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Menstrual-cycle phase-based periodization of resistance training versus cycle-agnostic resistance training for muscular strength and hypertrophy in eumenorrheic women: a protocol for a systematic review and meta-analysis

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ADMINISTRATIVE INFORMATION

Support - This review received no specific financial support.

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

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202660145

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 30 June 2026 and was last updated on 30 June 2026.

INTRODUCTION

Review question / Objective Objective: To determine whether menstrual-cycle phase-based periodization of resistance training, compared with luteal-phase-based or cycle-agnostic resistance training, alters gains in maximal muscular strength and muscle hypertrophy in eumenorrheic women, and to characterize the methodological factors (menstrual-phase-verification rigor; training-volume equating) that modify or confound these effects.
Review question: In eumenorrheic women, does menstrual-cycle phase-based periodization of resistance training, compared with luteal-phase-based or cycle-agnostic (non-periodized or evenly distributed) resistance training, change gains in maximal muscular strength and muscle hypertrophy?

Rationale Recommendations to periodize resistance training to menstrual-cycle phase — typically concentrating load in the follicular phase — are widely promoted to women, including through commercial cycle-tracking and training applications. The chronic-adaptation evidence base is small, methodologically heterogeneous, and conflicting: early small studies suggested a follicular-phase advantage, whereas a recent rigorously controlled trial found none. Existing quantitative syntheses address the acute, within-cycle effect of phase on strength and performance, or the effect of hormonal contraceptives, rather than chronic adaptations to phase-based training periodization; the most directly relevant prior synthesis on chronic adaptations is a narrative current-opinion article, and an umbrella review judged firm conclusions premature.
A registry search of INPLASY and PROSPERO on [28 June 2026 — confirm date] identified several systematic reviews on the acute, within-cycle effect of phase on strength and on hormonal-contraceptive associations, but none evaluating chronic adaptations to phase-based resistance-training periodization on strength and hypertrophy in eumenorrheic women (see Item 27). A transparent, registered review with an uncertainty-honest meta-analysis would quantify the current

best estimate and its bounds, characterize the methodological factors driving disagreement, and define the trials needed to resolve it.

Condition being studied Resistance-training adaptation in eumenorrheic women: whether ovarian-hormone fluctuations across the menstrual cycle modify resistance-training–induced gains in muscle strength and muscle mass (hypertrophy). Muscle strength and muscle mass are also determinants of musculoskeletal health and physical function across the female lifespan.

METHODS

Search strategy 2 (menstrual adj3 (cycle or phase*)).tw,kf.
3 (follicular or luteal or ovulat* or eumenorrh*).tw,kf.
4 exp Estradiol/ or exp Progesterone/
5 or/1-4
6 exp Resistance Training/
7 (resistance adj3 (training or exercise)).tw,kf.
8 (strength adj3 training).tw,kf.
9 (periodiz* or periodis* or "phase-based" or "phase based" or "cycle-based" or "cycle based").tw,kf.
10 (weight adj2 training).tw,kf.
11 or/6-10
12 exp Muscle Strength/
13 (1RM or "one repetition maximum" or "1-RM" or MVIC or "maximal voluntary contraction" or isometric or isokinetic).tw,kf.
14 exp Hypertrophy/ or exp "Muscle, Skeletal"/
15 (hypertroph* or "cross-sectional area" or "muscle thickness" or "lean mass" or "fat-free mass" or "muscle mass").tw,kf.
16 or/12-15
17 5 and 11 and 16.

Participant or population Inclusion: healthy eumenorrheic women (self-reported regular cycles, with cycle/phase status verified by any method), any training status (untrained to athlete) and any adult age consistent with natural cyclicity. Exclusion: studies confined to users of hormonal contraception or other exogenous sex-hormone therapy; pregnant or post-partum women; peri-/post-menopausal women; or participants with amenorrhea/oligomenorrhea. Mixed-population studies (e.g., eumenorrheic plus hormonal-contraceptive users) are included only if eumenorrheic-subgroup outcome data are separately extractable; otherwise they are listed and examined in a sensitivity analysis. Clinical rehabilitation populations are excluded from primary analyses and examined separately if sufficient.

