

Review. Global evolution of research on plyometric training for improving lower-limb muscle strength and power: a systematic review and bibliometric. Vol. 12, n. ° 4; p. 1-34, August 2026.

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Global evolution of research on plyometric training for improving lower-limb muscle strength and power: a systematic review and bibliometric

Evolución global de la investigación sobre el entrenamiento pliométrico en la mejora de la fuerza y la potencia muscular de las extremidades inferiores: revisión sistemática y análisis bibliométrico

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Abstract

This paper describes the global development of literature about plyometric exercise with the purpose of improving the strength and explosive force of the lower limbs. A combined systematic review with bibliometric analysis was carried out in the literature of Scopus, PubMed, and ScienceDirect databases for the period of 2001-2025. The PRISMA-2020 protocol guided the systematic review procedure. A total of 14 experimental and quasi-experimental studies were selected for the systematic review, together with 784 articles analyzed in the bibliometric analysis with VOS_viewer. The outcome of the analysis showed an increased rate of published literature after the year 2017, particularly among authors from Europe and authors from Oceania, with an emphasis changing from mechanism-oriented studies towards performance-related studies. With the literature analysis of improvements in force, speed, and functionality of the lower limbs of varying ages and sports situations, it can accordingly be concluded that the literature about plyometric exercise has indeed developed extensively around the globe with explicit efficiency while emphasizing new studies about optimal dosages.

Keywords: plyometric training; muscle strength; muscle power; athlete performance; bibliometric analysis.

Resumen

Este artículo describe el desarrollo global de la literatura sobre el ejercicio pliométrico con el propósito de mejorar la fuerza y la fuerza explosiva de las extremidades inferiores. Se realizó una revisión sistemática combinada con análisis bibliométrico en la literatura de las bases de datos Scopus, PubMed y ScienceDirect para el periodo 2001-2025. El protocolo PRISMA-2020 guió el procedimiento de revisión sistemática. Se seleccionaron un total de 14 estudios experimentales y cuasi-experimentales para la revisión sistemática, junto con 784 artículos analizados en el análisis bibliométrico con VOS_viewer. El resultado del análisis mostró un aumento en la tasa de literatura publicada después del año 2017, especialmente entre autores europeos y autores de Oceanía, con un cambio de énfasis de estudios orientados a mecanismos a estudios relacionados con el rendimiento. Con el análisis literario sobre mejoras en la fuerza, velocidad y funcionalidad de las

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extremidades inferiores de distintas edades y situaciones deportivas, se puede concluir que la literatura sobre el ejercicio pliométrico se ha desarrollado extensamente en todo el mundo con una eficiencia explícita, al tiempo que enfatiza nuevos estudios sobre dosis óptimas.

Palabras clave: entrenamiento pliométrico; fuerza muscular; potencia muscular; rendimiento del deportista; análisis bibliométrico.

Introduction

Lower-limbs muscle strength has long been recognized as a fundamental factor for physical performance, movement proficiency, and injury prevention in sports. In an educational or developmental context, having sufficient strength in the lower limbs is remarkably linked to mastering movement proficiency, locomotor skill, or physical literacy, which represent critical aims for a physical education program (Bel et al., 2021). Regarding physical performance, lower-limbs muscle strength represents a foundation for explosive movements such as sprinting, jumping, or shifting direction, which can be applied in many sports.

Among strength-oriented training methods, plyometric exercise has gained significant recognition as a strategy that elicits further muscular strength and power improvements utilizing the stretch-shortening cycle, SSC, made by the rapid eccentric-concentric muscle action (Markovic & Mikulic, 2010). Systematic reviews and meta-analyses in Europe, Asia, and Oceania provide evidence that plyometric training induces lower-limb strength, jumping performance, neuromuscular efficiency, moderate, and large improvements among youth and adults (Kubo et al., 2021); (Ramírez-delaCruz et al., 2022). In Asian cohorts, Iranian and East Asian groups have established plyometric training in improving explosive strength and reactive abilities when incorporated into school-based physical education programs and sport-specific training environments (Asadi et al., 2016; Yuan et al., 2025).

Apart from the use of plyometric exercise in the enhancement of athletic performance, studies conducted in the African and Mediterranean region have also emphasized the importance of plyometric training in the field of education. Studies

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conducted among young athletes in North Africa, for instance, have established the effectiveness of plyometric exercise programs conducted during training or physical education classes in enhancing muscular strength, acceleration, and jumping capacity among the athletes while exposing the athletes to low injury risk (Chelly et al., 2015; Martinez et al., 2018).

A considerable number of plyometric exercise protocols, including squat jumps, box jumps, tuck jumps, and horizontal bounding exercises, have been established to target different Force Velocity combinations and exercise patterns. This variation enables professionals and pedagogues to differentiate plyometric training based on age, maturity, and skill levels, thus optimizing SSC exercise performance in a pedagogically justifiable manner (Davies & Riemann, 2019). Short term to medium-term training interventions (6- to 10-week duration) with moderate training volumes have systematically revealed considerable improvements in maximal strength and explosive strength performance, especially in beginners and youth, who show a stronger potential for adaptation and improvement (Grgic, 2022; Matuszczyk et al., 2025a)

In spite of the many empirical studies that have supported the effectiveness of plyometric training, a high degree of heterogeneity exists in the literature with respect to intervention and the type of participants, thus creating the complexity in the formulation of general guidelines on the optimal dose of plyometric training (Sun et al., 2025). In addition, in spite of the popularity and the many studies on the topic of plyometric training, there have been few studies that have mapped the global development of the literature on the topic, in terms of the trend of publications, geographical distribution, and global cooperation networks (Hafiar et al., 2024).

In this respect, the use of bibliometric analysis has proved to be a useful methodological tool to effectively analyze the development of knowledge in the sciences, the role of prolific authors, institutions, and countries, as well as the most prominent and emerging themes of inquiry (Alkasasbeh, 2023). In this respect, the use of bibliometric analysis and the methodology associated with the systematic review would allow the authors of the present paper to effectively synthesize global research findings, while at

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the same time providing a useful perspective within the global research environment (Ma & Ismail, 2025).

This paper, therefore, proposes the undertaking of a systematic review and bibliometric analysis concerning global research on plyometric training and the strength of the muscles within the lower limbs, which is especially pertinent within the context of enhancing the performance level of the individual, as well as the application within the realm of sports science.

Method

Study Design

This study was designed as a systematic review combined with a bibliometric analysis to investigate the global development of research on plyometric exercise related to improvements in lower-limb muscle strength and power. The systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines.

Data Sources and Search Strategy

The literature search was conducted in October 2025 using three electronic databases: Scopus, PubMed, and ScienceDirect. Articles published between 2001 and 2025 were identified using the following search strategy: (“plyometric training” OR “plyometric exercise” OR “stretch–shortening cycle”) AND (“muscular strength” OR “explosive power” OR “power”) AND (“performance” OR “athlete” OR “sport”). Only peer-reviewed journal articles published in English were considered.

