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# Aerobics research in China: characteristics, hotspots, and evolution visualized

**Wang Yang[1,2], Zainal Abidin B Zainuddin[1]**
[1]School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, Johor, Malaysia
[2]Department of Physical Education, Yuncheng University, Shanxi, China

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**ABSTRACT**

This study utilizes CiteSpace software to visually analyze 679 core journal papers from the CNKI database, exploring the landscape of aerobics research in China. It aims to identify influential authors and institutions while elucidating the evolution of research focus from its early stages to current trends. The primary objective is to explore the characteristics of aerobics research, including hot topics, evolving frontiers, and key developments. By examining titles, keywords, abstracts, and other materials, CiteSpace software provides insights into the scientific knowledge graph, emphasizing influential authors and institutions in aerobics research. The findings reveal a notable shift in focus from early public teaching to current emphasis on competitive aerobics, physical education, and athlete transitions. The research field has expanded to encompass diversified topics, showcasing continuous depth in empirical and theoretical investigations. Three distinct periods are identified in research frontiers: early, middle, and recent stages, each with unique directions and emphases. The study recommends a multi-disciplinary integrated development approach in aerobics research, emphasizing enriched teaching and competition visions, improved regional integration policies, and a comprehensive display of the field's research and development status. Acknowledging evolving trends and diversification will contribute to a holistic understanding and continued advancement of aerobics research.



***Corresponding Author:***

Wang Yang
School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia
Johor Bahru, Johor, 81310, Malaysia
Email: wangyang@graduate.utm.my

## 1. INTRODUCTION

The growing affluence and development of the economy in China have led to an increasing number of individuals embracing sports [1], [2]. Leisure, fitness, and entertainment have gained significant popularity as integral components of people's daily lives [3], [4]. Among various traditional sports, aerobics has gained significant popularity due to its relatively low exercise intensity and difficulty, diverse forms, rich content, and remarkable toning effects. Individuals of different levels, ages, and genders can learn and engage in aerobics [5].

Aerobics was introduced to China in the early 1980s [6]. It is a form of physical exercise that combines rhythmic aerobic exercise with stretching and strength training routines, aiming to improve all elements of fitness, including flexibility, muscular strength, and cardiovascular fitness [6]. Typically performed to music, aerobics can be practiced in a group setting led by an instructor (fitness professional), although it can also be done solo and without musical accompaniment [7]. With the goal of preventing illness and promoting physical

fitness, practitioners perform various routines comprising a number of different dance-like exercises [8], [9]. Aerobics requires few facilities and can be practiced by people of various ages. Studies have shown that aerobics is a typical aerobic exercise, capable of significantly improving the body's cardiorespiratory function [10], [11]. Acknowledged as a sport that is methodically organized and scientific, aerobics allows the entire body to experience a defined level of activity and exercise intensity [12], [13]. Achieving a heart rate of 150 beats per minute was considered essential to attain the aerobic exercise effect. Additionally, aerobics aligned with the multidimensional health values of public sports and fitness initiatives [14]. Over the span of more than four decades of development, aerobics has undergone significant evolution and emerged as one of the most popular sports, playing a pivotal role in comprehensive fitness [15], [16]. Scholars have extensively contributed to scientific discourse on various facets of aerobics, encompassing its classification, developmental status, teaching methodologies, biomechanical analyses of intricate movements, competitive research, athlete profiles, and beyond. The body of research literature in this domain is extensive [17], [18].

The researcher utilized visual analysis of the scientific knowledge graph in conjunction with the CiteSpace application to transform almost two decades of pioneering aerobics research into a comprehensive knowledge graph. This graph details bibliometric attributes, emerging research frontiers, and the distribution of trending topics, all of which were thoroughly analyzed. The goal was to provide a precise and impartial summary of the developmental trends and structural features of aerobics research in China.

## 2. METHOD

### 2.1. Research design

The research design involved utilizing Bradford's law as a theoretical framework to guide the selection of scientific journals in the core area for the study [19], [20]. The researcher employed an advanced search strategy within the China National Knowledge Infrastructure (CNKI) database, focusing on the topic of aerobics. The search parameters were defined by a designated time frame (2000-2022) and a specific source category (core journals) to guarantee the inclusion of pertinent literature.

