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Application of Plyometric Training Method: A Bibliometric Analysis Based on Scopus Data From 2014 to 2024

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ABSTRACT

Background: In recent years, plyometric training methods have been widely applied to improve strength, explosive power, and athletic performance. This study aims to present a bibliometric analysis of publication trends related to plyometric training over the past decade.

Methods: This study employed a bibliometric approach, analysing publications related to plyometric training in the Scopus database from 2014 to 2024. A total of 1,339 documents were reviewed using VOSviewer and Biblioshiny software. The analysis focused on publication trends, country and institutional productivity, collaboration networks, author influence (H-Index), and keyword co-occurrence to identify dominant themes and research trends.

Results: Research findings show a consistent increase in publications related to plyometric training since 2014, peaking at 210 publications in 2024. The United States, the United Kingdom, and Spain were the most productive countries, with Spain receiving the highest number of citations. The Journal of Strength and Conditioning Research was ranked as the most productive and influential journal in its field. At the institutional level, the Universidad de Los Lagos (Chile) was the most dominant, with Rodrigo Ramirez-Campillo being the most influential author, having published 85 works and an H-Index of 30. Keyword analysis revealed that among the most frequently occurring keywords were 'Human', 'Plyometric exercise', and 'Physiology', with recent trends emphasising 'Velocity', 'Training', and 'Resistance training'.

Conclusion: Research related to plyometric training has shown significant progress over the past decade. The focus, which initially emphasised physiological and anthropometric aspects, has now shifted to practical applications for improving sports performance. Keyword analysis indicates a predominance of male participants, while the involvement of female participants, research on specific sports such as basketball, and aspects of anthropometric and biomechanical components of lower-limb joints remain limited. Future research should focus on reducing gender disparities, expanding sport-based research, and enhancing biomechanical studies to achieve more comprehensive and applicable results.

Keywords: Plyometrics, bibliometrics, Scopus database

1. INTRODUCTION

In the field of sports, an athlete's achievement is not only determined by natural talent, but is also greatly influenced by the training methods designed and implemented by the coach (Islam & Oktavia, 2025; Telaumbanua et al., 2024). Coaches, as central figures in developing athlete performance, need to pay attention to various important aspects in developing an effective training programme so that performance goals can be achieved (Huang et al., 2023; Islam et al., 2025a). The training methods used must be tailored to the specific needs of each athlete, taking into

account physical, technical, tactical, and mental factors (Bompa et al., 2013; Nubatonis et al., 2024). The application of appropriate training methods will significantly contribute to the development of optimal athlete performance, without increasing the risk of performance decline (Alcock et al., 2024).

One of the training methods often used to increase muscle strength and explosive power is plyometric training (Hansen & Kennelly, 2017; Islam et al., 2025b; Lengo et al., 2023). Plyometrics has become an integral part of the sports field because it has been proven to enhance aspects of explosive strength, speed, and muscular endurance (Hassan, 2018; Ploeg et al., 2010; Prianto et al., 2024). Its application has been widespread in various sports such as athletics, basketball, soccer, volleyball, and martial arts, with the primary goal of optimising muscle function by increasing the stretch-shortening cycle (Bolboli & Bagher, 2021; Chu & Myer, 2013; Huang et al., 2023).

The development of research topics regarding the application of plyometric training methods in recent years has also shown a significant increase, not only in the scope of physiological and biomechanical sciences, but also related to aspects of injury prevention (Huang et al., 2024), gender differences (Ebben et al., 2011; Lu & Duan, 2024), athlete age (Anversha & Ramalingam, 2023; Yılmaz & Çetintürk, 2024), and integration with other training methods such as strength training (León Muñoz et al., 2024; Slimani et al., 2016).

This indicates that plyometric training is not only relevant for improving aspects of physical performance but also has important benefits in preventing injuries and enhancing movement efficiency (Firmansyah et al., 2024; Gepfert et al., 2025). This is supported by several research results with a meta-analysis method approach, which shows that plyometric training has been proven to increase muscle strength significantly (Du, 2023), as well as explosive power, vertical jump ability (Stojanović et al., 2017), and sprint speed in athletes from various groups regardless of gender or age (Deng et al., 2022).

However, the effectiveness of this training can be influenced by several variables, including programme duration, weekly frequency, and training intensity (Asadi et al., 2016; Sylvester et al., 2024). Furthermore, a review by Ramirez-Campillo et al. (2020) highlighted that most applications of plyometric training methods still focus on male athletes and team sports, while studies on female athletes, individual sports, and elite levels are still limited, thus opening up opportunities for further research (Prvulović et al., 2024).

As the number of publications on the topic increases, bibliometric analysis becomes a relevant approach for mapping the development and direction of research trends globally (De Sousa et al., 2024). Through bibliometric analysis, researchers can understand collaboration patterns between authors, institutions, and countries, as well as identify dominant research topics and aspects that are rarely studied (Öğretmenoğlu et al., 2025). Therefore, this study aims to conduct a bibliometric analysis of the trends in the application of plyometric training methods, in order to provide a comprehensive picture of the evolution of research and the direction of future research development.

2. METHODS

This study uses a bibliometric approach to examine scientific publications related to the application of plyometric training methods in sports. Bibliometric analysis was conducted through two primary methods: descriptive analysis and science mapping, to understand research trends and patterns of plyometric training application over a specific time period.

In bibliometric studies, the research design is a crucial initial stage, beginning with the formulation of research questions and the selection of the most relevant bibliometric techniques (Al Barra et al., 2024; Coimbra et al., 2019). Various bibliometric techniques can be applied, ranging from descriptive statistical analysis, such as identifying authors, institutions, countries, journals, annual publication rates, and most cited articles (Öğretmenoğlu et al., 2025), to scientific network analysis, including keyword *co-occurrence, betweenness centrality, and co-citation analysis* (Ren et al., 2023). In this study, network analysis focused on keyword *co-occurrence and betweenness centrality* to map the relationships between topics and between researchers.

The data collection process was conducted using the Scopus database, with a publication period spanning from 2014 to 2024. This period was chosen to provide a comprehensive overview of the development of research trends related to plyometric training methods in the last decade. The literature search was conducted using the main keyword *'plyometric training'*, combined with the Boolean operators 'OR' and 'AND' and other relevant keywords, to expand the search scope while ensuring the relevance of the results to the research topic (Plakias, 2025).

