

Review

Bibliometric analysis on bodybuilding

Wei Chen*, Syahrul Ridhwan Morazuki

School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, Johor Bahru, Johor 81310, Malaysia

* Corresponding author: Chen Wei, wei-1991@graduate.utm.my

CITATION

Chen W, Morazuki SR. (2024).
Bibliometric analysis on
bodybuilding. Journal of
Infrastructure, Policy and
Development. 8(11): 9018.
<https://doi.org/10.24294/jipd.v8i11.9018>

ARTICLE INFO

Received: 7 September 2024
Accepted: 26 September 2024
Available online: 16 October 2024

COPYRIGHT



Copyright © 2024 by author(s).
*Journal of Infrastructure, Policy and
Development* is published by EnPress
Publisher, LLC. This work is licensed
under the Creative Commons
Attribution (CC BY) license.
[https://creativecommons.org/licenses/
by/4.0/](https://creativecommons.org/licenses/by/4.0/)

Abstract: Over the past few years, there has been a consistent rise in the popularity of bodybuilding. This study did a bibliometric analysis to offer a systematic overview and facilitate researchers in obtaining comprehensive insights on the peculiarities of bodybuilding research. This study utilized the bibliometric analysis program Bibliometrix to identify 940 papers on bodybuilding from the Web of Science database. The publications were selected from the years 1976 to 2024 and were used for the analysis. This study provides a thorough and detailed analysis of bodybuilding research using visual representations. It includes information on the frequency of publications, the nations that have had the most impact on bodybuilding research (including institutions, sources, and authors), and notable areas of focus within the field. Furthermore, the research collaboration among nations (regions), organizations, and authors is depicted based on a set of collaboration studies. The bibliometric study of current literature offers useful and groundbreaking sources for academics and practitioners in the field of bodybuilding-related studies.

Keywords: bodybuilding; bibliometric analysis; network analysis; scientific collaboration; research trends

1. Introduction

Bodybuilding is a hard discipline that integrates weightlifting, cardiovascular activity, and nutrition to train and enhance muscular development in the body. Bodybuilding training typically employs barbells, dumbbells, and a range of fixed resistance training equipment to deliver precise muscle stimulation, aiming to improve muscular growth, symmetry, and definition (Newmire and Willoughby, 2020). The program emphasizes targeted workouts to enhance muscle growth, definition, and sculpting, with a primary focus on enhancing the visual look of the muscles.

Bodybuilding traces its origins to the late 19th century, with its introduction in both Europe and America in 1893 (Murray, 1984). The inception of modern bodybuilding culture started in the aftermath of World War II (Roundtree, 2005). People have been practicing bodybuilding for millennia, but it gained widespread recognition as a competitive sport in the 20th century, marked by the inaugural Mr. Olympia competition in 1965. Subsequently, bodybuilding has seen significant development and has become a worldwide sensation, attracting millions of passionate followers and generating a lucrative industry worth billions of dollars (A History Lesson in Bodybuilding, 2005; Bodybuilding, 2023). Presently, there is a growing population of individuals who are actively engaging in bodybuilding, motivated by both aesthetic considerations and the desire for a wholesome way of life (Carmen Xavier Pereira, 2023). Some individuals view bodybuilding as a competitive sport and a distinctive way of life, while many others view it as a

recreational pursuit, according to research. Bodybuilding, a sport that emerged in the early 1950s, is relatively new and has gained popularity since then (Jiu-zheng, 2006; Stokvis, 2006). It encompasses not just physical exercise but also a unique way of living. According to research, even non-professional bodybuilders or those aiming for competition titles can experience a physique transformation and major life improvements by participating in this activity (Flamini, 2009).

Bodybuilding is a physical fitness activity that specifically targets the growth and sculpting of muscles to enhance muscular mass and improve body proportions. Exercise not only aids in decreasing body fat and enhancing physical fitness, but it also has a substantial impact on body contouring (Guo-qiang, 2012). Several studies indicate that individuals participating in this activity aim to increase their muscle mass, develop a larger and stronger body structure, and achieve a more visually appealing physique. The individuals in question exhibit a notable preoccupation with their physical appearance and make significant efforts to achieve a desirable body shape (Blouin and Goldfield, 1995; Güven and Tazegül, 2015; Ray et al., 2012). As bodybuilding becomes more popular, there is a growing trend of young men feeling unhappy with their physical appearance. The desire for increased muscle mass and a more muscular body typically drives this dissatisfaction (Devrim et al., 2018; Pope et al., 2000). The male body plays a crucial role in defining male identity, and bodybuilding involves several attributes associated with masculinity, including performance, strength, muscular aesthetics, and endurance (Gattario et al., 2015). Studies have shown a clear link between male muscular appearance and how others perceive their authority and confidence in social settings (Grogan and Richards, 2002; Lefkowich et al., 2017). Bodybuilders experience an enhanced sense of strength in social situations as a result of their improved physical appearance, leading to increased confidence and a feeling of empowerment (Subaşı and Okray, 2021).

Evidence indicates that bodybuilding is assuming a more significant role in our culture, not only in terms of competitive events but also in terms of its advantages for the general population. The advantages encompassed in this list include the provision of pleasurable leisure time, the promotion of excellent health, the cultivation of a positive body image, the provision of both physical and mental relaxation, the enhancement of self-confidence and personal dignity, and the attainment of respect from one's peers (Ferenc and Oborný, 2019). Despite its lengthy history, bodybuilding has seen a rather sluggish evolution in comparison to other sports, and there is a scarcity of academic study on the subject. Given the growing public acceptance, appreciation, popularity, and active participation in this sport, it is critical to do appropriate academic study. This study uses bibliometric analysis to offer a comprehensive review of the key features of bodybuilding literature. The article provides clear and comprehensive visual representations that demonstrate the research findings in the bodybuilding domain. It offers an up-to-date summary of bodybuilding research, as well as adjacent areas of study and potential future directions. This approach assists researchers and practitioners in detecting possible effects resulting from several factors, including authors, journals, nations, institutions, references, and research subjects.

Bibliometric analysis is a set of mathematical and statistical methods that, as a

powerful quantitative research approach, provides an objective framework for tracking the evolution and structural composition of knowledge within a specific research field (Ellegaard and Wallin, 2015; Lou et al., 2023). In recent years, bibliometric analysis has been applied across various research fields, such as pain, diabetes, dyslexia, depression, and cancer rehabilitation (Stout et al., 2018; Wang et al., 2019; S. Zhang, Fan, et al., 2021; Zhang, Zhu, et al., 2022). To our knowledge, despite the growing research on bodybuilding, no bibliometric analysis has yet been conducted in this area (Zhang et al., 2021). Bibliometric studies yield insights that enable researchers to precisely identify the present areas of focus and provide guidance for future research initiatives. Bibliometric approaches are quite valuable for analyzing bodybuilding research due to their major advantages. The aim of this work is to provide a thorough bibliometric analysis of bodybuilding research. This encompasses a comprehensive examination of previous studies, with a particular emphasis on the present condition of bodybuilding research, social networks, keyword analysis, and evaluating the existing situation.

2. Materials and methods

A comprehensive search for the keyword bodybuilding was conducted in the Web of Science database to screen all the scientific literature related to bodybuilding from 1976 to 2024, and the data collection process is shown in **Figure 1**.

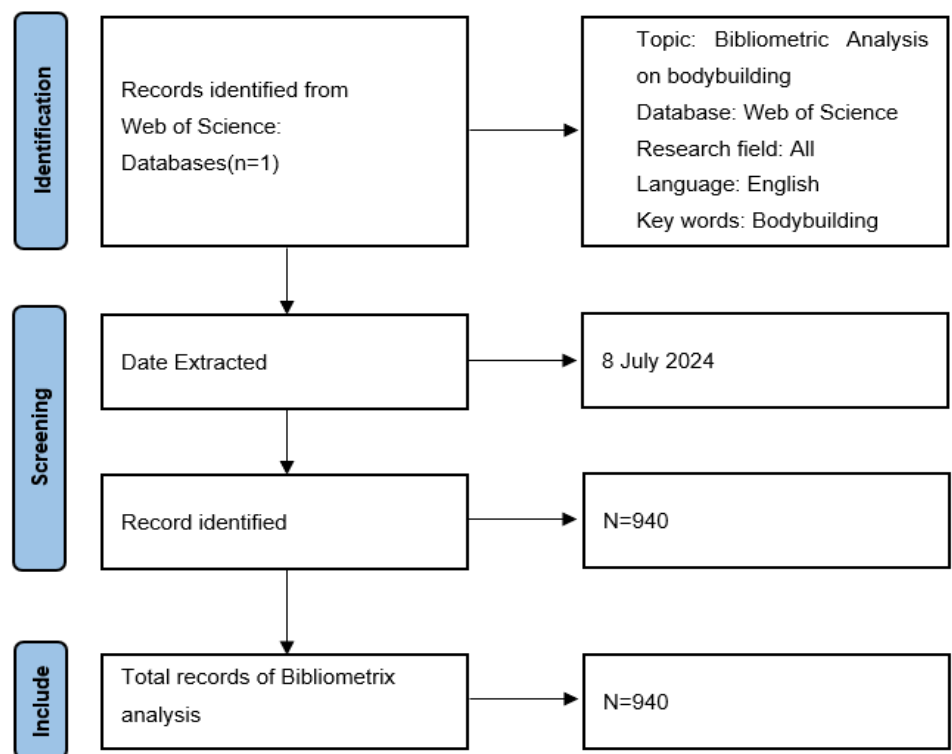


Figure 1. Flowchart of the publication’s selection.

The Web of Science is a very authoritative and extensive database, as stated by Bergeron et al. (2018). In order to find English literature, the keyword “bodybuilding” was used to search the title, abstract, and keyword fields of all texts.

The Bibliometrix software was employed to get data in BibTex format, apply filters to it, and validate its correctness (Sjöberg et al., 2020). Currently, it is considered the most comprehensive, integrated, and user-friendly bibliometric tool, an open-source tool for quantitative research in scientific measurement and bibliometrics (Kang et al., 2021).

The specific steps are as follows: Open the R runtime environment and enter “bibliometrix: biblioshiny.” Run the code to open a network window, click “import row file(s)” on the data loading page, and select the database type as “Web of Science.” load the previously filtered literature data, and then click the start button. Bibliometrix provides a range of scientometric methods, including collaboration analysis, word frequency analysis, citation analysis, and social network analysis, as well as various visualization analyses for analyzing bibliometric data.

3. Results

3.1. Main information

Using the keyword “bodybuilding” to search the Web of Science database yielded a total of 940 articles, spanning a significant time period from 1976 to 2024, as **Table 1** illustrates. A total of 544 distinct sources, including journals and books, provide the articles. Given the fundamental focus of this study, we conducted a comprehensive examination of the current research state on this topic, without specifically excluding any resources. The data analysis indicates a consistent upward trend in publications throughout the years, with an annual growth rate of 8.49%. Nevertheless, the document average age is 9.17 years, indicating a rather lengthy

Table 1. Main information about data.

