# INPLASY

## Impact of Resistance Training on Bone Mineral Density in Postmenopausal Women: A Meta-Analysis

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## INTRODUCTION

**R**eview question / Objective The primary objective of this systematic review and meta-analysis is to determine the impact of resistance training on bone mineral density (BMD) in postmenopausal women, with a focus on elucidating the effects across different intensities, durations, frequencies, and periods of training on various skeletal sites.

The review question can be articulated as follows:

"What is the effect of resistance training, in terms of varying intensities, durations, frequencies, and periods, on bone mineral density at the lumbar spine (LS), femoral neck (FN), total hip (TH), and trochanter (Troch) in postmenopausal women?"

The objectives of the review are to:

1. **Assess the efficacy**: To assess the efficacy of resistance training in improving BMD across specified skeletal sites in postmenopausal women.

2. **Explore variations**: To explore variations in the impact of resistance training based on different training parameters (intensity, duration, frequency).

3. **Identify optimal regimens**: To identify the most effective training regimens that could potentially optimize BMD outcomes in the studied population.

4. **Synthesize evidence**: To synthesize the existing evidence from randomized controlled trials (RCTs) to provide a comprehensive understanding of the benefits of resistance training on BMD.

5. **Guide clinical practice**: To guide the development of evidence-based exercise intervention programs for postmenopausal women aimed at improving bone health and reducing the risk of osteoporotic fractures.

6. **Address knowledge gaps**: To address the current gaps in knowledge regarding the optimal parameters of resistance training for enhancing BMD in postmenopausal women.

7. **Influence policy and recommendations**: To inform policy and recommendations for exercise

and physical activity in postmenopausal women's health and wellness programs.

By addressing these objectives, the systematic review and meta-analysis aim to provide a robust evidence base to support the role of resistance training as a non-pharmacological intervention for the prevention and management of osteoporosis in postmenopausal women.This meta-analysis aims to explore the effects of resistance training on bone mineral density (BMD) in postmenopausal women, specifically focusing on different training intensities, durations, frequencies, and periods, across various skeletal sites lumbar spine(LS), femoral neck (FN), total hip (TH), and trochanter (Troch).

**Condition being studied** The condition being studied in this systematic review and meta-analysis is osteoporosis in postmenopausal women, with a specific focus on the effects of resistance training on bone mineral density (BMD) across various skeletal sites. Osteoporosis is a chronic condition characterized by low bone mass and deterioration of bone tissue, leading to increased bone fragility and a higher risk of fractures, particularly of the spine, hip, and wrist. Postmenopausal women are at an elevated risk due to hormonal changes that accelerate bone loss.

The primary outcomes of interest include changes in BMD at specific skeletal sites, namely the lumbar spine (LS), femoral neck (FN), total hip (TH), and trochanter (Troch), as these areas are commonly affected by osteoporotic fractures. The review aims to investigate whether resistance training can mitigate the decline in BMD and thus potentially reduce the risk of osteoporosis-related fractures in this population.

The study also explores various factors that may influence the effectiveness of resistance training on BMD, such as training intensity, duration, frequency, and the specific period of the training program. By examining these factors, the review seeks to identify the most effective resistance training modalities for improving BMD in postmenopausal women.

The systematic review and meta-analysis will contribute to the existing literature by providing a comprehensive synthesis of the available evidence on the impact of resistance training on BMD in postmenopausal women. The findings have implications for the development of exercise intervention programs aimed at preventing osteoporosis and improving the quality of life for postmenopausal women.

## METHODS

**Participant or population** The patient, participant, or population under study in this systematic review and meta-analysis is specifically postmenopausal women. This population is of interest due to the increased risk of developing osteoporosis and experiencing bone mineral density (BMD) loss following menopause, which is associated with a decline in estrogen levels. The study aims to explore the effects of resistance training as a potential intervention to mitigate these risks and improve bone health in this demographic.

Key characteristics of the population include:

1. Postmenopausal Status: Women who have not experienced menstrual periods for at least 12 months or have undergone surgical menopause, indicating the end of their reproductive years.