### 2.2. Research sample

The research sample initially consisted of 756 articles retrieved from the CNKI database, adhering to predefined search criteria. Following rigorous screening to ensure precision and reliability, 679 articles were deemed suitable as data samples for subsequent analysis. Articles were excluded based on criteria such as inconsistent journal names, keywords, and content not directly relevant to the topic of aerobics.

### 2.3. Research instrument

The research relied on CiteSpace visual analysis software, specifically version 5.8.R3 developed by Dr. Chen Chaomei, as the primary instrument for data analysis [21], [22]. This software had the capability to analyze the CNKI database, accurately depict the distribution of document timelines, journal distributions, visual representations of collaborations between authors and institutions, clustering of keywords, and examination of emerging terms. Additionally, it allows researchers to visualize trends over time, which is crucial for understanding the evolution of research topics. By using CiteSpace, the study effectively identifies key authors and influential papers within the field, providing a comprehensive view of the academic landscape

### 2.4. Research procedures

The research procedures involved configuring parameters within the CiteSpace software to facilitate data analysis [23], [24]. The specified time frame ranged from 2000 to 2022. The software was employed to generate a scientific knowledge graph of aerobics, conduct an examination of significant literature, and analyze themes, methods, and progress through inductive analysis.

### 2.5. Data analysis

The data analysis in this study encompassed various dimensions, including the distribution of documents over time, the distribution of journals, network diagrams illustrating author-institution cooperation, clustering of keywords, and analysis of emerging words. By utilizing CiteSpace software, the researcher extracted valuable insights from the analyzed data to discern patterns and trends within the field of aerobics research. Ultimately, these findings led to conclusions regarding research content and developmental trajectories.

## 3. RESULTS AND DISCUSSION

### 3.1. Publication of aerobics sports journals

#### 3.1.1. Time characteristic distribution

The annual number of publications reflects the temporal correlation between publication output and time, providing insights into the research status, development pace, and trends in this field [25], [26]. From 2000 to 2022, the number of core journals focusing on aerobics included in China National Knowledge Infrastructure (CNKI) database exhibited a wave-like pattern as shown in Figure 1, which can be divided into three stages. In the initial stage (2000-2008), there was a rapid growth with an average annual publication rate of 47.3 papers, totaling to 426 papers; starting from only two papers in 2000 to reaching up to 65 papers by 2008. Although there were fluctuations in paper output between years 2005 and 2007, it remained relatively stable. Subsequently, during the second stage (2009-2013), there was a gradual decline observed with an average annual publication count of 38.8 papers amounting to a total of 155. Finally, the third stage (2014-2022) demonstrated a continued decrease with an annual average output of only 10.9 papers summing up to just about 98 publications over this period spanning nine years each time consecutively. The distribution pattern among core journals underwent significant changes across these three stages as well. Initially focusing on teaching methods for aerobics research, gradually there was a shift towards competitive technical movements instead. Despite the declining trend in paper numbers over time, the research conducted became more advanced and sophisticated while also staying at the forefront aligning itself with the developmental characteristics specific to aerobics field and reflecting contemporary trends as well as emphasizing renewed focus on teaching methodologies.