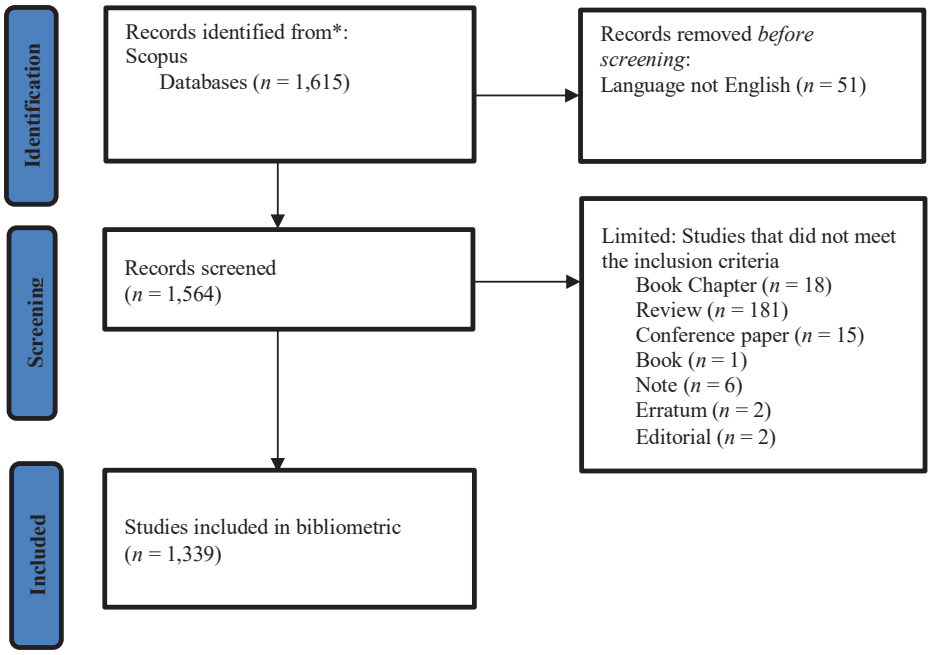
Selection of Articles for Bibliometric Analysis

The articles selected for analysis were limited to original research articles. Review articles, early access articles, book chapters, conference proceedings, and retracted publications were excluded from the sample. No publication year restrictions were imposed, thus all documents published up to December 30, 2024 were eligible for inclusion. Based on this selection, the final sample size was 1,339 articles.

Table 1. **Search terms by keywords and the base**

Keywords by Database
Scopus
TITLE-ABS-KEY (‘plyometric*’ OR ‘plyometric training’ OR ‘jump training’) AND TITLE-ABS-KEY (‘sport*’ OR ‘athlete*’ OR ‘athletic performance’ OR ‘exercise*’ OR ‘physical performance’)

Figure 1. **The search strategy flow diagram**



Bibliometric Data Analysis

Bibliometric data processing was performed using Biblioshiny, a web-based application from Bibliometrix, an open-source tool for quantitative bibliometric analysis (Aria & Cuccurullo, 2017). To enhance the visualisation results, VOSviewer version 1.6.20 was also used, which functions to build collaboration network maps, visualise relationships between keywords, and facilitate thematic research mapping (McAllister et al., 2022). The variables analysed included publication source, author, country affiliation, and author keywords, as listed in Table 2.

Table 2. **Main categories and variables analysed**

Measures	Items	Analysis
Overview	Main information Scientific production per year	RStudio/Bibliometrix/Biblioshiny
Sources	Most relevant journals	RStudio/Bibliometrix/Biblioshiny
Authors	Most relevant authors	RStudio/Bibliometrix/Biblioshiny
Countries	Countries' scientific production	RStudio/Bibliometrix/Biblioshiny
Affiliation	Most relevant institutions	VOSviewer
Social Structure	Collaboration map between countries Author collaboration network	VOSviewer
Documents	Global most cited articles	RStudio/Bibliometrix/Biblioshiny
	Frequent word network	VOSviewer
	Author's keywords	VOSviewer

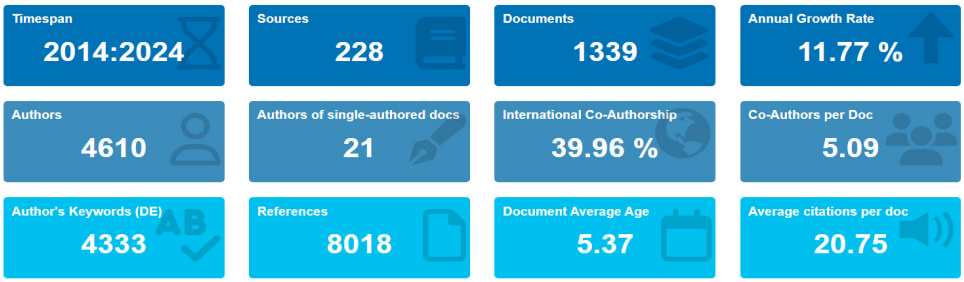
The research results were then analysed based on three main aspects: sources, authors, and documents. The final analysis focused on the ten most relevant journals and authors, collaborative networks between authors and countries, the ten most cited articles, the most productive countries and institutions, and author keywords. Furthermore, the H-Index of both journals and authors was calculated as an indicator of influence within the analysed publication pool.

3. RESULTS

Descriptive Analysis

The following is the main information regarding the sample scientific documents analysed in **Figure 2**. The data to be analysed include the number of research articles published per year, the average number of citations per year, and a three-field plot diagram illustrating the relationship between authors, keywords, and journals. Furthermore, the analysis results also highlight the most relevant journals, the application of Bradford's Law, the most productive authors, and the distribution of author productivity based on Lotka's Law. Furthermore, the number of scientific publications by country, as well as the countries with the highest number of citations, are displayed as well. Institutional aspects are also considered by identifying the most relevant institutions. From a collaboration perspective, the analysis results include a map of collaboration between countries and a collaboration network between authors. Furthermore, the analysis also highlights the most cited global articles, the network of frequently occurring words, and the distribution of author keywords.

Figure 2. **Main information about the data**



A total of 1,339 publications related to the application of plyometric training methods in exercise were published between 2014 and 2024, with contributions from 228 journal sources. These publications showed an annual growth rate of 11.77%, with an average document age of 5.37 years. Each document received an average of 20.75 citations, while a total of 8,018 references were used in all publications.

