Eur J Transl Myol 34 (4) 12888, 2024 doi: 10.4081/ejtm.2024.12888

Prescription criteria and effects of explosive strength training in indoor soccer players: a systematic review

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Abstract

Explosive strength is fundamental in the performance of athletes. The objective is to identify the criteria used for the prescription of Explosive Strength Training (EST) and to verify the changes it produces in futsal players. A systematic review of studies analyzing the criteria used for the prescription of explosive strength training was conducted in PubMed/MEDLINE and Scielo, considering the period between 2017 and 2023. The search strategy used the terms: players, Futsal, Futsal training, strength, physical exercise, explosive strength, intervention, experimental study. Data extraction included: year of publication, country, sample, protocol performed (content and activity developed, duration, intensity, frequency, total weeks). A total of six studies were identified. Fifty percent of the studies were developed in Brazil, the others in Italy, Spain and Portugal. Five studies applied a training of 2 sessions per week and one indicated 2-3 sessions. Three studies describe the training sessions (study 1: 15-30 minutes, study 2: 20-25 minutes, study 3: 1 hour). Five studies used 1RM and one study used subjective perception of exertion (PSE). The contents of the interventions were varied, from squats with weights, accelerations and decelerations, leg press, leg extension, plyometrics. The training criteria for explosive strength were: intensity controlled by a 1RM, frequency of 2 to 3 sessions per week, duration of 15 to 30 minutes per session and the training contents were varied. These results suggest positive changes in CMJ, increasing explosive strength from ∼2.0 to 4.6 cm (5.8 to 13.7%). These findings highlight the need to develop a more standardized protocol to optimize the benefits of explosive strength training in this athletic population.

Key Words: futsal, explosive strength, CMJ, training.

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Futsal is the 5-a-side version of indoor soccer (*i.e.*, a goalkeeper and four outfield players) sanctioned by the Fédération Internationale de Football Association.[1] During the match, athletes must maintain intermittent to high-intensity activities of short duration so that maximum physical, technical, and tactical performance is required.[2,3] Futsal requires each player to constantly adjust their playing position to perform offensive and defensive activities. Because of these requirements, a player's strength is crucial to ensure high levels of performance throughout the match.[4]

Despite its popularity, futsal has been the subject of little scientific research. The limited works available in the international literature describe the analysis and comparison of physical and physiological demands during a match,[5-7] especially when it comes to intervention studies.

In recent years, there has been greater clarity in the understanding of force development from the point of view of physiology and mechanics. According to Badillo and Ribas-Serna, strength is studied as an internal manifestation, defined as the neuromuscular capacity to generate tension.

From a mechanical perspective, muscular force is analyzed in terms of the external effect it produces, either by starting or stopping a movement, increasing or decreasing its speed, or changing direction. From the interaction of both perspectives arises the applied force, which is the external mani-

festation of the internal tension generated in the muscle in the face of a load.

Explosive force, in particular, is a type of applied force characterized by the ability to generate a large amount of tension in a short period of time to produce a rapid and powerful movement. Therefore, the correct assessment of explosive strength requires a multidimensional approach that considers both neuromuscular and mechanical aspects.

In fact, some physical capacities, such as lower extremity explosive strength, have been used to identify talent and to diagnose and monitor the effects of training in young soccer players.[9] VO2max can even be considered a physical variable dependent on the competitive level in futsal[5]. Although in some cases talent development should be considered monodisciplinary, adopting a geneticist or environmentalist view.[10] The approach proposes that talent development programs should focus on the individuality of athletes and the various constraints affecting their performance rather than evaluating current performance on physical tests referenced to group norms. Therefore, it is necessary to adopt a multidisciplinary and integrative perspective to advance the understanding of the development of expertise and sport talent.

In general, the level of motor competence of these athletes is crucial to ensure that players withstand the competitive demands throughout the season. Therefore, it is essential that efficient training methods are implemented and prescribed.[11]

In that sense, identifying and analyzing intervention programs that produce changes in the explosive strength of futsal players is highly relevant. This is because explosive strength seems to be fundamental to improve the performance of athletes during sport competition.[12]

In fact, to our knowledge, there are few systematic review or meta-analysis studies that have been interested in investigating intervention programs that produce changes in explosive strength (CMJ countermovement jump) in professional futsal players.[13-16] Therefore, this systematic review study seeks to identify the most effective intervention programs that allowed improving explosive strength, especially in CMJ jumping, in professional futsal players. For this purpose, the following question was proposed: What are the criteria used for prescribing explosive strength training and how have they impacted performance in the countermovement jump test (CMJ)? To answer these questions this study proposed the following objectives: i) to identify the criteria used for the prescription of explosive strength training (CMJ) and ii) to verify the changes it produces in futsal players.