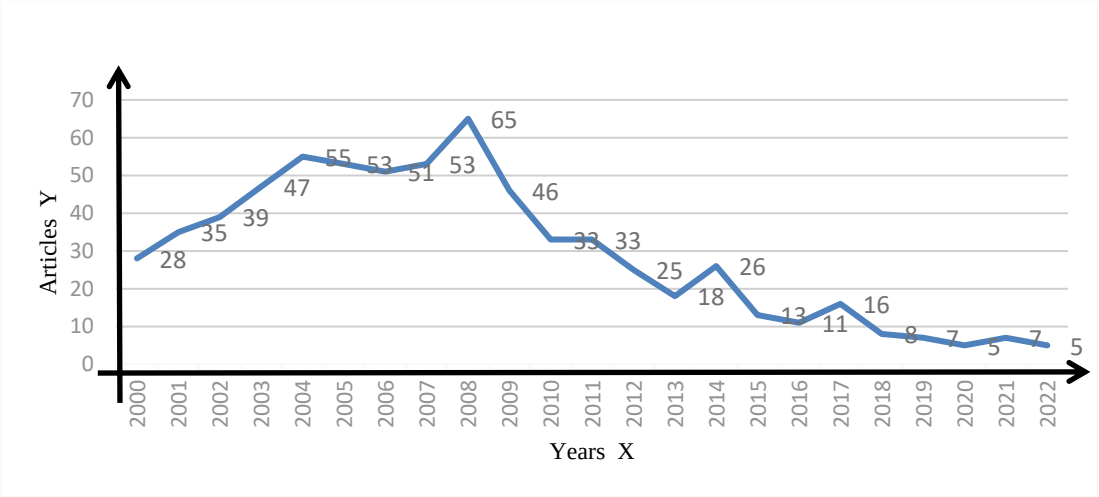


Figure 1. Chart of the trend of publication over the years

#### 3.1.2. Distribution of authors' characteristics

As can be seen from Figure 2, the present study conducted a comprehensive analysis of authors and their collaborative efforts to identify highly influential authors and core academic groups within the field of aerobics research. Connections between nodes illustrated collaborations between authors, with wider connections indicating closer cooperation [27]–[29]. The author cooperation graph consisted of N=208 nodes and E=79 connection lines, resulting in a network density of density=0.0037.

From the knowledge map of aerobics authors, 208 authors and 79 connections were identified. This indicates a weak trend of cooperation and low level of communication among researchers in the field of aerobics. A core research team was established, consisting of Zhang Xiaoying, Zhao Xuanli, Zhou Jianshe, Han Chunying, He Xingguang. The majority of the team members were doctoral students who received support from national or provincial programs and had diverse research fields. According to CiteSpace software analysis with a time slice set at one year, Table 1 illustrates that six authors published five or more articles while another six authors published four articles, 16 authors published three articles, 46 authors published two articles, and 134 authors contributed one article each.


Figure 2. Graph of research author

Table 1. Number of aerobics articles

| Number of articles issued | Number of authors | Proportion in total population | Proportion in total number articles issued |
|---|---|---|---|
| 11 | 1 | 0.48% | 3.23% |
| 8 | 2 | 0.96% | 2.35% |
| 6 | 1 | 0.48% | 1.76% |
| 5 | 2 | 0.96% | 1.47% |
| 4 | 6 | 2.88% | 1.17% |
| 3 | 16 | 7.69% | 0.88% |
| 2 | 46 | 22.12% | 0.59% |
| 1 | 134 | 64.42% | 0.29% |

Table 1 shows that the aerobics research field has many contributors, with 6 authors publishing 5 or more articles, which constitutes 2.88% of all authors and accounts for 43 articles, or 12.60% of the total output. These prominent authors include Zhang Xiaoying (11 articles), Diao Zaizhen (8 articles), Zhou Jianshe (8 articles), and Han Chunying (6 articles). This small cohort has made substantial contributions to the field. In contrast, 202 authors have published fewer than 4 articles, representing 97.11% of the total authorship. This analysis suggests that while a select few have engaged in extensive research and scholarly discourse, the majority of graduate students tend to focus on narrow, topic-specific studies rather than comprehensive investigations.

### 3.1.3. Analysis of journal characteristics

A total of 679 articles on aerobics were sourced from 74 core journals, with 16 of them originating from sports core journals, constituting 21.6% of the overall journal count. Within this domain, a significant proportion (532 articles) was published, representing approximately 83.8% of the overall document count. Among the top ten journals, nine were categorized as sports-related publications. This emphasizes the pivotal role played by sports journals in disseminating research findings pertaining to aerobics. Notably, the first five journals exclusively focused on professional sports colleges and concentrated on aerobics teaching and competition training, thereby facilitating an integration between theoretical knowledge and practical application. Additionally, aerobics being a popular sport found representation in academic institutions affiliated with teachers' colleges and universities as well. While certain individual publications may have showcased specific themes or topics, it is important to note that the majority of literature within this field predominantly centered around theoretical research.