2. Age: Typically, women aged 50 years or above, reflecting the standard definition of menopause and the age when postmenopausal bone loss becomes more pronounced.

3. Exclusion of Certain Health Conditions: Women without other health conditions that could confound the results, such as hypertension, diabetes, or cardiovascular diseases, as per the inclusion and exclusion criteria outlined in the systematic review.

4. Resistance Training Naive: Women who have not participated in any structured resistance training programs prior to the study, ensuring the resistance training intervention is the primary focus of the analysis.

5. Diverse Ethnicity and Nationality: The population is intended to be diverse, including women from different racial and ethnic backgrounds to generalize the findings broadly.

6. Inclusion in Randomized Controlled Trials (RCTs): Women who are participants in RCTs that evaluate the impact of resistance training programs on BMD, ensuring a high level of evidence for the review.

By focusing on postmenopausal women, this systematic review and meta-analysis aim to provide insights into how resistance training may influence BMD and contribute to the prevention and treatment of osteoporosis in this at-risk population.

**Intervention** The intervention under investigation in this systematic review and meta-analysis is resistance training, which is a type of exercise that involves the use of resistance to induce muscular contractions. This can include a variety of methods such as weight lifting, bodyweight exercises, resistance band training, and the use of resistance machines. The primary goal of resistance training in this context is to improve muscle strength and

bone mineral density (BMD) in postmenopausal women. The intervention is expected to vary in terms of intensity, duration, frequency, and the specific period of training, which will be assessed for their impact on BMD across different skeletal sites.

**Comparator** The comparator group in this study consists of postmenopausal women who do not participate in the resistance training program but may engage in normal daily physical activities or other non-resistance forms of exercise. This control group serves as a baseline to compare the effects of the resistance training intervention against. By contrasting the outcomes in the intervention group with those in the comparator group, the review aims to determine the effectiveness of resistance training in improving BMD in postmenopausal women.

**Study designs to be included** Randomized Controlled Trials (RCTs): These are considered the gold standard for evaluating the efficacy of an intervention. RCTs involve randomly assigning participants to either the intervention or control group, which helps to minimize bias.

**Eligibility criteria** Eligibility criteria: The eligibility criteria for study selection will be based on the PICOS framework:
Population (P): Postmenopausal women without other conditions that could affect bone metabolism, such as metabolic bone diseases other than osteoporosis.
Intervention (I): Resistance training programs of various intensities, durations, and frequencies.
Comparator (C): Non-exercising control groups or groups performing different types of exercise that do not include resistance training.
Outcomes (O): Changes in bone mineral density (BMD) measured at the lumbar spine (LS), femoral neck (FN), total hip (TH), and trochanter (Troch).
Study Design (S): Randomized controlled trials (RCTs) .
Publication Status: Published and peer-reviewed articles.
Language: Studies published in English language.
Date Range: Studies published from the inception of the databases up to a defined cut-off date.
Exclusion Criteria: Studies with insufficient data, non-relevant populations (e.g., premenopausal women, men), and non-comparative studies.
Risk of Bias: Studies with a high risk of bias as assessed by the Cochrane Risk of Bias tool or other appropriate criteria will be excluded.
Data Availability: Studies must report data in a usable format that allows for effect size calculations and meta-analysis.

**Information sources** Information sources: The information sources for this systematic review and meta-analysis will include a comprehensive search of the following electronic databases:
PubMed: A database of the U.S. National Library of Medicine that includes MEDLINE citations and other life science journals.
EBSCO: A database hosting a variety of sources including full-text journals, books, and other scholarly content.
Web of Science: A multidisciplinary database providing citations and abstracts from high-impact journals.
Cochrane Library: A source of high-quality evidence for healthcare decision-making, including the Cochrane Database of Systematic Reviews.

**Main outcome(s)** Bone Mineral Density (BMD): The primary outcome measure is the change in bone mineral density, specifically at the lumbar spine (LS), femoral neck (FN), total hip (TH), and trochanter (Troch) in postmenopausal women following resistance training interventions.

