



Development Review: 2012–2022 Physical Training Visualization

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Abstract. In order to better grasp the research progress of physical training, explore the current research hotspots and trends, and provide a theoretical basis for subsequent research. The current physical fitness training was systematically analyzed through visual analysis software CiteSpace 6.1.R6 and VOSviewer 1.6.18 by confirming the subject search term TS = (“physical fitness training” or “physical training”). After data cleaning. The result was 733 relevant papers. The results showed that the overall trend of physical training was stable over the past 10 years. The visual graph analysis revealed that Orr, R.M. was the author with the highest volume of articles, reaching 12 authors Kraemer. W.J. was the one with the highest volume of articles per article reaching 19.5 times/article, and the connection between author groups needs to be further strengthened; the University of São Paulo institution had the highest number of articles, reaching 31, and from a regional perspective, the United States was in the lead; keyword clustering could be a total of classify 8 clusters, in which high-frequency keywords appear in the order of sports, performance, intensity, physical fitness, sports injuries, education, and women. The focus on women’s issues is also increasing. From the epidemic vocabulary and time presentation graph, physical training is more prominent in the medical field, with keywords sports injury, epidemic, health, and physical training as the main keywords, and people in the post-epidemic era emphasize more on healthy lifestyles. The visualization analysis shows in detail the current research hotspots and development trends of physical fitness training, which show diversified development trends in the process of continuous expansion.

Keywords: Physical training · Fitness · Bibliometrics · CiteSpace · Fitness training · Sport

1 Introduction

Physical training has not only been simply applied to the military in the past [1], but it evolved from the military to play an important role in the field of sports, special physical training in various sports, whether it is throwing sports [2] or antagonistic sports. It is of

great research importance to help athletes improve their athletic performance, to improve their level of physical fitness, and to help them recover better and prevent athletic injury problems [3], Through physical training or fitness training to help athletes to better improve physical function and athletic performance [4, 5], to address the physical health of the elderly, to improve muscle strength and poor physical function of the elderly, to improve their sense of well-being [6], adolescent children in adolescence exercise habits on the health problems of sedentary flexibility [7], and some female physical health problems have been a great breakthrough [8]. So physical training, already an important exercise to help us reduce physical diseases and improve physical fitness, and for other aspects brought by physical training, such as cognitive function [9], improvement of diseases brought by obesity [10], and the development of motor skills [11], are gradually expanding its value and research from the initial military field to the field of sports, psychology, and then medicine dynamics.

So by reviewing a complete physical training over a 10-year period, we understand the current development status in the field and make the information clearer and more accurate by visualizing the existing high-frequency keywords, core authors, major countries and future trends in the timeline graph to understand the current research hotspots and future research trends. Through the visualization study of physical training, we can provide some reference to the current scholars or research teams in the field.

2 Data and Methods

2.1 Data Sources

Used the authoritative database WOS (with two core databases SCI and SSCI as the main search library), with the subject TS = (“Physical training” OR “Fitness training”) as the main search subject term, and the time node was set to a total of 10 years from 2012 to May 2022, and a total of A total of 4350 papers were found, and 3848 papers were found mainly in the literature and review category, and then a total of 928 papers were found by selecting the category Sports Science as the main field, 837 papers were found after setting the language to English, 3 duplicate papers were deleted, and 101 papers were removed with a small degree of relevance to the topic, and finally 733 papers were left, and this paper conducted keyword searches on these 733 papers. In this paper, we analyzed the 733 documents by keywords, authors, institutions and countries.

The search finally revealed that the 733 papers had a total of 3228 authors belonging to 1145 institutions, divided into 61 countries, from 80 journals citing a total of 25640 references, with an average of 35 references per paper.

Two visual analysis software, CiteSpace 6.1.R6, and VOSviewer 1.6.18 were used as research tools to complement each other to derive a clear visualization map. CiteSpace 6.1.R6 performs similarity measures through a set-theoretic approach to data normalization and obtains a time zone view and a timeline view within a time slice, which allows for this allows the evolution of knowledge and the historical span of the literature in a certain cluster to be clearly outlined in the time dimension and to understand the development process and trends in the field [12].