Eligibility Criteria

Studies were eligible for inclusion if they met the following criteria: (1) experimental or quasi-experimental study design; (2) conducted in human participants; (3) implementation of plyometric exercise as the primary intervention; and (4) reported outcomes related to muscle strength, muscle power, or physical performance. Studies were excluded if they did not involve plyometric exercise interventions, were conducted in non-human subjects, or were published as conference proceedings, editorials, or other non-peer-reviewed documents.

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Study Selection Process

The study selection process followed the PRISMA framework. After the removal of duplicate records, titles and abstracts were screened to assess relevance. Subsequently, full-text articles were evaluated for eligibility based on the predefined inclusion and exclusion criteria. Of the 2,804 records initially identified, 14 studies met the eligibility criteria and were included in the systematic review.

Data Extraction

Data extraction was conducted independently using a standardized data extraction form. Extracted information included study characteristics, participant demographics, plyometric training protocols, outcome measures, and key findings. Any discrepancies in data extraction were resolved through discussion and consensus among the authors.

Bibliometric Analysis

The bibliometric analysis examined publication trends, journals, authors, institutions, countries, citation indicators, keyword co-occurrence, and collaboration networks related to plyometric exercise research. Bibliographic data were exported from the selected databases and analyzed using VOSviewer (version 2023). A full counting method and predefined threshold values were applied to optimize the visualization of bibliometric networks.

Quality Assessment

The methodological quality and risk of bias of the included studies were assessed using appropriate criteria for experimental and quasi-experimental research designs. The results of the quality assessment were considered when interpreting the findings of the systematic review.

Results

Figure 1 presents the PRISMA flow diagram illustrating the study selection process. A total of 2,804 records were identified through database searching in Scopus, PubMed, and ScienceDirect for publications between 2001 and 2025. After the removal of duplicates and records excluded based on predefined criteria, 2,065 records were screened by title and abstract. Subsequently, 406 full-text articles were sought for

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retrieval, of which 50 articles were assessed for eligibility. Finally, 14 studies met the inclusion criteria and were included in the systematic review and bibliometric analysis.

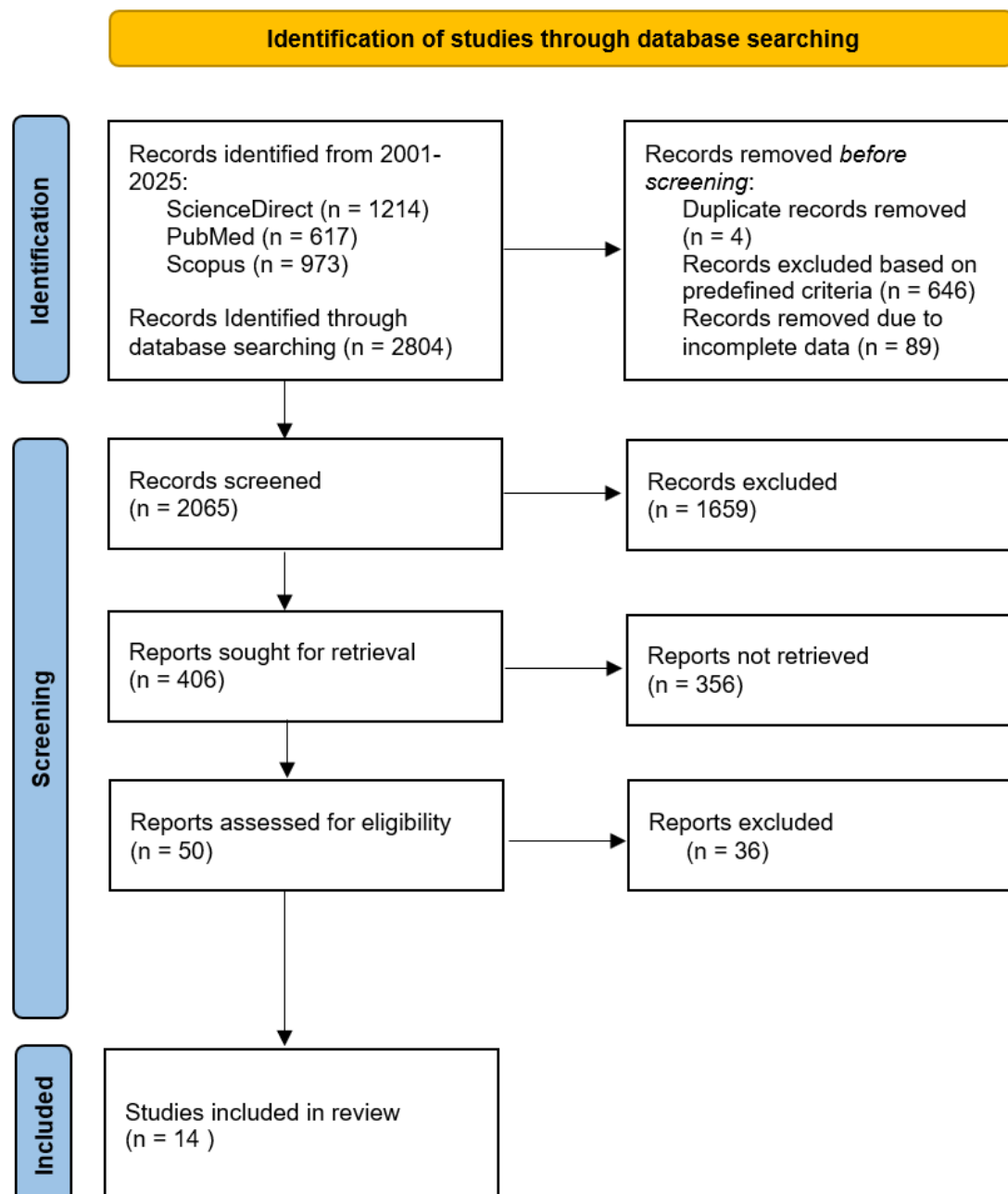


Figure 1. PRISMA flow diagram of the study selection process.

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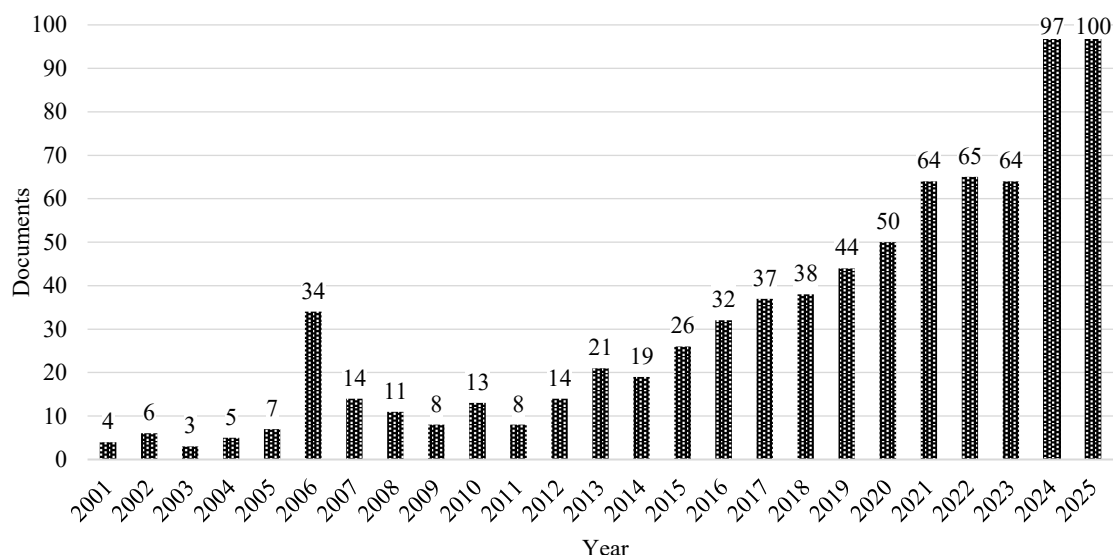


