, the development characteristics of road running events in the United States, the review of IAAF events [42], and the event sponsorship market; the research based on the field of sports human sciences is mainly about the identification and diagnosis of exertional pyrexia [43] and the strategy of cooling treatment.

The research direction of the College of Sports Industry and Leisure of Nanjing Sports Institute is sports humanities and sociology, and Jin Wang is the main output scholar of the institution, who independently published three articles into an integrated research posture, respectively, on marathon event development, spatial distribution, and sponsorship market. Additional studies have tended to focus on race regulation and the construction of urban imagery under marathon race orientation [44].

The Department of Radiology of the Affiliated Hospital of Hangzhou Normal University has focused on the application of MRI technology in the lower limb muscles and knee joints of the running population, and has repeatedly demonstrated that, in the absence of positive findings in conventional MRI, the use of T2* mapping quantitative MRI technology can indirectly reflect the biochemical compositional changes of the articular cartilage that occur in the process of exercise and that the patellar tendon length, regional CSA, and volume of the patellar tendon of the male amateur marathoners were significantly lower in the male half marathon runners [45]. length, regional CSA and volume produced changes that were reversible [45].

The Institute of Sport Science of the State General Administration of Sport has focused on the changes in physiological and biochemical indices of marathon runners and the adaptive mechanisms of the heart.

The School of Exercise Science of Shanghai Institute of Physical Education focuses on the study of electroacupuncture intervention in marathon athletes' post-competition recovery within the context of sports human science, as well as the adverse effects and potential risks of marathon exercise on the heart.

The research scope of the Shanghai Sports Institute radiates widely, involving the development of marathon races, runners' knee injuries, and consumer behavior characteristics. The five academic papers from the Sports Culture Development Center of the State General Administration of Sport are all from scholar Xiaolin Zhang, who mainly conducts research from the perspectives of marathon event value, cultural traceability, cultural comparison, and women's participation.

Table. 4 Top 10 Research Institutions and Content Published

No.	Name of the institution	Number of Published	Year of First Publication	Article	Author	Journal
1	Beijing Sport University	17	1994	The main characteristics of modern sports training and Ma Junren training load arrangement and thinking on load principle	Jiaxing G.	Sports Science
2	Northeast Normal University Physical education institute	6	2017	The cold thinking behind the "hot" marathon	Jinming X. (2nd author)	Journal of Physical Education

3	Nanjing Normal University Faculty of Sports Science	7	2007	Looking at Beijing from Osaka – an urgent presentation of China's athletics preparations for the Beijing Olympics	Shanguan g G. (2nd author)	Sports and Science
4	Department of Physical Education, Tsinghua University	6	2017	The cold thinking behind the "hot" marathon	Bo L. (2nd author)	Journal of Physical Education
5	Nanjing Institute of Physical Education School of Sports Industry and Leisure	6	2007	Development characteristics and paths of marathon events in China	Jing W.	Sports Culture Guide
6	Hangzhou Normal University Department of Radiology, Affiliated Hospital	6	2019	Quantitative study of MRI T2* value of knee cartilage before and after half marathon runners in amateur marathon runners	Yanjing Z, Li Z, Wanzhen Y, Xiaozhong Z, Yi Z.	Chinese Journal of Radiology
7	State General Administration of Sports Institute of Sports Science	6	2011	Key factors for winning a marathon (1) On-site nutritional science guidance	Erwei D, Qingzhang W.	China Sports Technology
8	Athletic at Shanghai Institute of Sport Faculty of Science	6	2007	Acupuncture intervention in immune cells after half marathon Varying characteristics	Zheng Z.	Shanghai Institute of Sport Journal
9	Shanghai Institute of Sport	5	2015	The development history of modern Shanghai city marathon	Youqiang L.	Sports Culture Guide
10	Sports of the State General Administration of Sports Cultural Development Center	5	2016	Analysis of the value of the "hot" phenomenon of marathon events in China	Xiaoling Z.	Shenyang Institute of Physical Education Journal