Description	Results
Timespan	1976:2024
Sources (Journals, Books, etc.)	544
Documents	940
Annual Growth Rate %	8.49
Document Average Age	9.17
Average citations per doc	16.44
References	28,418
Author’s Keywords (DE)	2046
Authors	3137
Authors of single-authored docs	158
Co-Authors per Doc	3.92
International co-authorships %	17.77

duration. This may imply that advancements in bodybuilding research occur at a slower rate, perhaps resulting in a delayed manifestation of the effects of new studies. The average number of citations per document is 16.44, signifying a commendable degree of impact and acknowledgement within the academic world. The 940 articles collectively reference 28,418 sources, with an average of around 30

citations per article, indicating a thorough examination of the literature and a wide range of expertise. The inclusion of 2046 keywords indicates that bodybuilding studies cover a wide range of directions and is-sues. Out of the 940 articles, there are a total of 3137 writers. Among these authors, 158 individuals have produced a single article, which represents around 5% of the total. The average number of co-authors per document is 3.92. Furthermore, the international collaboration rate is 17.77%, indicating a significant level of active cross-border cooperation in the field of bodybuilding research. This inclusive collaborative methodology advances the discipline's progress and successfully expands research viewpoints and influence.

Table 2 shows the leading 20 journals, authors, organizations, and countries with the highest number of publications on bodybuilding research. The journal "RBNE-REVISTA BRASILEIRA DE NUTRICAÇÃO ESPORTIVA" has the highest number of articles, with 36, in the field of bodybuilding research. The "Journal of Strength and Conditioning Research" follows with 15 articles, while the "Journal of the International Society of Sports Nutrition" follows with 13 articles. "JOURNAL OF THE INTERNATIONAL SOCIETY OF SPORTS NUTRITION" secured the third position with 13 articles, while "INTERNATIONAL JOURNAL OF DRUG POLICY" and "INTERNATIONAL JOURNAL OF DRUG POLICY" tied for fourth and fifth place with 11 articles each. The writers that had the greatest number of papers were Schoenfeld BJ with 21 articles, Liokafts D with 12 articles, Ferdinand C with 10 articles, Smit DL with 10 articles, and De Ronde W with 9 articles. The institutions that had the largest number of publications were the University of Sydney with 36 publications, the University of Sao Paulo with 26 publications, Aarhus University with 24 publications, the University of Queensland with 23 publications, and the University of South Florida with 22 publications. The nations that had the biggest quantity of published papers were the United States (630), Brazil (333), the United Kingdom (254), Australia (202), and China (155). To access publishing information on journals, authors, institutions, and countries listed from 6th to 20th, please refer to the table.

Table 2. The top 20 productive sources, authors, organizations, and nations in terms of ranking.

Ranking	Source Titles	Authors		Organizations-Enhanced		Countries/Regions		
	ST	PC	Name	PC	Organizations	PC	Countries/Regions	PC
Top 1	RBNE-REVISTA BRASILEIRA DE NUTRICA O ESPORTIVA	36	SCHOENFELD BJ	21	UNIV SYDNEY	36	USA	630
Top 2	JOURNAL OF STRENGTH AND CONDITIONING RESEARCH	15	LIOKAFTOS D	12	UNIV SAO PAULO	26	BRAZIL	333
Top 3	JOURNAL OF THE INTERNATIONAL SOCIETY OF SPORTS NUTRITION	13	HEFFERNAN C	10	AARHUS UNIV	24	UK	254
Top 4	INTERNATIONAL JOURNAL OF DRUG POLICY	11	SMIT DL	10	UNIV QUEENSLAND	23	AUSTRALIA	202
Top 5	STRENGTH AND CONDITIONING JOURNAL	11	DE RONDE W	9	UNIV S FLORIDA	22	CHINA	155
Top 6	GENEALOGY OF MALE BODYBUILDING: FROM CLASSICAL TO FREAKY	10	CAMPBELL BI	8	AUCKLAND UNIV TECHNOL	15	GERMANY	114
Top 7	JOURNAL OF GENDER STUDIES	10	MITCHELL L	8	CUNY LEHMAN COLL	15	SPAIN	109
Top 8	JOURNAL OF SPORTS MEDICINE AND PHYSICAL FITNESS	10	ESCALANTE G	7	UNIV TORONTO	15	ITALY	95
Top 9	SPORTS	10	HELMS ER	7	LINNAEUS UNIV	14	CANADA	91
Top 10	FRONTIERS IN PSYCHOLOGY	9	ANDREASSON J	6	UNIV TEXAS AUSTIN	14	FRANCE	85
Top 11	SPORTS MEDICINE	9	ARAGON AA	6	MCMASTER UNIV	13	IRAN	70
Top 12	DRUG TESTING AND ANALYSIS	8	HELMS E	6	TANTA UNIV	13	POLAND	59
Top 13	INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	8	JOHANSSON T	6	UNIV MELBOURNE	13	NETHERLANDS	56
Top 14	RBONE-REVISTA BRASILEIRA DE OBESIDADE NUTRICA O E EMAGRECIMENTO	8	MCVEIGH J	6	KINGS COLL LONDON	12	TURKEY	55
Top 15	REVISTA BRASILEIRA DE MEDICINA DO ESPORTE	8	TOUSSON E	6	LIVERPOOL JOHN MOORES UNIV	12	DENMARK	51
Top 16	BRITISH JOURNAL OF SPORTS MEDICINE	7	BARAKAT C	5	QUEENSLAND UNIV TECHNOL	12	SWITZERLAND	47
Top 17	INTERNATIONAL JOURNAL OF SPORTS MEDICINE	7	HACKETT DA	5	UNIV N CAROLINA	12	NEW ZEALAND	40
Top 18	SCIENCE\& SPORTS	7	O'CONNOR H	5	LEHMAN COLL	11	INDIA	39
Top 19	SOCIOLOGY OF SPORT JOURNAL	7	PERRY PJ	5	MED UNIV SILESIA	11	ROMANIA	38
Top 20	BODY IMAGE	6	PETROCZI A	5	UNIV PADUA	11	SWEDEN	36

PC: publication count

3.2. Trends analysis

3.2.1. Trends in country publications

Figure 2 demonstrates a substantial rise in worldwide scholarly production in the domain of bodybuilding research between 1976 and 2024. The United States has continually had a dominant position, with its publishing output increasing from 1 article in 1984 to 630 articles in 2024, showcasing continuous research efforts and significant contributions to the discipline of bodybuilding. The output from the United Kingdom, Germany, and Canada has experienced progressive growth since the late 1990s. By 2024, the number of articles produced by these countries had reached 254, 114, and 91, respectively. In addition, Australia and Brazil have experienced substantial increases in their outputs, with Australia reaching 202 articles and Brazil reaching 333 articles by 2024. Significantly, the production of research papers on bodybuilding in China and Iran has had a remarkable growth in recent years, with 139 articles published in 2023 and 70 articles in 2024, respectively. In general, research on bodybuilding indicates a growing pattern across several countries.

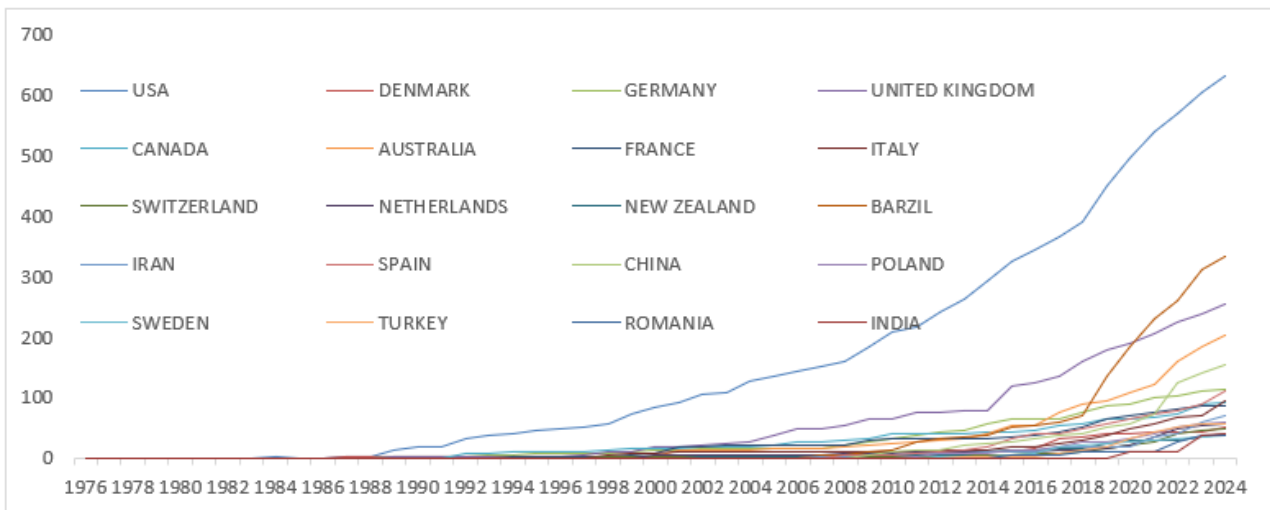


Figure 2. Countries’ production over time.

3.2.2. Affiliations’ production over time

Figure 3 illustrates a substantial rise in scholarly production on the subject of bodybuilding across almost all institutions from 1976 to 2024, with a special emphasis on the last ten years. For example, the University of Sydney has undergone significant expansion in its scholarly production since 2017, with the number of publications rising from 6 in 2017 to 36 in 2024. Since 2007, the University of São Paulo’s publication count has steadily increased, going from 1 item in 2007 to 26 articles in 2024. In 2017, Aarhus University published 17 research papers on the topic. Since 2019, the university has routinely published 24 articles each year. Since 2017, the University of Queensland has seen significant growth in academic productivity, with the number of papers published going from 4 in 2017 to 23 in 2024. Since 2008, the University of South Florida has seen a significant surge in productivity, with its publication count rising from 1 item in 2008 to 22 articles in

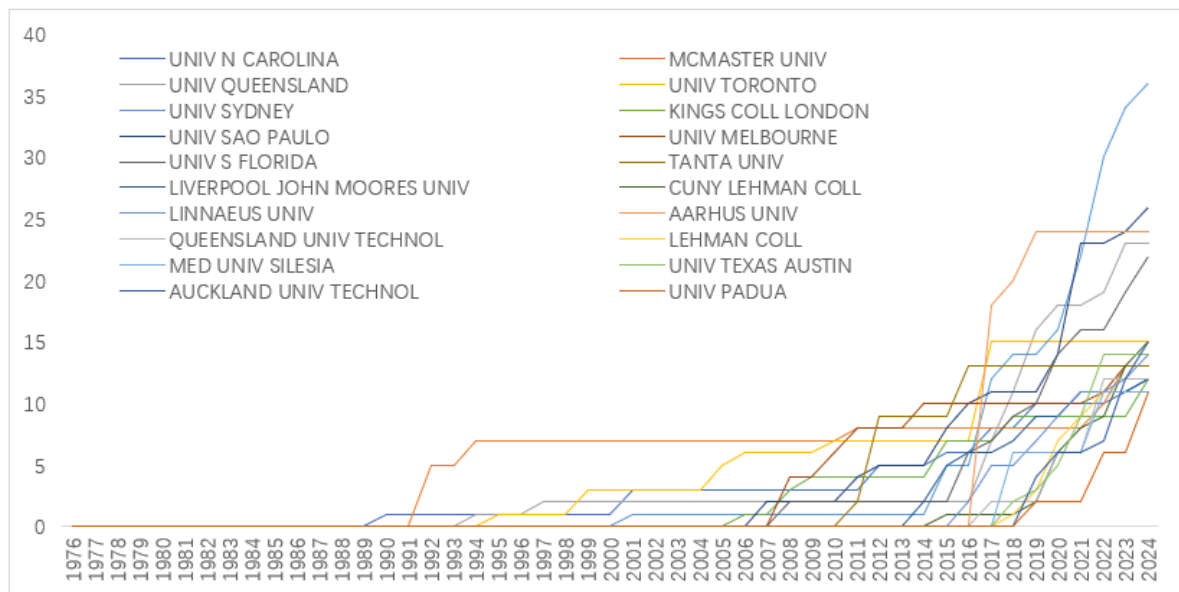


Figure 4. Sources’ production over time.

