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INPLASY

Muscle- and Region-Specific Quadriceps Femoris Hypertrophy Following Resistance Training With Different Repetition Tempos: A Systematic Review

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ADMINISTRATIVE INFORMATION

Support - None.

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 21 August 2026 and was last updated on 21 August 2026.

INTRODUCTION

Review question / Objective To determine whether different prescribed repetition tempos during resistance training produce differential hypertrophic responses among individual muscles and/or anatomical regions of the quadriceps femoris in healthy adults.

Eligible studies will include randomized longitudinal resistance-training trials comparing different eccentric, concentric, or overall repetition durations/velocities. The primary outcomes will be muscle-specific and/or region-specific quadriceps hypertrophy assessed by validated imaging methods, with studies required to report at least two individual quadriceps muscles and/or at least two anatomical regions.

Rationale To determine whether different prescribed repetition tempos during resistance training produce differential hypertrophic responses among individual muscles and/or anatomical regions of the quadriceps femoris in healthy adults.

The review will include healthy adults aged ≥18 years undergoing resistance training. Eligible interventions will involve prospectively prescribed or manipulated repetition tempo, including eccentric-phase duration/velocity, concentric-phase duration/velocity, or overall repetition duration/velocity, compared with the same or otherwise comparable resistance-training exercise performed using a different prescribed tempo. Eligible outcomes will include muscle-specific and/or region-specific quadriceps hypertrophy, with studies required to report hypertrophy for at least two individual quadriceps muscles and/or at least two anatomical sites or regions. Hypertrophy may be assessed using muscle thickness, anatomical cross-sectional area, or muscle volume measured by validated imaging methods such as ultrasonography, MRI, or CT. Only randomized controlled longitudinal resistance-training trials, including parallel-group and randomized within-

subject/contralateral-limb designs, will be included.

Condition being studied Resistance-training-induced hypertrophy of the quadriceps femoris in healthy adults. The quadriceps femoris comprises the rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius. Hypertrophic adaptations may occur non-uniformly between these individual muscles and across different anatomical regions within the same muscle. Repetition tempo is a modifiable resistance-training variable that determines the duration and/or velocity of the concentric and eccentric phases of each repetition and may influence the distribution of mechanical loading throughout the range of motion. This review will examine whether different prescribed repetition tempos are associated with differential muscle-specific and region-specific hypertrophic responses within the quadriceps femoris.

METHODS

Search strategy PubMed/MEDLINE, Scopus, and Cochrane CENTRAL will be searched from inception to 25 August 2026. The WHO International Clinical Trials Registry Platform (ICTRP) will also be searched to identify relevant registered trials and associated publications. Search terms will combine concepts related to resistance training (e.g., resistance training, strength training, squat, knee/leg extension), repetition tempo or movement velocity (e.g., tempo, repetition duration, eccentric/concentric duration, movement velocity, time under tension), muscle hypertrophy (e.g., hypertrophy, muscle thickness, cross-sectional area, muscle volume), and quadriceps femoris (e.g., quadriceps, rectus femoris, vastus lateralis, vastus medialis, vastus intermedius). Controlled vocabulary (e.g., MeSH) and database-specific proximity operators will be used where applicable. Reference lists of included studies and relevant reviews will also be screened for additional eligible reports.

Participant or population Healthy adults aged 18 years or older who undergo resistance-training interventions will be eligible, regardless of sex, training status, or previous resistance-training experience. This may include untrained, recreationally trained, resistance-trained, or athletic adults, provided they are otherwise healthy.Studies involving participants with clinical conditions, musculoskeletal or neurological disorders, postoperative rehabilitation, or other diseases that could substantially influence muscle hypertrophy or resistance-training responses will be excluded.

Intervention Resistance-training interventions in which repetition tempo is prospectively prescribed or manipulated. Eligible tempo manipulations may involve the duration and/or velocity of the eccentric phase, concentric phase, or overall repetition. Examples include comparisons of slower versus faster eccentric actions, concentric actions, or total repetition durations/velocities.The tempo manipulation must represent the principal between-condition training difference. Studies in which movement velocity is only measured, or in which velocity loss is used solely as a set-termination or fatigue threshold, will not be considered eligible tempo interventions unless different repetition velocities are explicitly prescribed between conditions.

Comparator The comparator will be the same or an otherwise comparable resistance-training exercise performed using a different prospectively prescribed repetition tempo. Comparisons may involve different eccentric-phase durations/velocities, concentric-phase durations/velocities, or overall repetition durations/velocities.Other major training variables, including exercise selection, range of motion, load/intensity, training frequency, and intervention duration, should be sufficiently comparable to allow the effect of repetition tempo to be meaningfully evaluated. Studies with major unequal co-interventions that prevent isolation of the tempo effect will be excluded.

Study designs to be included Randomized controlled longitudinal resistance-training trials will be included, including parallel-group RCTs and randomized within-subject or contralateral-limb designs. Trials must compare at least two prescribed repetition-tempo conditions and have a training duration of at least 4 weeks. Non-randomized, acute, cross-sectional, and observational studies will be excluded.