Figure 2. Annual growth of publications on plyometric exercise research (2001–2025)

Figure 2 illustrates the annual growth of global publications on plyometric exercise research focusing on lower-limb muscle strength and power from 2001 to 2025. Based on the bibliometric dataset, publication output remained relatively low during the initial period from 2001 to 2005. This was followed by a phase of gradual and more stable growth between 2007 and 2015. A noticeable increase in publication volume was observed from 2016 onwards, reaching the highest levels during the final years of the study period.

Table 1. Leading Journals in Plyometric Training Research

Journal	Doc	Cited	Citations	Citescore	h-index	P.Y Start
Journal of Strength and Conditioning Research	165	161	10.353	55.1	62	2001
International Journal of Sports Physiology and Performance	51	47	1.767	69.4	25	2013
Journal of Sports Sciences	40	38	1.433	55.5	22	2003
Journal of Sports Medicine and Physical Fitness	28	27	719	26.5	14	2001
Frontiers in Physiology	26	21	439	64.8	12	2017

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The five journals with the highest number of publications in plyometric exercise research were led by the Journal of Strength and Conditioning Research, reporting the highest number of articles (165), followed by the International Journal of Sports Physiology and Performance (51 articles), the Journal of Sports Sciences (40 articles), the Journal of Sports Medicine and Physical Fitness (28 articles), and Frontiers in Physiology (26 articles). In addition to the number of publications, Table 1 also displays the number of cited documents, total citations, CiteScore, h-index, and year of publication for each journal.

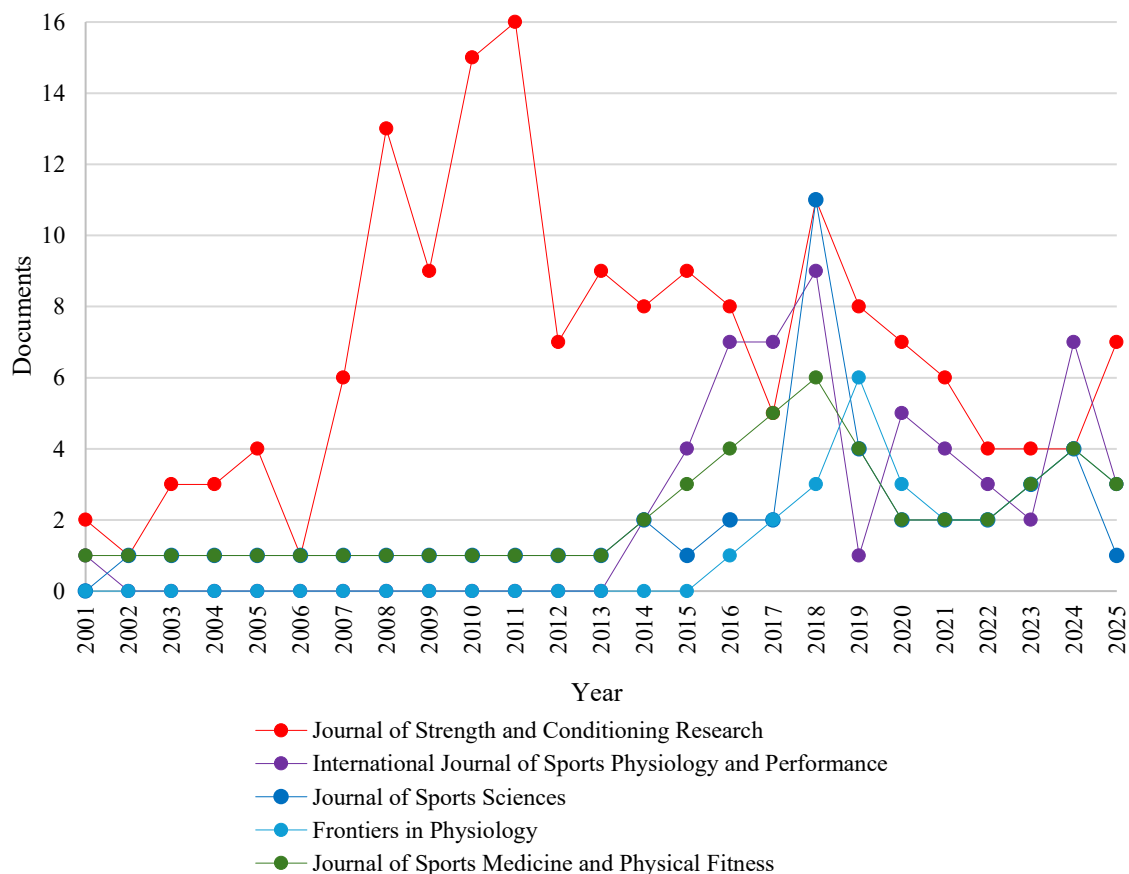


Figure 3. Temporal Evolution of Publications in 5 Major Journals

Figure 3 shows the temporal trends in plyometric exercise research publications across five major journals from 2001 to 2025. The journal Strength and Conditioning Research exhibited publication activity throughout the study period, with a higher annual

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publication count observed between 2007 and 2012. From 2014 onward, the International Journal of Sports Physiology and Performance and Frontiers in Physiology showed an increase in publication output, with the highest number of publications for both journals occurring in 2019. The Journal of Sports Sciences and the Journal of Sports Medicine and Physical Fitness showed a lower but consistent annual publication frequency, particularly between 2017 and 2020. Figure 3 illustrates the differences in publication timing and annual output among the five journals over the analyzed period.

