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Isoinertial training in futsal players: a scoping review of current evidence and research gaps

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ABSTRACT

Futsal demands high-intensity neuromuscular performance, making the optimisation of strength and power crucial. Isoinertial training, known for its eccentric overload, has shown potential to enhance these qualities. This scoping review aimed to map the available literature and identify research gaps regarding the application of isoinertial training in futsal. Following PRISMA-ScR guidelines, searches were conducted across Scopus, Web of Science, and ScienceDirect up to June 2025. Longitudinal intervention studies involving isoinertial training in futsal players and reporting physical performance outcomes were eligible. Study selection, data extraction, and methodological quality assessment using the PEDro scale were conducted by the author. Of 11 records identified, only one controlled trial met the inclusion criteria. This study (PEDro score: 6/10) included 10 semi-professional players and compared 8 weeks of isoinertial training (1 session/week) with bodyweight training. No significant improvements were found in vertical jump performance. However, significant gains were observed in linear speed ($p < .05$; $ES = 1.05$) and change-of-direction speed ($p < .01$; $ES = 6.03$), notably 2 weeks post-intervention. Evidence on isoinertial training in futsal is extremely limited. Preliminary findings suggest it may improve speed-related performance but not jumping ability, highlighting a significant gap in current research.

KEYWORDS: flywheel; futsal; eccentric overload; team sports; physical performance; strength and conditioning.

INTRODUCTION

Futsal is a dynamic and complex team sport characterised by intermittent high-intensity efforts. Time-motion analysis has revealed that players perform a high-intensity action every 20–30 seconds, accumulating significant distances in short sprints (< 10 m), accelerations, sharp decelerations, jumps, and, crucially, numerous changes of direction (Barbero-Alvarez et al., 2008; Naser et al., 2017). This constellation of explosive actions critically depends on a highly developed neuromuscular system, particularly the ability to produce force in fractions of a second (Rate of Force Development, RFD) and the efficiency of the stretch-shortening cycle (SSC) (Sánchez-Sánchez et al., 2017). The SSC, which involves a rapid eccentric phase followed by an immediate concentric contraction, is the underlying physiological mechanism for most explosive actions in sport, allowing for greater power production than a purely concentric contraction (Komi, 2000).

Within this framework, eccentric strength—the muscle's ability to produce force while lengthening—emerges as a fundamental physical quality. It is decisive not only for the "loading" phase of the SSC in jumps and sprints but also for the braking and deceleration phases that precede changes of direction (Spiteri et al., 2014). Furthermore, a greater eccentric strength capacity, especially in the hamstring musculature, has been consistently associated with a reduced risk of muscle injuries, a major concern in team sports (Askling et al., 2003; Opar et al., 2012). Consequently, strength and conditioning programmes that prioritise eccentric overload are of paramount interest for optimising the performance and health of futsal players.

In the last decade, isoinertial training has gained remarkable attention as an advanced methodology specifically designed to maximise eccentric overload (Gonzalo-Skok et al., 2017). Available evidence suggests that this type of training increases the force and speed of muscle responses (Sáez-Michea et al., 2023). Unlike traditional gravitational resistance (e.g., free weights), which is limited by the load that can be lifted concentrically, isoinertial (or flywheel) devices use the inertia

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of a flywheel. The athlete accelerates the flywheel during the concentric phase and must then decelerate and reverse the movement during the eccentric phase, absorbing all the accumulated kinetic energy (Beato & Dello Iacono, 2020). This principle allows for variable, accommodating resistance and, most importantly, an eccentric overload that can significantly exceed the concentric one (Fiorilli et al., 2020; Maroto-Izquierdo et al., 2017). This unique stimulus has been shown to induce superior neuromuscular adaptations, such as changes in muscle architecture (e.g., increased fascicle length), increased muscle-tendon stiffness, and improvements in neural control (Douglas et al., 2017).

The efficacy of isoinertial training in improving jumping, speed, and agility performance has been validated by multiple studies and meta-analyses across a variety of team sports, including basketball, soccer, and volleyball (Buonsenso et al., 2023; Gonzalo-Skok et al., 2017). Despite the clear biomechanical and physiological similarities of futsal with these sports, there is a surprising lack of scientific evidence on its specific application in this discipline. To our knowledge, no systematic review has yet synthesised the experimental literature on this topic. Although some studies have explored the use of flywheel technology for biomechanical analysis in futsal players (Radakovic et al., 2021), its effects as a chronic training modality remain unclear.