Materials and Methods

Protocol

A systematic review of experimental studies analyzing the criteria used for the prescription of explosive strength training was performed. The study was conducted according to the Preferred Reporting Items for Systematic Review and Meta-Analyses - PRISMA statement.[17]

Search strategy

The systematic literature search was performed in November 2023 in the following databases: PubMed/MEDLINE and Scielo. Articles published between 2017 and 2023 were considered. The search strategy was based on the PICOT elements, which were adapted and allowed us to formulate the question in this review. The PICOT strategy was composed of: P (Population: futsal players); I (Intervention: explosive strength training programs); C (Comparison: Present an experimental group that is subjected to different types of activity, intensity, frequency and duration, with or without a control group); O (Outcomes: describe the criteria used in prescribing sports training); S (Type of study: experimental studies). Therefore, the following question is formulated: what are the criteria used for the prescription of explosive strength training in male futsal players?

For the search strategy, MeSH was used to obtain relevant terms in English, combined with Boolean operators: "players" OR "Futsal" OR "Futsal training" OR "Strength" OR "physical exercise" OR "Explosive Strength" OR "Intervention" AND "experimental study".

Inclusion and exclusion criteria

The studies that were included in the review met the following criteria: i) experimental studies ii) describing the explosive strength training program; iii) studies in futsal players; iv) original studies written in English, Portuguese and Spanish. Cross-sectional studies and studies composed of special/clinical populations (e.g., players with a specific disease) were excluded.

Selection of studies

The results of the studies were downloaded, analyzed and duplicate articles were excluded using the Endnote bibliographic manager. At first, the initial selection of the studies was made according to the reading of the title and abstract. The article selection and evaluation process was performed by two independent reviewers (AG and MCB), with a third reviewer (RGC) participating in case of discrepancies. In the next step, a full-text analysis was performed to verify whether the studies met the inclusion criteria. Subsequently, the research group performed a manual search for other studies that had not been found in the initial search. Finally, the full-text analysis and data extraction of the selected studies was performed.

Data extraction and analysis

For the extraction of data from each article, a Microsoft Office Excel® 2010 (Microsoft, United States) document was designed to break down the relevant data into different categories such as: year of publication, country, sample (age range), groups considered (control group and experimental group), protocol performed (content and activity developed, duration, intensity, frequency, total weeks). For the presentation of the results of the articles, the descriptive information of the protocols developed in the studies was used, which made it possible to extract the indicators (criteria) of the exercise programs of each study.

Methodological quality

The methodological quality of the eligible studies in this review was assessed according to the Physiotherapy Evidence Database (PEDro Scale).[18] The PEDro Scale helps to identify, by means of 11 evaluation criteria, which of the studies may have internal validity (criteria 2 to 9). As well as containing sufficient statistical information so that their results can be interpreted (criteria 10 and 11). After applying the scale, the studies were classified according to the scores obtained as follows: those with scores between zero and four were considered to be of low quality; from four to five, of moderate quality; from six to eight, of high quality; and from nine to ten, of excellent methodological quality.[18]

Data analysis

The analysis of the synthesis of the systematic review was based on quantitative and/ or qualitative procedures. In the first case, the data were organized by means of frequencies, range, percentages (%) and in the second case by means of content analysis of the indicators considered in the information recording form for interpretative analysis.

Results

Selection process

A total of 256 studies were identified through the electronic search, 18 of which were eliminated because of duplicates. Subsequently, 141 documents were excluded because they were not related to the objectives of the study, resulting in 97 potentially relevant articles. Forty-five articles were excluded after reading the title and abstract because they did not prescribe explosive strength training. Next, the full text of the 52 articles was analyzed and 46 papers were excluded because they did not show the contents of the exercise program. This resulted in a total of 6 articles that were included in the review. The process and outcome of the literature selection are presented in detail in Figure 1.

Table 1 shows the six studies that have developed interventions to improve explosive strength in young futsal players. Fifty percent of the studies (n= 3) were developed in Brazil, while the others, were carried out in Italy, Spain and Portugal. In general, all studies showed an average age ranging from 18.5±1.1 years to 24.8±5.4 years.