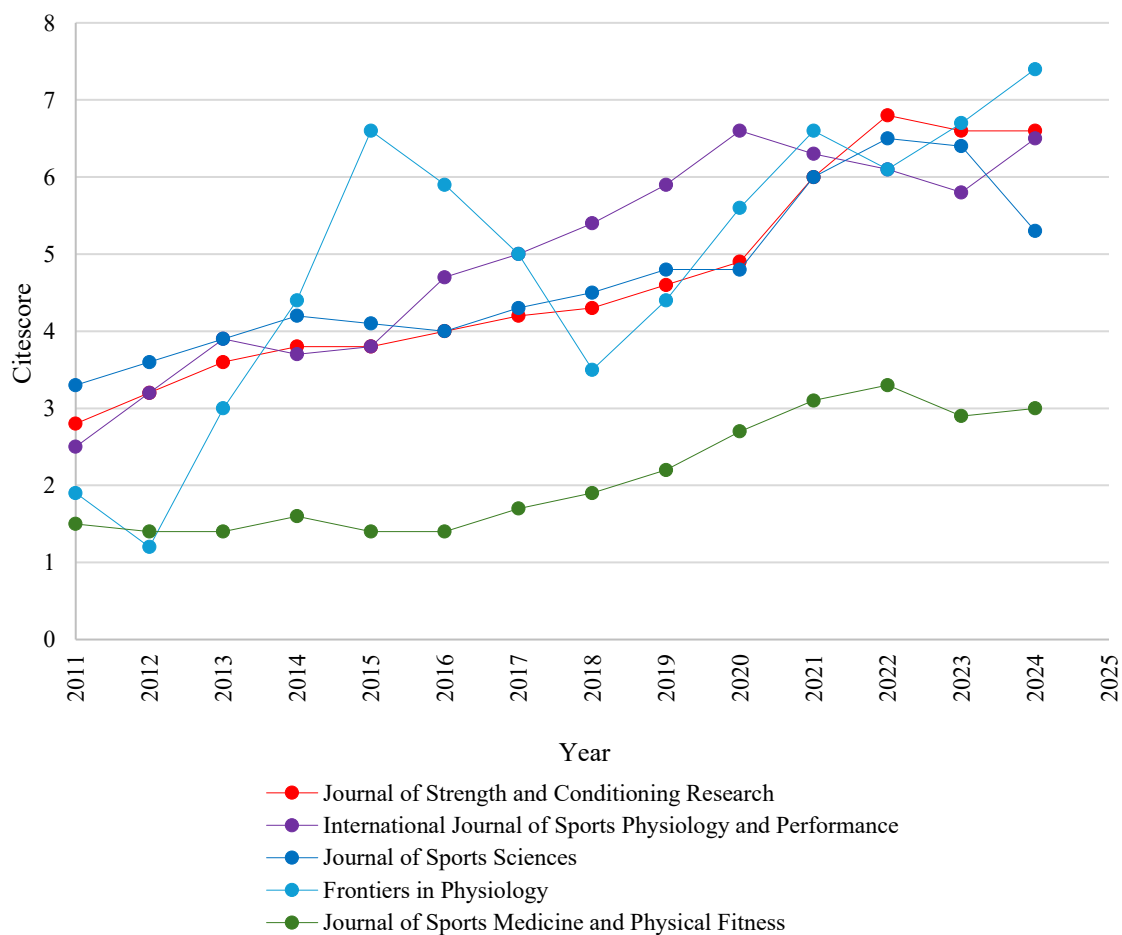


Figure 4. Temporal Changes in CiteScore from the Top 5 Journals

Figure 4 illustrates the temporal changes in CiteScore values for the five most productive journals in plyometric exercise research from 2011 to 2024. The CiteScore values for these five journals show year-to-year variation over the analyzed period. The

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Journal of Strength and Conditioning Research, the International Journal of Sports Physiology and Performance, and the Journal of Sports Sciences show a general increase in CiteScore values from 2011 onward, with higher values observed during the later years of the period. Frontiers in Physiology also shows fluctuations with an overall upward trend, while the Journal of Sports Medicine and Physical Fitness shows a lower CiteScore value with gradual changes from year to year. This visualization presents the differences in CiteScore trajectories among these five journals over time.

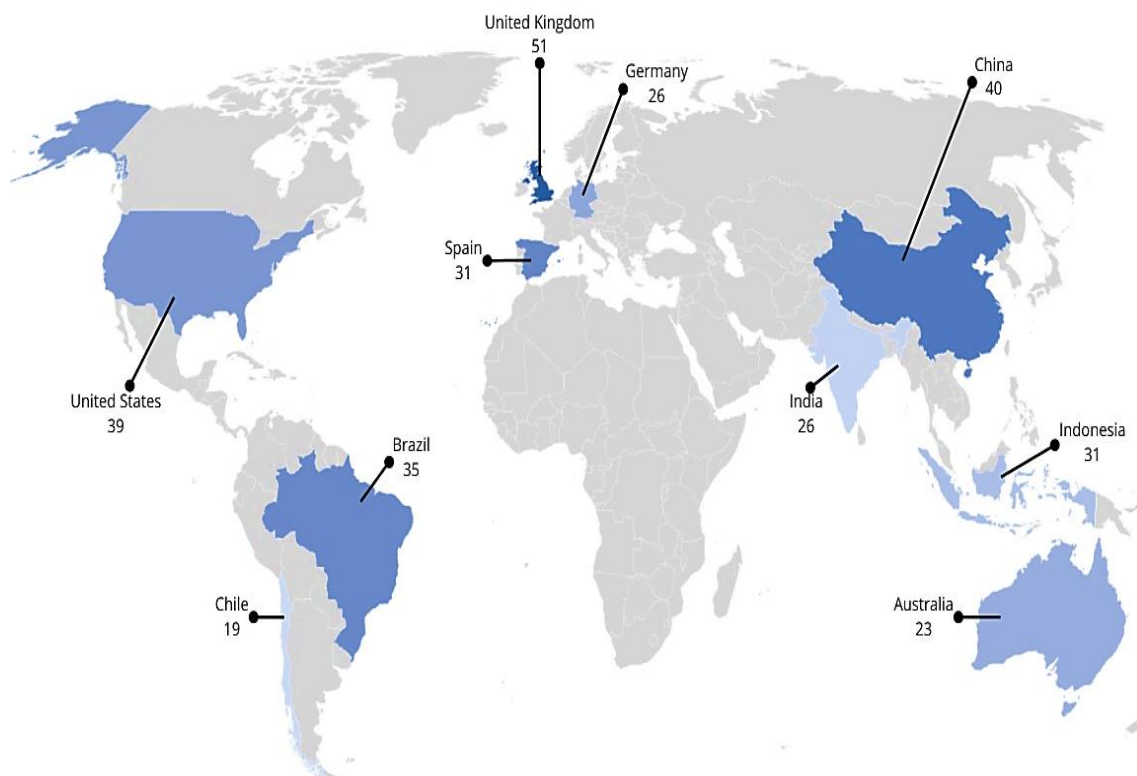


Figure 5. Global Distribution of Research by Country

Figure 5 presents the global distribution of publications on plyometric exercise research by country. The figure shows that publications are contributed by multiple countries across different regions worldwide. Countries such as the United Kingdom, China, the United States, and Spain display higher numbers of publications, while additional contributions are observed from countries in Asia, South America, and



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Oceania. The distribution illustrates the geographical spread of research output related to plyometric exercise as depicted in the figure.