**Quality assessment / Risk of bias analysis** The methodological quality and risk of bias of the included studies in this systematic review and meta-analysis were assessed using the Cochrane Collaboration's risk of bias tool as outlined in the Cochrane Handbook for Systematic Reviews of Interventions, version 5.1.0. The assessment covered seven domains that are critical to the reliability of the study findings:
1. Random Sequence Generation.
2. Allocation Concealment.
3. Blinding of Participants and Personnel.
4. Blinding of Outcome Assessment.
5. Incomplete Outcome Data.
6. Selective Reporting.
7. Other Bias.
Each study was categorized as having a low, high, or unclear risk of bias for each domain. The risk of bias assessment was conducted independently by two reviewers , with disagreements resolved by a third reviewer . This process ensured the reliability and transparency of the risk of bias assessment, contributing to the overall quality evaluation of the included studies.
The findings from the risk of bias assessment were integrated into the interpretation of the study results, with considerations given to the impact of potential biases on the overall conclusions of the systematic review and meta-analysis. Any potential biases identified were discussed in the context of the study outcomes and the strength of the evidence presented.
**Strategy of data synthesis** The data synthesis strategy for this systematic review and meta-

analysis, which aims to investigate the effects of different resistance training modalities on bone mineral density in postmenopausal women, will be as follows:

Data Extraction: Extract relevant data from the included studies using a pre-designed form, capturing details such as first author, publication year, sample size, participant age, intervention modalities, and outcome measures.

Effect Size Calculation: Calculate effect sizes using the Standardized Mean Difference (SMD) and construct 95% confidence intervals (CI) for the differences in bone mineral density (BMD) between the intervention and control groups.

Heterogeneity Assessment: Assess heterogeneity among the included studies using the $I^2$ statistic. A threshold of $I^2 > 50\%$ and $P < 0.10$ will indicate substantial heterogeneity.

Meta-Analysis Model: Select the appropriate meta-analytic model based on the heterogeneity assessment. Employ a random-effects model in the presence of substantial heterogeneity, otherwise use a fixed-effect model.

Software Utilization: Use Review Manager (RevMan) 5.4 software to perform the meta-analysis, which will facilitate the generation of forest plots and other statistical outputs.

Risk of Bias Consideration: Interpret the results in the context of the risk of bias assessment, considering the methodological quality of the included studies.

Sensitivity Analysis: Conduct sensitivity analyses to evaluate the robustness of the findings by excluding studies with a high risk of bias.

Publication Bias: Assess the risk of publication bias using visual inspection of funnel plots and statistical tests if appropriate.

**Subgroup analysis** Given the structured approach outlined in the provided materials, the analysis of subgroups or subsets in this systematic review and meta-analysis will be performed to investigate potential effect modifiers of resistance training on bone mineral density in postmenopausal women. The subgroup analyses will be conducted as follows:

Subgroup Variables: The subgroup analyses will be based on variables identified a priori as potentially influencing the effect of resistance training on BMD. These may include:

Training intensity (high-intensity, moderate-intensity resistance , low-intensity resistance training).

Training duration (short-term [≤48 weeks] vs. long-term [>48 weeks]).

Training frequency (≤3 times per week vs. >3 times per week).

Duration per time： （＜60min，≥60min）Give.

**Sensitivity analysis** The sensitivity analysis in this systematic review and meta-analysis will be conducted to assess the robustness and reliability of the findings regarding the impact of resistance training on bone mineral density (BMD) in postmenopausal women. The process will involve several steps:

1. Risk of Bias Assessment: Begin by excluding studies that have a high risk of bias, as identified using the Cochrane Collaboration's risk of bias tool, and recalculate the pooled effect size to determine if the overall results are influenced by these potentially less reliable studies.

2. Study Quality: Remove studies with lower methodological quality (e.g., those not randomized or with unclear allocation concealment) and assess whether the results remain consistent.

3. Publication Bias: Conduct analyses after excluding studies that may be subject to publication bias, using indicators such as funnel plot asymmetry or results from statistical tests for publication bias.

4. Sample Size: Exclude the smallest studies to check if the findings are driven by larger studies, which may have more reliable estimates.

**Country(ies) involved** China.

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