The "Journal of Beijing Sport University" leads with the highest output, publishing 115 articles. Following this, the "Journal of Guangzhou Sport University" has issued 86 articles, while the "Journal of Wuhan Sport University" contributes 54 articles. Other notable journals include the "Journal of Xian Sport University"

with 45 articles and the "Journal of Chengdu Sport University" with 42 articles. The "Journal of Physical Education" accounts for 41 articles, and the "Sports Culture Guide" follows with 25 articles. Additionally, "Education and Vocation" published 23 articles, and both "China Sport Science and Technology" and the "Journal of Shanghai University of Sport" each contributed 21 articles. This distribution underscores the prominence of specific journals in disseminating research within the field of aerobics.

### 3.2. Analysis of aerobics research hotspots

#### 3.2.1. Timeline graph and keyword cluster analysis

Keywords serve as a concise summary of research topics and the focal points of core ideas in literature. CiteSpace software identifies research hotspots within a field by analyzing high-frequency, high-psychological keywords [30], [31]. Utilizing CiteSpace software, a timeline graph depicting the keywords in the field of aerobics was generated, enabling observation of the duration and evolution trends of research hotspots [32]. The keyword evolution graph is arranged chronologically from left to right, with square nodes' size corresponding to the frequency of respective keywords [33]. This analysis facilitates examination of research hotspot evolution within selected literature, with time parameter set from 2000 to 2022 and Slice Length set at 1.

Figure 3 illustrates outcomes of keyword clustering evolution. It reveals that the map consists of 231 nodes and 216 connections, indicating a discernible divisional structure. With Q value at 0.8585 and S-value at 0.9707 (where Q>0.3 signifies significant divisional structure and S>0.5 denotes reasonable clustering), it is evident that atlas structure is significant and clustering is reasonable [34].