Visualization mapping of the cooperation relationship between research institutions in China's marathon sport (as shown in Figure 3). Among them, the research institution cooperation cluster centered on Beijing Sport University is the most significant; then the research institution cooperation network composed of the School of Sport Science of Nanjing Normal University, the School of Sport Industry and Leisure of Nanjing Sport Institute, the School of Physical Education and Sports of Suzhou University, the Graduate Department of Nanjing Sport Institute, and the National Research Center of Cultural Industry of Nanjing University; followed by the research institution cooperation network composed of the School of Physical Education and Sports of Northeast Normal University, the Department of Physical Education of Tsinghua University, and the Chaohu College of Physical Education and Sports, Tsinghua University, and Chaohu College of Physical Education and Sports are more significant research institution cooperation networks.

In addition, in combination with the above ranking of research institutions, Beijing Sport University, as a research institution with a high volume of publications in this field, is the research

institution with the most significant cooperation network. This suggests that active academic cooperation among research institutions is conducive to increasing the output of academic publications. However, the reality is that the majority of research institutions are small groups of research institutions and independent research institutions. Therefore, although there are a certain number of marathon research institutions in China, the density of cooperation is not high, and thus the output rate of collaborative academic articles is low.

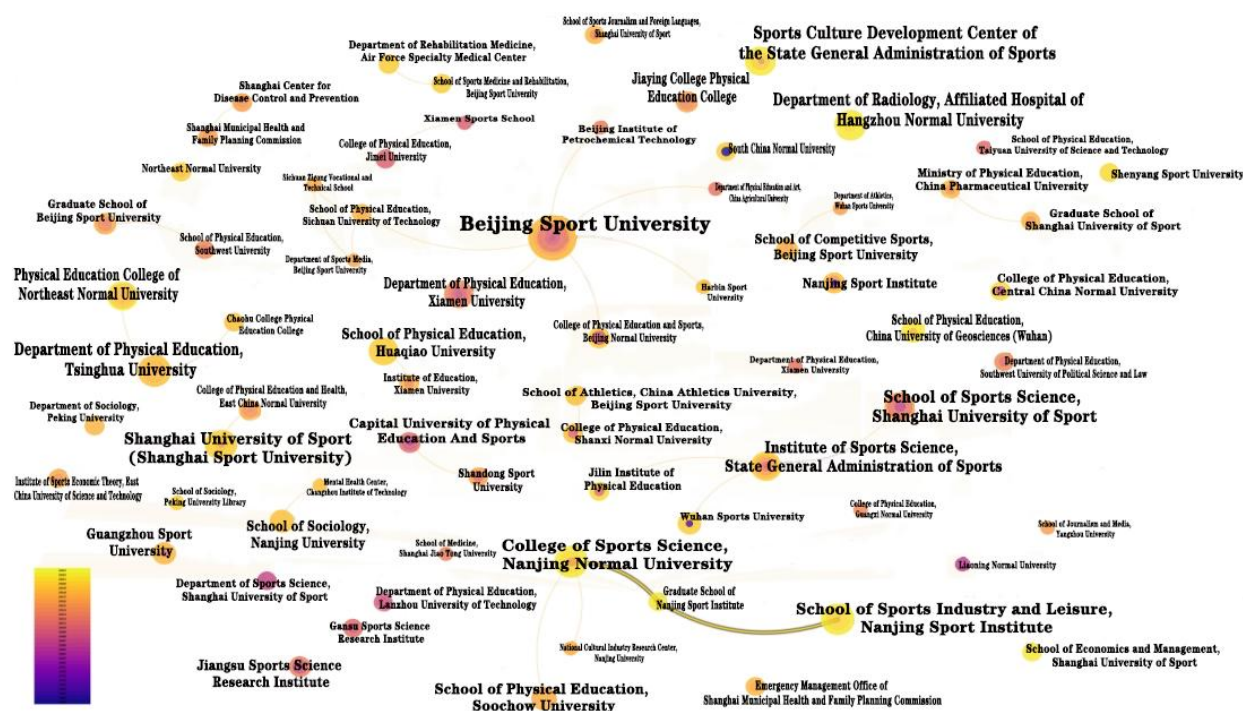


Fig. 3 Visualization of the partnership between research institutions in China's marathon sport