Table 2. Subject Area Analysis of Plyometric Exercise Research

Subject Area	Doc	Cited	Citations	h-index	P.Y Start
Medicine	246	199	4280	35	2001
Health Professions	230	195	4020	34	2001
Biochemistry, Genetics, and Molecular Biology	60	49	724	15	2001
Social Sciences	55	41	233	9	2006
Multidisciplinary	29	21	373	10	2014
Engineering	16	8	56	4	2015
Computer Science	15	10	55	4	2015
Business, Management, and Accounting	13	12	52	4	2019
Physics and Astronomy	12	7	41	3	2021
Chemical Engineering	12	5	37	3	2015

Table 2 presents the distribution of subject areas in plyometric exercise research. The *Medicine* subject area records the highest number of publications, with 246 documents, 4,280 citations, and an h-index of 35, followed by *Health Professions* with 230 documents, 4,020 citations, and an h-index of 34. Both subject areas show publication activity starting from 2001. The *Biochemistry, Genetics, and Molecular Biology* subject area includes 60 documents with a total of 724 citations. In addition, *Social Sciences* contributes 55 documents, while the *Multidisciplinary* category records 29 documents with a total of 373 citations. Technological subject areas show lower publication counts, including *Engineering* (16 documents), *Computer Science* (15 documents), and *Chemical Engineering* (12 documents). The *Physics and Astronomy* subject area records 12 documents, with publications beginning in 2021. The distribution illustrates the variation in research contributions across subject areas.

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Table 3. Studies Performance Indicators: 10 Most Productive Authors

Author	Docs	Cited	Citations	h-index	P.Y Start
Ramírez-Campillo, R.	24	21	503	14	2017
Loturco, I.	23	21	778	15	2015
Granacher, U.	20	20	777	16	2016
Pereira, L.A.	16	15	504	12	2015
Moran, J.	13	13	324	10	2019
Kobal, R.	12	12	535	12	2015
Chelly, M.S.	12	12	724	11	2010
Chaabene, H.	12	12	313	11	2017
Newton, R.U.	10	10	1.298	9	2002
Negra, Y.	10	10	265	9	2017

Based on the bibliometric indicators presented in Table 3, several authors demonstrated a higher publication frequency in plyometric exercise research related to lower limb muscle strength and power during the period 2001–2025. Ramírez-Campillo recorded the highest number of publications (24 documents), followed by Loturco (23 documents) and Granacher (20 documents). These authors also demonstrated higher citation counts and h-index values compared to the other contributors listed in the table. Other authors, including Pereira, Moran, Kobal, Chelly, and Chaabene, contributed between 12 and 16 documents, with varying citation counts and h-index values. Newton and Negra each contributed 10 documents and also demonstrated significant citation metrics. This demonstrates variability in publication volume, citation count, and h-index values among authors contributing to this research area.



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Table 4. Studies Performance of the 10 Most Productive institutions

Affiliation	Doc	Cited	Citations	h-index	P.Y Start
Edith Cowan University	32	30	1.597	16	2006
Auckland University of Technology	30	29	2.183	17	2005
Institut Supérieur du Sport et de l'Éducation Physique de Ksar-Saïd	25	24	1.059	19	2010
Université de la Manouba	23	22	793	17	2012
Universidad de Los Lagos	20	18	607	13	2015
Universität Potsdam	20	20	777	16	2016
Aristotle University of Thessaloniki	17	16	794	10	2003
Universidade de São Paulo	16	14	383	9	2011
Cardiff Metropolitan University	16	13	442	9	2006
Universidad Andrés Bello	15	11	99	6	2021

Citation-based performance indicators and the initial year of publication activity indicate that some institutions exhibit substantial citation impact and h-index values that are not fully proportional to publication volume. Auckland University of Technology recorded the highest total number of citations (2,183) and a high h-index (17), while the Institut Supérieur du Sport et de l'Éducation Physique de Ksar-Saïd showed the highest h-index value (19), reflecting consistent citation performance over time. Institutions such as Aristotle University of Thessaloniki and the University of Potsdam also exhibit comparable citation impact despite differences in their total number of papers. Furthermore, the reported initial year of publication activity indicates variability in the temporal development of institutional contributions, with some institutions engaging in plyometric exercise research earlier and others entering the field more recently. These indicators offer complementary insights into institutional research performance beyond publication volume alone.

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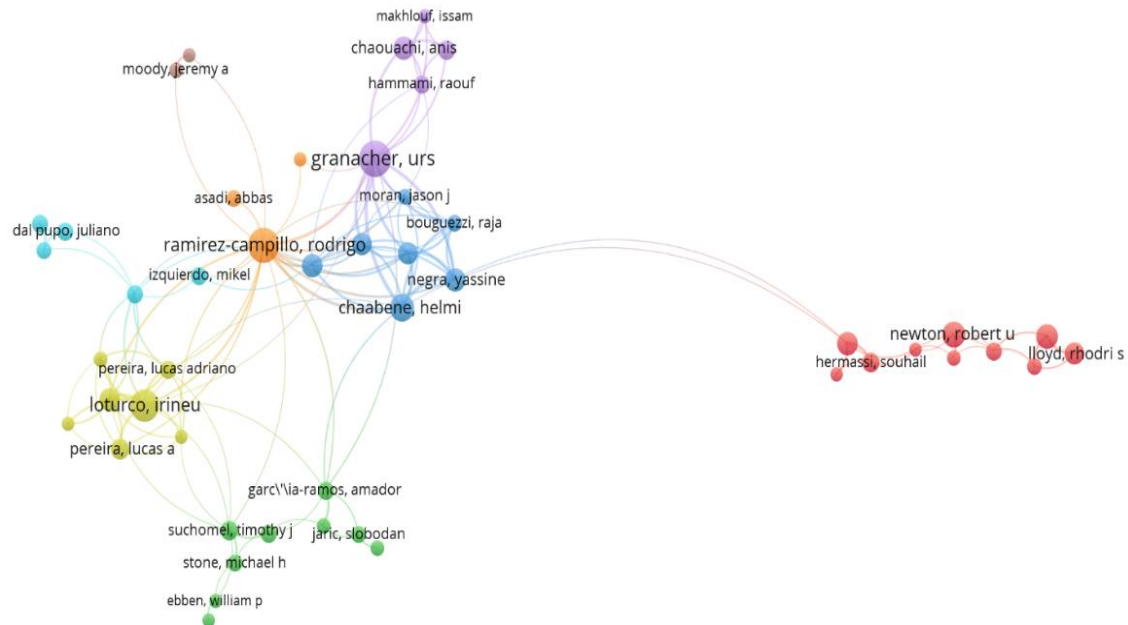


Figure 6. Global Author Collaboration Network

Co-authorship relationships among authors publishing research on plyometric exercise in network visualization revealed several collaborative clusters formed through recurring co-authorship links, indicating ongoing collaborative activity in this field. One prominent cluster represents a group of authors frequently connected through joint publications, while other distinct clusters reflect collaboration patterns among researchers related to performance science and applied training. Additional collaborative clusters were also observed, including smaller groups that appeared more loosely connected or relatively independent from the central network structure. The co-authorship network illustrates the presence of multiple research teams with varying degrees of interconnectedness, highlighting a collaborative research landscape characterized by stable partnerships and parallel research groups.