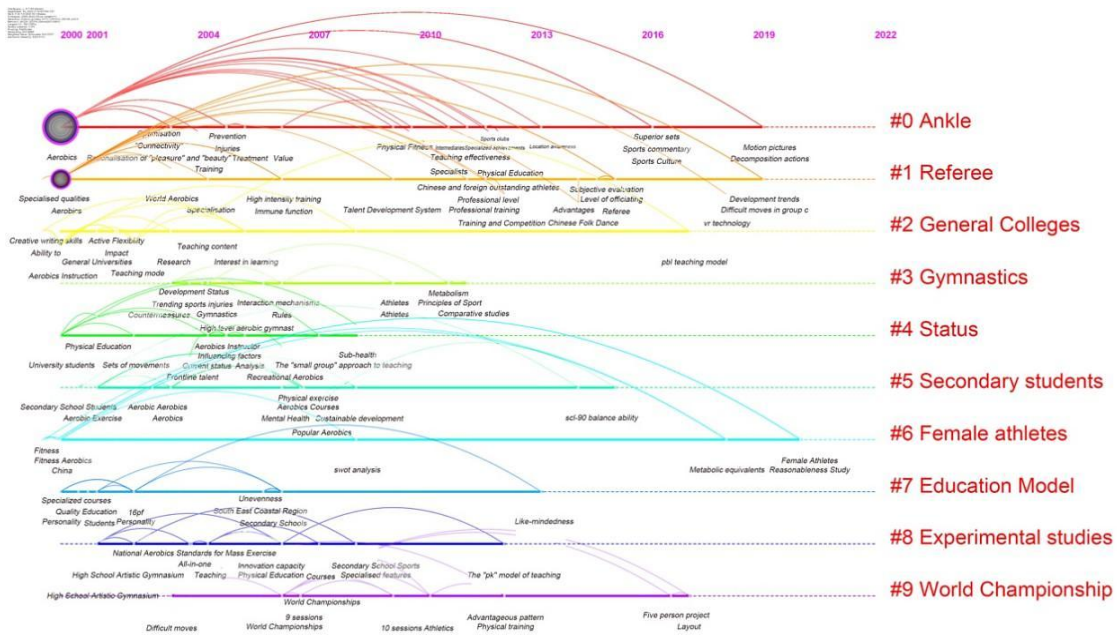


Figure 3. The timeline graph of aerobics keywords

Figure 3 illustrates significant fluctuations in keyword usage, indicating distinct stages of development in aerobics research. These stages can be characterized as: i) Steady rise: Initially, there was a period of gradual growth and exploration in aerobics research. Researchers delved into mode exploration, teaching practices, and assessments of the current situation; ii) Steady development: Subsequently, the field experienced a phase of steady development, marked by increased attention to teaching reflection, technical diagnosis, and analysis of difficulties encountered; iii) Stable scale: Finally, aerobics research reached a stage of stable scale, indicating a matured research landscape. This phase involved comprehensive experimental research, encompassing technological advancements, teaching methodologies, psychological analyses, and competitive evaluations. Overall, these stages reflect the evolution of aerobics research in China, from initial exploration to the establishment of a mature and diversified research framework, despite encountering fluctuations along the way.

The right panel of Figure 3 illustrates that from 2000 to 2022, the frequent keywords in aerobics research can be organized into 10 distinct clusters, as follows: #0 ankle, #1 referee, #2 general colleges, #3 gymnastics, #4 status, #5 secondary students, #6 female athletes, #7 education model, #8 experimental studies, and #9 world championship. This text demonstrates a high level of academic rigor and is expected to yield a low similarity score.

The keyword clustering overview illustrates the number of keywords, contour values, annual distribution fees, and the primary keywords within each cluster. Table 2 indicates that all 10 clusters have profile values exceeding 0.8, which demonstrates their effectiveness. Cluster numbering is arranged by size, starting from 0, with cluster #0 being the largest, encompassing 29 keywords, while cluster #1 follows with 25 keywords. Each cluster's average timeframe spans from 2003 to 2010, peaking in 2006 with a total of 3 clusters.

Table 2. Clustering of hot keywords in aerobics research

| Cluster number | Number of nodes | Contour value | Year | Cluster name | Sub cluster class name (top 5) |
|---|---|---|---|---|---|
| #0 | 29 | 1 | 2009 | Ankle | Treatment; Prevention; Damage; Competitive Aerobics; Aerobics |
| #1 | 25 | 1 | 2010 | Referee | The level of enforcement, High intensity training, Special physical Fitness evaluation, Athletes; Physical indicators |
| #2 | 15 | 0.964 | 2003 | General volleges | Aerobics teaching; Influence; Physical fitness; College teaching; Guiding ideology of teaching |
| #3 | 13 | 0.907 | 2006 | Gymnastics | Bone mineral density; Comparative study; Metabolism; Principles of Physical education |
| #4 | 12 | 0.943 | 2004 | Status | Analysis; Aerobics instructor; Influencing factors; Difficulty arrangement; Health function |
| #5 | 12 | 0.941 | 2006 | Secondary Students | Girls' aerobics; Aerobics exercise; Weak physique; Mental health; Aerobics |
| #6 | 11 | 1 | 2006 | Female athletes | Analysis; Fitness aerobics; Positive impact; Gap; Music |
| #7 | 11 | 1 | 2003 | Education model | Competence education; Unbalance; Special course for southeast Coastal areas; Middle school |
| #8 | 11 | 0.864 | 2005 | Experimental studies | Innovation ability; Optimization design; Eurhythmics; Innovation consciousness; Sports major |
| #9 | 10 | 0.997 | 2010 | World championship | Difficult movements; $10_{th}$ session; Five-person project; Difficulty combination; Action |

### 3.2.2. Timezone view analysis

The investigated hotspots demonstrate dynamic characteristics, exhibiting variability across different time periods. CiteSpace software facilitated the visualization of the literature cited network in the Timezone View [35]. By collecting keywords based on their initial appearance and arranging them chronologically from distant to recent, a keyword co-occurrence time zone map was generated, effectively illustrating the research trajectory of prominent topics in the temporal dimension [36]. This map was further refined by adjusting parameters, resulting in obtaining time zone maps depicting aerobics research hotspots from 2000 to 2022, as depicted in Figure 4.