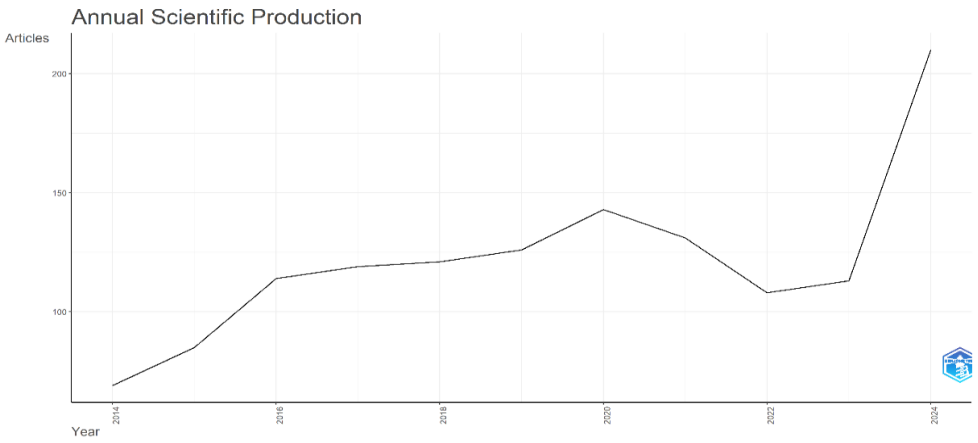
In terms of keywords, 4,333 items were recorded, reflecting the diversity of research focuses on this topic. Author contributions were also substantial,

with a total of 4,610 authors; however, only 21 documents were written by a single author. This indicates a high collaboration index, with an average of 5.09 authors per document. Furthermore, 39.96% of publications involved international collaboration, reflecting the global connectedness of authors in research on the application of plyometric training methods.

Annual Scientific Production

Annual Scientific Production describes the development of the number of research publications each year on research topics that will be analysed further.

Figure 3. **Annual scientific production (2014–2024)**



The results in Figure 3 indicate that research on the application of plyometric training methods has undergone significant development since 2014. At the beginning of the analysis period, 69 documents were recorded; subsequently, the number of publications increased steadily to reach 143 by the end of 2020. Although there were fluctuations in 2021 (N = 131 documents) and 2022 (N = 108 documents), the overall trend remained positive. The peak productivity occurred in 2024 with 210 publications, almost double the previous annual average. Overall, the period 2014–2024 yielded 1,339 publications, confirming that plyometric research is growing rapidly in the field of research.

Most Relevant Journals

Regarding the analysis results by the publisher, 228 journals published research on plyometric training methods between 2014 and 2024. Of these, ten key journals were the most relevant and dominated the publications.

Figure 4. **Most relevant sources**

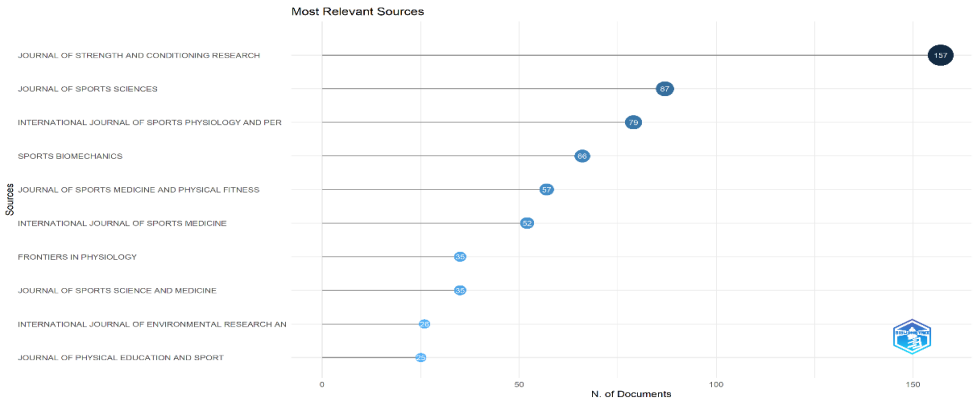


Figure 4 shows that the Journal of Strength and Conditioning Research had the highest number of publications, with 157 articles, followed by the Journal of Sports Sciences with 87 articles, and the International Journal of Sports Physiology and Performance with 79 articles. Furthermore,

several other journals that also contributed significantly included Sports Biomechanics (66 articles), the Journal of Sports Medicine and Physical Fitness (57 articles), and the International Journal of Sports Medicine (52 articles).

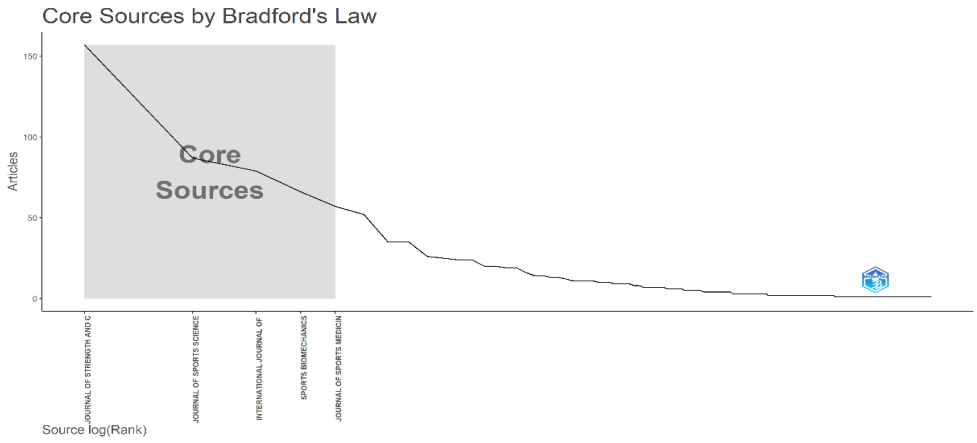
Table 3. **Descriptive information of the top ten most relevant sources**

Journal Name	HI	GI	MI	NP	SJR
Journal of Strength and Conditioning Research	44	68	3.667	5,818	Q1
International Journal of Sports Physiology and Performance	28	46	2.545	2,330	Q1
Journal of Sports Sciences	28	46	2.333	2,459	Q1
International Journal of Sports Medicine	23	40	1.917	1,654	Q1
Sports Biomechanics	19	25	1.727	868	Q1
Frontiers in Physiology	16	28	1.778	824	Q2
Journal of Sports Medicine and Physical Fitness	16	25	1.333	788	Q2
Journal of Sports Science and Medicine	15	26	1.364	703	Q1
Medicine and Science in Sports and Exercise	15	24	1.25	640	Q1
PLoS ONE	15	24	1.25	636	Q1

Notes: H-Index (HI): the number of publications cited is at least that number; **G-Index (GI):** measures the impact of publications based on the highest total citations; **M-Index (MI):** H-Index divided by the length of the publication career; **NP:** number of publications; **SJR:** scientific journal rankings.