Examining the entire time span indicates that between 1976 and 1992, there was a scarcity of publications. Between 1993 and 2002, a limited number of papers started to garner scholarly interest. From 2003 to 2013, there was a yearly increase in the number of publications, indicating a growing interest in the topic. Between 2014 and 2024, there has been a significant rise in the quantity of publications, establishing bodybuilding research as a major subject.

In general, there has been a notable increase in the number of publications on bodybuilding, especially in recent years when the rise has been particularly rapid. Sports science and medicine dominate the primary publications that make significant contributions. However, the existence of social science and psychology journals also highlights the multidisciplinary aspect of bodybuilding research. We expect the number of publications in this sector to continue rising with ongoing research advancements, leading to a greater number of scientific breakthroughs and practical implementations.

3.2.4. Trends in author publications

The advancement of a discipline depends greatly on the active contributions of researchers. **Figure 5** shows that several prominent bodybuilding scholars have made significant academic contributions. Schoenfeld BJ has produced many notable works since 2014, which have had a significant influence in the academic community. Schoenfeld’s works from 2014 and 2015 had TCpY (total citations per year) values of 9.727 and 5.100, respectively. This demonstrates the extensive reference and acknowledgement of his early research findings. Schoenfeld BJ experienced substantial growth in the number of publications and the frequency of citations for his work from 2019 to 2021. 2020 marked the highest point, with an average yearly citation frequency (TCpY) of 8.4. This demonstrates Schoenfeld’s continuous research efforts and his influential position in the area. Smit DL has made significant contributions to bodybuilding research, with impressive TCpY scores of 15.0 and 18.0 in 2021 and 2022, respectively. These scores indicate that his study

has garnered widespread attention and has had a significant academic impact over the years. Helms ER's article in 2014 had a Total Citations per Year (TCpY) of 11.727, indicating the significant influence of his early research. In addition, Helms' investigations conducted in 2015, 2019, and 2020 consistently demonstrated a significant academic impact, as evidenced by TCpY values of 5.100, 2.500, and 5.600, respectively. Additionally, notable authors such as Liokaftos D. and Mitchell L. have made substantial contributions to the topic. Liokaftos D's TCpY (total citations per year) was relatively lower in 2017, possibly due to the spread of their research emphasis. On the other hand, Mitchell L. attained a Total Citation per Year (TCpY) score of 16.375 in 2017, demonstrating his significant academic influence and contributions during that particular year.

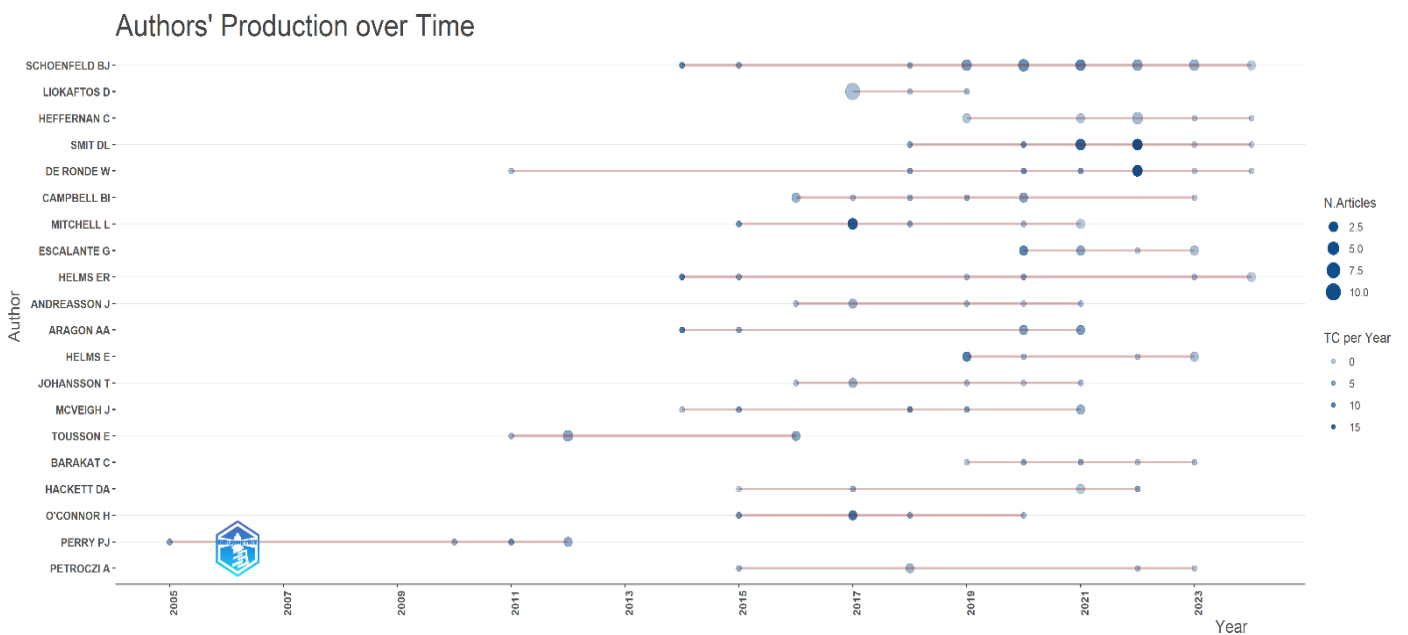


Figure 5. Authors' production over time.

Overall, the study findings of these highly productive writers not only showcase their scholarly output and impact, but also indicate the prominent areas of research and emerging trends in the field of bodybuilding across different time periods. This data and analysis provide valuable insights into the area's intricate academic processes and future trajectories. The aforementioned study reveals several significant patterns in the field of bodybuilding research. Firstly, the consistent and significant contributions made by influential academics suggest that the discipline is experiencing steady growth and accumulating academic knowledge. Furthermore, in recent years, there has been a significant increase in research hotspots and highly cited publications, indicating the progressive advancement and refinement of bodybuilding research. Furthermore, the increasing number of rising researchers and the frequent publication rate suggest that the topic has garnered the interest and involvement of a greater number of academics, indicating a future of more vigorous and varied study.

3.3. Analysis of citations

3.3.1. Analysis of country citations

Table 3 clearly shows that the United States (USA) is the frontrunner in bodybuilding research, with a total citation count (TC) of 6022, highlighting its substantial impact. Nevertheless, its average citations per piece are 31.50, which ranks it third. The United Kingdom (UNITED KINGDOM) and Australia (AUSTRALIA) have 2146 and 1287 citations, respectively, placing them in the second and third positions, respectively. The Netherlands has a total citation count of 1,131, but its average citations per article are the highest, at 75.40. This suggests that the research conducted in the Netherlands is of exceptional quality and has a significant influence. Finland and Norway, with citation counts of 214 and 114, respectively, have impressive average citations per publication of 42.80 and 28.80. This places them second and fourth in terms of academic influence.

Table 3. Most cited countries.

Country	TC	Average Article Citations	Country	TC	Average Article Citations
USA	6022	31.50	NETHERLANDS	1131	75.40
UNITED KINGDOM	2146	26.80	FINLAND	214	42.80
AUSTRALIA	1287	26.30	USA	6022	31.50
NETHERLANDS	1131	75.40	NORWAY	144	28.80
GERMANY	523	13.10	NEW ZEALAND	255	28.30
BRAZIL	411	4.20	UNITED KINGDOM	2146	26.80
ITALY	408	18.50	AUSTRALIA	1287	26.30
SPAIN	379	15.20	BAHRAIN	26	26.00
CANADA	378	13.50	BULGARIA	49	24.50
FRANCE	342	18.00	ITALY	408	18.50
NEW ZEALAND	255	28.30	BELGIUM	111	18.50
FINLAND	214	42.80	FRANCE	342	18.00
SWEDEN	179	13.80	PORTUGAL	117	16.70
POLAND	173	9.60	EGYPT	142	15.80
IRAN	157	7.80	SPAIN	379	15.20
NORWAY	144	28.80	SWEDEN	179	13.80
EGYPT	142	15.80	CANADA	378	13.50
PORTUGAL	117	16.70	GERMANY	523	13.10
TURKEY	117	5.80	JORDAN	43	10.80
BELGIUM	111	18.50	POLAND	173	9.60

TC: Total Citations

3.3.2. Most global cited documents

With a total of 823 citations and an average of 32.92 citations per year, **Table 4** reveals that Pluim (2000)’s paper is the most frequently referenced among all bodybuilding research. This emphasizes its substantial impact on the convergence of cardiovascular health and exercise research. The works authored by Kicman (2008) and Shahidi (2001) have had significant influence in the fields of pharmacology and

clinical therapy, respectively. These studies investigate drug utilization and its clinical implications in the context of bodybuilding. Navarro (2014, 2017) conducted a study that specifically examined the influence of herbal and dietary supplements on liver health in the context of bodybuilding. The 2017 publication had the most normalized total citations (11.82), suggesting its significant contribution to recent research in this field. Additional extensively referenced publications include Parkinson (2006), which undertook a comprehensive examination of the impacts of anabolic androgenic drugs on bodybuilders, and Helms (2014), which offered a thorough analysis of diet and supplements in the preparation for natural bodybuilding competitions. The papers in question encompass a diverse array of subjects, such as cardiovascular health, pharmacology, clinical treatment, exercise science, liver health, basic physiology, nutrition, emergency medicine, molecular endocrinology, psychological health, sports medicine, eating disorders, and bone health. They provide an abundance of materials and references for conducting research about bodybuilding.

Table 4. Most global cited documents.