Table 5: Empirical Studies of the Effects of Plyometric Exercises reviewed

Title Author(s) & Year	Study Design	Participants	Intervention	Outcome Measures	Key Findings
1. The effects of plyometric jump training on jump and sport-specific performances in prepubertal female swimmers. (Sammoud et al., 2021).	Quasi-experimental intervention groups and control groups.	22 Prepuberty female swimmer with a competitive background.	An 8-week plyometric jump training program integrated into dry-land training, focusing on stretch-shortening cycles, in addition to regular swimming exercises.	Jumping ability (e.g., <i>countermovement jump</i>), Sport-specific swimming performance (e.g., sprint swim time), Leg muscle explosiveness indicator	Plyometric jump exercises significantly improved jumping ability and specific swimming performance compared to the control group, suggesting that plyometric exercise was effective as a ground exercise intervention to increase leg muscle power and transfer performance to sports in early-age female swimmers.
2. Unilateral Plyometric Training is Superior to Volume-Matched Bilateral Training for Improving Strength, Speed and Power of Lower Limbs in Preadolescent Soccer Athletes (Drouzas et al., 2020)	Randomized controlled trial with three groups.	68 preadolescent male soccer players.	10-week plyometric program (2×/week); unilateral group performed single-leg jumps, bilateral group performed volume matched double leg jumps, control group continued regular soccer training.	Vertical and horizontal jump performance, sprint speed (5–20 m), agility, balance, and maximal lower-limb strength.	Unilateral plyometric training elicited greater gains in hamstrings strength, short sprint performance, and single-leg jumping ability than bilateral training, while both methods similarly improved double-leg jumps.
3. Effects of Plyometric Training on Lower-Limb Explosive Power and Its	Randomized controlled trial with a pre-test–	40 male sprinters.	Experimental group: Progressive plyometric	Leg muscle explosions: Squat Jump (SJ),	Plyometric training results in significant and greater improvements in explosive



Retention After Detraining post-test in Sprinters. (Shuai et al., design. 2025)			exercise for 6 weeks (3 sessions/week). Control group: Traditional lower extremity strength exercises (squat, deadlift, hang clean, leg press). Followed by detraining for 2 weeks without training.	Countermovement Jump (CMJ). Do sprints: 30m Sprint, 100m Sprint. Horizontal jump: Long Jump Standing (LJ), Triple Jump Standing (STJ).	power and sprint speed than traditional strength training, as well as better performance retention after 2 weeks of detraining, especially in SJ, CMJ, and sprint.
4. The Effects of Plyometric Training with Speed and Weight Overloads on Volleyball Players' Strength, Power, and Jumping Performance. (Iranpour et al., 2025)	Randomized, controlled, double-blind experiment with a pre-test-post-test design and four treatment groups.	40 men's volleyball athletes.	4-week plyometric training program: PT: standard plyometric, PTS: plyometric + speed overload, PTW: plyometric + load overload, PTSW: combination of speed overload & load.	Functional performance: Sargent jump, spike jump, Sheppard test (agility & jump) - Kekuatan & power: MVIC, RFD, peak torque (PTQ), relative peak torque (RPT), average power (AP), otot lutut (isokinetik & isometrik).	The PTSW group showed the most superior improvements in isokinetic strength, explosive power, and jump performance compared to the other groups, confirming the effectiveness of the combined speed and load overload in male volleyball athletes.
5. Effect of plyometric training and neuromuscular electrical stimulation-assisted strength training on muscular, sprint, and functional performances in	Randomized controlled trial (RCT) -Mixed-design (2 × 2).	60 university-level men's soccer athletes, Young adulthood.	The experimental group received PT+ST+NMES, while the control group received PT+ST+sham NMES for 8 weeks.	Pre- and post-intervention measurements included muscle strength (sit-to-stand test), sprint	All performance variables improved significantly after 8 weeks of intervention (p < 0.05), with large-moderate effects on muscle strength (STN, d = 10.84) and sprint



collegiate male football
players. (Hasan et al., 2022)

performance (sprint
test), and functional
performance (single-
leg triple hop test).

performance ($d = 1.31$), as
well as small effects on
functional performance
(SLTHT, $d = 0.613$). No
significant differences were
found between the NMES
group and the NMES sham.
The combination of
plyometric training and
strength training effectively
improves performance with or
without NMES.

6. Effect of vertical, Randomized
horizontal, and combined controlled trial
plyometric training on with a pre-
jump, sprint, and change of intervention
direction performance in design.
male soccer players. (Moran
et al., 2023)

24 semi-
professional
men's soccer
players.

Vertical, horizontal,
and combination
plyometric exercises
were performed 2
times per week with a
volume of 100 foot
contacts per session for
8 weeks.

Sprint performance
(10 m and 40 m),
jump ability (vertical
jump and standing
long jump), and
change of direction
ability (505 change of
direction test).

Vertical, horizontal, and
combination plyometric
exercises both improved jump
and change of direction
performance, but provided
only a small increase in linear
sprint speed and showed no
consistent differences in
advantage between methods.

7. Effects of a 4-week Randomized
plyometric training on controlled trial
activity patterns during with a pre-post
different phases of one-leg intervention
drop jump with focus on design.
jump height. (Ahmadabadi
et al., 2023)

20 women are
active.

The plyometric
exercise program
lasted for 4 weeks, 2
sessions per week, with
a duration of 60
minutes per session,
while the control group
underwent daily

Lower leg muscle
activity using sEMG
(RF, BF, TA, GaM),
ergo-jump variables
(preparation phase
time, contact, flight
phase, and jump
height)

Plyometric exercises for 4
weeks improved
neuromuscular control
through earlier muscle
activation in the preparatory
phase, changes in lower leg
muscle activity patterns, and
improved knee joint stability,

		activities without additional exercise.	When one leg drops, jump.	although there was no significant difference in ergo-jump performance variables.
8. Effects of Vertical and Randomized Horizontal Plyometric Controlled Exercises on Explosive Trial (Pretest–Capacity and Kinetic Posttest Variables in Professional Design) Long Jump Athletes. (A. V. Taher et al., 2021)	20 professional long jump athletes	Experimental group: vertical & horizontal plyometric exercises (box jumps, hurdle hops, ankle jumps, power skips, split squat jump, zig-zag drill). Control group: long jump standard exercises (sprint, take-off drill, approach run, conditioning circuit).	Sprint 30 m, Vertical jump, Standing long jump, Max vertical height, Horizontal speed at take-off, Vertical speed at take-off, Flight time, Take-off duration, Long jump distance.	The plyometric group showed significant improvement over the controls on: 30 m sprint, Vertical jump, Horizontal take-off speed, and Long jump distance. Vertical & horizontal plyometric exercises are more effective at increasing explosive capacity than other kinetic variables.
9. Resisted Plyometric Randomized Exercises Increase Muscle Strength in Young Basketball Players. (Pamuk et al., 2022)	35 men's basketball players aged 15–16 years, with about 4 years of coaching experience.	A 12-week training program. Standard basketball practice control group. Plyometric group standard basketball practice + plyometric practice 3 times per week. Group resisted plyometric standard basketball exercises + resistive plyometric exercises using the Vertimax tool 3 times per week.	Vertical jump height, anaerobic power, and isokinetic strength of the knee muscles (flexion and extension) at speeds of 60°/s, 180°/s, and 300°/s.	Plyometric and plyometric resistive exercises significantly increase isokinetic muscle strength. The greatest improvement occurred in the plyometric resistance group, especially in the knee flexor muscles. No significant improvement was found in vertical jump performance. Resistive plyometric exercises are effective for improving the muscle strength of young basketball players.



