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Acute Responses and Long-Term Adaptations to Resistance Training: A Systematic Review and Meta-Analysis

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ADMINISTRATIVE INFORMATION

Support - No funding support.

Review Stage at time of this submission - Preliminary searches.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 17 October 2025 and was last updated on 17 October 2025.

INTRODUCTION

Review question / Objective 1. What are the acute effects of cluster resistance training on athletes' strength, power, fatigue, and physiological
responses?
2. Compared to traditional set structures, what are the chronic adaptive changes in athletic performance and neuromuscular outcomes from clustertraining?
3. Which moderating factors (e.g., rest intervals, intensity, training duration, athlete level) influence these acute and chroniceffects?

Rationale Resistance training (RT) is designed to induce muscular tension through external loads, leading to improvements in strength, power, and muscle morphology. Traditional set structures (TS) typically involve performing multiple repetitions consecutively (e.g., 8–12 reps) followed by a longer rest period. While this approach effectively induces metabolic stress and mechanical tension, it often results in rapid fatigue accumulation, which may reduce power output and movement quality across repetitions.

Condition being studied Resistance training (RT) is one of the fundamental methods used to enhance athletes' strength, power, speed, and overall physical performance. Systematic RT induces both neural and morphological adaptations, thereby improving athletic capacity and competitive performance. For high-level athletes, optimizing training structure and load distribution is crucial for maximizing performance gains and minimizing excessive fatigue.

METHODS

Search strategy Search the following databases: PubMed/EMBASE, Web of Science, Google Scholar, CNKI, SCOPUS, and SportDiscus electronic databases. Conduct keyword searches by title using: ("bottleneck training" or "group training" or "interval group training" or "resistance training" or "strength training") AND ("acute response" or "physiological response" or "fatigue"

or “strength” or “speed” or ‘power’ or “long-term adaptation” or “neuromuscular adaptation” or “training effect”). After removing irrelevant and duplicate items, the initial screening yielded literature consistent with this study.

Participant or population This analysis will consider studies involving healthy male and female athletes or other populations. Studies involving individuals with acute injuries, chronic conditions, or contraindications to exercise will be excluded.

Intervention The intervention was cluster-set training (CST), defined as high-intensity interval resistance training.

Comparator Traditional continuous resistance training served as the control group, with both groups matching in exercise type, intensity, and training volume, differing only in rest intervals.

Study designs to be included Including randomized controlled trials (RCTs), controlled clinical trials, and crossover studies.

Eligibility criteria Inclusion Criteria: (1) Healthy individuals and athletes; (2) Participants with resistance training experience, free from severe diseases, injuries, or neuromuscular disorders; (3) Intervention involving training using the polyphasic training method; (4) Control group undergoing traditional training or other training methods.
Exclusion Criteria: (1) Studies involving injured athletes; (2) Studies lacking a control group; (3) Non-human studies; (4) Non-English articles; (5) Studies without test results.

Information sources This review was conducted based on the PRISMA guidelines for search strategies, eligibility criteria, article selection, and data extraction.

Main outcome(s) To compare physiological and performance changes induced by Convergent Strength Training (CST) versus Traditional Resistance Training (TRT). These include neuromuscular performance (average power, peak power), physiological metabolic responses (blood lactate concentration, heart rate), subjective responses (PRE, perceived exertion), maximum strength (1RM test), and explosive power (CMJ, power output, velocity).

Additional outcome(s) Secondary outcomes may include hormonal response; restoration of sensory function; training efficiency and technical stability.

Data management Two independent authors screened titles and abstracts using the data retrieval strategy, while two authors independently reviewed full texts for eligibility. Discrepancies were resolved through coordinated discussion within a review panel.

Quality assessment / Risk of bias analysis Quality assessment of included studies using the Cochrane Risk of Bias tool in Review Manager 5.4 comprises seven domains: ① Random sequence generation; ② Allocation concealment; ③ Blinding of personnel and participants; ④ blinding of outcome assessment; ⑤ completeness of outcome data; ⑥ selective reporting; ⑦ other sources of bias. Each domain is rated as “high risk,” “low risk,” or “unclear” for risk of bias.

Strategy of data synthesis Statistical analysis will employ a meta-analysis using a random-effects model, comparing the primary outcome differences between cluster-based resistance training (CST) and traditional resistance training (TRT) using standardized mean differences (SMD) and 95% confidence intervals (CI). Research heterogeneity will be assessed using Cochran’s Q test and the I^2 statistic; the random-effects model will be used when $I^2 \geq 50\%$, otherwise the fixed-effects model will be employed. Subgroup and sensitivity analyses will be conducted based on training cycles, athlete types, etc. Data that cannot be quantified will be synthesized descriptively. Publication bias will be evaluated using funnel plots and Egger’s test. All analyses were performed using RevMan 5.4 and Stata 17.0 software.

Subgroup analysis Subgroup analyses based on available data included acute/long-term training studies, training level, gender, sport type, training cycle duration (short-term ≤6 weeks, medium-term 7–12 weeks, long-term >12 weeks), training intensity, intra-set rest duration (short ≤15 s, medium 16–30 s, long >30 s), and outcome type.

Sensitivity analysis Sensitivity analysis will assess the impact of study quality and risk of bias, publication status, statistical model selection, and methods for handling missing data.

Language restriction Only studies published in English were included.

Country(ies) involved China.

Keywords Resistance training; Acute response; Long-term adaptation; Systematic review; Meta-analysis.

Contributions of each author

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