3.4 Regional Distribution of Research Organizations

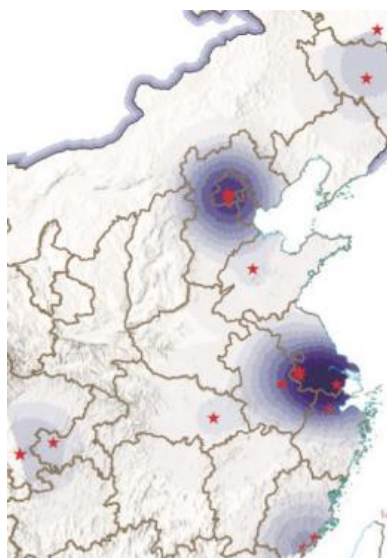


Fig. 4 Marathon sports research institutions and regional heat distribution map in China

ArcGIS software was utilized to generate thermal distribution maps of major marathon sport research institutions and regions in China. It is observed that there are currently six major marathon sport research institutions regional set points in China. In terms of administrative regions, the first one is the distribution area centered on the capital city of Beijing, the second one is the distribution area centered on the city of Shanghai, the third one is the distribution area centered on the city of

Xiamen in Fujian Province, followed by the distribution areas of research institutions centered on the municipality of Chongqing, the capital of Heilongjiang Province, Harbin, and Wuhan in Hubei Province. Geographically, the main research institutions are concentrated in coastal areas, while inland research institutions are mainly concentrated in the area of Chongqing municipality, Sichuan Province. The heat map of research institutions with Shanghai as the core covers the widest area and the core circle has the brightest color, which indicates that the distribution of research institutions in this region is dense, and the research institutions cooperate closely and are geographically concentrated. On the whole, the major research institutions are located in mega cities with high GDP and transportation, and the regional distribution of research institutions is not equal, and the phenomenon of tilted research resources is obvious.

3.5 Research Journals and Journal Publications

From 1992 to 2023, the top ten journals ranked in terms of the number of articles published are as follows: Sports and Culture Guide Journal published 54 articles, accounting for 12.11%; China Sports Science and Technology published 33 articles, accounting for 7.40%; Journal of Beijing Sport University published 24 articles, accounting for 5.38%; Journal of Guangzhou Institute of Physical Education published 22 articles, accounting for 4.93%; Journal of Sports and Science and Journal of Shandong Institute of Physical Education each published 20 articles, accounting for 4.48%; Chinese Journal of Sports Medicine and Journal of Wuhan Institute of Physical Education each published 18 articles, accounting for 4.04%; and Journal of Wuhan Institute of Physical Education each published 18 articles, accounting for 4.04%. and Journal of Shandong Institute of Physical Education each recorded 20 articles, accounting for 4.48%; Chinese Journal of Sports Medicine and Journal of Wuhan Institute of Physical Education each recorded 18 articles, accounting for 4.04%; Sports Science recorded 16 articles, accounting for 3.59%, and finally, Journal of Shanghai Institute of Physical Education recorded 15 articles, accounting for 3.36%. As far as the current data is concerned, sports core journals are still the main form of articles on marathon in China, but there is no lack of sociological journals such as China Youth Studies that pay attention to the participation of young people in running and the formation of a new type of social culture in our society.