The results of the quality analysis of the articles are shown in Table 2. All the studies included in this systematic review presented criteria for the selection of participants, intention-

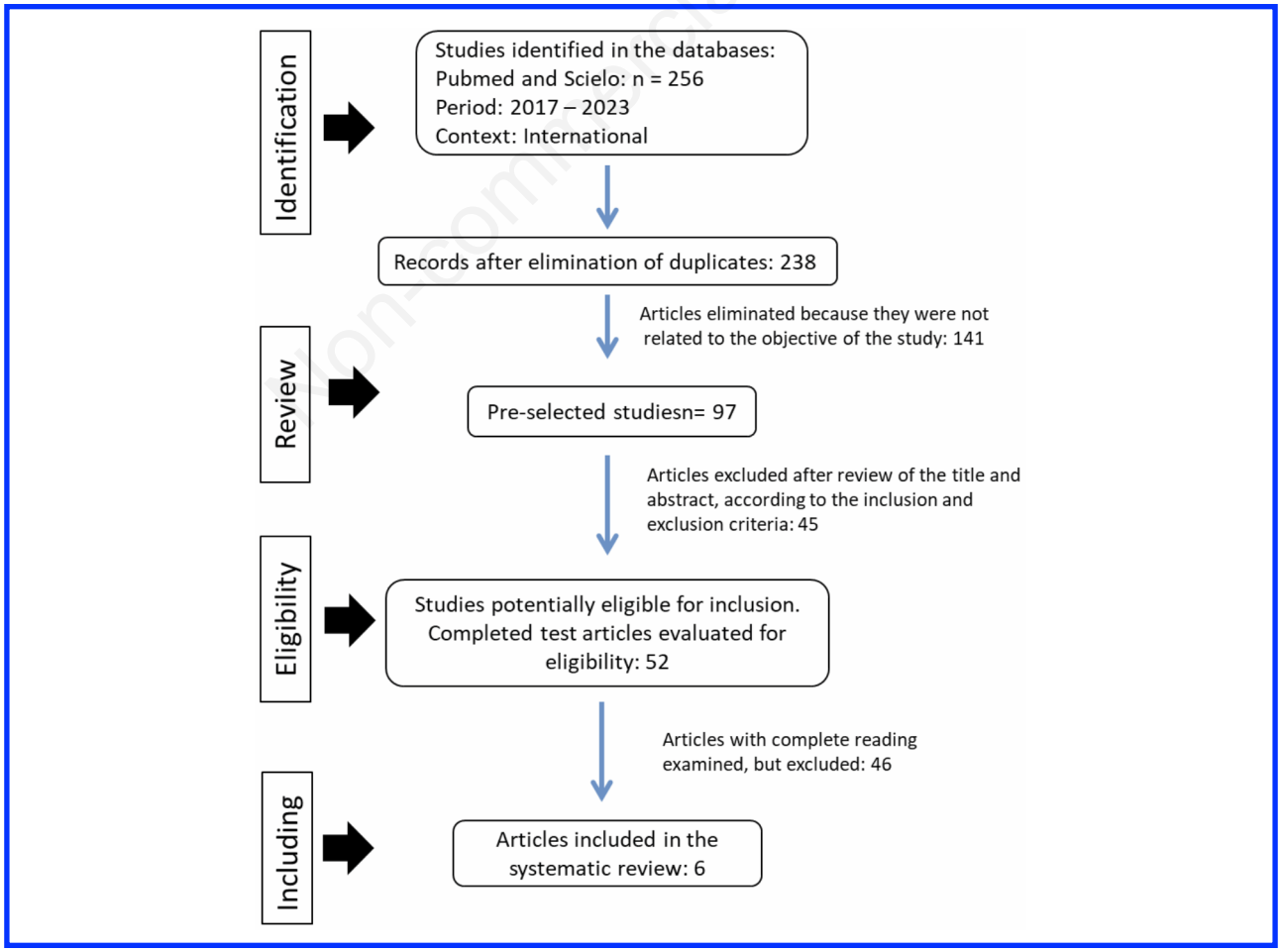

Figure 1. *PRISMA flow chart for the systematization of original articles 2017-2023.*