Figure 1 shows that from 2012–2021, physical training has been developing steadily, reaching a peak of 60 articles in 2021, mainly due to the outbreak of Covid-19 in 2021,

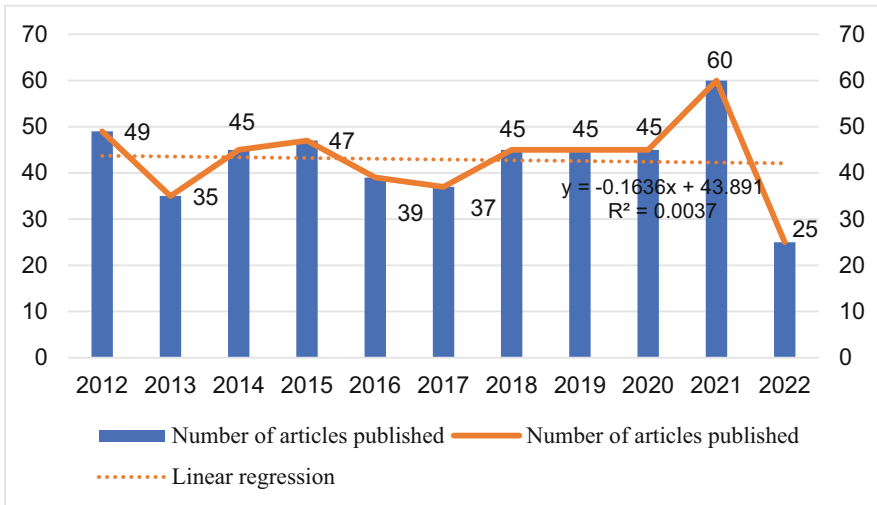


Fig. 1. Statistical chart of the number of articles issued from 2012–2022

which led to the highest number of articles as people began to look for ways to better solve their health problems. The regression equation: $y = -0.163x + 43.891$, $R^2 = 0.0037$, will continue to grow at a high rate in the future. Physical training is still in a high hot research area in current research.

2.2 Bibliometric Analysis of the Author

First, the analysis of the authors in the field allows to know the core figures and emerging authors in the field, according to the scholar Price (1963), who pointed out that half of the papers in the same field are written by a group of scholars with a high level of productivity, and the number of the set of these authors is approximately equal to the square root of all authors (Price, 1963) with the following formula:

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

where n [13] represents the number of authors who have authored x papers. $I = n_{\max}$ is the number of authors of the most productive papers in the field, which can be calculated by VOSviewer 1.6.18 as $n_{\max} = 11N$ is the total number of authors, and m is the minimum number of publications of core authors. According to Price's Law, the minimum number of articles $m = 0.749 \times \sqrt{n_{\max}} \approx 2.48$, so the authors with the number of articles ≥ 2 are positioned as the core authors in the field, and the first author with the maximum number of articles $I = 19$, $m = 2$, $m + 1 = 3$ has 65 core authors between 3 and 11 articles, with a total of 262 articles. This represents 35.7% of the total number of papers published, which does not meet Price's criterion of half (50%) of the total number of papers published. Bringing the values into Price's Law's formula found that they do not

Table 1. Literature information of authors with ≥ 6 publications

Rank	Author	Documents	Citations	Average Citation/Publication
1	Orr, R. M.	12	175	14.58
2	Dawes, J. J.	10	121	12.1
3	Kyrolainen. H.	9	81	9
4	Lockie. R. G.	7	70	10
5	Jone. B. H.	7	88	12.57
6	Dulla. J. M.	6	70	11.67
7	Bartolome. I.	6	54	9
8	Munoz. D.	6	54	9
9	Nindl, B. C.	6	95	15.83
10	Kraemer. W. J.	6	117	19.5
11	Bloch. W.	6	37	6.17

match, so it can be assumed that there is no more stable collaborative group in the field at present, see Table 1.

Through the statistical results in Table 1, it is concluded that Orr, R. M. is the most published scholar with 12 articles, followed by Dawes, J. J., Kyrolainen. H., Lockie. R. G., and Jone. B. H. with 10, 9, 7, and 7, respectively, and we found through reading that Orr. R. M. published mostly about the development of military physical fitness and mostly help soldiers to improve their physical fitness [14], helping to improve soldiers' aerobic training ability and reduce sports injuries, helping soldiers to improve and prevent injuries and diseases while performing military training [15–17], and the average citations per article reached 14.58. as the highest average citations per article Kraemer. W. J. reached 19.5/article, his literature is mostly combined with sports medicine, aerobic exercise on military physical fitness has a positive impact [18], as well as the excellent athletic performance of athletes are closely related to physical training [19]. So, for the future the main research is still to focus on people's health and enhancement of physical fitness, even more so especially in post-epidemic era conditions.