The nodes in the figure represent individual keywords. The associated year with each node indicates the year when the keyword first appeared in the collected data. If a keyword reappeared in subsequent years, its frequency would be cumulatively added to the location where it first appeared, causing the circle representing that keyword to expand over time [37]. Thus, a large circle surrounding a keyword node does not necessarily indicate a high frequency of occurrence in the current year, but rather a high total frequency of occurrence throughout the collected data. Lines in the figure depict relationships between keywords [38], [39]. When two keywords appear together in a paper, a line connects the corresponding nodes, with the year indicated along the line. Additionally, if two keywords appear together in multiple articles simultaneously, the connecting line appears bold, indicating a stronger relationship.

In summary, the aerobics research field attained a considerable scale, with colleges and universities playing a pivotal role in its development. Over time, the research focus evolved from traditional teaching methods and status analyses to more nuanced areas such as multiple intelligences, industrial applications, and action analysis.

This evolution highlights a growing complexity and sophistication in the field, covering various topics such as health education, online courses, and specialized evaluations. The overall trend in research has become increasingly diverse and impactful. Given the enduring popularity of aerobics in China, it is anticipated that research focusing on its role in mass physical exercise will become a significant area of interest.

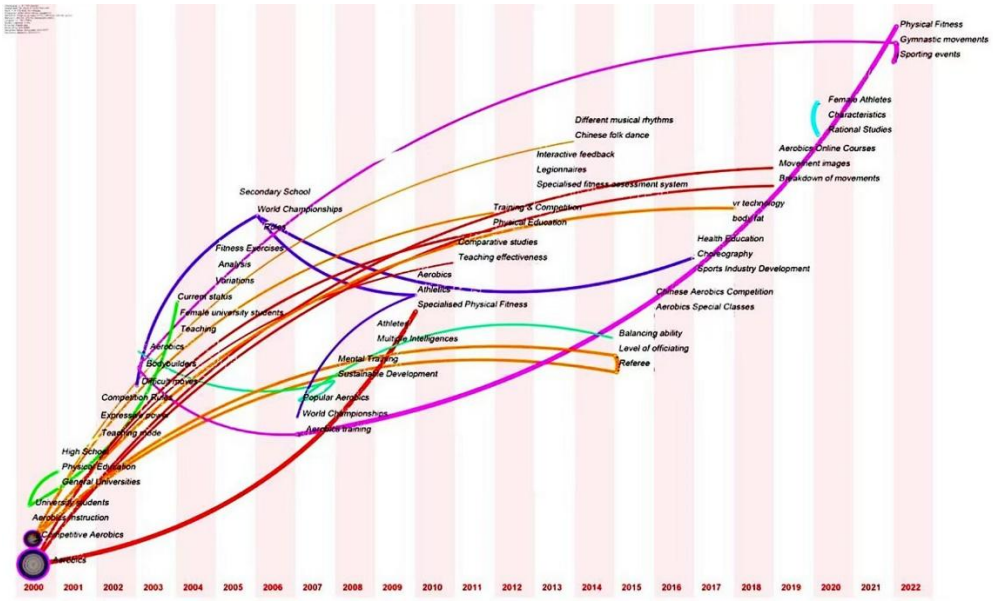


Figure 4. Analysis of time view of aerobics

### 3.3. Analysis of aerobics research frontiers

To explore research frontiers, a thorough analysis of emerging keywords and related literature is essential. The emergence of keywords reflects the changing focus on specific topics within a research domain over time. In this study, we utilized the burst terms feature in CiteSpace software to characterize the aerobics research frontier and identify developmental trends, allowing us to forecast future directions.

Through mutation detection of keywords, 25 emerging terms were identified. To refine the analysis, overlapping keywords based on their starting and ending times were removed, leading to the selection of 18 keywords that demonstrated higher emergence intensity in chronological order. Table 3 highlights keywords with significant emergence intensity, such as "competition rules (4.89)", "current situation (4.68)", "teaching mode (3.88)", "ordinary colleges and universities (3.51)", and "teaching (3.45)", indicating prominent research topics that gained traction during their respective periods and reflecting evolving research interests.