Table 1. *General characterization of the systematized studies.*

N°	Author (s)	Year	Country	Sample	Age range (years)
1	Campos *et al.*[15]	2021	Brasil	EG: HIT85%: n=6 HIT 100%: n=5	18.5±1.1
2	Marques *et al.*[12,16]	2022	Portugal	EG: n= 10	24.8±5.4
3	Torrelo *et al.*[13]	2016	España	CG: n=10 FSG: n=12 CFSG: n=12	22.9±5.1
4	Freitas *et al.*[19]	2019	Brasil	EG: n=10	23.70±5.8
5	Yanci *et al.*[14]	2017	Brasil	EG= PTG1: n=12 PTG2: n=15 CG: n=12	22.5±5.0
6	Lodice *et al.*	2020	Italia	EG: SRT: n=15 TRT: n=15	24.0±1.5

EG, Experimental Group; HIT, High Intensity Interval Training; CG, Control Group; FSG, Full Squat Group; CFSG, Combined Full Squat Group; PTG1, Plyometric Training Group 1 day per week; PTG2, Plyometric Training Group 2 days per week; SRT, Slow Speed Resistance Training; TRT, Traditional Resistance Training.

Table 2. *Methodological analysis of the quality of the systematized studies.*

	Analysis of the methodological quality of the selected articles	1	2	3	4	5	6
1	Generation of the randomization sequence	No	No	Yes	No	Yes	Yes
2	Assignment secrecy	No	No	No report	No	No report	Yes
3	Adherence of the endorsed	Yes	Yes	Yes	Yes	Yes	Yes
4	Adherence of the professionals who implemented the intervention	No report	Yes	Yes	Yes	Yes	Yes
5	Blindness of the evaluators of the residuals	No report	No report	No report	No report	No report	No report
6	Similar groups at baseline assessment	No report	No report	Yes	No report	Yes	Yes
7	Participant selection criteria	Yes	Yes	Yes	Yes	Yes	Yes
8	Intention-to-treat analysis	Yes	Yes	Yes	Yes	Yes	Yes
9	Static comparison between groups	Yes	Yes	Yes	Yes	Yes	Yes
10	Description of losses and exclusions	No report	No report	Si	No report	No report	No report
11	PEDro scale score	4	5	8	5	7	8

to-treat analysis and adherence of those evaluated. A total of 83.3% indicated adherence of the professionals who applied the intervention. Likewise, three studies (50%) reported the generation of the randomization sequence and the use of similar groups in the initial evaluation. However, only 16.7% considered secrecy of allocation and description of losses and exclusions. No study reported blinding of the assessors of the residuals.

The evaluation of methodological quality, through the PEDro23 scale, showed that the two studies with the highest scores were Torrelo *et al.*[13] and Lodice *et al.* (8 points), followed by Yanci *et al.*[14] (7 points); Marques *et al*.[12] and Freitas *et al.*[19] (5 points) and Campos[15] (4 points) on this scale. Overall, the assessment of the methodological quality of the six selected articles shows variability in the quality of the studies. Three of the six studies complied with randomization sequence generation, whereas concealed allocation and blinding of the assessors were rarely reported, suggesting possible bias in these aspects.

The prescription of the training programs is shown in Table 3. Of the six studies, five have applied a training of 2 sessions per week except for one, which indicates 2-3 sessions per week (Brazil).[15] The training sessions range from 20-25 minutes,[13] 15-30 minutes,[14] 1 hour.[12] The following three studies do not specify the working time.

Regarding intensity control, five studies used 1RM and one study subjective perception of exertion (PSE). The contents of the interventions were varied, as each study proposed a different activity, ranging from squats with weights, accelerations and decelerations, leg press, leg extension, plyometrics. In sum, the six studies indicate that the minimum time frame for improving explosive strength (CMJ) ranges from 4 to 10 weeks, respectively.

The reviewed studies show a lack of uniformity in the prescription criteria for explosive strength training in futsal players. Most of the studies applied two training sessions per week with a duration varying between 15 and 60 minutes, the training intensity was mostly controlled by 1RM, with one exception using subjective perception of exertion (PSE).