Paper	Total Citations	TC per Year	Normalized TC
PLUIM BM, 2000, CIRCULATION	823	32.92	9.06
KICMAN AT, 2008, BR J PHARMACOL	374	22.00	8.75
SHAHIDI NT, 2001, CLIN THER	313	13.04	4.12
PARKINSON AB, 2006, MED SCI SPORTS EXERC	296	15.58	3.79
NAVARRO VJ, 2014, HEPATOLOGY	259	23.55	7.33
NAVARRO VJ, 2017, HEPATOLOGY	241	30.13	11.82
MARDEN JH, 1989, PHYSIOL ZOOL	212	5.89	3.42
LEMON PWR, 1992, J APPL PHYSIOL	158	4.79	4.62
ZVOSEC DL, 2001, N ENGL J MED	155	6.46	2.04
RONIS MJJ, 2018, ANNU REV PHARMACOL TOXICOL	152	21.71	7.13
MILLER KD, 2002, ANN INTERN MED	142	6.17	2.70
HELMS ER, 2014, J INT SOC SPORT NUTR	129	11.73	3.65
DYER JE, 1991, AM J EMERG MED	129	3.79	3.00
KANAYAMA G, 2018, MOL CELL ENDOCRINOL	116	16.57	5.44
IP EJ, 2011, PHARMACOTHERAPY	113	8.07	4.82
AHTLAINEN JP, 2003, INT J SPORTS MED	113	5.14	3.60
CAFRI G, 2008, COMPR PSYCHIAT	113	6.65	2.64
PERRY PJ, 2005, CLIN J SPORT MED	110	5.50	2.71
MOSLEY PE, 2009, EUR EAT DISORD REV	109	6.81	4.30
MOREL J, 2001, OSTEOPOROSIS INT	109	4.54	1.43

TC: Total Citations

3.3.3. Analysis of annual scientific production and citation data

Figure 6 demonstrates that the scientific output and citation data from 1976 to 2024 exhibit substantial advancements and transformations in the domain of bodybuilding research. The topic received little academic attention from 1976 to

1988, as evidenced by the restricted and poor impact of the scientific output during that period. Following the year 1989, there was a notable rise in both the quantity of articles and the average number of citations. This growth was particularly prominent during the late 1990s and early 2000s. Sports scholars and fitness specialists have increasingly focused on examining how exercise affects body composition and strength development. The significant productivity and citation rates throughout the early 2000s highlight the critical importance and wide-ranging applicability of bodybuilding research in the domains of health and sports. Nevertheless, as time passed, particularly after 2010, despite the increasing number of articles, the average citation counts decreased. Recent research may face a delay in acceptance and referencing due to the time it takes for academic circles to widely recognize newly conducted studies. Between 2020 and 2024, there has been a rise in the number of papers published. However, there has been a noticeable decrease in the average number of citations, suggesting that new research trends or approaches are still in the early stages of acquiring popularity. In general, the scientific research and citation statistics indicate that the field of bodybuilding research has achieved substantial advancements in recent decades. However, it also faces challenges with growing fields and approaches. To maximize the academic influence and real-world applicability of bodybuilding studies, we should prioritize multidisciplinary collaboration and innovation in future research.

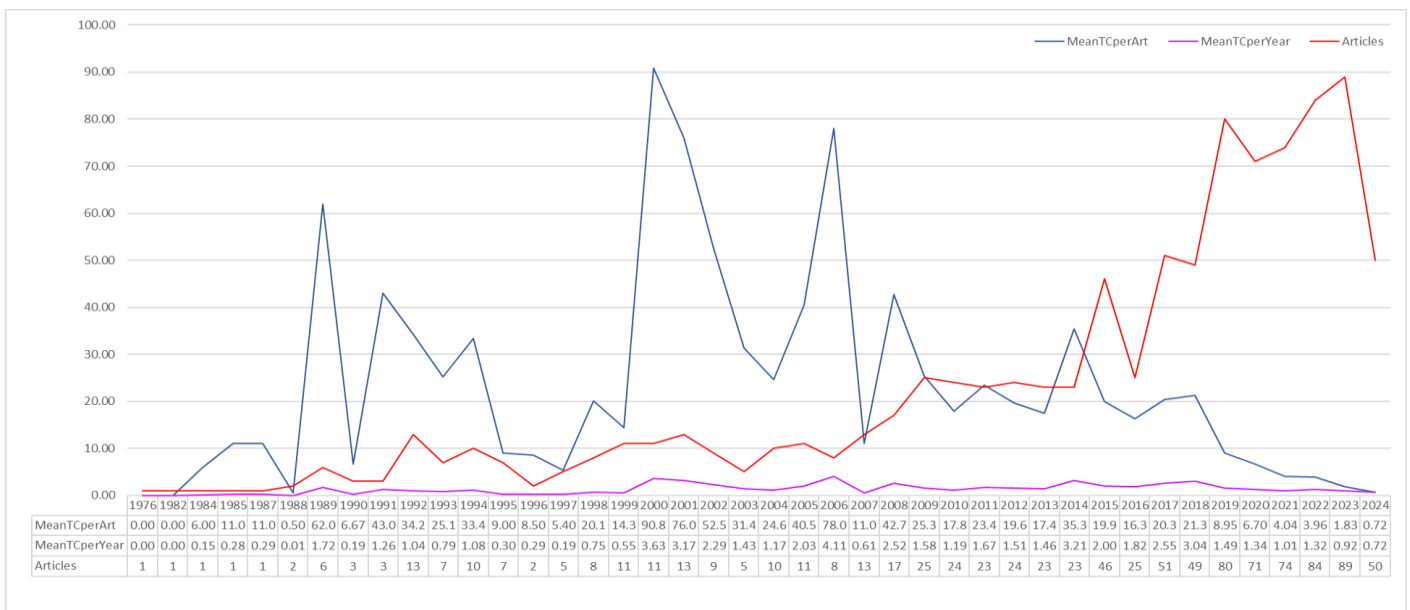


Figure 6. Annual scientific production and citation data.

3.4. Analysis of collaboration networks

3.4.1. Country collaborative analysis

Figures 7 and 8 illustrate the multi-layered and complicated features of the partnership patterns and influence of nations in the field of bodybuilding research. The United States is the foremost leader in research, excelling both in terms of the quantity of publications and the prevalence of single-country publications (SCP) and multiple-country publications (MCP), which highlights its pivotal role in the global

research network. Although Brazil, the United Kingdom, and Australia have fewer publications, they have a significant impact on certain collaboration connections, as evidenced by their high shares of SCP and MCP. Up-on further examination, it is evident that Switzerland and New Zealand have significant MCP ratios of 50.0% and 55.6%, respectively, indicating considerable partnerships with a small number of nations. China and Germany, although they excel in SCP and MCP ratios, have lesser connectedness in their collaboration networks, indicating a more focused and concentrated approach to cooperation. Moreover, nations like Canada and Spain exemplify a comprehensive international collaboration model, as seen by their larger MCP ratios (25.0% and 36.0%, respectively). These ratios indicate strong collaborative partnerships with various countries, which in turn contribute to the expansion and advancement of global bodybuilding research.

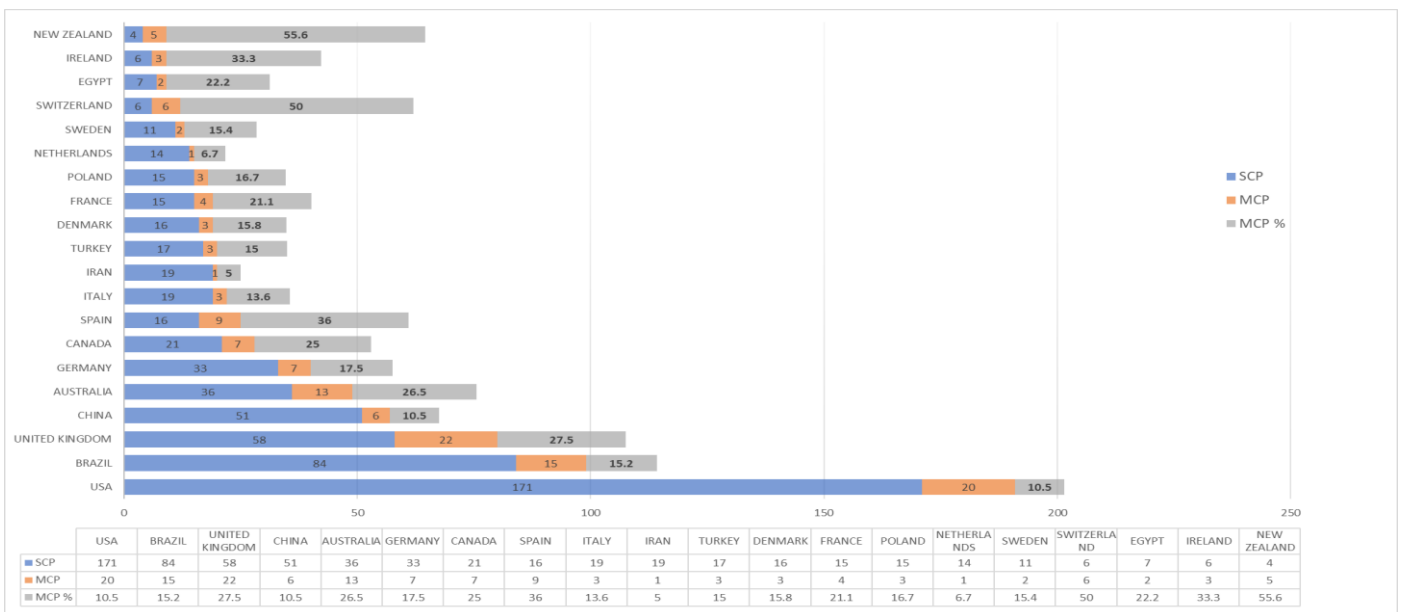


Figure 7. Corresponding author's countries.

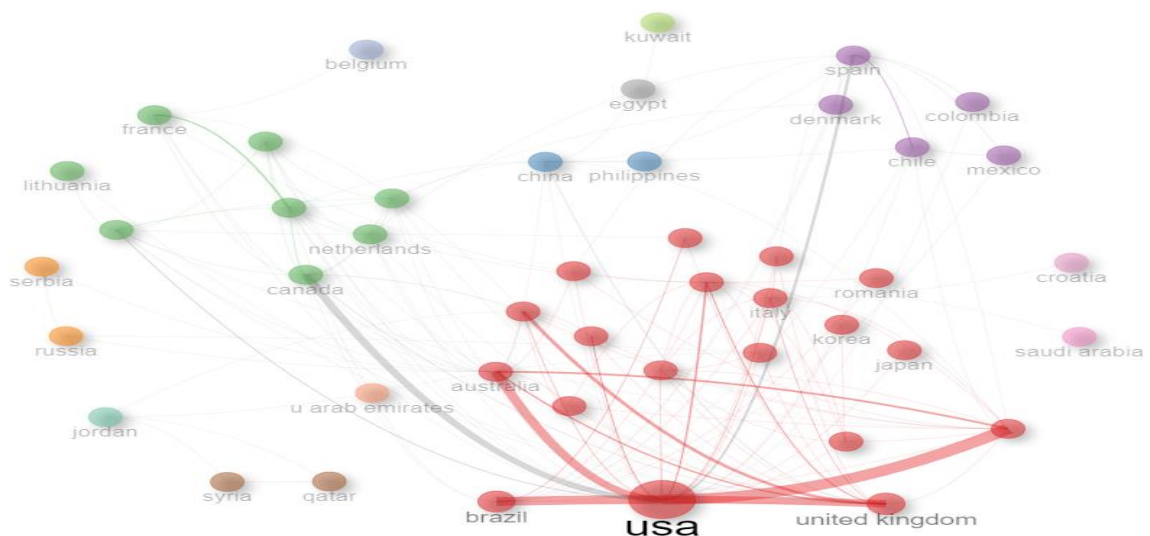


Figure 8. Countries' collaboration network.