2.3 Bibliometric Analysis of the Journal

The statistical information Table 2. For the institutions shows that University Sao Paulo is in the first place, with many small groups of authors collaborating, followed by Bond University, as the most productive author, Orr. R. M. is part of this institution. The highest citation belongs to University Copenhagen, where < Exercise as medicine - evidence for prescribing exercise as therapy in 26 different chronic diseases > is cited a high 933 times, the quality of literature is high and it clearly explains how many chronic diseases are effectively intervened with physical training [20]. However, there is still relatively little cross communication between institutions, and it is important to expand

Table 2. Top 6 institutions in terms number of articles issued

Organization	Documents	Citations	Documents/Citations
University Sao Paulo	31	328	10.58
Bond university	20	253	12.65
University Copenhagen	13	1077	82.85
University Fed Sao Paulo	12	60	5
University Southern	12	246	20.5

the cooperation between institutions in the future to promote the progress of globalized scientific research.

2.4 A Bibliometric Analysis of the Country

The visualization of the countries using VOSviewer 1.6.18. Figure 2 reveals that they can be roughly divided into five clusters: red, green, blue, purple, and yellow. The size of the circle indicates the size of the country's publication volume, and the thickness of the line represents the connection between them, and we can also see from the specific information in the Table 3 that USA is in the first place, with 159 publications in the field of physical training during 2012–2022 and an average citation of 17.63 times, of which England has an average citation of 24.82 times, with 50 related literatures, and the quality of the literature was high. Australia's Bond University institution has 72 publications with 1217 citations and 16.90 citations per article, and USA has the highest volume of literature and 2803 citations, which is related to superior military development of USA, so it has deeper research on military physical training.

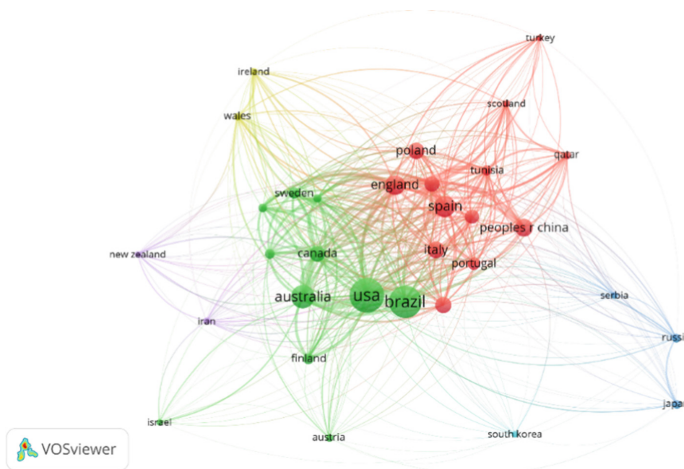
**Fig. 2.** Visual analysis of physical training country regions

Table 3. Statistical information on the volume of regional national issuances

Country	Documents	Citations	Documents/Citations
USA	159	2803	17.63
Brazil	142	1262	8.89
Australia	72	1217	16.90
Spain	61	839	13.75
England	50	1241	24.82

2.5 Keyword Co-occurrence Analysis

Through Fig. 3 we can see that after analysis by CiteSpace 6.1.R6 software, a total of eight clusters emerged, and can also see that in these eight clusters, mostly medical-related aerobic exercise, muscle strength, etc., and more focus on the improvement of people’s quality of life, whether it is exercise intervention after sedentary lifestyle [21], or for the impact of various diseases under physical training intervention [21] is to improve people’s quality of life.

Through Table 4 and Fig. 4 can be found, exercise appeared 267 times intensity reached 893, performance ranked second, the number of appearances reached 140 times, intensity value 523, it is worth noting that women as the key words in this field appeared 42 times, intensity reached 157, women’s health problems and female athletes are also gradually prominent and visible. And in Fig. 4, where the highest explosive coefficient of the muscle strength reached 4.5, because the essence of physical training is to improve the physical quality of the human body problems, so and muscle is inseparable. The figure also finds that athletic injury, physical fitness, epidemiology, and health are being studied so far, and this will be an important direction for future research.