Meanwhile, Table 3 shows that when reviewed based on the H-Index as a measure of citation influence and impact, the three journals with the highest achievements are the Journal of Strength and Conditioning Research (H-Index = 44), the International Journal of Sports Physiology and Performance (H-Index = 28), and the Journal of Sports Sciences (H-Index = 28).

Figure 5. **Bradford's Law**



According to Bradford's Law, which explains the distribution of academic articles in scientific journals, articles on a particular topic are not evenly distributed among all journals but tend to be concentrated in a small number of journals known as *core journals*. This law divides the distribution of articles into three zones: Zone 1 (core journals), Zone 2 (secondary journals), and Zone 3 (peripheral journals) (Yumnam & Singh, 2024). In the analysis, nine of the ten most relevant journals fall into the core category (Zone 1), which are the most productive journals and contain the majority of primary

articles (Figure 4). The results (Table 4) show that Zone 1 comprises five journals (2.2%), which collectively produced 446 articles (33.6%), reflecting the dominance of core journals in contributing to the publications. Zone 2 comprises 24 journals (10.5%) and 445 articles (33.5%), confirming the significant role of secondary journals. Meanwhile, Zone 3 comprises 199 journals (87.3%) but produced only 438 articles (32.9%), indicating low productivity in most of these journals. This finding aligns with Bradford's Law, which states that most publications are concentrated in a few core journals. In contrast, most journals contribute only a small portion of the total scientific output.

Table 4. **Distribution of scientific production according to Bradford's Law**

Distribution of scientific production according to Bradford's Law		
Zone	**Result**	
	Number of Journals	**Number of Articles**
Zone 1	5 (2.2%)	446 (33.6%)
Zone 2	24 (10.5%)	445 (33.5%)
Zone 3	199 (87.3%)	438 (199 (87.3%)

Most Relevant Authors

Lotka's Law is a bibliometric law used to measure the productivity of scientific authors. This Law states that the number of authors producing a certain number of publications is inversely proportional to the square of the number of publications (Pratiwi et al., 2024). In other words, most authors produce only a few publications, while only a few authors are very productive and produce many publications. Regarding the output analysis, it shows that 4,610 authors have published 1,339 articles on the application of plyometric training methods, with an average of 5.09 authors per document. Based on the application of Lotka's Law in Figure 6, which illustrates the distribution of scientific productivity among authors on a particular topic, it is estimated that 79.3% of authors have contributed only once in this field. In comparison, 12.6% of authors have contributed at least twice, and only 0.4% of authors have managed to publish three or more articles.

Figure 6. **Author productivity through Lotka's law**

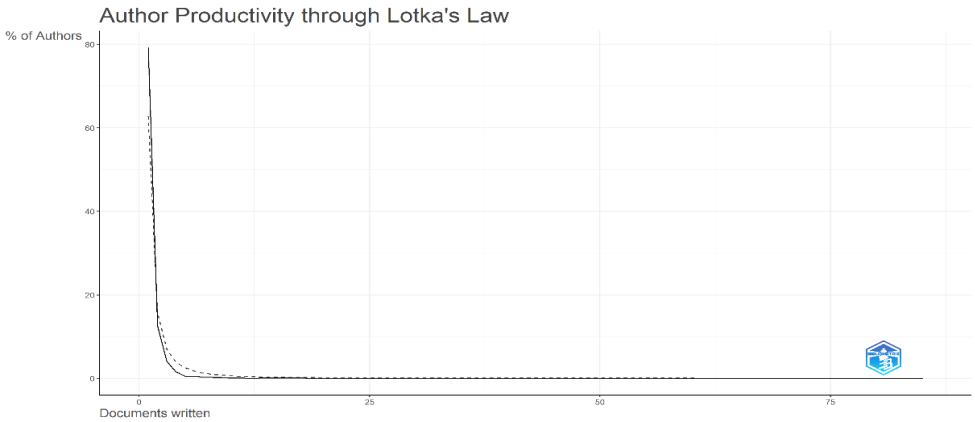
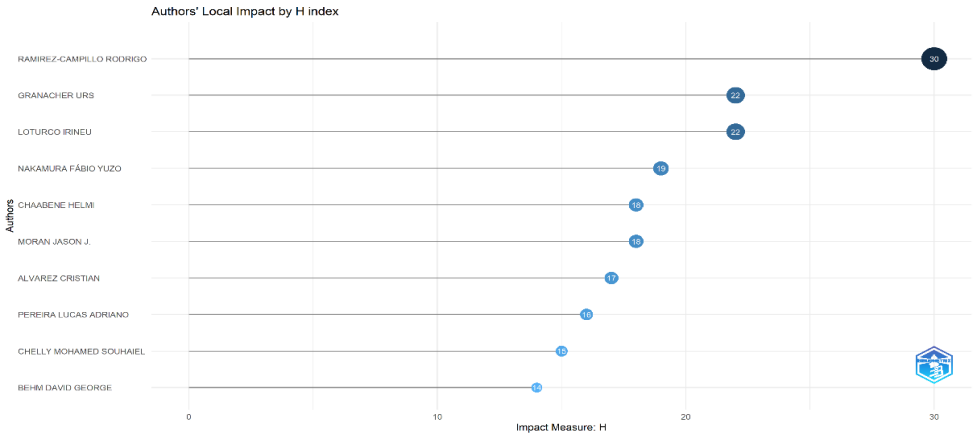


Figure 7 shows the ten most influential authors in research on the application of plyometric training methods based on the H-Index. Among these authors, Ramirez-Campillo Rodrigo stands out as the most influential locally, with an H-Index of 30.

Figure 7. **Authors' local impact**



Additionally, the ten most productive authors in research on plyometric training methods are listed in Table 5. Among the several authors, Ramirez-Campillo is the author with the most publications, at 85.

Table 5. **Most productive writers**

Writer	Documents	Citations	Total Link Strength
Ramirez-Campillo, Rodrigo	85	2,536	23,741
Loturco, Irineu	34	1,233	10,339
Alvarez, Cristian	17	1,224	7,921
Granacher, Urs	36	1,200	11,215
Nakamura, Fábio Yuzo	26	1,081	7,177
Moran, Jason J.	33	873	11,735
Chaabene, Helmi	27	850	11,963
Pereira, Lucas Adriano	25	831	6,618
Negra, Yassine	18	628	6,796
Thapa, Rohit Kumar	18	133	5,267

Production and Collaboration Between Countries

Regarding the output of the analysis results by country, as many as 74 countries contributed to publications in the field of applying plyometric training methods in training, both through individual authors and international collaborations between countries worldwide.