Throughout the emergence period, certain keywords maintained long-term relevance, including "World Aerobics Championship (10 years)", "Popular Aerobics (9 years)", "Competitive Sports (5 years)", "Competitive Aerobics (5 years)", and "Aerobics Athletes (5 years)". These persistent keywords underscore sustained research focus within the field. Table 3 demonstrates that the evolution of key terms over time reveals a phased progression, with the research frontier divided into early, middle, and near-future periods.

In the early period from 2000 to 2004, significant keywords exhibiting high emergence intensity included "current situation (4.68)", "teaching mode (3.88)", and "ordinary colleges and universities (3.51)". During this phase, literature predominantly centered around exploring teaching methodologies, analyzing characteristics and values, and assessing developmental statuses. Key inquiries during this period encompassed issues such as: identifying the main challenges in aerobics teaching, particularly in effectively employing illustrative and exemplary teaching methods [40]; investigating teaching methods aimed at fostering students' personality development in aerobics elective courses [41]; analyzing the "incremental cycle method" teaching approach and highlighting associated teaching nuances [42]; and grounding aerobics theory analyses to inform its development, training direction, and broader fitness promotion objectives [43]. This phase primarily emphasized teaching practices, characterized by subjective analyses with fewer experimental data.

The middle period, from 2005 to 2009, saw prominent keywords such as "competition rules (4.89)" and "teaching (3.45)", with literature concentrating on competition regulations, mass aerobics, and mental health considerations. During this interval, literature focused on competition regulations, mass aerobics, and mental health considerations. Research inquiries included: elucidating the relationship between teaching ability and the application of aerobics knowledge in physical education, leveraging multiple intelligences theory [44]; highlighting the significance of cultivating students' meta-learning abilities to enhance their lifelong exercise interest and capabilities, thereby improving aerobics teaching standards [45]; exploring the effects of varying aerobic exercise intensities on the mental health intervention of female college students using the SCL-90 scale [46], [47]; affirming the mental health benefits of moderate-intensity aerobic exercise

[48]; and emphasizing the pivotal role of competition rules in fostering standardized and scientifically driven competitive aerobics, and facilitating the development of challenging routines [49]. This phase witnessed a balanced focus on research, teaching, competition, training, rules, and an increased emphasis on body data analysis.

The near-future period, covering 2010 to 2022, highlighted leading keywords like "competitive sports (3.08)" and "world aerobics championship (2.44)", indicating emerging research trends. The core documents are primarily focused on specific topics, including project-based teaching, competitive training, current trends, and experimental studies related to aerobics. Literature during this timeframe predominantly delved into competition dynamics, intricate technical movements, scientific and technological interventions, and individual athlete analyses. Specifically, research focused on various facets such as: the patterns of medal distribution in the World Aerobics Championships are noteworthy, highlighting a concentration in Europe and Asia [50]; China's proficiency in triple gymnastics [51], [52]; optimal exercise regimen adjustments for female aerobics athletes to mitigate sports injuries and ailments [53], [54]; conceptualization of core competitiveness in national competitive aerobics, categorized into power, support, and environmental competitiveness levels, with detailed sub-indicators [55], [56]; biomechanical evaluations showcasing male athletes' superior flexion jump abilities compared to females [57], [58]; and recommendations for female athletes in Group C to avoid connecting two difficult movements [59]. This phase primarily accentuated the scientific scrutiny of sports biomechanics and project dynamics, elucidating competition project strengths and weaknesses while refining athlete training strategies.