In general, the partnership patterns in the worldwide bodybuilding research field exhibit a wide range of different approaches and a focus on certain areas of expertise. More international collaboration and the promotion of extensive knowledge sharing could potentially boost future improvements and stimulate innovation and development in bodybuilding research on a global scale.

3.4.2. Affiliations' collaboration analysis

The bibliometric study of bodybuilding research uncovers significant links and research centers through the examination of collaborative networks across institutions. **Figure 9** demonstrates that institutions exhibit a wide range of link patterns and cooperation, especially in the field of bodybuilding research. Each node, represented by a colored dot, corresponds to an institution. The size of the node signifies the significance of the institution, and it also considers the quantity of its collaborative links. The connections between nodes represent cooperative partnerships among institutions. Colors and positioning can differentiate nodes, signifying different geographical regions or study topics. The University of North Carolina (UNC) plays a vital role in linking various institutions and promoting the exchange of knowledge and re-sources. Furthermore, the University of South Florida (Univ. S. Florida) is strategically located in the center of the network, emphasizing its fundamental role and substantial impact in establishing connections with other schools and fostering cooperation. In addition, Liverpool John Moores University (Liverpool John Moores University) is notable for its bridging function and significance, highlighting its role as a crucial partner in the field of bodybuilding research. These findings demonstrate that these universities are not only prominent research hubs, but they also make a significant contribution to the advancement of the subject through broad collaboration. Collaboration networks facilitate the identification of significant research focal points and potential prospects for further cooperation, thereby promoting advancements in bodybuilding research.

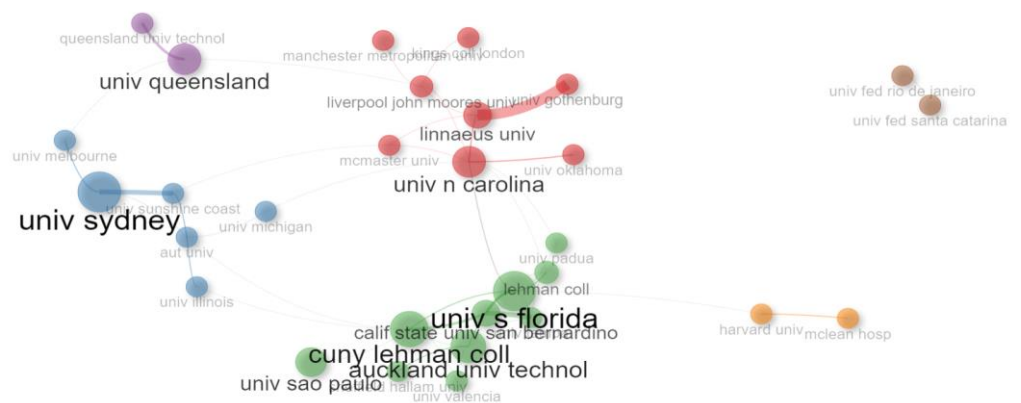


Figure 9. Affiliations' collaboration network.

3.4.3. Author' collaboration analysis

Through the examination of author collaborations, the bibliometric study of the bodybuilding research area uncovers significant links and research centers. **Figure 10** demonstrates the strong partnerships that Schoenfeld BJ has with several writers, including Campbell BI, Escalante G, and Helms ER. This emphasizes his significant

contribution to bodybuilding research. Aragon AA and Escalante G play important roles in the network, and their partnerships strengthen their positions. The network features strong inter-connectedness among authors like Andreasson J, Johansson T, Tousson E, and El-Moghazy M, facilitating the sharing of information and resources among them. These collaborative networks facilitate the identification of significant study areas and potential opportunities for further cooperation, ultimately promoting advancements in bodybuilding research. The picture illustrates the author cooperation network, which reveals that Schoenfeld BJ holds a central position as an author and often collaborates with numerous scholars. The dimensions of the nodes and the width of the connecting lines correspond to the authors' levels of activity and the intensity of their partnerships. You can use color coding to indicate various study disciplines or organizations. This methodology facilitates the identification of primary authors and pat-tens of collaboration, establishing a basis for future studies. Examining these connections enhances our comprehension of the dynamics and patterns of academic cooperation, providing useful insights for future tactics in collaboration, choices in research directions, and intellectual exchanges.

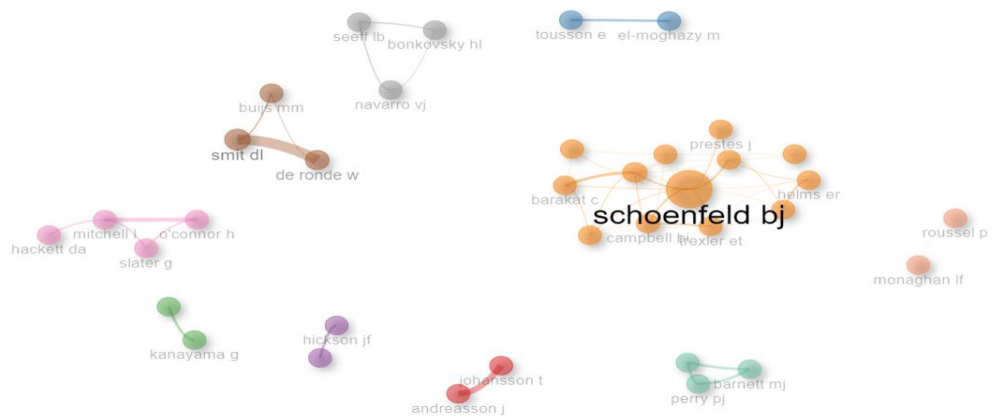


Figure 10. Authors' collaboration network.

3.5. Analysis of keywords

3.5.1. Most frequent words

Keywords are specific keywords or phrases that accurately represent the primary substance of articles (Pluim et al., 2000). According to the frequency analysis depicted in **Figure 11**, studies in the field of bodybuilding un-cover many significant themes and patterns. The primary research investigates different forms of exercise and strength training techniques, as well as their influence on total athletic performance. Additionally, there is a focus on alterations in body composition, specifically regarding the impact of nutrition, exercise, and supplements on body composition and weight loss. Health is a prominent topic that encompasses several facets, including cardiovascular health, metabolic health, and mental health. Gender studies in body-building investigate the differences in involvement and outcomes between males and females. In addition, research investigates the influence of bodybuilding on body image and eating habits, such as self-esteem, body satisfaction, and the possibility of developing eating disorders. Another significant

domain of concern is drug abuse, namely the misuse of anabolic-androgenic steroids. This research aims to examine the prevalence, underlying reasons, and potential health hazards linked to steroid abuse. The study also examines the prevalence and significance of physical exercise in the context of bodybuilding. The issue of interest is the impact of hormones, namely testosterone, on bodybuilding, which encompasses both natural and synthetic hormones. Finally, research investigates the precise alterations and adjustments that occur in the body and skeletal muscle, as well as the significance of resistance training. In general, bodybuilding research encompasses a broad spectrum of subjects, including training techniques, alterations in body composition, health implications, psychological effects, and substance misuse. This study offers significant perspectives on the present emphasis and prospects of investigation in this domain.

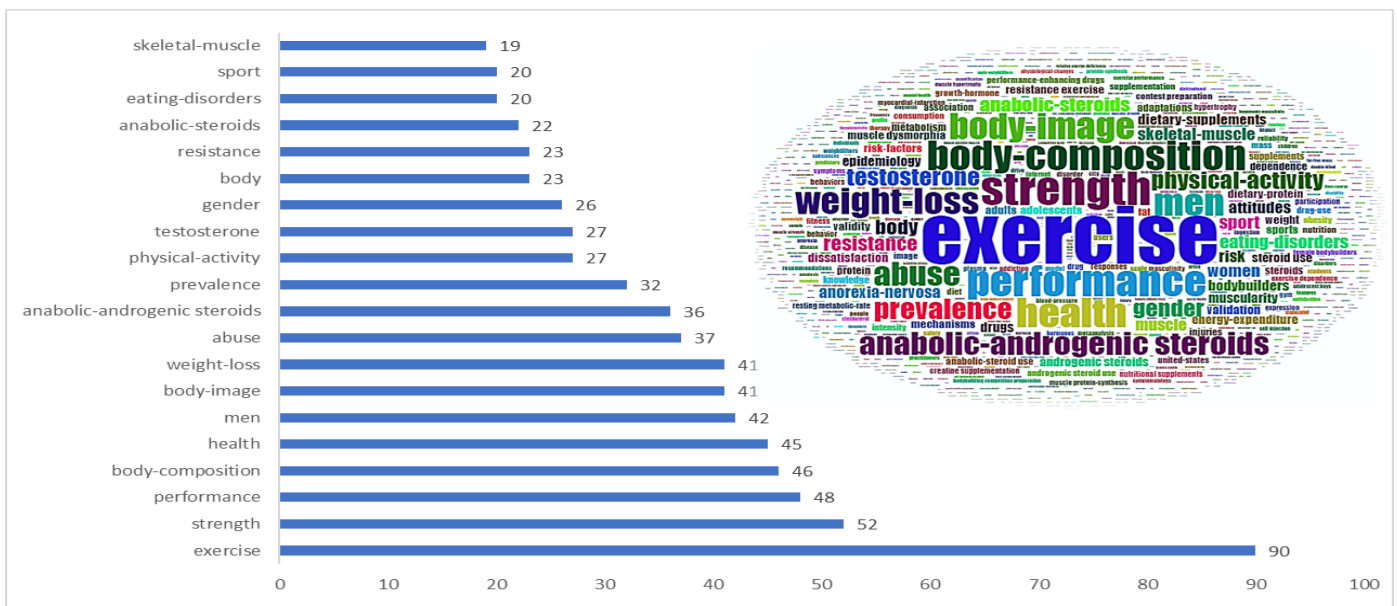


Figure 11. Most frequent words.

3.5.2. Keywords’ co-occurrence network analysis

Figure 12 demonstrates that the study of the Keywords Co-occurrence Network classifies the keywords into three primary clusters, each reflecting separate topics or research areas.

The initial cluster centers around the topics of health and abuse, incorporating terms pertaining to health, substance misuse, and related epidemiological investigations. High Betweenness and PageRank scores indicate frequent mentions and citations of the keywords “health,” “men,” “abuse,” “prevalence,” and “testosterone” in academic literature. The close associations and strong ability to spread knowledge of these keywords demonstrate their importance within the academic community.

