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Effects of core training on balance in older adults: a systematic review and meta-analysis

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ADMINISTRATIVE INFORMATION

Support - This research was supported by Jiangxi University of Science and Technology. The funding provided essential resources and support for the design, execution, and completion of this study, including access to academic databases, software for data analysis, and other research-related expenses.

Review Stage at time of this submission - Data analysis.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY2024120007

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 2 December 2024 and was last updated on 2 December 2024.

INTRODUCTION

Review question / Objective This systematic review and meta-analysis aim to evaluate the effects of core training on balance among healthy older adults. Utilizing the PICOS framework, the research question is defined as follows:

Population (P): The target population consists of healthy older adults aged 60 years or older, free from significant cognitive impairments, orthopedic problems, neurological disorders, or other mobility-restricting comorbidities. This demographic is selected to assess the impact of core training on balance without the interference of severe health conditions that may affect physical performance.

Intervention (I): Core training interventions are specifically isolated and explicitly discussed, including core stability exercises, core resistance training, and similar modalities, with a minimum duration of 4 weeks. These interventions focus on strengthening the core musculature to improve balance.

Comparison (C): Comparisons are made between intervention groups and control groups, or within single-group trials. The control groups may follow routine training or no training programs.

Outcomes (O): The primary outcome is the assessment of at least one behavioral balance measure, such as dynamic balance, static balance, functional balance, or postural balance. Tools like the Functional Reach Test (FRT), Star Excursion Balance Test (SEBT), or other validated measures are used to evaluate improvements in balance.

Study Design (S): Eligible study designs include randomized controlled trials (RCTs) and single-group trials that adhere to experimental methodologies, ensuring robust evidence to address the review question.

The objective of this review is to synthesize existing evidence and quantitatively determine the effectiveness of core training in enhancing balance

among older adults. By focusing on well-defined inclusion criteria, the study aims to identify trends, evaluate the strength of current findings, and provide actionable insights for designing interventions to promote balance and reduce fall risks in the aging population.

Condition being studied This study investigates the impact of core training interventions on balance in healthy older adults. Balance impairments are a prevalent concern in the aging population, often leading to an increased risk of falls, reduced functional mobility, and diminished quality of life. Maintaining balance is critical for older adults to sustain independence in daily living and to prevent fall-related injuries, which are a major public health concern globally.
Core training has been recognized as a potential intervention to improve balance by targeting the deep trunk muscles, which are essential for postural stability and movement coordination. Despite the growing interest in core stability exercises, there is a lack of consensus on their efficacy in enhancing balance outcomes among older adults. This study specifically focuses on interventions lasting at least four weeks and examines their effects on various balance measures, such as static balance, dynamic balance, functional balance, and postural control.
By synthesizing evidence from randomized controlled trials and single-group trials, this systematic review and meta-analysis aim to provide a comprehensive evaluation of the role of core training in mitigating balance impairments and its potential application in preventive and rehabilitative strategies for older adults.

METHODS

Participant or population Population (P): The target population consists of healthy older adults aged 60 years or older, free from significant cognitive impairments, orthopedic problems, neurological disorders, or other mobility-restricting comorbidities. This demographic is selected to assess the impact of core training on balance without the interference of severe health conditions that may affect physical performance.

Intervention Intervention (I): Core training interventions are specifically isolated and explicitly discussed, including core stability exercises, core resistance training, and similar modalities, with a minimum duration of 4 weeks. These interventions focus on strengthening the core musculature to improve balance.

Comparator Comparison (C): Comparisons are made between intervention groups and control groups, or within single-group trials. The control groups may follow routine training or no training programs.

Study designs to be included Study Design (S): Eligible study designs include randomized controlled trials (RCTs) and single-group trials that adhere to experimental methodologies, ensuring robust evidence to address the review question.

Eligibility criteria Prominent academic databases were considered to search the related literature, including Ebscohost, Scopus, PubMed, Web of Science, as well as Google Scholar, until 30th Nov 2024. For each independent database, a strategic search query was conducted by the title and abstract. The primary keywords considered for gathering related studies were: (“Core Strength Training” OR “Core-Muscle Training” OR “Core training” OR “Core-Stability Exercise” OR “Core Exercise”) AND (“balance” OR “static balance” OR “dynamic balance” OR “functional balance” OR “postural balance”) AND (“old” OR “aged” OR “senior” OR “elder”).