10. Effect of 12 Weeks of Quasi-the Plyometric Training experimental Program Model on Speed study with a and Explosive Strength between-group Abilities in Adolescents. design and (Kryeziu et al., 2023) pretest–pretest-posttest control group design.	195 young men ages 15 ± 6 months.	Plyometric exercises for 12 weeks. The PG group exercises plyometric 3 times per week in addition to regular physical education lessons. The CG group only attended regular physical education lessons with no additional exercise. Programs: short sprints, one- and two-foot jumps, deep jumps, box jumps, and sprint–jump combinations, intensity of about 60–75 percent.	Running speeds are 30 m, 80 m, and 100 m. Leg muscle explosiveness through the standing long jump, standing triple jump, and vertical jump.	The 12-week plyometric program significantly improved the running speed of 30 m and 80 m in the PG group compared to the CG group. Significant improvements were also found in all explosive power indicators, namely, standing long jump, standing triple jump, and vertical jump. The program is effective in improving speed and explosive power in adolescents, and is recommended as a model of exercise in physical education and the development of young athletes.
11. Long-Term High- True Intensity Plyometric experimental Training Increases Muscle research with a Strength and Power of the pretest-posttest Lower Body in Young control group Healthy Males. (Raharjo et design. al., 2024)	40 healthy young men aged 20–24 years with no history of chronic disease.	High-intensity plyometric exercises for 6 weeks with a frequency of 4 times per week. Workouts last 30–35 minutes per session and include a combination of single-leg plyometric sprint jumps and hurdle jumps with an intensity	Lower leg muscle strength is measured using a back and leg dynamometer. The explosive power of the lower leg muscles was measured using a vertical jump test. Measurements were taken on the pretest and posttest.	There was no significant change in the strength and explosiveness of the control group's muscles. The HIPT group showed significant improvements in lower leg muscle strength and muscle explosiveness after the intervention. Long-term high-intensity plyometric exercises have been shown to be



		of 80–90 percent HRmax. The control group did not receive any special exercise treatment.		effective in improving the strength and power of the lower extremity muscles in healthy young men.
12. The Effects of the Use of Quasi-Plyometric Exercises with experimental and without the Ball in the Development of Explosive Strength in Volleyball. using two groups. (Esposito et al., 2024)	20 male volleyball players under-19 category of the Italian Volleyball League.	Plyometric exercises for 6 weeks, frequency 3 times per week. The experimental group performed plyometric exercises with an integrated ball blocking technique. The control group performed the same plyometric exercise without the use of a ball.	Vertical jump performance was measured through Squat Jump and Countermovement Jump with Arm Swing. Measurements using the Optojump system. Data were taken before and after the intervention.	Both groups experienced significant improvements in Squat Jump and Countermovement Jump with Arm Swing. There was no significant difference between groups in the Squat Jump. There was a significant difference in the Countermovement Jump with Arm Swing, with the advantage in the exercise group using the ball, which was thought to be influenced by motivational stimuli and coordination of movements.
13. The Effectiveness of Quasi-Lateral Box Shuffle Plyometric Exercise on Increasing Limb Muscle Power of Badminton Athletes. (Hidayat et al., design. 2025)	78 badminton athletes were randomly selected.	Lateral box shuffle plyometric training for 24 sessions, 3 times per week.	Leg muscle power was measured using the vertical jump test (validity 0.978; reliability 0.989).	Significant improvement in leg muscle power in the treatment group compared to the control group ($p < 0.05$). Post-test mean: 95.71 kg·m/s (treatment) vs 78.93 kg·m/s (control).
14. Effect of Randomized-electromyostimulation and to-Groups	90 male state-level	Plyometric training twice per week for 4	Agility T-test, 30-m sprint test, standing	Plyometric training significantly improved 30-m



plyometrics training on pretest–posttest sports-specific parameters design with two in badminton players. experimental (Panda et al., 2022) groups.	badminton players (17–24 years).	weeks; Electromyostimulation training four times per week for 4 weeks; the Control group received no additional intervention beyond routine training.	broad jump, vertical jump height.	sprint time (3.83%, $p < 0.01$) and jumping ability; Electromyostimulation significantly improved jumping ability only; no significant improvement in agility or lower limb explosive power compared with control.
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Review. Global evolution of research on plyometric training for improving lower-limb muscle strength and power: a systematic review and bibliometric. Vol. 12, n. ° 4; p. 1-34, August 2026.

<https://doi.org/10.55040/rvn56q17>

Fourteen experimental and quasi-experimental studies reviewed showed that plyometric exercises were applied to a wide range of age groups, from prepubertal children, adolescents, to adult athletes, and covered a wide range of sports such as football, volleyball, basketball, athletics, swimming, and badminton. The research design used included randomized controlled trials and quasi-experiments, with intervention durations ranging from 4 to 12 weeks and training frequency of 2–4 sessions per week. Most studies reported improvements in key physical performance variables, particularly leg muscle strength and explosiveness, as measured through vertical and horizontal jump tests, short-distance sprints, and isokinetic and isometric strength measurements. In groups of young and adolescent athletes, some studies reported significant improvements in running speed and limb muscle explosiveness after a medium- to long-duration plyometric exercise program. Meanwhile, in adult and trained athletes, plyometric interventions have also been reported to improve explosive performance, including jumping and sprinting ability. In addition, variations in intervention forms such as vertical, horizontal, unilateral, bilateral, and plyometric with resistance or speed overload were also reported in the reviewed studies. Several studies have also evaluated the impact of plyometric exercise on neuromuscular and biomechanical variables, including muscle activation and joint stability. In general, all studies reported positive changes in at least one indicator of physical performance after the plyometric exercise intervention compared to the control group or initial condition.

Discussion

Table 1 summarizes the top five journals publishing research on plyometric exercise related to lower-limb muscle strength and power, along with their respective impact metrics. A total of 160 journals contributed to the publication output in this research field, with the five leading journals accounting for 14.58% of total publications, representing 301 articles. The Journal of Strength and Conditioning Research showed the highest number of publications (165 documents) and total citations, followed by the International Journal of Sports Physiology and Performance and the Journal of Sports Sciences. These journals also demonstrated varying citation counts, CiteScore values, and

Review. Global evolution of research on plyometric training for improving lower-limb muscle strength and power: a systematic review and bibliometric. Vol. 12, n. ° 4; p. 1-34, August 2026.