Table 6. **Top ten countries with the most publications**

Country	Number of Publications	Citations	Total Link Strength
United States of America	249	4,693	19,173
United Kingdom	199	5,104	23,780
Spain	184	5,705	23,139
Brazil	131	3,204	18,177
Australia	125	3,266	14,269
Chile	105	2,832	20,817
Germany	93	2,338	16,915
Canada	75	2,934	10,902
Tunisia	73	2,435	15,491
Italy	67	2,025	7,945

The results in Table 6 show that the United States ranked first with 249 publications, followed by the United Kingdom with 199 publications, and Spain with 184 publications. In terms of citation count, the three countries with the highest achievements were Spain, with 5,705 citations, the United Kingdom, with 5,104 citations, and the United States, with 4,693 citations.

Figure 8. **Collaboration between countries**

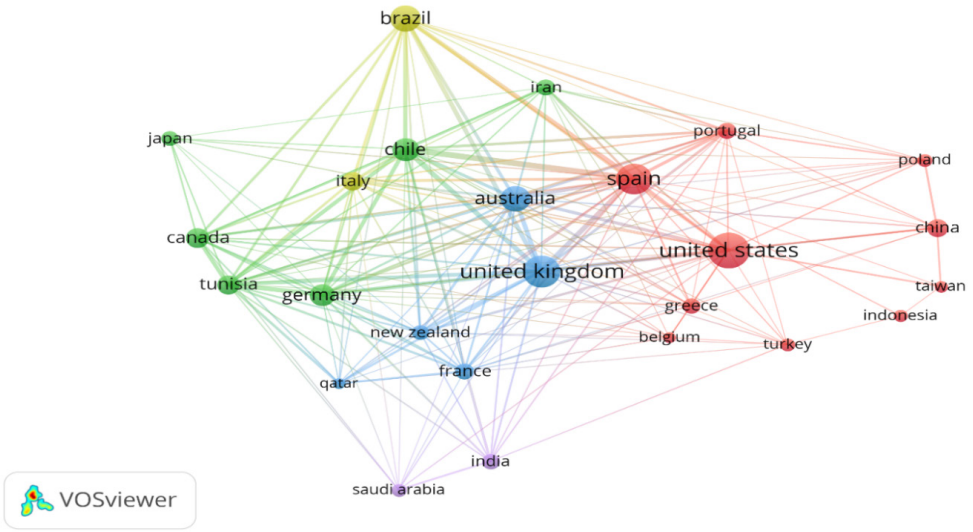


Figure 8 shows that, in terms of global collaboration, the United Kingdom occupies the highest and most dominant position, with a total link strength of 23,780, followed by Spain (23,139), Chile (20,817), and the United States (19,173).

Productive Institutions

Authors from 282 affiliated institutions have published research on the application of plyometric training methods. An analysis of publication productivity shows that several institutions dominate both in terms of the number of articles produced and the number of citations received.

Table 7. **Most productive institutions**

Institution	Country	Number of Publications	Citation
Universidad de Los Lagos, Osorno	Chile	62	2,342
University of Potsdam, Potsdam	Germany	43	1,470
Universidad Andrés Bello, Santiago	Chile	41	575
Auckland University of Technology, Auckland	New Zealand	40	1,154
Edith Cowan University, Perth	Australia	35	977
Universidad Pablo de Olavide, Seville	Spain	31	1,430
Université de La Manouba, Manouba	Tunisia	31	1,021
Universidade de São Paulo, São Paulo	Brazil	26	713
Universidad de La Frontera, Temuco	Chile	25	1,394
Universidad de Granada, Granada	Spain	24	473

The analysis results in Table 7 show that the three most productive institutions are Universidad de Los Lagos, Osorno (Chile), with 62 publications, followed by University of Potsdam, Potsdam (Germany), with 43 publications, and Universidad Andrés Bello, Santiago (Chile), with 41 publications. Meanwhile, when viewed from the number of citations as an indicator of academic influence, the three institutions with the highest achievements are Universidad de Los Lagos, Osorno (Chile), with 2,342 citations, University of Potsdam, Potsdam (Germany), with 1,470 citations, and Universidad de La Frontera, Temuco (Chile), with 1,394 citations.

Most Cited Articles

Continuing the analysis of the most cited documents globally, the results of Table 8 show that the article titled *"*Alternative countermovement-jump analysis to quantify acute neuromuscular fatigue", published in 2015 in the International Journal of Sports Physiology and Performance, obtained a total of 294 citations, with an average of 6.04 citations per year.

Table 8. **Global most cited articles**

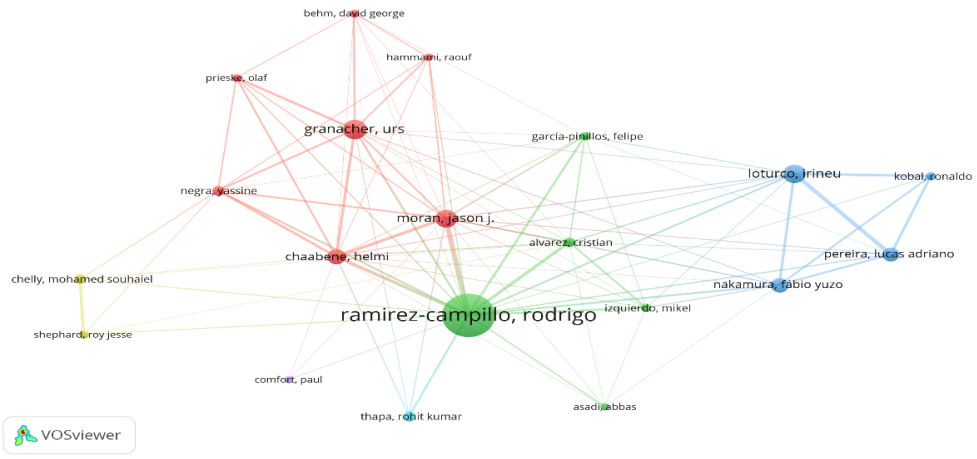
Author	Title	TC	TCY
(Gathercole et al., 2015)	Alternative countermovement-jump analysis to quantify acute neuromuscular fatigue	294	26.73
(Samozino et al., 2014)	Force-velocity profile: Imbalance determination and effect on lower limb ballistic performance	181	15.08
(Ramírez-Campillo et al., 2015b)	Effect of vertical, horizontal, and combined plyometric training on explosive, balance, and endurance performance of young soccer players	179	16.27
(Pareja-Blanco et al., 2014)	Effect of movement velocity during resistance training on neuromuscular performance	165	13.75
(Tous-Fajardo et al., 2016)	Enhancing change-of-direction speed in soccer players by functional inertial eccentric overload and vibration training	155	15.50
(Lloyd et al., 2016)	Changes in sprint and jump performances after traditional, plyometric, and combined resistance training in male youth pre- and post-peak height velocity	148	14.80
(Ramírez-Campillo et al., 2014)	Effects of in-season low-volume high-intensity plyometric training on explosive actions and endurance of young soccer players	142	11.83
(Ramírez-Campillo et al., 2015a)	Effect of unilateral, bilateral, and combined plyometric training on explosive and endurance performance of young soccer players	140	12.73
(McGrath et al., 2016)	The effect of limb dominance on lower limb functional performance – A systematic review	138	13.80
(Benjaminse et al., 2015)	Optimization of the anterior cruciate ligament injury prevention paradigm: Novel feedback techniques to enhance motor learning and reduce injury risk	138	12.55