The second cluster focuses on exercise and body composition, encompassing terms associated with physical activity, body composition, and nutritional supplements. Keywords like “exercise,” “strength,” “performance,” and “body composition” have significant Betweenness and PageRank values, highlighting their essential relevance in the subject of research. These terms’ high concentration and

PageRank scores indicate their frequent citation and significance in the research literature, emphasizing their relevance in the fields of sports nutrition, exercise physiology, and fitness training.

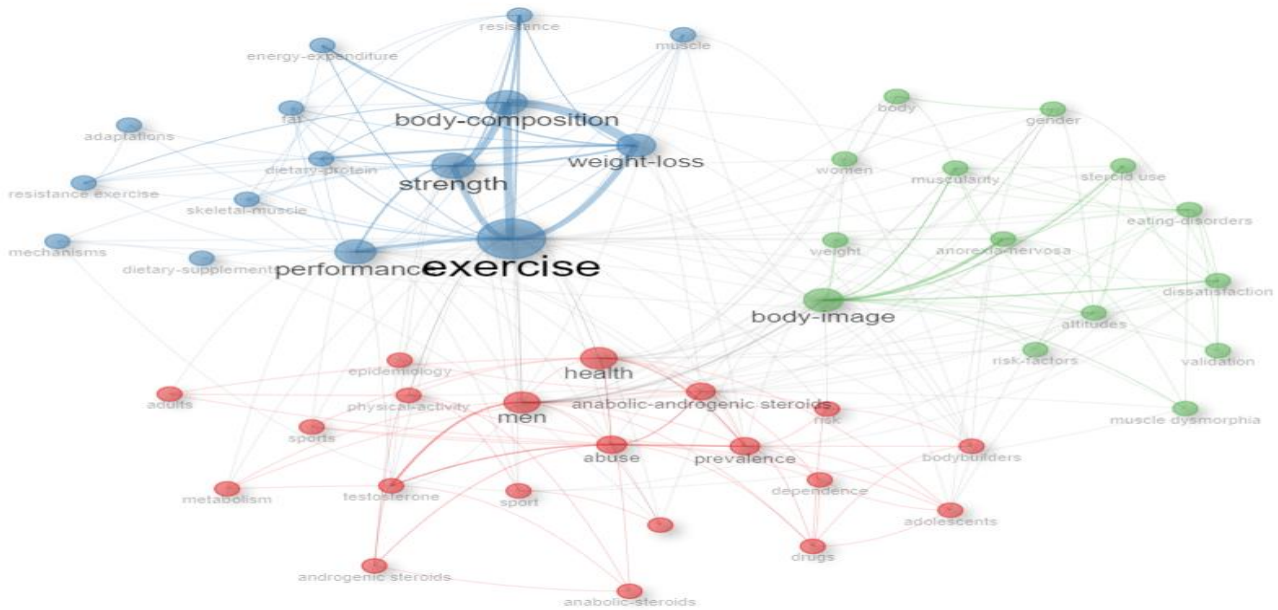


Figure 12. Keywords’ co-occurrence network.

The third cluster pertains to the concepts of body image and psychology. It specifically focuses on terms related to body image, psychological well-being, and eating disorders. The keywords “body image,” “eating disorders,” “muscularity,” and “anorexia-nervosa” have high Betweenness and PageRank values, suggesting their significance and influence in the domains of psychology, mental health, and eating behavior disorders. The strong correlations between these terms indicate their considerable focus in both scholarly study and clinical application.

In summary, the co-occurrence network data of these terms not only reveals their connection patterns and relevance within academic literature, but also provides a comprehensive understanding of the diverse study topics and issues in the field of bodybuilding.

3.5.3. Trend topics

Figure 13 demonstrates that the examination of words’ frequency over time reveals notable progress and transformation in the realm of bodybuilding research over recent decades. Keywords such as “exercise,” “strength,” “performance,” “body composition,” and “health” have seen a significant rise in occurrence, suggesting an increasing emphasis and investment in research in these domains. The frequency of exercise and strength has increased from 2 occurrences in 1992 to 90 occurrences in 2024, and from 1 occurrence in 1994 to 52 occurrences in 2024, respectively. Similarly, the frequency of performance and body composition has risen significantly from 1 occurrence each in 1999 to 48 and 46 occurrences, respectively, in 2024. The frequency of the term “health” has experienced a substantial increase, from 2 instances in 2008 to 45 instances in 2024, indicating a heightened emphasis on the influence of bodybuilding on general well-being. Research on males, body

image, and weight reduction has likewise steadily risen, reaching 42, 41, and 41 instances, respectively, in 2024. There is an increasing fascination with gender disparities, body perception, and weight control. Furthermore, there has been a notable increase in the frequency of studies on the misuse of anabolic-androgenic steroids. This increase in research activity indicates a greater emphasis on drug abuse involving steroids and other performance-enhancing substances. The frequency of these terms has increased from 1 occurrence each in 1994 and 2007 to 37 and 36 occurrences in 2024. Words such as “prevalence,” “physical activity,” “testosterone,” “gender,” “body,” and “resistance” have become more prevalent, indicating an increased focus on bodybuilding-related behaviors, exercise, gender differences, body adaptation, and resistance training.

In general, the statistics on word frequency show a significant increase in bodybuilding research in recent decades, covering many subjects such as training techniques, changes in body composition, health consequences, psychological repercussions, and drug misuse. This demonstrates the thorough and detailed nature of this discipline’s study, as well as a full emphasis on bodybuilding’s scientific basis and practical uses.

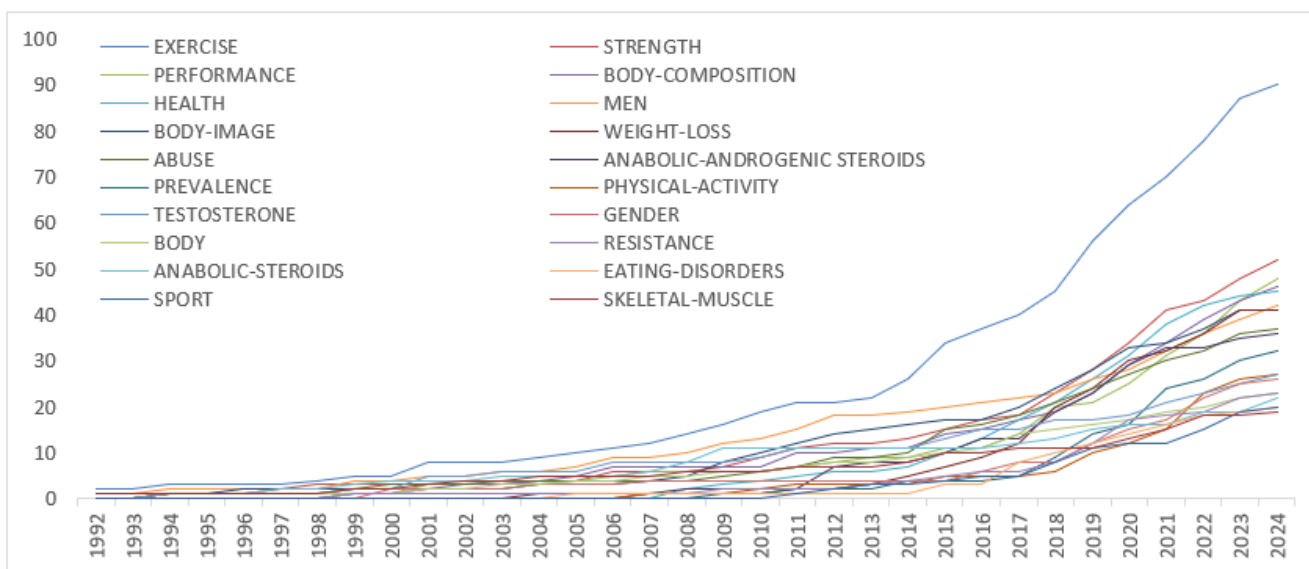


Figure 13. Words’ frequency over time.

Figure 14 demonstrates that there has been a notable rise in research on exercise and strength in the field of bodybuilding since 2014. This indicates a persistent focus on these areas. Themes like performance, body composition, health, males, body image, weight reduction, and abuse have emerged as prominent study areas in recent years, highlighting the wide range and variety of studies conducted in this discipline. Furthermore, there has been a steady growth in studies concerning testosterone, physical activity, and prevalence. This underscores the significance of testosterone in bodybuilding, physical activity, and prevalence rates. Research generally focuses on training techniques, practical applications, and health benefits. This suggests that the bodybuilding industry is experiencing continued growth and advancement in research.

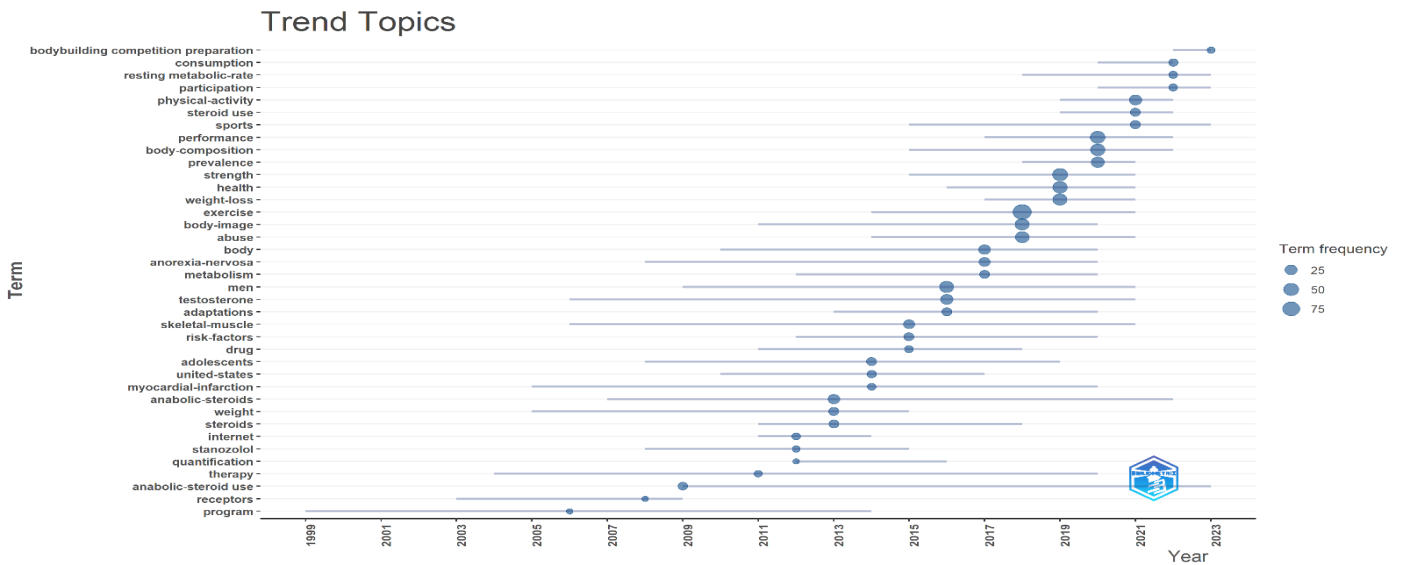


Figure 14. Trend topics.