<https://doi.org/10.55040/rvn56q17>

h-index metrics, reflecting differences in publication volume and citation impact across outlets.

Synthesis of Key Findings from 14 Studies

By comprehensively integrating the findings of 14 empirical studies reviewed with bibliometric findings, it provides a comprehensive overview of the effectiveness, mechanism, and direction of development of plyometric exercise research in increasing the strength and explosiveness of leg muscles. Consistently, all studies show that plyometric exercise is an effective intervention in improving neuromuscular performance, although the magnitude of the effect is strongly influenced by the characteristics of the subject, the design of the exercise program, and the context of the sport.

Effectiveness Across Ages and Experience Levels

One of the key findings is the flexibility of plyometric exercises that are effectively applied to a wide range of age groups, from prepuberty children to competitive-level adult athletes. In the child and adolescent population, a significant increase in the speed and explosiveness of the leg muscles (Kryeziu et al., 2023; Hidayat et al., 2025) shows that the developing neuromuscular system is highly responsive to stimuli based on stretch-shortening cycles (SSCs). This adaptation is most likely driven by improved inter- and intramuscular coordination and recruitment efficiency of motor units, rather than solely by morphological changes in muscles. In experienced and trained athletes, the impact of plyometric exercise still counts, but to a greater extent, more specific and intense stimulation is needed. In studies (Shuai et al., 2025) and (Raharjo et al., 2024). Intensity, overload progressiveness, and combining with the specific demands of respective sports are essential elements to achieve optimal adaptations. This means that the more experienced the athletes are, the more specific and customized activity designs are required in plyometric exercise programs to effectively elicit improvements in athletic performance and skill.

Review. Global evolution of research on plyometric training for improving lower-limb muscle strength and power: a systematic review and bibliometric. Vol. 12, n. ° 4; p. 1-34, August 2026.

<https://doi.org/10.55040/rvn56q17>

The Role of Variation and Modification of Exercise Programs

Various findings from studies prove that different forms of plyometric exercise modes affect adaptation differently. Vertical exercises, horizontal exercises, and combinations (Moran et al., 2023); (S. M. Taher, 2025) Show that no level of training is best suited to every component. Vertical training is better associated with vertical jumping capability enhancement, and horizontal training is more applicable to horizontal speed-based explosive sprints. Moreover, the plyometrics with the overload resisted method (Pamuk et al., 2022); (Iranpour et al., 2025) Has a higher adaptive capacity with respect to strength and explosive power than traditional plyometrics. Adding weight or speed overload might improve the mechanical and neuromuscular stress levels, thus intensifying the adaptation stimulation zone. Nevertheless, this training type demands higher technical precision and injury risk management, particularly with youth athletes.

Neuromuscular and Biomechanical Adaptation

From a mechanistic perspective, the present study's findings align with (Ahmadabadi et al., 2023), and recent evidence from under-represented regions showing that training-induced neuromuscular adaptations do not always immediately translate into improvements in macro performance markers such as jump height or sprint times. Instead, adaptations such as altered muscle activation strategies, optimized coordination, and enhanced integration of muscle-tendon mechanics form the foundation for long-term performance improvement. For instance, combined plyometric and change-of-direction training has been shown to influence neuromuscular performance and explosive control in elite young athletes in North Africa (Cherni et al., 2025), while combined aerobic and plyometric interventions in Ethiopia resulted in improved neuromuscular performance indicators including speed and vertical jump (Bulti & Dugasa, 2023). Systematic analyses further confirm that such interventions produce consistent neuromuscular and SSC-related adaptations across diverse populations (Deng, Soh, Abdullah, Huang, et al., 2023)

Transfer of Performance to a Specific Sport

Plyometric exercises also have high performance transfer value to specific sports settings (Zheng et al., 2025). Enhanced swimming performance in prepubertal individuals

Review. Global evolution of research on plyometric training for improving lower-limb muscle strength and power: a systematic review and bibliometric. Vol. 12, n. ° 4; p. 1-34, August 2026.

<https://doi.org/10.55040/rvn56q17>

(Sammoud et al., 2021). Greater long jump range in professional athletes (A. V. Taher et al., 2021), as well as enhanced spike and block performance in volleyball players (Esposito et al., 2024); (Iranpour et al., 2025) Clearly indicates that plyometric exercises can be effectively implemented after being fully incorporated in a way that augments the biomechanical aspects of sports. The incorporation of engineering components, volleyball plyometric exercises with the use of balls, has also been established to help augment the effectiveness levels related to coordination and motivation (Deng, Soh, Abdullah, Huang, et al., 2023).

Integrating Bibliometric Findings with Future Research Directions

The link between bibliometric analysis with the outcome of the analysis of 14 studies illustrates and supports that there has been a shift from a fundamental, mechanistic study of plyometric exercise to an application-oriented and performance-oriented study (Kons et al., 2023). The dominance of keywords such as “performance,” “agility,” “sprint,” and “power” illustrates that the current studies are increasingly application-oriented and are focused on applying their ideas and concepts in practice (Deng, Soh, Abdullah, & Huang, 2023). Nevertheless, there still exist gaps in research regarding the exercise dose and individual variability, and long-term effects.

Practical Implications and Recommendations for Further Research

Practically, the results of the study confirm that plyometric exercises should be a core component in the leg muscle strength and explosiveness development program (Ojeda-Aravena et al., 2023). Coaches and practitioners need to adjust the type, intensity, and volume of exercise to the age, level of experience, and demands of the sport (Bedoya et al., 2015). For further research, longitudinal studies with a stronger experimental design are needed to explore long-term adaptation, plyometric interactions with other exercise methods, as well as the utilization of biomechanical and neuromuscular technologies for program optimization (Barrio et al., 2023).

Review. Global evolution of research on plyometric training for improving lower-limb muscle strength and power: a systematic review and bibliometric. Vol. 12, n. ° 4; p. 1-34, August 2026.

<https://doi.org/10.55040/rvn56q17>

Conclusion

The study confirms a significant increase in the number of plyometric exercise research publications in the last decade, with the dominance of highly reputable journals and the contributions of authors, institutions, and countries forming the core of studies development in this field. Keyword mapping shows a shift in research focus from mechanistic and biomechanical studies to a more applicative and performance-oriented approach. Synthesis from selected empirical studies shows that plyometric exercises consistently improve the strength and strength of leg muscles in different age groups and experience levels, although the magnitude of adaptation is influenced by the design of the exercise program, intensity, duration, and specificity of the exercise. However, empirical evidence is still concentrated on specific sports, while research on sports with multidirectional and repetitive demands, such as badminton, is relatively limited. Therefore, further research based on a cross-disciplinary approach involving biomechanics, physiology, neuroscience, and motion analysis technologies is needed to optimize the application of precise, safe, and contextual plyometric exercises to a variety of sports.

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Review. Global evolution of research on plyometric training for improving lower-limb muscle strength and power: a systematic review and bibliometric. Vol. 12, n. ° 4; p. 1-34, August 2026.

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