Notes: TC: total citations; TCY: total citations per year.

Collaboration Network Among Authors

An analysis of the academic collaboration network among authors researching physical literacy in physical education produced a visualisation map to understand the dynamics of research collaboration (Li et al., 2022). This map is displayed in various colours, where each colour represents a collaboration group (Barabási et al., 2002; Ren et al., 2023). A point or node represents each author involved in a publication in the analysed dataset, and the size of the node indicates the extent of that author's influence in the collaboration network (Esmaeili Mahyari et al., 2025; Newman, 2011). The lines connecting the authors represent collaborative relationships, with the thickness of the lines indicating the strength of the collaboration (Froehlich, 2022; van Eck & Waltman, 2010).

Figure 9. **Collaboration network among authors**



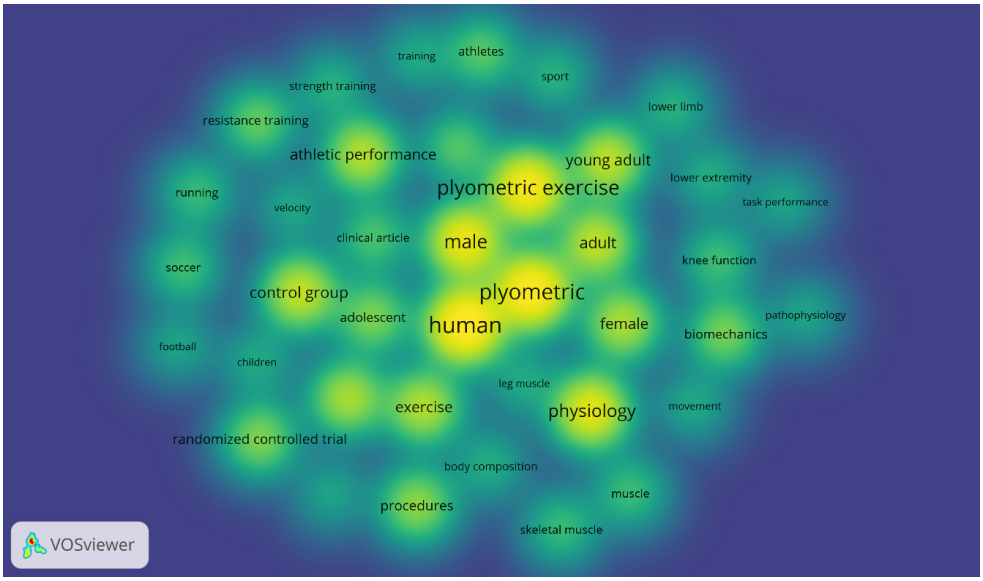
After analysing the author collaboration patterns, a total of 4,631 authors were identified, with a distribution ranging from one to seven authors per document. Figure 9 shows the distribution and collaboration between authors, with a total of 20 authors collaborating on two or more studies. The most dominant collaboration network is the red network, consisting of eight authors. Among them, author Rodrigo Ramirez-Campillo occupies the most prominent position, with an extensive network of connections with other authors.

Authors' Keyword Analysis

Keyword analysis in this study utilised VOSviewer software to map trends and the relationships between research topics related to the application of plyometric training methods. The data results were processed using VOSviewer software to produce a visual map in the form of a *co-occurrence map*. At this stage, the most frequently appearing keywords will be displayed in a larger font size, while the colour intensity, ranging from green to yellow, describes the level of frequency of occurrence (Robot, 2024; Zhang & Chen, 2025). Of the total 4,333 keywords identified, 50 keywords with the highest frequency were selected for further analysis.

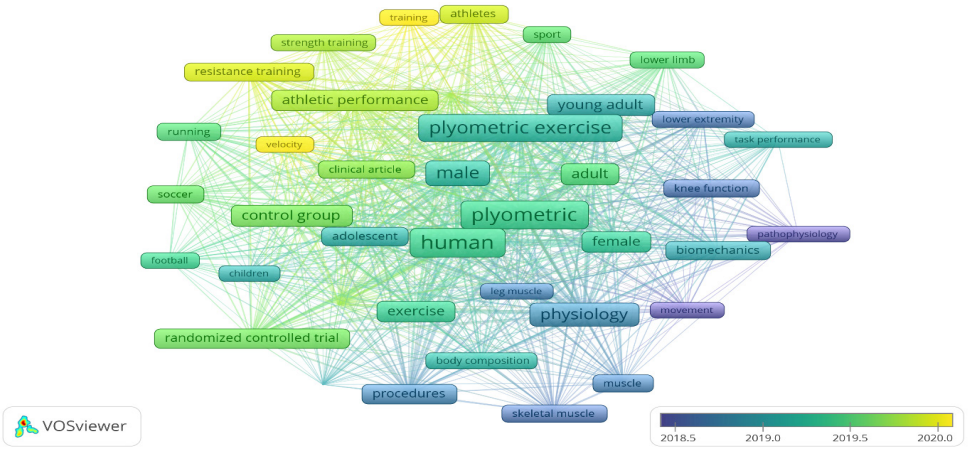
The results of the analysis show that there are 4,333 keywords in this study. It was found that of the 50 keywords most used by authors with colour, five keywords stand out because of their relevance and frequency of appearance, namely 'Human' (n = 1,068), 'Plyometric' (n = 997), 'Plyometric exercise' (n = 885), 'Male' (n = 783), 'Physiology' (n = 720), and the least frequent keywords are 'Basketball' (n = 81), 'Height' (n = 82), 'Power' (n = 83), 'Hip joint' (n = 86), and 'Ankle' (n = 90) (Figure 10).

