INPLASY

The Impact of Brain Endurance Training on Athletes' Performance - A Systematic Review

INPLASY202610050
doi: 10.37766/inplasy2026.1.0050
Received: 15 January 2026
Published: 15 January 2026

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ADMINISTRATIVE INFORMATION

Support - No financial support.

Review Stage at time of this submission - The review has not yet started.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202610050

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 15 January 2026 and was last updated on 15 January 2026.

INTRODUCTION

Review question / Objective Review question What are the effects of brain endurance training on athletic performance outcomes in athletes compared with control conditions?

Objective The objective of this systematic review is to systematically evaluate and synthesize the available evidence on the effects of brain endurance training on athletic performance outcomes in athletes. Specifically, this review aims to examine whether brain endurance training improves physical, technical, and cognitive performance compared with control conditions, and to explore potential moderating factors such as sport type, training duration, and performance outcome domains.

Rationale Brain endurance training has been proposed as a novel training strategy aimed at enhancing athletes' tolerance to prolonged cognitive demands and mental fatigue during sport performance. In many sports, especially those requiring sustained attention, decision-making, and technical execution under pressure, mental fatigue has been shown to impair physical output, technical skills, and cognitive efficiency. As a result, interventions targeting the central nervous system and cognitive fatigue have gained increasing interest in sport science research.

In recent years, a growing number of experimental studies have investigated the effects of brain endurance training on various athletic performance outcomes, including endurance capacity, technical performance, reaction time, and decision-making. However, the findings across studies are inconsistent, likely due to differences in sport type, training protocols, outcome measures, and study design. Moreover, existing narrative reviews often focus on mental fatigue or cognitive training in general, rather than systematically evaluating brain endurance training as a distinct intervention targeting sport-specific performance.

To date, no comprehensive systematic review has synthesized the available evidence on the effects of brain endurance training on athletic performance outcomes across different sports and performance domains. Therefore, a systematic synthesis of the current literature is warranted to clarify the effectiveness of brain endurance training, identify potential moderators of training effects, and provide evidence-based guidance for researchers and practitioners.

Condition being studied Mental fatigue induced by sustained cognitive demands during sport participation and training, and its impact on athletic performance.

METHODS

Search strategy A systematic literature search will be conducted in the following electronic databases: PubMed, Web of Science, Embase, Scopus, SPORTDiscus, and the Cochrane Library. In addition, reference lists of relevant studies and reviews will be manually screened to identify potential eligible articles.

The search strategy will combine terms related to brain endurance training, mental fatigue, and athletic performance using Boolean operators. Key search terms will include: ("brain endurance training" OR "cognitive endurance training" OR "mental endurance training" OR "cognitive fatigue training" OR "mental fatigue training") AND ("athletic performance" OR "sport performance" OR "physical performance" OR "technical performance" OR "decision making" OR "reaction time") AND ("athlete" OR "sport*").*

No restrictions will be applied regarding publication year. Only studies published in peer-reviewed journals and written in English will be considered.

Participant or population Trained athletes of any sex and age who regularly participate in organized competitive sports.

Intervention Brain endurance training, defined as structured training protocols combining prolonged or repeated cognitively demanding tasks with concurrent or subsequent physical exercise, designed to enhance tolerance to mental fatigue and improve sport-related performance.

Comparator Control conditions including usual training, passive control, sham or neutral cognitive tasks, or alternative non–brain endurance training interventions.

Study designs to be included Randomized controlled trials, non-randomized controlled trials, and crossover experimental studies that evaluate the effects of brain endurance training on athletic performance.

Eligibility criteria

Inclusion criteria:
(1) Participants are athletes of any sex, age, or competitive level who participate in organized sports;
(2) Studies investigate brain endurance training as the primary intervention, defined as structured protocols involving prolonged or repeated cognitively demanding tasks combined with physical exercise;
(3) Studies include a control or comparator condition (e.g., usual training, passive control, or sham/neutral cognitive tasks);
(4) At least one athletic performance outcome is reported, including physical, technical, or cognitive performance measures;
(5) Experimental study designs, including randomized controlled trials, non-randomized controlled trials, or crossover experimental studies;
(6) Studies are published in peer-reviewed journals and written in English.

Exclusion criteria:
(1) Studies involving non-athlete or recreationally active participants only;
(2) Interventions focusing solely on cognitive training, neurofeedback, or brain stimulation without a physical exercise component;
(3) Observational studies, case reports, case series, conference abstracts, editorials, or review articles;
(4) Studies not reporting relevant athletic performance outcomes;
(5) Animal studies.

Information sources The following electronic databases will be searched: PubMed, Web of Science, Embase, Scopus, SPORTDiscus, and the Cochrane Library. In addition, reference lists of included studies and relevant review articles will be manually screened to identify additional eligible studies.

Main outcome(s) The primary outcomes will be athletic performance measures, including physical performance (e.g., endurance capacity, strength, power, speed, and agility), technical performance (e.g., sport-specific skills such as passing, shooting, accuracy, and execution quality), and cognitive performance relevant to sport (e.g., reaction time, decision-making, and attentional performance).

Quality assessment / Risk of bias analysis A modified version of the Quality Index Scale (Downs and Black, 1998), which reduced the number of evaluation questions from the original 24 to 14.

Strategy of data synthesis A narrative synthesis will be conducted to summarize and integrate the findings of all included studies. The results will be organized and presented according to sport type, brain endurance training characteristics (e.g., training duration and cognitive task type), and performance outcome domains (physical, technical, and sport-related cognitive performance).
Where appropriate, studies will be grouped based on similarities in study design, participant characteristics, interventions, and outcome measures to facilitate structured comparison across studies. The direction and consistency of effects will be qualitatively described rather than statistically pooled.
Methodological quality will be considered in the interpretation of findings, with greater weight given to studies of higher quality. Due to expected heterogeneity in interventions, outcome measures, and study designs, quantitative synthesis (meta-analysis) will not be performed.

Subgroup analysis Subgroup analyses will be conducted using a qualitative approach. Where sufficient information is available, findings will be compared across subgroups defined by sport type (team vs. individual sports), brain endurance training characteristics (training duration and cognitive task type), and performance outcome domains (physical, technical, and sport-related cognitive performance). Differences in the direction and consistency of effects across subgroups will be descriptively summarized.

Sensitivity analysis Sensitivity analyses will be conducted using a qualitative approach to assess the robustness of the findings. The main conclusions will be re-examined after excluding studies with lower methodological quality or higher risk of bias. In addition, sensitivity analyses may be performed by restricting the synthesis to randomized controlled trials or studies with longer training duration, where applicable. Any changes in the direction or consistency of findings will be descriptively reported.

Country(ies) involved China.

Keywords Brain Endurance Training; Athletes; performance; Sport.

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