Table 4 shows the changes observed in explosive strength. The six studies reviewed showed improvements in explo-

Table 3. *Criteria used for the prescription of explosive strength training (ETS) in young futsal players.*

N°	Authors	Frequency per week	Duration per session	Intensity	Type of exercise	Total weeks
1	Campos *et al.*[15]	3-2 sessions	N/S	86% of PSEF	128 and 64 accelerations and 96 and 48 decelerations/actions	10 weeks
2	Marques *et al.*[12]	2 sessions	1 hour	45-65% of one repetition maximum (1RM)	Full squat and complementary exercises with the same volume.	8 weeks
3	Torrelo *et al.*[13]	2 sessions	20-25 min	45-58% of one repetition maximum (1RM)	Full squat exercise (SG) or full squat combined with change of direction exercises.	6 weeks
4	Freitas *et al.*[19]	2 sessions	N/S	65% of one repetition maximum (1RM)	Leg Press, Leg Extension, Abduction Machine and Adduction Machine. Squat with loaded jump, unipodal jump, deadlift with jump	4 weeks
5	Yanci *et al.*[14]	2 sessions	15- 30 min	3x3 Rep.	Single leg horizontal side jump; vertical countermovement jump with arm swing; single leg vertical side jump; vertical drop jump; vertical drop jump with dominant leg; vertical drop jump with non-dominant leg.	6 weeks
6	Lodice *et al.*	2 sessions	N/S	80% of 1RM	Bilateral leg extension and flexion exercises on isotonic machines.	8 weeks

PSEF, subjective perception of exertion; 1RM, 1 repetition maximum; NS, not specified.

sive strength measured through the countermovement jump (CMJ), with percentage change ranging from 5.8% to 13.7%, corresponding to an increase of approximately 2.0 to 4.6 cm in jump height. The studies by Campos *et al.* (2021) and Yanci *et al.* (2017), conducted in Brazil, stood out for obtaining the greatest improvements, with increases of 10.6% to 13.7% (~4.6 cm) after 10- and 6-week interventions, respectively. In comparison, the other studies reported more modest improvements, with increases of 5.8% to 7.2% (~2.0 to 2.6 cm).

Discussion

The results of the study have evidenced that, out of a total of six studies, five have reported data on the prescription of training to improve CMJ explosive strength.

In general, these studies have used varied physical exercises to improve explosive strength, (from weighted squats, accelerations and decelerations, leg press exercises, leg extension and plyometrics). These training contents were performed in 2 to 3 sessions per week, with each session lasting approximately 15 to 30 minutes, and the intensity control was carried out using 1RM.

The studies systematized in this research have developed intervention programs from 4 to 10 weeks, in which they have managed to increase the CMJ from ~2.0 to 4.6 cm in futsal athletes. Indeed, in team sports such as volleyball, basketball, soccer and futsal, high jumping is essential for athletes and is closely related to their explosive strength performance.[21]

Recently a systematic review study of young soccer players, has shown similar findings to the present study. Where they highlight that speed and explosive strength are relevant components of sports performance in soccer players and can be improved by training programs that include sessions of 20 to 40 minutes, training two to five times per week for a period of approximately 6 to 9 weeks.[22]

In relation to the training contents, the six systematized studies have based their interventions on exercises that have to do with squats with weights, accelerations and decelerations, leg press, leg extension and plyometrics. These exercises have to do with models dedicated to resistance training, plyometric training and weight lifting.[23]

In general, apparently to produce positive changes in explosive strength in athletes, regardless of the sport modality, the average duration of a mesocycle is 8 to 9 weeks as suggested by Markovic.[24] In the present study we observed from 4 to 10 weeks, which is consistent with what is reported in the literature from 4 to 12 weeks respectively.[24,25]

The evaluation and control of the training process in sports become fundamental to understand the evolution of physical condition and motor skills.[26] In this review it was verified that the 1RM was the one used in 5 investigations and 01 the PSE scale. These findings highlight the importance of properly selecting assessment methodologies to control intensity in explosive strength. Although 1RM can provide a general idea, it is an imperfect predictor of actual intensity, as this can vary from individual to individual.

Therefore, it is crucial to combine various assessment tools to obtain a more accurate and personalized measure when assessing explosive strength. This could optimize training programs, maximizing performance and minimizing the risk of injury.[27]

Resistance training intensity is commonly quantified as

Table 4. *Changes observed in CMJ explosive strength in young futsal players.*

N°	Author (s)	Year	Country	Test	CMJ			
					X	SD	%(δ)	cm
1	Campos *et al.*[15]	2021	Brazil	Pre test Post test	33.4 38	3.7 4.7	13.7	4.6
2	Marques *et al.*[12]	2022	Portugal	Pre test Post test	36.8 39.1	3.9 3.9	6.3	2.3
3	Torrelo *et al.*[13]	2016	Spain	Pre test Post test	34.2 36.2	4.3 4.8	5.8	2
4	Freitas *et al.*[19]	2019	Brazil	Pre test Post test	N/E N/E	N/E N/E	NE	NE
5	Yanci *et al.*[14]	2017	Brazil	Pre test Post test	43.2 38.63	5.23 5.57	10.6	4.6
6	Iodice *et al.*[20]	2020	Italy	Pre test Post test	36.1 38.7	2.47 2.14	7.2	2.6