Table. 5 The number of articles published in marathon sports research journals in China

No.	Journal	Number of posts	Accounts for the total (%)
1	Sports Culture Guide	54	12.11
2	China Sports Science and Technology	33	7.40
3	Journal of Beijing Institute of Physical Education	24	5.38
4	Journal of Guangzhou Institute of Physical Education	22	4.93
5	Sports and Science	20	4.48
6	Journal of Shandong Institute of Physical Education	20	4.48
7	Chinese Journal of Sports Medicine	18	4.04
8	Journal of Wuhan Institute of Physical Education	18	4.04
9	Sports Science	16	3.59
10	Journal of Shanghai Institute of Physical Education	15	3.36

China Sports Science and Technology began to publish marathon sports-related articles in 1992, the former national team track and field coach Zhangyan Yu in the "Slightly on the purpose and relevance of track and field training" article clearly put forward "endurance is the basis for a comprehensive arrangement, depending on the person, pay attention to the effectiveness of the training principles of endurance as a guiding principle, and Combined with modern meteorologists and exercise physiologists pointed out that winter training can improve the ability to withstand oxygen debt, enhance the body's resistance, absorption of nutrients, and promote recovery [46]. The theoretical foundation of academic significance has been laid for the in-depth research of training methods such as plateau training since then. Since the publication of the first marathon research

paper in the Journal of Sports Culture Guide in 2010, the trend of publication has grown rapidly, and the number of articles has accumulated to 54. Combined with the aforementioned research directions, this is due to the large number of research scholars engaged in the field of humanities and sociology of sports, and the event culture as an important breakthrough in the study of China's marathon has received extensive attention from the academic community.

4. Research hotspots, evolution and frontier analysis

4.1 Research hotspots

Using the VOSviewer keyword Co-occurrence visualization function and setting the number of independent keyword occurrences > 3 times, we generated a visual analysis map of the hotspots of marathon research based on the significance of sports in China (shown in Figure 5). It can be seen that the distribution of hotspots in China's marathon research as a whole shows a focus on "marathon" as the core, to "marathon events", "marathon running", "marathon run", "marathon athlete" and other multi-faceted research routes. In the hotspot analysis knowledge graph, the keywords are represented by circles and labels, and the degree of activity is positively correlated with the size of the circles, and the closer the distance between the two circles, the closer the relationship between the two[47], and according to the keyword node intensity data (shown in Table 6), it is known that the research on marathon, marathon events, sports management, sports events, and magnetic resonance imaging is relatively centralized, and the keyword frequency is consistent with the circle of the graph. nodes are consistent with the graph circles.

Table. 6 Marathon Research Keyword Frequency and Nodal Intensity

No.	Keyword	Frequency	Nodal Intensity
1	Marathon	146	143
2	Marathon Sport Events	48	48
3	Sports Management	24	37
4	Sports Events	25	36
5	MRI	11	25
6	Mass Sports	17	24
7	China	11	21
8	Urban Marathon	17	21
9	knee Joints	6	17
10	Sports Medicine	10	17