Figure 10. **Visualisation of keyword occurrence frequency**



The results of the authors' keyword analysis by average year of publication show that the most recent keywords in yellow are 'Velocity', 'Training', and 'Resistance training'. Meanwhile, the oldest keywords in purple are 'Pathophysiology' and 'Movement', as shown in Figure 11.

Figure 11. **Authors' keywords by average year of publication**



4. DISCUSSION

This study aimed to analyse the trend in the use of plyometric training methods in training over the past decade by examining the most frequently discussed research topics and the primary collaboration networks between authors and institutions. Based on bibliometric data obtained from the Scopus database, it was found that publications related to this topic have experienced significant growth, especially in the last decade. The results of the analysis show that the number of publications related to the application of plyometric training methods has experienced a quite significant growth since 2014. At the beginning of the analysis period, 69 publications were recorded, which then continued to increase steadily to reach 143 publications by 2020. Although there were fluctuations, with a decrease in the number of publications in 2021 (131) and 2022 (108), the general trend remains positive. Peak productivity was achieved in 2024, with 210 publications, nearly double the annual average in the previous period.

This increasing trend in publications can be attributed to several factors. First, plyometrics is increasingly being used as an effective training method to improve explosive strength, power, and functional performance in various sports, both individual and team (Lerche et al., 2024; Ojeda-Aravena et al., 2023; Yu et al., 2025). Plyometric training is a form of exercise that utilises muscle movements that stretch and then immediately contract to increase the body's ability to produce power more effectively (Cardiel-Sánchez et al., 2024; van Roie et al., 2020). Simply put, plyometrics is a type of training that allows muscles to reach their maximum strength in the shortest amount of time. This speed-strength ability is known as power (Chu & Myer, 2013; Salama et al., 2024).

The application of plyometric training methods can produce maximum muscle contractions in a short time by involving movements that are beneficial for training nerve cells and strengthening tissue in response to stimuli through muscle contractions in specific patterns (Parish, 2022). Plyometric training often involves jumping, leaping, and landing movements, which require the muscles to work harder and faster than regular training (Duchateau & Amiridis, 2023). Plyometric training can provide benefits by strengthening the connection between muscles and the nervous system, which is crucial for improving quick reactions and body coordination in situations that require sudden changes in direction or bursts of force (Chen et al., 2023; Islam et al., 2025c). Furthermore, plyometrics is also helpful in increasing muscle endurance and strengthening connective tissues, such as tendons and ligaments (Prianto et al., 2024). Second, advancements in biomechanical measurement technology and wearable devices enable researchers to evaluate the effects of plyometric training more accurately, thereby encouraging the emergence of new experimental studies (Mañas-Paris et al., 2022).

The rapid growth of publications on this research topic is also driven by increasing research

collaboration between countries. The study results show that the United States is the country with the most publications (249). However, in terms of scientific impact, as measured by the number of citations, Spain actually recorded the highest achievement with 5,705 citations. Meanwhile, the United Kingdom holds the most dominant position in the country's collaborative network, demonstrating its role as a key link between researchers from various countries.

Furthermore, an analysis of the most influential journals on the topic of applying plyometric training methods to exercise revealed a concentration of publications in a few core journals, consistent with Bradford's Law, which states that most articles in a field of knowledge are concentrated in a few primary publication channels. The Journal of Strength and Conditioning Research emerged as the most dominant publication source. This not only reflects the high level of research interest in the topic but also demonstrates that this journal has a scope specifically relevant to the study of physiology-based training methods and physical performance (Furuhashi et al., 2022; Kadlubowski et al., 2025; Romero et al., 2021).

Furthermore, the results of the *co-citation network analysis* indicate the existence of thematic specialisation in studies on the use of plyometric methods in training. Key authors serve as the central nodes connecting various related research fields. Authors such as Ramirez-Campillo, Loturco, Alvarez, Granacher, and Nakamura occupy central positions in the network, reflecting their influence in shaping the direction of research development in this field. The frequency of *co-citations* among these authors suggests that their contributions form an epistemological foundation that fosters conceptual cohesion within this research topic. The interconnectedness of the authors within the network also indicates the formation of a systematic, international collaborative structure.

Furthermore, the institutional analysis revealed that 1,658 institutions were affiliated with publications related to the application of plyometric training methods. Productivity analysis revealed that Universidad de Los Lagos, Osorno (Chile), was the most productive institution with a total of 62 publications. In terms of citation count, an indicator of academic influence, this institution also ranked the highest, with 2,342 citations.

The results of the analysis on *the most cited articles aspect* show that the most cited article globally was written by Gathercole et al. (2015), titled *"Alternative countermovement-jump analysis to quantify acute neuromuscular fatigue"*. This article was published in the *International Journal of Sports Physiology and Performance* and successfully obtained a total of 294 citations, with an average of 26.73 citations per year. In addition, the results of the analysis show that 4,631 authors have contributed to publications related to the application of plyometric training methods. Based on the *H-Index measure* as an indicator of academic productivity and influence, Ramirez-Campillo Rodrigo stands out as the most influential author with an *H-Index value* of 30. Additionally, in terms of productivity, Ramirez-Campillo has the most significant number of publications, specifically 85.

Furthermore, keyword analysis using VOSviewer revealed 4,333 keywords used by authors in all publications related to plyometric training, with the 50 keywords of highest frequency being further analysed. From this list, the five most dominant keywords were *'Human'* (n = 1,068), *'Plyometric'* (n = 997), *'Plyometric exercise'* (n = 885), *'Male'* (n = 783), and *'Physiology'* (n = 720). The dominance of keywords such as 'Human' and 'Physiology' confirms that studies in this field tend to be directed at understanding biological responses, neuromuscular adaptations, and biomechanical mechanisms in response to plyometric training stimuli. This is in line with research conducted by Mănescu (2025), which identified that the development of research topics on plyometric training is still dominated by physiological and biomechanical approaches aimed at improving athlete performance. These results are also consistent with a review conducted by Barrio et al. (2023), which emphasised that plyometric training is generally studied in relation to muscle adaptation, increased explosive strength, and neuromuscular system efficiency.