NS, not specified; %, percentage; X, mean; SD, standard deviation; cm, centimeters.

the load lifted relative to an individual's maximal dynamic strength.[28] Often, optimal prescription of resistance exercise load (kg) is essential for maximal strength development.[29] Although internal load control by means of PSE, which aims to assess the subjective intensity of exertion, tension, discomfort and/or fatigue felt during exercise, is also considered.[30] This method has proven to be effective in training with intense exercises, such as jumps or resistance exercises.[31]

Particularly in futsal, some studies have emphasized the importance of optimizing different components (*i.e.*, body weight, the ability to withstand high-intensity exercise and muscular power in the lower body) during the preseason.[32,33] Therefore, in the daily training link, athletes and coaches should pay sufficient attention to lower limb strength training. For the contraction of muscles, is the main driving force, which are fundamental to the coordination of the whole body.[35]

In essence, intervention programs that aim to increase explosive strength in futsal (CMJ) can help improve speed, agility and the ability to change direction quickly on the field of play and especially produce positive and important changes in overall explosive strength. This can translate into a competitive advantage in situations such as aerial ball contests, shots on goal and defensive actions between competitors.

Explosive strength training programs should take advantage of their full potential to develop the strength-velocity of the neuromuscular system. This allows improving the physical and physiological condition associated with high-level performance. Indeed, in recent years, several studies have evidenced positive effects on morphological characteristics, motor skills such as speed and explosive strength.[36-]

This review suggests that future research should focus on standardizing explosive strength training protocols, considering the observed variability in session duration, frequency and intensity. In addition, it is recommended to investigate the optimal combination of exercises and assessment tools, such as 1RM and Subjective Perception of Exertion (PSE), to further customize training programs and maximize benefits in different athlete populations. From a practical perspective, futsal coaches and trainers can use these findings to design more effective training programs tailored to the specific needs of their players. This could result in a significant improvement in sport performance, particularly in critical skills such as Countermovement Jumping (CMJ).

This systematic review presents some strengths, for example, it is one of the first studies that has verified the criteria that have been used to prescribe explosive strength training and the increases it produces in the CMJ test. The results of this study will be relevant to professionals working in futsal. This information can be used to implement future training programs in youth futsal. It also presents some weaknesses, given that we investigated a 7-year interval (2017 to 2023) and two databases were used (Scopus and WOS), so these could limit the results achieved. Future studies should extend the range of years and cover other databases.

The systematized studies present variability in the training programs, use different training contents and durations, which makes the direct comparison of the results and the identification of a standard protocol difficult. On the other hand, regarding Intensity control, although most studies used 1RM to control intensity, this method may not be an accurate predictor of actual intensity for all individuals. Also, only one study used subjective perception of exertion (PSE). This highlights the need to combine several assessment tools. Also, the variability in program duration (4 to 10 weeks) is highlighted as a limitation, as there is no definitive consensus on the optimal duration to maximize improvements in explosive strength among the systematized studies.

Conclusions

The study demonstrates that the prescription of explosive strength training in futsal players, based on an intensity controlled by 1RM, a frequency of 2 to 3 sessions per week, and a duration of 15 to 30 minutes per session, is effective in improving explosive strength. Training programs that include varied exercises such as barbell squats, accelerations, decelerations, leg press, leg extension, and plyometrics result in significant increases in CMJ performance, with improvements of ∼2.0 to 4.6 cm (5.8% to 13.7%). These results underscore the efficacy of a well-structured approach to explosive strength training in optimizing physical performance in futsal.

List of abbreviations

EST, Explosive Strength Training.
RM, maximum repetitions.
PSE, subjective perception of exertion.
CMJ, countermovement jump test.

Conflict of interest

The authors declare no potential conflict of interest, and all authors confirm accuracy.

Ethics approval and consent to participate

Not aplicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

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Submitted: 1 August 2024.
Accepted: 24 August 2024.
Early access: 17 October 2024.