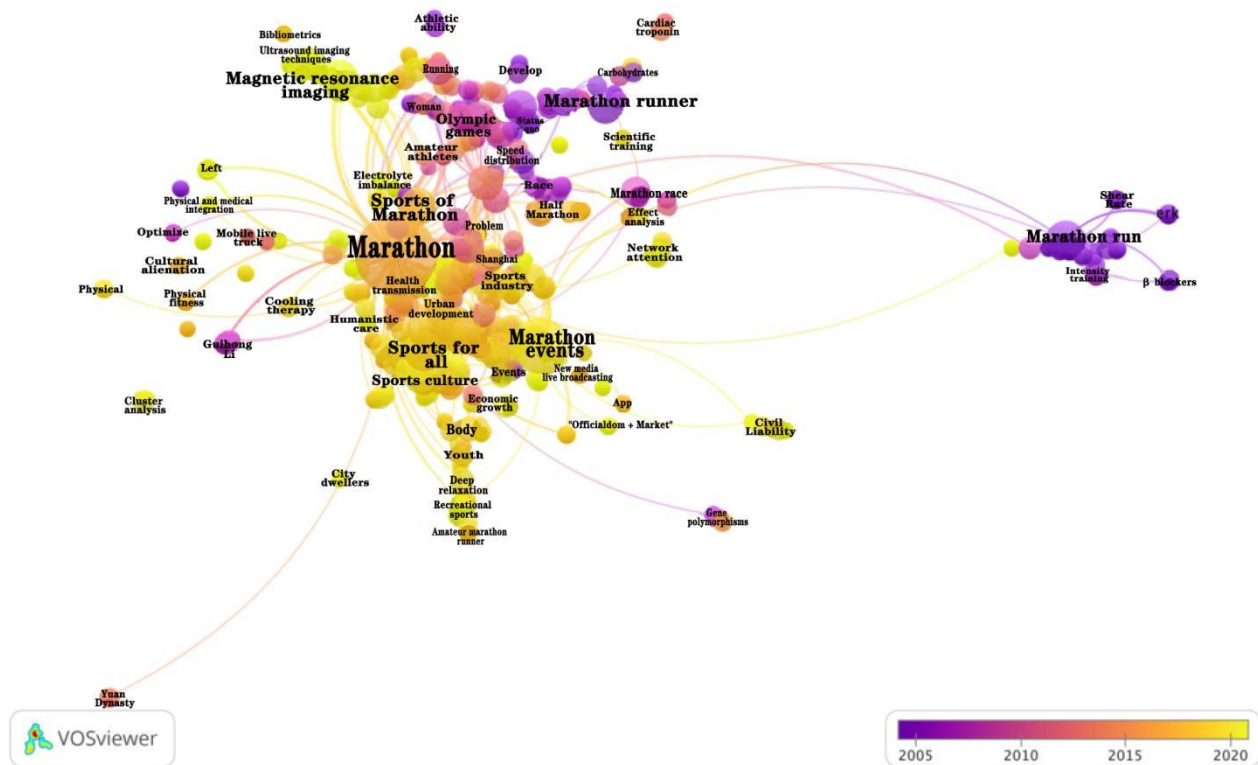


Fig. 5 Co-occurrence visualization mapping of keywords in China's marathon sports research

As shown in the figure, the research on "marathon race" has been the mainstream of China's marathon research since the beginning, according to the extended nodes along the vein of data lexical meaning and textual material synchronization analysis, it can be seen that the basic radiation scope of the marathon research threshold includes: Amateur athletes (Participants), Recreational sports (Sport events ontology), Deep relaxation (Sport events ontology), Youth (Participants), Body (participants), "Officialdom + Market" (Organizers), Economic growth (Sport events ontology), New media live broadcasting (Organizers), and so on. Therefore, it can be summarized that there are three major perspectives of "the core of the cultural ontology of tournament value, the middle-level organization and implementation of tournament managers and participants, and the peripheral data performance of the tournament industry and economy", and the corresponding research ideas are "cultural value exploration and comparison, the dilemmas of tournament governance and the optimization path, and the evaluation of industrial economic benefits and assessment", The corresponding research ideas are "exploration and comparison of cultural values, dilemmas and optimization paths of event governance, and evaluation of industrial economic benefits".

In addition to the mainstream research hotspots, on the "marathon running" sports training content development, event sports performance changes, sports injury prevention and rehabilitation of the series of research branches also gradually appeared, its "training race rehabilitation" trinity of characteristic research ideas Its characteristic research idea of "training, competition and rehabilitation" is remarkable, and it is mainly a research product of the interdisciplinary research of sports training and sports medicine. The research in the direction of sports training usually captures the data of physiological indicators such as hemoglobin, serotonin, serum creatine kinase, maximum oxygen uptake, pulmonary ventilation, etc.[48] to reflect the characteristics of training, in order to rationally adjust the training program and scientifically predict the competition results. The research in the direction of competition performance is mainly to intercept the performance of excellent athletes in elite events, analyze their evolution trends and potential influencing factors, and reveal the laws and characteristics of sports development[49]. The research in the direction of

sports injury and rehabilitation focuses on analyzing athletes' post-competition injuries, cardiac risks, sudden death[50], and points out the need to establish a prevention system for cardiovascular accidents in marathons[50] and other preventive strategies.