The preceding study clearly indicates that research on bodybuilding predominantly centers around exercise, strength, performance, body composition, health, males, body image, and weight loss. Undoubtedly, these areas hold significant importance, as extensive research has shown that bodybuilding, as a physical activity, significantly impacts various body components and overall health. It is important to mention that the keywords that are becoming more prominent include misuse, anabolic-androgenic drugs, and testosterone. The initial documentation of abuse dates back to 1994 and has garnered 37 references. We first documented anabolic-androgenic steroids in 2007 and have referenced them 36 times. We first documented testosterone in 2005 and have referenced it 27 times. Furthermore, there has been a notable rise in the use of terms like abuse, anabolic-androgenic drugs, and testosterone in bodybuilding studies, suggesting a substantial emphasis on substance misuse in this area. Bodybuilders and fitness enthusiasts' primary concern is their general health, which is dependent on the discipline and self-control needed to develop a robust muscular system (Ballard, 1998), rather than prioritizing specific achievements at the expense of health by resorting to drug use. Studies indicate that the use of performance-enhancing drugs (PES) is a highly debated topic in the field of bodybuilding. These chemicals include anabolic steroids, human growth hormone, insulin, diuretics, and stimulants. Although bodybuilding does not exclusively use PES (performance-enhancing substances), it does use them more frequently than other activities (Performance-Enhancing Drugs: Know the Risks, 2023; Saugy et al., 2006). Mantri et al. (2023) conducted a thorough examination of the use of performance-enhancing substances (PES) in bodybuilding and its effects on public health in their study. They observed that prolonged usage of anabolic steroids and other substances designed to enhance performance can result in various health complications, including but not limited to acne, alopecia, mood fluctuations, hepatic impairment, cardiovascular ailments, endocrine dysfunctions, infertility, and psychological disorders. Individuals place a great emphasis on the importance of regulation and education, pushing for the advancement of natural bodybuilding and scientific fitness to improve public health.

To summarize, an examination of literature keywords in bodybuilding research indicates that the current main areas of focus include different forms of exercise and strength training techniques, body composition and general well-being, disparities between genders, body image, mental health, and concerns related to substance misuse. Future research should prioritize the optimization of training techniques, the investigation of long-term health advantages, the creation of individualized training programs, the improvement of psychological health treatments, and the prevention of drug misuse. These efforts will contribute to the advancement of scientific knowledge and the practical application of bodybuilding training.

4. Discussion and conclusion

4.1. Discussion

The bibliometric analysis presents a comprehensive overview of the bodybuilding research landscape. The increasing number of publications in recent decades signifies a growing academic interest and recognition in the field of bodybuilding. This surge in attention can be attributed to the unique effects of bodybuilding on the human body, capturing the interest of experts and scholars. Studies indicate that bodybuilding training predominantly targets skeletal muscles, focusing on progressive resistance exercises to promote muscle building, control, and development through hypertrophy (Trujillo et al., 2024). Skeletal muscle hypertrophy training has been shown to significantly increase muscle mass, enhance insulin action, improve insulin sensitivity (Hokken et al., 2021; Maestroni et al., 2020; Nedergaard et al., 2013), and reduce the risk of type II diabetes (Pesta et al., 2017; Thyfault and Bergouignan, 2020). Furthermore, muscle, functioning as an endocrine organ, contributes to the management of metabolic diseases by producing cytokines and myokines (Schnyder and Handschin, 2015). In chronic diseases, muscle mass and body fat play crucial roles in conditions like type 2 diabetes and cardiovascular disease (Duda et al., 2019). Muscle serves as a regulator of body mass and energy expenditure (Rolfe and Brown, 1997), closely linked to exercise, glucose metabolism, and lipid homeostasis. Therefore, bodybuilding emerges as a promising intervention to enhance physical fitness (Tian et al., 2010).

Bodybuilding training has been shown to play a significant role in society, extending beyond competitive sports to benefit the general population by providing leisure, promoting health, shaping positive body image, offering relaxation, boosting self-confidence and dignity, and earning peer respect (Ferenc and Oborný, 2019). This widespread appeal explains the increasing attention bodybuilding has garnered recently. The United States stands out as a leader in bodybuilding research, reflecting its historical and cultural ties to the sport and substantial investment in sports science. The high citation rate of U.S. publications underscores their significant impact on the scientific community. In contrast, while China has excelled in other Olympic sports, progress in bodybuilding has been slower. Despite its introduction in the late 1920s (Crosset and Brownell, 1997), the sport has gained attention in China, particularly after a Chinese athlete achieved fifth place in the 2019 Mr. Olympia competition. However, continuous advancements are necessary for further development of bodybuilding in China.

Bodybuilding is gaining popularity among the general public, driven by a growing emphasis on aesthetics and a desire for a healthy lifestyle (Carmen Xavier Pereira, 2023). Enthusiasts of this sport aim to increase muscle mass, develop larger and stronger physiques, and enhance their overall appearance. Research by Blouin and Goldfield (1995), Güven and Tazegül (2015) and Ray et al. (2012), indicates a strong focus on achieving an aesthetically pleasing body. Keyword analysis highlights muscle hypertrophy, strength training, and anabolic steroids as primary research topics, with nutrition and supplements warranting further investigation. International collaborations, as revealed by collaboration network analysis, are increasingly prevalent in bodybuilding research, enhancing the quality and diversity of outcomes through the exchange of knowledge and methodologies to drive innovation in the field.

Numerous gaps and challenges persist in the field of bodybuilding. Recent studies have drawn attention to a spate of high-profile fatalities in the bodybuilding community, largely linked to the utilization of performance-enhancing substances like steroids, growth hormones, insulin, and diuretics in the pursuit of the substantial muscle mass necessary for success in non-drug-tested competitions (Greenshields, 2024). Therefore, there is a pressing need for further research into the ethical implications of performance-enhancing drugs. Additionally, a crucial area warranting investigation is the design of bodybuilding training regimens. Research indicates that incorrect technique, unscientific approaches, or inadequate preparation can result in injuries such as sprains, strains, and tendon damage (Chen, 2022). Hence, training program design should be methodical and grounded in scientific principles. To optimize training outcomes, enhance performance, and boost physical fitness, a comprehensive grasp and application of fundamental training principles are imperative: overload, reversibility, progression, individualization, periodization, and specificity (Kasper, 2019). These principles should inform both the conception and implementation of bodybuilding training programs. In the realm of bodybuilding research, Bauer et al. (2023) underscored in their review the dearth of exploration into training program development and recommended that forthcoming studies delve deeper into the structuring of bodybuilding training protocols.

4.2. Conclusion

To summarize, our bibliometric analysis of bodybuilding literature offers unique insights on the development, present patterns, and prospects of research in this domain. There is a growing amount of material that suggests bodybuilding is becoming more recognized as an important field of scientific research. The analysis emphasizes the significant contributions made by scholars, namely those from the United States, and the crucial role of international collaboration in developing the discipline. The study delineates fundamental research domains, including muscular hypertrophy, strength training, and anabolic steroids, which mirror the predominant concerns among the scientific community. Despite the increasing volume of bodybuilding research, notable gaps persist, particularly in the areas of ethical considerations regarding drug utilization in bodybuilding practices and the establishment of evidence-based training regimens. This study contributes to a

deeper comprehension of the current landscape of bodybuilding research. Given the favorable impact of bodybuilding on individuals, it is imperative to promote further research that delves into the enduring advantages of bodybuilding, the ethical dilemmas associated with drug usage, and the development of training protocols. Furthermore, there is a need for additional exploration into the intricate interplay among training, nutrition, and overall health within the realm of bodybuilding.

Acknowledgments: Special thanks to my supervisor for his guidance throughout the writing of my article.

Limitations of the research: Since this study is a bibliometric analysis of bodybuilding, it has certain limitations despite using the “Web of Science” database, which is considered the most authoritative and comprehensive. The study only retrieved articles from the “Web of Science” and included only those published in English, which restricts the scope of the analysis. In future research, we will expand the search to include additional databases to comprehensively capture research information related to bodybuilding.

Conflict of interest: The authors declare no conflicts of interest.

References

- A History Lesson in Bodybuilding. (2005). Bodybuilding.Com. Available online: <https://www.bodybuilding.com/fun/drobson61.htm> (accessed on 21 March 2024).
- Ballard, G. S. D. (1998). Pump Fiction: The bodybuilding sub-culture and attitudes towards health [Master’s thesis]. Lincoln University.
- Bauer, P., Majisik, A., Mitter, B., et al. (2023). Body Composition of Competitive Bodybuilders: A Systematic Review of Published Data and Recommendations for Future Work. *Journal of Strength and Conditioning Research*, 37(3), 726–732. <https://doi.org/10.1519/jsc.0000000000004155>
- Bergeron, J., Doiron, D., Marcon, Y., et al. (2018). Fostering population-based cohort data discovery: The Maelstrom Research cataloguing toolkit. *PLOS ONE*, 13(7), e0200926. <https://doi.org/10.1371/journal.pone.0200926>
- Blouin, A. G., & Goldfield, G. S. (1995). Body image and steroid use in male bodybuilders. *The International Journal of Eating Disorders*, 18(2), 159-165. [https://doi.org/10.1002/1098-108x\(199509\)18:2<159::aid-eat2260180208>3.0.co;2-3](https://doi.org/10.1002/1098-108x(199509)18:2<159::aid-eat2260180208>3.0.co;2-3)
- Bodybuilding. (2023). Available online: <https://www.britannica.com/sports/bodybuilding> (accessed on 1 August 2023).
- Carmen Xavier Pereira, T. (2023). The Social Representations of Pre- and Post-Training Nutrition in Bodybuilders (Portuguese). *Revista Científica Semana Acadêmica*, 10(228), 1–14. <https://doi.org/10.35265/2236-6717-228-12362>
- Chen, C. (2022). Research on Intelligent Bodybuilding System Based on Machine Learning. *Journal of Sensors*, 2022, 1–8. <https://doi.org/10.1155/2022/6293856>
- Crosset, T. W., & Brownell, S. (1997). Training the Body for China: Sports in the Moral Order of the People’s Republic. *Contemporary Sociology*, 26(2), 245. <https://doi.org/10.2307/2076815>
- Devrim, A., Bilgic, P., & Hongu, N. (2018). Is There Any Relationship Between Body Image Perception, Eating Disorders, and Muscle Dysmorphic Disorders in Male Bodybuilders? *American Journal of Men’s Health*, 12(5), 1746–1758. <https://doi.org/10.1177/1557988318786868>
- Duda, K., Majerczak, J., Nieckarz, Z., et al. (2019). Human Body Composition and Muscle Mass. *Muscle and Exercise Physiology*, 3–26. <https://doi.org/10.1016/b978-0-12-814593-7.00001-3>
- Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*, 105(3), 1809–1831. <https://doi.org/10.1007/s11192-015-1645-z>
- Ferenc, I., & Oborný, J. (2019). Fitness And Bodybuilding as A Physical Activity and Its Importance for Physical Development, Physical Fitness and Mental Wellbeing. *Advances in Social Sciences Research Journal*, 6(2). <https://doi.org/10.14738/assrj.62.6135>