Information sources Prominent academic databases were considered to search the related literature, including Ebscohost, Scopus, PubMed, Web of Science, as well as Google Scholar, until 30th Nov 2024. For each independent database, a strategic search query was conducted by the title and abstract.

Main outcome(s) The studies included in this review were published between 2013 and 2024, with their characteristics summarized in Table 2. The research was conducted in various countries, including Italy, Germany, South Korea, the United States, Spain, and France, collectively involving a total of 309 older adults. Key characteristics of the studies are outlined below:
1) Gender: Four studies specifically focused on female participants , while the remaining studies included mixed-gender samples.
2) Age: All studies reported participant age, with a range of 60 to 85 years identified across the eight studies.
3) Interventions: Regarding the interventions, five studies employed core training methods such as core muscle training, core instability strength training, core resistance training, or core stability training. The remaining three studies incorporated Pilates-based core training approaches.
4) Training Frequency: All studies reported the frequency of training sessions, which ranged from 1 to 3 sessions per week.

5) Training Duration per Session: The duration of each training session varied between 20 and 60 minutes across all studies.
6) Intervention Duration: The total intervention periods ranged from 6 to 18 weeks, as reported in all included studies.

Quality assessment / Risk of bias analysis Two independent review authors (WG and YZ) independently evaluated the risk of bias of the includedarticles using Cochrane's risk of bias tool. CochraneRisk of Bias checklistconsisted of six items: (1) selection bias, (2) performance bias, (3) detection bias, (4) attrition bias (5), reporting bias and (6) other biases. In cases where there was disagreement, consensus was achieved through discussion between the authors or by consulting a third author.

Strategy of data synthesis The data synthesis process for this meta-analysis was conducted using RevMan (version 5.4) and Stata (version 17.0). The following steps outline the analytical approach and tools employed for the synthesis:
1. Risk of Bias Assessment:
The risk of bias for the included studies was evaluated using the Cochrane Risk of Bias tool within RevMan. Each study was assessed across six domains: selection bias, performance bias, detection bias, attrition bias, reporting bias, and other potential biases. The results were visualized in risk of bias graphs and summary tables generated by RevMan, facilitating an intuitive understanding of methodological quality.
2. Effect Size Calculation:
For continuous outcomes, the mean difference (MD) or standardized mean difference (SMD) with 95% confidence intervals (CIs) was calculated to measure the effect size. Stata was used for this purpose due to its robust statistical capabilities, ensuring precise computation and flexibility in managing heterogeneous datasets.
3. Heterogeneity Analysis:
Statistical heterogeneity among studies was assessed using the I^2 statistic and Chi-square test. I^2 values above 50% indicated substantial heterogeneity. Depending on the degree of heterogeneity, a fixed-effects model or a random-effects model was applied. Stata's meta-analysis functions were utilized for this analysis, providing detailed insights into the consistency of study results.
4. Subgroup Analysis:
Subgroup analyses were conducted to explore potential sources of heterogeneity, such as differences in gender, intervention duration, or types of core training. These analyses were performed in Stata to evaluate whether these factors influenced the intervention effects on balance outcomes.
5. Publication Bias:
Publication bias was examined using funnel plots and Egger's regression test in Stata. The funnel plot asymmetry was interpreted to assess whether smaller studies with non-significant findings were underreported, ensuring the reliability of the pooled estimates.
6. Sensitivity Analysis:
Sensitivity analyses were conducted to evaluate the robustness of the findings. This involved sequentially excluding individual studies and recalculating the pooled effect size to determine the stability of the results.
7. Graphical Representation:
Forest plots were generated in RevMan to visually present the effect sizes and confidence intervals for each study, as well as the overall meta-analytic results. These plots provided a clear and concise summary of the data synthesis.

Subgroup analysis Subgroup analyses were conducted to explore potential sources of heterogeneity, such as differences in gender, intervention duration, or types of core training. These analyses were performed in Stata to evaluate whether these factors influenced the intervention effects on balance outcomes.

Sensitivity analysis Sensitivity analyses were conducted to evaluate the robustness of the findings. This involved sequentially excluding individual studies and recalculating the pooled effect size to determine the stability of the results.

Country(ies) involved China - Jiangxi University of Science and Technology.

Keywords Balance, Core training, Older adults, Pilates training, Fall prevention.

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