4.2 Analysis of research evolution

Keyword emergence is mainly analyzed by algorithms to derive research hotspots that can reflect the emergence of the time period or continue to receive attention, reflecting the hotspot changes and trends in the research field [51]. Citespace software was used to create a visualization map of keyword emergence in the China's marathon literature, with the display condition set as: keyword display frequency ≥ 1 , and a total of 2176 valid keywords were obtained. After eliminating the English synonyms in the Chinese literature, the keyword density distribution analysis visualization mapping of China's marathon research can be obtained (shown in Figure 6).

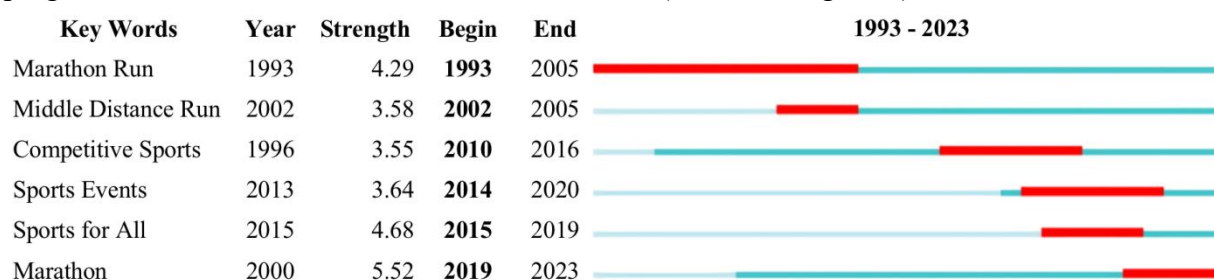


Fig. 6 Top 6 keywords with the Strongest Ciation Bursts

It can be seen that the China's marathon research hotspot has undergone three obvious iterations, the China's sports-based meaning of "Marathon Run" research time domain wide, research span, research scope wide. China's marathon research to follow the dynamic changes in the country's current situation and a major shift has occurred, from focusing on marathon athletic talent training research and then shifted to comply with the "Sports for All" era demand for the study of mass sports, and now the establishment of a "New Type of National Lifting System[52]," research once again returned to the "Marathon Run" research, the study of "Marathon Run" research. Nowadays, with the establishment of the "New National Sports System", the research has once again returned to the "Marathon" as the main subject.

Based on the time perspective, from 1993 to 2005, CNKI included 52 research papers on marathon. Among them, the research involves people, material and property as the conditions of differentiation, found on the participation of marathon athletes in training or competition related to the sports human body class research for 47 articles; to marathon training or competition of external material and equipment research for three articles, respectively, are "middle-distance running, marathon athletes training process real-time monitoring and guidance system development and research", "based on radio frequency technology marathon timing identification system" and "mobile satellite communication system (mobile communication)". The Utilization of Mobile Satellite Communication System in Marathon Broadcasting", and two studies aiming at exploring the operation mode and socio-economic role of marathon sports industry. Taking the gender of the research subjects as the filtering condition, it was found that there were 6 studies on female athletes and only 1 study on male athletes. Thus, it can be seen that the China's research on marathon based on the significance of sports "early" based on the needs of the times, focusing on mining elite athletes training competition training mode, emphasizing the enhancement of athletic performance, for the masses to participate in marathon races and other studies of secondary concern, and due to the temporary failure to form a large-scale, industrialized, diversified, and synergistic, As the scale, industrialization, diversification, synergization and digitalization of the marathon economic industry chain have not been formed yet, the research on the economy of marathon races is characterized by significant homogenization.