- Flamini, A. (2009). A Semiotic Approach to The Study of Bodybuilding: The Importance of Male Body Image and Its Indications of Masculinity in Contemporary Western Society. Available online: <https://dspace.sunyconnect.suny.edu/handle/1951/44943> (accessed on 10 May 2023).
- Gattario, K. H., Frisén, A., Fuller-Tyszkiewicz, M., et al. (2015). How is men's conformity to masculine norms related to their body image? Masculinity and muscularity across Western countries. *Psychology of Men & Masculinity*, 16(3), 337–347. <https://doi.org/10.1037/a0038494>
- Greenshields, W. (2024). Death, jouissance and the bodybuilder. *Psychoanalysis, Culture & Society*, 29(2), 205–221. <https://doi.org/10.1057/s41282-024-00428-6>
- Grogan, S., & Richards, H. (2002). Body Image. *Men and Masculinities*, 4(3), 219–232. <https://doi.org/10.1177/1097184x02004003001>
- Guo-qiang, Q. (2012). Effects of Bodybuilding Training on Self-confidence and Mental Health of Weak Fitness Male College Students. Available online: <https://www.semanticscholar.org/paper/Effects-of-Bodybuilding-Training-on-Self-confidence-Guo-qiang/afc708ce3c5bd34853004c09c5f8de5e109a94af> (accessed on 9 May 2023).
- Helms, E. R., Aragon, A. A., & Fitschen, P. J. (2014). Evidence-based recommendations for natural bodybuilding contest preparation: nutrition and supplementation. *Journal of the International Society of Sports Nutrition*, 11(1). <https://doi.org/10.1186/1550-2783-11-20>
- Hokken, R., Laugesen, S., Aagaard, P., et al. (2020). Subcellular localization- and fibre type-dependent utilization of muscle glycogen during heavy resistance exercise in elite power and Olympic weightlifters. *Acta Physiologica*, 231(2). Portico. <https://doi.org/10.1111/apha.13561>
- Jiu-zheng, Z. (2006). An Analysis of the Concept of Modern Body-building. Available online: <https://www.semanticscholar.org/paper/An-Analysis-of-the-Concept-of-Modern-Body-building-Jiu-zheng/d5e5073194f24101c4b3a7181142dfeeae9ba59d> (accessed on 10 May 2023).
- Kang, Y., Choi, N., & Kim, S. (2021). Searching for New Model of Digital Informatics for Human–Computer Interaction: Testing the Institution-Based Technology Acceptance Model (ITAM). *International Journal of Environmental Research and Public Health*, 18(11), 5593. <https://doi.org/10.3390/ijerph18115593>
- Kasper, K. (2019). Sports Training Principles. *Current Sports Medicine Reports*, 18(4), 95–96. <https://doi.org/10.1249/jsr.0000000000000576>
- Kicman, A. T. (2008). Pharmacology of anabolic steroids. *British Journal of Pharmacology*, 154(3), 502–521. Portico. <https://doi.org/10.1038/bjp.2008.165>
- Lefkowich, M., Oliffe, J. L., Hurd Clarke, L., et al. (2016). Male Body Practices. *American Journal of Men's Health*, 11(2), 454–463. <https://doi.org/10.1177/1557988316669042>
- Lou, Y., Sun, N., Zhang, M., et al. (2023). Trends in exercise for hypertension: a bibliometric analysis. *Frontiers in Cardiovascular Medicine*, 10. <https://doi.org/10.3389/fcvm.2023.1260569>
- Maestroni, L., Read, P., Bishop, C., et al. (2020). The Benefits of Strength Training on Musculoskeletal System Health: Practical Applications for Interdisciplinary Care. *Sports Medicine*, 50(8), 1431–1450. <https://doi.org/10.1007/s40279-020-01309-5>
- Mantri, S., Agarwal, S., Jaiswal, A., et al. (2023). Bodybuilding: A Comprehensive Review of Performance-Enhancing Substance Use and Public Health Implications. *Cureus*. <https://doi.org/10.7759/cureus.41600>
- Murray, T. E. (1984). The Language of Bodybuilding. *American Speech*, 59(3), 195. <https://doi.org/10.2307/454485>
- Navarro, V. J., Barnhart, H., Bonkovsky, H. L., et al. (2014). Liver injury from herbals and dietary supplements in the U.S. Drug-Induced Liver Injury Network. *Hepatology*, 60(4), 1399–1408. Portico. <https://doi.org/10.1002/hep.27317>
- Navarro, V. J., Khan, I., Björnsson, E., et al. (2016). Liver injury from herbal and dietary supplements. *Hepatology*, 65(1), 363–373. Portico. <https://doi.org/10.1002/hep.28813>
- Nedergaard, A., Henriksen, K., Karsdal, M. A., et al. (2013). Musculoskeletal ageing and primary prevention. *Best Practice & Research Clinical Obstetrics & Gynaecology*, 27(5), 673–688. <https://doi.org/10.1016/j.bpobgyn.2013.06.001>
- Newmire, D. E., & Willoughby, D. S. (2020). Partial Range of Motion Resistance Training: A Feasible Bodybuilding Training Regiment for Local or Regional Muscle Hypertrophy? *Strength & Conditioning Journal*, 42(5), 87–93. <https://doi.org/10.1519/ssc.0000000000000550>
- Parkinson, A. B., & Evans, N. A. (2006). Anabolic Androgenic Steroids. *Medicine & Science in Sports & Exercise*, 38(4), 644–651. <https://doi.org/10.1249/01.mss.0000210194.56834.5d>
- Performance-enhancing drugs: Know the risks. (2023). Mayo Clinic. Available online: <https://www.mayoclinic.org/healthy->

- lifestyle/fitness/in-depth/performance-enhancing-drugs/art-20046134 (accessed on 20 June 2023).
- Pesta, D. H., Goncalves, R. L. S., Madiraju, A. K., et al. (2017). Resistance training to improve type 2 diabetes: working toward a prescription for the future. *Nutrition & Metabolism*, 14(1). <https://doi.org/10.1186/s12986-017-0173-7>
- Pluim, B. M., Zwinderman, A. H., van der Laarse, A., et al. (2000). The Athlete's Heart. *Circulation*, 101(3), 336–344. <https://doi.org/10.1161/01.cir.101.3.336>
- Pope, H. G., Gruber, A. J., Mangweth, B., et al. (2000). Body Image Perception Among Men in Three Countries. *American Journal of Psychiatry*, 157(8), 1297–1301. <https://doi.org/10.1176/appi.ajp.157.8.1297>
- Ray, P., Demirkol, M., & Tamam, L. (2012). Body Dysmorphic Disorder. *Psikiyatride Guncel Yaklasimler Current Approaches in Psychiatry*, 4(4), 547. <https://doi.org/10.5455/cap.20120432>
- Rolfe, D. F., & Brown, G. C. (1997). Cellular energy utilization and molecular origin of standard metabolic rate in mammals. *Physiological Reviews*, 77(3), 731–758. <https://doi.org/10.1152/physrev.1997.77.3.731>
- Roundtree, L. K. (2005). A critical sociology of bodybuilding. Available online: <https://www.proquest.com/openview/c6bdfaa038eab2d39a8421f4da8e1fab/1?pq-origsite=gscholar&cbl=18750&diss=y> (accessed on 12 June 2023).
- Saugy, M., Robinson, N., Saudan, C., et al. (2006). Human growth hormone doping in sport. *British Journal of Sports Medicine*, 40(1), i35–i39. <https://doi.org/10.1136/bjism.2006.027573>
- Schnyder, S., & Handschin, C. (2015). Skeletal muscle as an endocrine organ: PGC-1 α , myokines and exercise. *Bone*, 80, 115–125. <https://doi.org/10.1016/j.bone.2015.02.008>
- Shahidi, N. T. (2001). A review of the chemistry, biological action, and clinical applications of anabolic-androgenic steroids. *Clinical Therapeutics*, 23(9), 1355–1390. [https://doi.org/10.1016/S0149-2918\(01\)80114-4](https://doi.org/10.1016/S0149-2918(01)80114-4)
- Sjöberg, Y., Siewert, M. B., Rudy, A. C. A., et al. (2020). Hot trends and impact in permafrost science. *Permafrost and Periglacial Processes*, 31(4), 461–471. Portico. <https://doi.org/10.1002/ppp.2047>
- Stokvis, R. (2006). The Emancipation of Bodybuilding. *Sport in Society*, 9(3), 463–479. <https://doi.org/10.1080/17430430600673480>
- Stout, N. L., Alfano, C. M., Belter, C. W., et al. (2018). A Bibliometric Analysis of the Landscape of Cancer Rehabilitation Research (1992–2016). *JNCI: Journal of the National Cancer Institute*, 110(8), 815–824. <https://doi.org/10.1093/jnci/djy108>
- Subaşı, B., & Okray, Z. (2021). Construction of Masculinity through Bodybuilding: A Qualitative Study (Turkish). *Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 30(1), 83–91. <https://doi.org/10.35379/cusosbil.773123>
- Tazegül, Ü. (2015). Bodybuilding Athletes and Athletes in Different Sports and Sports (Turkish). *The Journal of Academic Social Science Studies*, 3(33), 465–465. <https://doi.org/10.9761/jasss2770>
- Thyfaut, J. P., & Bergouignan, A. (2020). Exercise and metabolic health: beyond skeletal muscle. *Diabetologia*, 63(8), 1464–1474. <https://doi.org/10.1007/s00125-020-05177-6>
- Tian, F., Yao, G., Zhou, X., et al. (2010). The Test Analysis of the National Fitness in China from the Perspective of National Physical. Available online: <https://www.webofscience.com/wos/woscc/full-record/WOS:000288183400094> (accessed on 13 May 2023).
- Trujillo, M. O. E., Villegas, A. D. R., Hoyos-Ruiz, G., et al. (2023). Musculoskeletal Hypertrophy Training for Overweight and Obesity. *Migration Letters*, 21(S1), 458–465. <https://doi.org/10.59670/ml.v21is1.6080>
- Wang, X. Q., Peng, M. S., Weng, L. M., et al. (2019). Bibliometric Study of the Comorbidity of Pain and Depression Research. *Neural Plasticity*, 2019, 1–16. <https://doi.org/10.1155/2019/1657498>
- Zhang, J., Zhang, Y., Hu, L., et al. (2021). Global Trends and Performances of Magnetic Resonance Imaging Studies on Acupuncture: A Bibliometric Analysis. *Frontiers in Neuroscience*, 14. <https://doi.org/10.3389/fnins.2020.620555>
- Zhang, S., Fan, H., & Zhang, Y. (2021). The 100 Top-Cited Studies on Dyslexia Research: A Bibliometric Analysis. *Frontiers in Psychiatry*, 12. <https://doi.org/10.3389/fpsy.2021.714627>
- Zhang, Z., Zhu, Y., Wang, Q., et al. (2022). Global Trends and Research Hotspots of Exercise for Intervening Diabetes: A Bibliometric Analysis. *Frontiers in Public Health*, 10. <https://doi.org/10.3389/fpubh.2022.902825>