Intervention Supervised or prescribed resistance training in which training load (volume, frequency, or intensity) is deliberately periodized to the menstrual cycle, with a greater stimulus in a specified phase — most commonly follicular phase-based training. Minimum duration: one full menstrual cycle (operationally ≥ 4 weeks). Eligible interventions must deliver a phase-periodized resistance-training programme: studies that only measure strength or performance across cycle phases without delivering a phase-periodized training intervention are NOT eligible (those acute, cross-phase questions are addressed by separate existing reviews). A pre-specified secondary analysis additionally considers phase-based periodization of other modalities (e.g., sprint-interval/aerobic training), with modality as a moderator.

Comparator Two comparisons, analyzed separately:
• Comparison 1 — follicular-emphasis versus luteal-emphasis phase-based training.
• Comparison 2 — any phase-based periodization versus cycle-agnostic (non-periodized or evenly distributed) resistance training; sensitivity analysis restricts to volume-load–equated comparisons where reported.

Study designs to be included Randomized controlled trials (parallel-group, within-participant/unilateral, and cluster designs) and prospective controlled non-randomized intervention studies. Excluded: uncontrolled (single-arm), cross-sectional, and acute single-session studies, and studies reporting only within-cycle performance variation without a training intervention.

Eligibility criteria Studies are eligible if they meet the population, intervention, comparator, outcome, and design criteria above and last at least one full menstrual cycle (≥ 4 weeks), reporting at least one primary or secondary adaptation outcome. No restriction is applied by publication date, language, or publication status (a deliberately inclusive choice to reduce bias and avoid an empty review); non-English reports will be translated. Explicitly excluded: cross-sectional or repeated-measures studies comparing strength/performance between cycle phases without a phase-periodized training intervention; acute single-session studies; and studies whose intervention is not resistance training (e.g., sprint-interval or endurance training), except within the pre-specified broadened secondary analysis. No other arbitrary restrictions are applied.

Information sources MEDLINE (Ovid), Embase (Ovid), the Cochrane Central Register of Controlled Trials (CENTRAL), SPORTDiscus (EBSCO), Web of Science Core Collection, and CINAHL (EBSCO). Trial registries: ClinicalTrials.gov and the WHO ICTRP. Preprints: SportRxiv and medRxiv (flagged as non-peer-reviewed). Reference lists and forward citations of included studies and key reviews will be screened; study authors will be contacted for missing or unpublished eumenorrheic-subgroup data.

Main outcome(s) (1) Maximal muscular strength — dynamic (e.g., one-repetition maximum) or isometric/isokinetic maximal voluntary contraction; a pre-specified hierarchy selects one estimate per study per comparison (lower-body multi-joint 1RM > isometric knee-extension MVIC > other). (2) Muscle hypertrophy — direct measures preferred (MRI/CT cross-sectional area; ultrasound thickness/CSA) over regional DXA lean mass over whole-body fat-free/lean mass. Both assessed at end of intervention (and latest common follow-up). Effect measure: standardized mean difference (Hedges' g) with 95% confidence/credible interval; mean difference also reported where a common instrument is used.

Additional outcome(s) Muscle power / rate of force development (e.g., countermovement jump); regional or whole-body lean/fat-free mass (when not the hypertrophy primary); adherence and session completion; withdrawals/dropout and adverse events (e.g., injury, menstrual-symptom burden). These support interpretation of the primary adaptations and are assessed at end of intervention.

Data management Records are de-duplicated and screened (title/abstract then full text) independently by two reviewers using a piloted form; disagreements resolved by discussion or a third reviewer; a PRISMA 2020 flow diagram documents the process. Two reviewers independently extract data into a piloted form. Values available only in figures are extracted with a calibrated digitizer (e.g., WebPlotDigitizer) and flagged as figure-derived. Software: [reference manager, e.g., Zotero]; [screening tool, e.g., Rayyan/Covidence]; analysis in R (metafor) and Python (PyMC/ArviZ) for the Bayesian model.

Quality assessment / Risk of bias analysis Two reviewers independently assess: randomized studies with Cochrane RoB 2 (appropriate variant for crossover/within-participant designs); non-randomized intervention studies with ROBINS-I. Each study additionally receives a menstrual-phase-verification appraisal graded against published standards (serum-hormone confirmation as reference standard; calendar/cycle-length and urinary-LH or basal-body-temperature methods progressively weaker; Janse de Jonge et al., 2019). Verification rigor is used as a signalling item, a subgroup factor, and a sensitivity criterion. Certainty of evidence is rated with GRADE.