Between 2010 and 2020, in order to meet the multilevel and diversified sports life needs of the masses and effectively enhance the people's sense of gain and happiness, the State Council successively issued a number of important documents, such as the Guiding Opinions of the General Office of the State Council on Accelerating the Development of the Sports industry [53]. At this time, the sports industry, as a sunrise industry and green industry under China's new development concept, is highly valued at the national level, and sports consumption, as the fundamental driving force on the demand side of the sports industry, has become a key node in the development of the sports industry [54]. So far, the policy conditions and economic market environment for the development of the marathon race industry have been configured. Many scholars cut to the industrial economic management point of view, comprehensive use of questionnaires, Delphi, expert interviews and other research methods, with amateur runners, brand sponsors, leisure sports scholars, economic management researchers, race volunteers and other industry-related objects to collaborate on the study of "race influencing factors and effect mechanism", "Race and City Synergistic Development Strategy", "Race Organization and Management and Optimization Path", "Race Communication Media and Content Analysis", "Mass Tournament Participation Behavior and Theoretical Explanation", "Tournament Culture Deconstruction and Rational Thinking", "Tournament Industry Model and Consumption Behavior Characteristics", and "Tournament Policies, Regulations and Practical Theories". ", "Tournament Culture Deconstruction and Rational Thinking", "Tournament Industry Model and Consumption Behavior Characteristics" and "Tournament Policies and Regulations and Practice Theory". It can be seen that the China's research on marathon based on the significance of sports "development period", tends to marathon race industry model, mass participation in marathon races and other research attention to increase the formation of a certain scale of the digital marathon economic industry chain.

The period from 2020 to 2023 is the key period for promoting the sports industry to become a pillar industry of the national economy. In order to implement the Opinions of the General Office of the CPC Central Committee and the General Office of the State Council on Building a Higher Level of Public Service System for National Fitness, the Opinions of the General Office of the State Council on Promoting National Fitness and Sports Consumption to Promote the High-quality Development of the Sports Industry, and the 14th Five-Year Plan for Sports Development, the SPSA has issued the Outdoor Sports Industry Guidelines for the Promotion of Sports Consumption, and helped to build a new development pattern. development, promoting and expanding sports consumption, and helping to build a new development pattern, the General Administration of Sport, together with the Development and Reform Commission and other six major departments, issued the Outdoor Sports Industry Development Plan (2022-2025) [55]. Under the situation of normalized epidemic prevention and control, marathon ushered in a new development pattern and emerging industry vitality with the China's macrocycle as the main body and the China's and international double cycle promoting each other, and the new round of scientific and technological revolutions, such as 5G, big data, blockchain, Internet of Things, artificial intelligence, etc., will boost outdoor sports product innovation and service upgrading, and increase the impetus for the development of the marathon sports industry. The event theory research on industrialization and technologization of marathon events, and the research on event model innovation have become the hot topics in this period.

4.3 Research Frontier Analysis

By analyzing the content statistics of the highly cited literature, sports law research such as risk and liability determination of marathon races in China has gradually become a point of academic excavation, which was mainly caused by the sports safety accident that occurred in the "Yellow River Stone Forest Mountain Marathon 100km Cross-country Race" [56] held in Baiyin City, Gansu Province, resulting in the deaths of 21 athletes who participated in the event. The impact of the incident. As a result, marathon accidents, marathon injuries, marathon organization negligence and other legal provisions of the applicability and liability allocation of the connotation and

corresponding research propositions have gradually become the focus of the marathon event management is still the field of rigorous discussion of the argument.

Absorbing digital technology to reshape the development of marathon under the new national system, and promoting the "diversification of subject synergy, information and data flow, and flattening of organizational structure[57]" is another trend in the study of marathon. Fundamentally, the new scientific and technological revolution represented by 5G technology, artificial intelligence, quantum science, etc. is prying the "big change in the sports industry", which will profoundly change the way of constructing the marathon industry and the form of social organization. In this regard, the study combines the policy background of the newly issued "Implementing Program on Promoting the Action of "Cloud Computing and Empowering Wisdom" to Cultivate the Development of New Economy" and "Opinions on Supporting the Healthy Development of New Industries and New Models to Activate the Consumption Market and Drive the Expansion of Employment", and points out that based on the concept of "digital ecology Based on the concept of "digital ecology", integrating multiple resources, upgrading the operation mode of marathon[58], perfecting the collection of runners' participation information, improving the efficiency of booking registration and authentication identification, accurately identifying the participants at different timing points, capturing the participants' dynamic images, realizing the live broadcast of the whole event, preserving and processing dynamic resources such as records of the individual race conditions, and creating the IP of the event with a point of profitability to realize the commercialization and digitalization of marathon sports. Upgrade the commercial strategy of digital marathon sports, improve the digital weather conditions monitoring system and the all-round supervision system of the event.