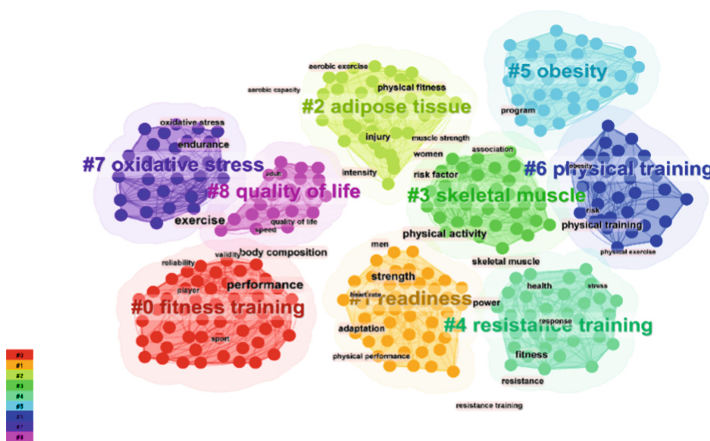


Fig. 3. Visual analysis chart of cluster analysis of co-cited keywords

Table 4. Table of co-occurrence information of co-cited keywords

Rank	Keyword	Occurrences	Total link strength	Rank	Keyword	Occurrences	Total link strength
1	Exercise	267	893	10	Power	42	182
2	Performance	140	523	11	Women	42	157
3	Strength	82	347	12	Body composition	41	184
4	Fitness	72	319	13	Training	40	137
5	Physical activity	60	241	14	Responses	39	154
6	Physical training	56	187	15	Risk factors	39	138
7	Endurance	54	253	16	Muscle strength	35	127
8	Men	50	220	17	Resistance	34	150
9	Skeletal muscle	50	174	18	Sports	33	87

The Fig. 5 timeline diagram clearly shows the development of each category of keywords during the passage of time, as well as the close connection with other keywords, and eight clusters into which they are divided by cluster analysis and time evolution in the visualization analysis. The size of the keyword node (circle) indicates its sustained intensity, the larger the circle, the earlier it appears and the more often it appears, which is also consistent with the performance formed in Fig. 3 and Fig. 4, for the quality of life and physical function aspects of study is showing a high rate of development[22]. For the cluster0 fitness training, it is not only in the military field, sports field, but also in the field of medical rehabilitation, heart field, for sports, rehabilitation and psychotherapy will also become the key research direction in the future.

Top 25 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2012 - 2022
muscle strength	2016	4.5	2016	2019	
response	2012	3.45	2013	2015	
athletic injury	2021	3.32	2021	2022	
fatigue	2014	2.99	2014	2014	
expression	2012	2.86	2016	2017	
supplementation	2018	2.83	2018	2020	
fitness training	2012	2.79	2012	2012	
physical fitness	2012	2.52	2020	2022	
oxidative stress	2012	2.5	2017	2018	
epidemiology	2020	2.43	2020	2022	
profile	2015	2.41	2015	2015	
physiological response	2012	2.39	2012	2012	
load carriage	2015	2.31	2019	2020	
weight lo	2014	2.18	2018	2019	
balance	2013	2.18	2018	2019	
plasma	2013	2.16	2018	2018	
health	2013	2.13	2019	2022	
human immunodeficiency virus	2016	2.12	2016	2017	
physical performance	2012	2.12	2020	2020	
stress	2012	2.08	2014	2015	
children	2012	2.08	2016	2016	
soldier	2015	2.05	2015	2016	
motor skill	2018	2.04	2018	2019	
quality of life	2013	2.01	2013	2016	
obesity	2012	1.98	2012	2012	

Fig. 4. Frequency and year of outbreak of explosive keywords 2012–2022

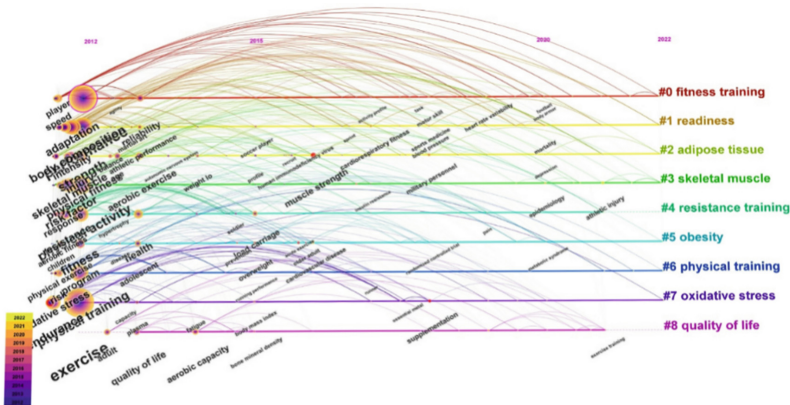


Fig. 5. Visual analysis chart about the keyword outbreak timeline from 2012–2022.

3 Conclusion

By using a combination of this two-visualization software, CiteSpace 6.1.R6 and VOSviewer 1.6.18, we have made a simple visualization of the development of fitness training in 2012–2022 and predicted the current research hotspots and future trends in the field through keyword clustering, author analysis, and institutional and country visualization. Author groups are currently with core authors, but according to Price's law still need to strengthen the connection between authors, and under its influence, institutions, and countries to which they belong also need to reduce mustiness and strengthen cooperation to improve human health and prevent diseases. This paper also has some limitations, as the research on the field of physical training was only selected between 2012 and 2022 in the category of sports science, without integrating all the categories. It is hoped that the review and development of physical training over 10 years period will supply some reference for researchers or institutions in the future research process.

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