Given the scarcity of specific studies observed in preliminary searches, a systematic review regarding efficacy might be premature. Therefore, the objective of this study was to conduct a scoping review to map the existing literature, describe the characteristics of interventions used, and identify critical knowledge gaps regarding isoinertial training in futsal players.

METHODS

This scoping review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR; Tricco et al., 2018).

Eligibility criteria

Eligibility criteria were predefined using the PICO framework (Population, Intervention, Comparison, Outcomes). Longitudinal intervention studies, including randomised controlled trials, non-randomised controlled trials, and single-group pre-post studies, were eligible if they investigated the effects of a supervised isoinertial training programme lasting at least 4 weeks in futsal players of any age or competitive level. Studies with an active or passive comparison group, as well as single-group pre-post designs, were considered eligible. The intervention had to use isoinertial devices (e.g., flywheel) as the primary modality. Studies were required to report at least one quantitative measure of physical performance, such as jumping, sprinting, change-of-direction ability, strength, or flexibility. No language or publication date restrictions were applied to maximise search sensitivity.

Information sources and search strategy

A comprehensive systematic search was conducted in three electronic databases (Scopus, Web of Science, ScienceDirect) in June 2025. The search strategy combined keywords for the population (futsal OR "indoor soccer") and the intervention (isoinertial OR flywheel OR "yo-yo technology" OR "eccentric overload") using Boolean operators. The search syntax was adapted for each database. Additionally, the reference lists of included articles were reviewed to identify potential studies (snowball search).

Selection process and data extraction

All identified records were imported into the Mendeley reference management software to remove duplicates. Subsequently, the author performed a two-phase screening process. First, the titles and abstracts of all records were evaluated. Next, the full text of potentially relevant articles was retrieved for a final eligibility assessment. Data extraction was conducted using a standardised spreadsheet that included information on participants, the intervention protocol, outcome variables, and main findings. Any uncertainties arising during the process were resolved through a re-evaluation of the eligibility criteria and the relevant full-text reports.

Methodological quality assessment

The methodological quality of the included study was assessed by the author using the PEDro scale, which comprises 11 items and yields a total score ranging from 0 to 10 because the first item is not included in the total score. This scale assesses the risk of bias in clinical trials using criteria such as randomisation, blinding, and participant follow-up.

RESULTS

Study selection

The search and selection process is detailed in the PRISMA flow diagram (Figure 1). The initial search yielded 11 records. After screening titles and abstracts, 8 articles were excluded,

primarily because they did not meet the population or intervention criteria. The full text of the remaining 3 articles was assessed for eligibility. Of these, 2 reports were excluded: one for not applying an isoinertial intervention and another for having an acute study design rather than a chronic training programme. Finally, a single controlled trial (Sánchez-Sánchez et al., 2017) met all inclusion criteria and was included in the qualitative synthesis.

Characteristics and methodological quality of the included study

The characteristics of the included study are summarised in Table 1. The study by Sánchez-Sánchez et al. (2017) was a controlled trial involving 10 semi-professional futsal players, which compared an 8-week isoinertial training programme (GMAQ) with a bodyweight training control group (GAUT). The study obtained a PEDro score of 6/10.

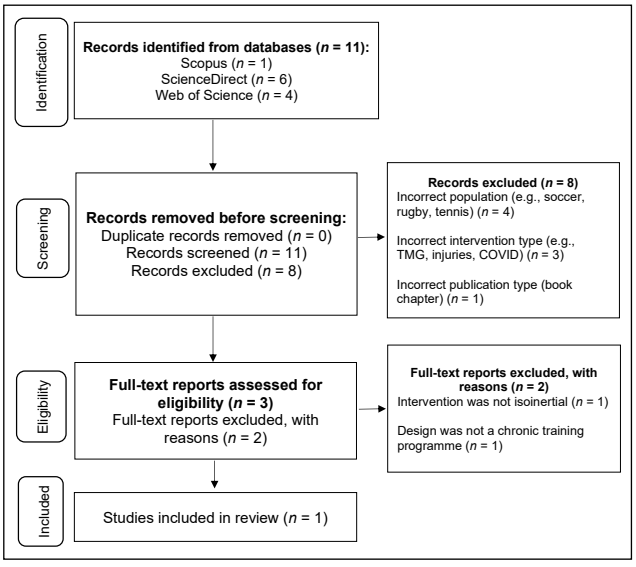


Figure 1. PRISMA flow diagram of the study selection process.