The ecological and sustainable development of marathon events is one of the research trends. As a relatively complex social system, the marathon event is composed of various organizational elements that are interlinked, interact with each other and their mutual use of connections [32]. In view of this, the marathon under the development of the new era must be based on the construction of socialist market economy and ecological civilization, and based on the principle of ecological environment law, to build a balanced system of marathon that is truly compatible with the development of the society and the ecological environment, so as to realize the ecological and sustainable development of marathon [59].

5. Conclusion

Based on the bibliometric perspective, the hotspots, evolution and frontiers of the development of marathon research based on the significance of sports in China for more than thirty years were statistically analyzed with the help of metrological software, such as VOSviewer, Citespace, and ArcGIS Pro.

First, marathon research as a whole presents a long-term gradual growth after the decline of the decline in the trend of articles.

Second, the top ten collaborative research authors and the top ten research authors are basically the same, and China's current research field of marathon scholars need to further improve the degree of cooperation, hoping to build a certain size of the research team.

Third, China's marathon research institutions in the partnership, Beijing Sport University is the field of high volume of articles issued by research institutions. Among the cooperative relationships among the marathon research institutions in China, Beijing Sport University is the research institution with a high volume of publications in the field, and it is also the research institution with the most significant cooperative network. However, the cooperation between small groups of research institutions and independent research institutions occupy the majority.

Fourth, the regional distribution of research institutions is mainly concentrated in the coastal economically developed regions, with tilted and uneven distribution of scientific research resources.

Fifth, "Sports Culture Guide" is the journal with the highest number of articles in this field, and sports core journals are still the main form of including and publishing articles on marathon in China.

Sixth, the distribution of research hotspots of marathon events in China presents a vein pattern that expands to multi-directional research routes such as "Marathon Events", "Marathon Running" and "Marathon Runners" around "Marathon" as the core.

Seventh, China's marathon research hotspots occurred 3 times obvious iteration, the China's based on the significance of the sport of the The China's research on "marathon running" has a wide time domain, a large research span and a wide research scope. China's marathon research to follow the dynamic changes in the country's current situation and significant changes, from focusing on marathon athletic talent training research and then shifted to meet the needs of the era of "Sport for all" mass sports research, and now the establishment of a "New Type of National System," the research Now that the "New National Sports System" has been established, the research has once again returned to the meta-main body of "Marathon".

Eighth, absorbing digital technology to reshape the development context of marathon under the new national system, and promoting "subject coordination and diversification, information and data flow, and flat organizational structure" are the main trends in marathon sports research.

6. Prospects

Looking forward to the blueprint for the development of China's sport-based marathon research field, future marathon research will pay more attention to interdisciplinary cooperation. Experts in the fields of physiology, psychology, nutrition, engineering and computer science will jointly conduct research to comprehensively understand all aspects of marathon sports and provide more comprehensive and precise guidance, and the amount of cross-cutting and cross-disciplinary collaborative outputs and publications is expected to show an upward trend, and the scale of the study urgently needs to be expanded along with the team of research scholars. Research institutes continue to promote inter-regional collaborative models, deepen the density of cooperation in order to avoid academic information barriers, improve the overall quality and level of research on marathon based on the significance of sports, establish a multi-level academic exchange conference system, balance and generalize the resources of related research institutes, and promote the cultivation mode of high-level talents in marathon theory and empirical evidence; and it is expected to open up and create a new academic research body based on marathon based on the significance of sports. It is also expected to develop and establish high-quality journals and magazines for the academic research of marathon sports, gather the most cutting-edge researches at home and abroad, and systematically and comprehensively expand and list the marathon researches based on the significance of sports.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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