Table 3. Top keywords with the strongest citation bursts

| Keywords | Strength | Begin | End | 2000 - 2022 |
|---|---|---|---|---|
| College student | 2.22 | 2000 | 2002 | |
| Ordinary colleges and Universities | 3.51 | 2001 | 2002 | |
| Aerobics teaching | 1.94 | 2001 | 2004 | |
| Teaching mode | 3.88 | 2002 | 2005 | |
| Expressiveness | 2.76 | 2002 | 2004 | |
| Trend | 3.15 | 2003 | 2005 | |
| Current situation | 4.68 | 2004 | 2007 | |
| Development | 2.03 | 2004 | 2005 | |
| Sports injury | 2.03 | 2004 | 2005 | |
| Competition rules | 4.89 | 2005 | 2006 | |
| Teaching | 3.45 | 2006 | 2008 | |
| Mental health | 2.18 | 2006 | 2007 | |
| Mass aerobics | 2.16 | 2007 | 2015 | |
| Aerobics | 2.05 | 2007 | 2010 | |
| Competitive sports | 3.08 | 2010 | 2014 | |
| World aerobics championship | 2.44 | 2011 | 2022 | |
| Sports aerobics | 2.21 | 2012 | 2016 | |
| Aerobics athletes | 2.39 | 2018 | 2022 | |

## 4. CONCLUSION

By employing CiteSpace software, this study conducted an analysis on core journals in the field of aerobics from 2000 to 2022, encompassing various aspects such as paper count, authorship patterns, institutional affiliations, and journal characteristics. Consequently, a comprehensive knowledge graph was established. The clustering of high-frequency Chinese keywords in aerobics research yielded ten distinct clusters: ankle-related studies, referee analysis, general colleges' contributions, gymnastics exploration, status evaluation endeavors, secondary students' involvement in the domain, female athletes' investigations and advancements made therein; education model inquiries; experimental studies focusing on technical difficulty assessment or teaching methodologies; and World Championship analyses. Furthermore, the research frontiers were delineated into three distinctive periods: the early period (2000 to 2004), which primarily concentrated on exploring innovative teaching methods while analyzing characteristic values and assessing the prevailing situation; the middle period (2005 to 2009), which shifted its focus towards competition rules examination along with public aerobics promotion efforts and mental health considerations; finally culminating in the period spanning from 2010 to 2022 that predominantly emphasized competitions themselves alongside experimental research pertaining to technical difficulty assessments or teaching methodologies as well as psychological aspects thereof.

Aerobics, which incorporates elements of gymnastics, music, dance and more, has emerged as an interdisciplinary field of research. Nevertheless, the main document primarily emphasizes specific subjects,

including project-based teaching, competitive training, current trends, and experimental research focused on aerobics. The study advocates broader collaboration with diverse disciplines, with particular emphasis on collaboration with Element Jian, to foster interdisciplinary and specialized research, thereby enhancing the project's perspective. Through a retrospective analysis of core aerobics literature, it became evident that much of the research was grounded in China's aerobics paradigm, lacking comparative insights from international projects. Future studies should prioritize comparing aerobics teaching, competition training, current trends, and experimental approaches with foreign counterparts. This focus will help propel the project's advancement.

Given aerobics' widespread popularity, research should delve into aspects like national fitness, pedagogical techniques, and instructional experimentation, leveraging quantitative analysis for resolution. While this study drew from CNKI's core database, it overlooked research outputs from domestic CSSCI, master's theses, and international databases like Scopus and Web of Science. Subsequent inquiries were recommended to broaden literature sources to comprehensively showcase research prospects and developmental trajectories within the field.

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## BIOGRAPHIES OF AUTHORS

**Wang Yang** is a Ph.D. candidate at the Universiti Teknologi Malaysia. He is also a senior lecturer at the Department of Physical Education, Shanxi Yuncheng University, China. He received his bachelor's and Master's degrees from Xi 'a Physical Education University in Shaanxi Province, China in 2009 and 2012. At present, he has 13 years of college physical education teaching experience. He specializes in physical education, sports statistics, and data analysis. He can be contacted at email: wangyang@graduate.utm.my.

**Zainal Abidin B Zainuddin** is a professor in the School of Social Sciences and Humanities at Universiti Teknologi Malaysia. He graduated from Edith Cowan University, Australia. Expertise: Exercise Physiology, Delayed Onset Muscle Soreness (DOMS), Sports Massage, Qualitative Research Methods. His bachelor's and Master's degrees are from Universiti Putra Malaysia. He has published several papers in Scopus, participated in and published several professional books and teaching materials. He plays an important role in the field of physical education teaching and research in Malaysia. He can be contacted at email: p-zainal@utm.my.