The study demonstrated strengths in randomisation, baseline group comparability, and statistical analysis, but it lacked allocation concealment and blinding, which are common limitations in exercise research.

Vertical jump performance

The within-group analysis revealed no statistically significant improvements in the Squat Jump (SJ) or the Countermovement Jump (CMJ) for the isoinertial training group (GMAQ) at any time point (post-test or re-test) compared to baseline values. The between-group analysis also showed no significant differences between the isoinertial and the control group.

Linear and change of direction speed

The isoinertial group (GMAQ) showed no significant improvements in linear speed (30 m sprint) immediately after the intervention. However, a statistically significant improvement was observed at the re-test measurement (2 weeks post-intervention) with a large effect size ($p < .05$; $ES = 1.05$). The most pronounced improvement was observed in change-of-direction speed, with a statistically significant within-group improvement at re-test compared with baseline ($p < .01$) and a very large effect size (ES = 6.03).

DISCUSSION

The objective of this scoping review was to identify, critically appraise, and synthesise the experimental evidence on the effects of isoinertial training on the physical performance of futsal players. The most significant and compelling finding of this work lies not in the synthesis of multiple studies, but in the revelation of an extreme scarcity of research in this area. Despite a systematic and rigorous search across three major databases, only a single controlled trial met the

Table 1. Characteristics and results of the study included in the scoping review.

Study	Participants	Intervention & Comparison	Duration & Frequency	Outcome Measures	Main Results	Quality (PEDro)
Sánchez-Sánchez et al. (2017)	*n* = 10 male semi-professional futsal players (Second Division B). Age: 23.7 ± 5.5 years.	IG (*n* = 5): Isoinertial training with eccentric overload (KBox® and Versapulley® devices). CG (*n* = 5): Bodyweight training with auxiliary equipment (TRX, fitball).	8 weeks 1 session/week	• Vertical jump (SJ, CMJ) • Linear speed (30 m) • Change of direction speed (V-cut) • Flexibility (Sit-and-Reach)	Between-group: = No significant differences between IG and CG in any variable. Within-group (IG): ↑ Linear speed (only at re-test; $p < .05$) ↑ Change of direction speed (only at re-test; $p < .01$) = No changes in vertical jump.	6/10

IG: Isoinertial Group; CG: Control Group; SJ: Squat Jump; CMJ: Countermovement Jump; ↑: Statistically significant improvement; = No statistically significant change.

inclusion criteria. This fact alone constitutes a highly relevant conclusion, underscores the originality and necessity of this review, and highlights a concerning disconnect between sports practice and scientific research.

The single included study (Sánchez-Sánchez et al., 2017), which obtained a PEDro score of 6/10, offers a preliminary yet informative insight. Its findings suggest that a low-frequency (1 session/week) isoinertial training programme over 8 weeks can induce significant improvements in linear speed and, more notably, in change-of-direction speed in futsal players. Curiously, these effects were not immediate but emerged two weeks after the cessation of the stimulus (re-test). This delayed response may reflect the time required for recovery and the manifestation of neuromuscular adaptations following eccentric-overload training; however, this interpretation remains speculative because it is based on findings from a single study. Eccentric-overload exercise may induce muscle damage and transient neuromuscular fatigue, potentially extending the recovery period before performance adaptations become fully apparent (Hody et al., 2019).

On the other hand, the absence of improvements in vertical jump performance (CMJ and SJ) in the same study presents an interesting dichotomy. This finding may be partly explained by the principles of movement and force-vector specificity. The training protocol, focused on squats and pulls, may have had greater transfer to horizontal force-production movement patterns (sprinting, braking, and re-acceleration during changes of direction) than to predominantly vertical ones (jumping) (Contreras et al., 2015). Furthermore, the improvement in change-of-direction ability, a task that relies substantially on efficient deceleration, is consistent with the capacity of isoinertial training to emphasise the eccentric phase of movement (Spiteri et al., 2014).