Meanwhile, the high frequency of the keyword 'Male' indicates an imbalance in gender representation in sports research, with male subjects being used more frequently than female subjects. The findings of this study align with those of Ramirez-Campillo et al. (2020), who highlighted that most plyometric training methods remain focused on male athletes, while studies on female athletes are still limited. This study also corroborates the findings of Lu and Duan (2024), who reported that men experienced significantly greater improvements than women in maximal strength, medicine ball throws, peak and average power output, and reaction time after upper-body plyometric training, highlighting the importance of considering gender

in training outcomes. This is partly due to physiological, hormonal, and baseline performance differences between male and female groups, which are thought to influence research results (Herring et al., 2021).

In contrast, the emergence of low-frequency keywords such as *'Basketball'* (n = 81), *'Height'* (n = 82), *'Power'* (n = 83), *'Hip joint'* (n = 86), and *'Ankle'* (n = 90) suggest a gap in research, particularly regarding the application of plyometric training in specific sports, anthropometric parameters, and biomechanical analysis of the primary joints involved in explosive movements. These findings align with research conducted by Yang (2025), which demonstrated that plyometric training significantly enhanced the ability to change direction in adolescent basketball players. This suggests that its application should be further explored due to its superior effectiveness compared to resistance training in improving player performance.

Furthermore, the low occurrence of the keywords 'Height' and 'Power' suggests that research highlighting the relationship between anthropometric characteristics, such as height and explosive power, remains rare (Mohamed Althuwaini, 2025). Anthropometric variables, such as body mass, height, and strength, are crucial in studying plyometric training, as they influence performance outcomes, including jump height and ground reaction force, which in turn affect training intensity and progression within training programmes. These results align with the opinion of D'Isanto et al. (2018), who stated that although a significant relationship exists between anthropometric characteristics and explosive power in individuals, research specifically addressing this relationship remains limited. Therefore, further studies are needed to more thoroughly explore the relationship between anthropometric variables and explosive performance, particularly in the context of plyometric training applications. Interestingly, the keyword 'Power' is also relatively rarely used, despite the primary essence of plyometric training being the development of muscular explosive power. This is due to researchers' preference for using other technical terms, such as jump performance or explosiveness (Santa et al., 2025).

Sugisaki et al. (2013) also highlighted that biomechanical components, such as the hip joint and ankle, play a crucial role in generating explosive force during the propulsion phase. Research conducted by Arias-Vázquez et al. (2024) revealed that the biomechanical role of the hip and ankle joints in plyometric training remains relatively underexplored. Based on the analysis results, it can be concluded that the emergence of low-frequency keywords such as 'Basketball', 'Height', 'Power', 'Hip joint', and 'Ankle' indicates that research on plyometric training is still uneven in various important aspects, including sports, anthropometric characteristics, and biomechanical analysis. This finding confirms the existence of a research gap that needs further exploration.

The analysis of *the authors' keywords by average year of publication* shows a shift in research focus over time. Based on the data visualisation, keywords in yellow, such as *'Velocity', 'Training', and 'Resistance training'*, have a more recent average publication year, indicating that these topics are current research trends. This phenomenon indicates that in recent years, researchers' attention has increasingly focused on velocity-based training (VBT) approaches and the combination of resistance training and plyometric training. Velocity-based training is a training approach that controls intensity based on the speed of muscle movement, rather than solely relying on load or the number of repetitions (Guppy et al., 2024; Hess et al., 2023). In plyometric training, VBT can be integrated to monitor and optimise explosive power output, as both VBT and plyometrics focus on force production in a short period of time (Włodarczyk et al., 2021). Research conducted by Weakley et al. (2021) confirmed that velocity-based training enables more accurate monitoring of training intensity compared to traditional methods based on the percentage of maximum load. This enables trainers to adjust training volume and intensity in *real-time* to maximise muscle strength and explosive power (Pareja-Blanco & Loturco, 2022). Furthermore, research by Baena-Marín et al. (2022) found that resistance training with a high-speed approach contributed significantly to improvements in sprint and vertical jump performance in elite athletes.

The link between the keyword trends of *velocity-based training* and *resistance training*, as well as the application of plyometric training, has become increasingly apparent in recent research. Plyometric training emphasises the development of explosive muscle power through the stretch-shortening cycle, which is strongly influenced by the speed of muscle contraction and the efficiency of energy transfer. According to León Muñoz et al. (2024), integrating plyometric methods with resistance training or *velocity-based training* can result in greater performance improvements, as the combination optimises both maximum strength and muscle contraction

speed. Thus, the emerging trend of new keywords such as '*Velocity'* and '*Resistance training'* reflects the direction of more modern plyometric exercise research, where the focus is no longer solely on increasing explosive power, but also on how velocity, load, and biomechanical characteristics can be manipulated to achieve optimal results.

This study has several limitations that need to be considered. One of these lies in the limited database used. This study utilised a single database, Scopus, without incorporating other databases, such as Google Scholar and Web of Science (WoS). This limitation can introduce bias in the analysis and evaluation of results, especially when comparing different fields, such as institutions or countries (Echchakoui, 2020; Mongeon & Paul-Hus, 2016). In fact, a recent 2024 article examined a similar topic using only the Web of Science, demonstrating a different yet potentially complementary approach in terms of publication coverage, journals, and relevant authors. The choice of a single database may also influence the results, particularly in terms of the number of citations and the scope of the research mapping involved.

5. CONCLUSIONS

Overall, this bibliometric study reveals a significant increase in publications on the application of plyometric training methods in exercise. The analysis indicates that the United States has emerged as the most influential country in the development of this research, both in terms of publication productivity and academic influence. In terms of global collaboration, the United Kingdom occupies a central position as a key link between countries in international research networks. At the institutional level, Universidad de Los Lagos, Osorno (Chile) has become one of the leading centres contributing to the dissemination of knowledge on plyometrics. Meanwhile, Ramirez-Campillo Rodrigo has emerged as the most prominent researcher in terms of both productivity and scientific impact. He can therefore be considered a central figure in the global development of plyometric research. However, research gaps remain in certain aspects, such as the involvement of female participants, the application to specific sports like basketball, and the study of joint biomechanics, including *the hip* and *ankle*. Therefore, future research needs to be more inclusive and contextualised so that the use of plyometric training methods can be optimised precisely to meet the needs of modern sports performance.

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