Eligibility criteria Eligible studies must report longitudinal hypertrophic outcomes for at least two individual quadriceps femoris muscles (rectus femoris, vastus lateralis, vastus medialis, and/or vastus intermedius) and/or at least two distinct anatomical sites or regions within the quadriceps or an individual quadriceps muscle (e.g., proximal, middle, distal). Hypertrophy must be assessed using validated imaging-based measures, including muscle thickness, anatomical cross-sectional area, or muscle volume obtained by ultrasonography, MRI, or CT.Studies reporting only a single quadriceps muscle at a single anatomical site will be excluded, as will studies assessing only muscle-fiber cross-sectional area from biopsy, lean

mass by DXA, limb circumference, bioimpedance, fascicle length, pennation angle, echo intensity, or acute post-exercise muscle swelling without an eligible measure of chronic hypertrophy.Only peer-reviewed, full-text articles published in English will be included. Conference abstracts, dissertations/theses, preprints, protocols, registry-only records, and unpublished studies will be excluded from the evidence synthesis. Trial registries may be used to identify corresponding published reports.For multi-arm or factorial trials, studies will be eligible only when a meaningful comparison between different prescribed repetition tempos can be isolated without major confounding from unequal co-interventions. Multiple publications arising from the same participant cohort will be treated as a single study, with the most complete report used for outcome extraction and supplementary reports used where necessary.

Information sources The following electronic databases will be searched from inception to the final search date: PubMed/MEDLINE, Scopus, and Cochrane Central Register of Controlled Trials (CENTRAL). The WHO International Clinical Trials Registry Platform (ICTRP) will also be searched to identify relevant registered trials and associated published reports.

The reference lists of included studies and relevant systematic reviews will be screened for additional eligible studies, and forward citation searching of included articles will be performed where feasible.

Only peer-reviewed full-text published articles will be included in the evidence synthesis. Trial-registry records, conference abstracts, theses/dissertations, preprints, and other unpublished or grey-literature records will not be included as evidence, although registry records may be used to identify corresponding publications. Study authors may be contacted when clarification of study methods, eligibility, or missing outcome data is required.

Main outcome(s) The primary outcome will be muscle- and/or region-specific hypertrophy of the quadriceps femoris following different prescribed repetition tempos. Eligible outcomes will include changes in muscle thickness, anatomical cross-sectional area, or muscle volume measured by ultrasonography, MRI, or CT.

Outcomes will be evaluated separately for individual quadriceps muscles (rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius) and/or for distinct anatomical regions or measurement sites (e.g., proximal, middle, and distal).

The principal time point will be the post-intervention assessment following completion of the resistance-training period (minimum duration ≥4 weeks). When multiple post-intervention time points are reported, the assessment closest to completion of the intervention and before a substantial detraining period will be prioritized.

Effects will be expressed as between-condition differences in absolute or relative change from baseline. Where quantitative pooling is appropriate, mean differences will be used for outcomes reported on comparable scales, and standardized mean differences will be considered when measurement scales differ, with 95% confidence intervals. For randomized within-subject/contralateral-limb trials, paired data will be used or accounted for whenever sufficient information is available.

Quality assessment / Risk of bias analysis Risk of bias will be assessed independently by two reviewers using the Cochrane Risk of Bias 2 (RoB 2) tool for randomized trials. The assessment will consider bias arising from the randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. Each domain, and the overall study result, will be judged as low risk of bias, some concerns, or high risk of bias according to RoB 2 guidance.

For randomized within-subject or contralateral-limb trials, the RoB 2 assessment will be applied with attention to the paired design, including adequacy of random allocation of limbs/conditions and any potential carryover or contamination where relevant.

Disagreements between reviewers will be resolved through discussion, with consultation of a third reviewer if consensus cannot be reached. Risk-of-bias judgments will be incorporated into the interpretation of the findings and, where sufficient studies are available, explored in sensitivity analyses excluding studies judged to be at high risk of bias.

Strategy of data synthesis Eligible studies will be summarized descriptively by participant characteristics, training protocol, repetition tempo, quadriceps muscle/region assessed, measurement method, and hypertrophy outcome.

A narrative synthesis will be conducted for all included studies. Meta-analysis will be performed only when at least two studies are sufficiently comparable in intervention, comparator, anatomical outcome, and measurement method. Individual quadriceps muscles and anatomical regions will be analyzed separately.

Between-group differences in change from baseline will be preferred. Mean differences or standardized mean differences with 95% confidence intervals will be calculated as appropriate. Random-effects models will be used, with heterogeneity assessed using I^2 and τ^2. Paired designs will be analyzed accounting for within-subject dependence, and multi-arm studies will be handled to avoid double-counting. If pooling is inappropriate, results will be synthesized narratively.

Subgroup analysis Where sufficient data are available, subgroup analyses will be considered according to: (1) type of tempo manipulation (eccentric-phase, concentric-phase, or overall repetition tempo/velocity); (2) exercise type (single-joint vs multi-joint); and (3) training status (untrained vs resistance-trained participants).

Subgroup analyses will only be performed when there are enough studies to permit meaningful comparison; otherwise, these factors will be explored narratively.

Sensitivity analysis Sensitivity analyses will be performed, where sufficient data are available, by excluding studies judged to be at high risk of bias. Additional sensitivity analyses may exclude studies with important between-group differences in training variables or co-interventions that could confound the effect of repetition tempo. The robustness of pooled estimates to alternative analytical assumptions will also be explored when appropriate.

Language restriction English.

Country(ies) involved Thailand.

Keywords quadriceps femoris; muscle hypertrophy; regional hypertrophy; resistance training; repetition tempo; eccentric duration; concentric duration; movement velocity; muscle thickness; cross-sectional area;.

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