The true scale of the research gap in futsal is revealed when comparing these findings with the robust evidence available in analogous sports. Evidence from systematic reviews across different sports suggests that flywheel training may improve several sport-specific performance outcomes, although the magnitude and consistency of these effects vary according to the population, exercise selection, and training protocol (Buonsenso et al., 2023). Studies conducted in other team sports have reported improvements in vertical jump, sprint performance, change-of-direction ability, and other neuromuscular outcomes following eccentric-overload training (Gonzalo-Skok et al., 2017; Fiorilli et al., 2020). This body of external evidence supports the rationale for investigating isoinertial training in futsal and further highlights the scarcity of sport-specific research.

It is crucial, however, to critically analyse the limitations of the only available study. The small sample size of the included study (n = 10) represents a major limitation and increases the risk of a Type II error, that is, failing to detect a genuine effect because of insufficient statistical power. The limited statistical power associated with this small sample may partly explain the absence of statistically significant between-group differences. Moreover, the low training frequency (1 session/week), though pragmatic in a competitive setting, might have been insufficient to maximise adaptations, especially for complex variables such as jump power (de Hoyo et al., 2016; de Keijzer et al., 2021).

Furthermore, the study selection and data extraction process were conducted by a single reviewer. Although systematic, this approach may increase the risk of bias, and future reviews should incorporate a dual-reviewer process to enhance methodological rigour.

Given the very limited evidence, strength and conditioning coaches may cautiously consider isoinertial training as a complementary stimulus targeting linear speed and change-of-direction performance. However, the available evidence is insufficient to establish an optimal weekly frequency or confirm that one session per week is effective across different futsal populations. Any practical application should therefore be accompanied by caution and individual monitoring because the current findings are based on a single study.

Future research agenda

To address the critical gaps identified in this scoping review, the following research avenues are proposed:

- Target Populations: Research is urgently needed on female futsal players and youth academy athletes, as current evidence is restricted solely to adult male semi-professional players;
- Dose-Response Protocols: Future Randomised Controlled Trials (RCTs) should compare different training frequencies (e.g., 1 vs 2 sessions per week) to identify the minimum effective dose that optimises performance without interfering with technical-tactical training loads;
- Injury Prevention: Longitudinal studies are required to assess whether the eccentric overload provided by isoinertial training effectively reduces the incidence of muscle injuries (specifically hamstring strains) over a full competitive season in futsal;
- Methodological Comparisons: Direct comparisons between flywheel training and traditional gravity-based resistance training (e.g., traditional weight training) are necessary to determine whether isoinertial devices offer superior transfer to futsal-specific tasks such as cutting and braking.

CONCLUSION

This scoping review aimed to synthesise the experimental evidence on the efficacy of isoinertial training for improving physical performance in futsal players. The primary and most compelling finding is that the current evidence base is extremely scarce, limited to a single controlled trial.

The preliminary findings from this study suggest that a low-frequency isoinertial training programme may be a promising strategy for inducing significant improvements in linear speed and, most notably, change-of-direction ability, although it does not appear to affect vertical jump capacity. However, the most important conclusion of this review is not the intervention's efficacy, but the identification of a critical gap in the sports science literature. There is a clear disconnect between the evidence supporting isoinertial training in other team sports and its almost complete absence in futsal research.

Therefore, while a potential benefit of isoinertial training can be inferred, caution is warranted. It is imperative that the scientific community addresses this lack of research by designing and conducting high-quality randomised controlled trials. Only then can these preliminary findings be confirmed, evidence-based training protocols be established, and futsal players and coaches make informed decisions about the safe and effective use of this training technology.

Supplementary Material

Supporting information for this article is available online. The supplementary material includes a summary of the methodological process:

Table S1: Complete search strategies used in each database.

Table S2: List of studies excluded during the full-text review stage with reasons for exclusion.

Table S3: Detailed risk of bias assessment (PEDro Scale) for the included study.

Furthermore, to promote maximum transparency and reproducibility, the complete set of review materials, including the bibliographic search record (Screening.ris) and the article screening matrix (Screening.html), has been openly deposited in the Open Science Framework (OSF) and can be accessed via the following link: https://osf.io/kecwn/files/osfstorage?view_only=98ff815ad17d4bfcb25206e1956c3d54

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Erwin Farid Peña Ardila — Conceptualization; Methodology; Formal analysis; Investigation; Data curation; Writing – original draft; Writing – review & editing; Visualization; Project administration.

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