Strategy of data synthesis Continuous outcomes synthesized as standardized mean differences (Hedges' g) by inverse-variance random-effects meta-analysis. Primary (frequentist): Paule–Mandel or REML τ^2 estimator with the Hartung–Knapp–Sidik–Jonkman confidence-interval adjustment (more reliable than DerSimonian–Laird with few studies), reporting a prediction interval; a fixed-effect estimate only as a sensitivity comparison.
Co-primary (Bayesian): a hierarchical normal–normal random-effects model with a weakly informative half-Normal prior on the between-study standard deviation τ (e.g., $\tau \sim$ Half-Normal(0, 0.5) on the SMD scale) and a weakly informative Normal prior on the pooled effect; reporting the posterior median SMD with 95% credible interval, the posterior probability of benefit, and the posterior probability of exceeding a pre-specified smallest effect size of interest. Prior sensitivity against at least one alternative prior on τ; MCMC diagnostics (R-hat, bulk/tail effective sample size, divergences) and posterior predictive checks; implemented in PyMC with a fixed seed and reported package versions.
Heterogeneity reported with τ^2 (and CI), I^2, and Cochran's Q (exact p), interpreted via the prediction interval given small-k limitations. Missing SDs derived from SEs/CIs/exact p-values or imputed by established methods, with influence checked in sensitivity analysis. Reporting-bias diagnostics (funnel plot, Egger's test) only if ≥ 10 studies. The two comparisons and the two outcomes are synthesized separately.

Subgroup analysis Exploratory subgroups, only where data permit and interpreted as hypothesis-generating given the anticipated small number of studies: menstrual-phase verification rigor (serum-confirmed vs not); training status (untrained vs trained/athlete); whether total training volume-load was equated between arms; study design (parallel vs within-participant); and, in the broadened analysis, training modality. Meta-regression only if ≥ 10 studies contribute to a model.

Sensitivity analysis Leave-one-out (important at small k); restriction to low-risk-of-bias studies; restriction to serum-verified studies; restriction to volume-equated comparisons; restriction by

design type; exclusion of pilot/very-small studies (e.g., per-arm n < 8); alternative τ^2 estimators and removal of the HKSJ adjustment; and exclusion of figure-derived or imputed data. Robustness across these analyses will be reported.

Language restriction No language restriction will be imposed; non-English reports will be translated.

Country(ies) involved México.

Other relevant information Duplication assessment (registry search). To avoid duplication, the registries INPLASY and PROSPERO were searched on 28 June 2026 for registered or ongoing systematic reviews on this question, complemented by web searches.
• INPLASY: searches for "menstrual cycle resistance training", "follicular luteal resistance training", "menstrual cycle periodization", "phase-based resistance training" and related terms returned no records addressing chronic menstrual-cycle phase-based resistance-training periodization for strength or hypertrophy.
• PROSPERO: seven related but non-duplicative records were identified, all addressing different questions — the acute, within-cycle effect of phase on strength/performance measured across phases (CRD42021240729; CRD42024591316; CRD420251045704); the association of cycle phase and/or hormonal contraceptives with strength, muscle damage, fatigue, perceived exertion, or muscle function (CRD42024466886; CRD420251165911; CRD42024620198); and the effect of resistance training on menstrual-cycle symptoms (CRD420261389330). A further related published review on hormonal-contraceptive use and resistance-training adaptations (PROSPERO CRD42022365677) is likewise non-duplicative.
None of these evaluates chronic adaptations (strength and hypertrophy) to deliberately phase-periodized resistance training in eumenorrheic women; the present review is therefore non-duplicative. Registry internal search has known limitations and does not replace the formal bibliographic search (Items 11 and 17); the informal scoping conducted during protocol drafting is not the formal search. Ongoing primary trials directly relevant as potential included studies (not duplicate reviews) include ClinicalTrials.gov NCT06679491 (three-arm follicular- vs luteal- vs continuous resistance training in female athletes); the ongoing IMPACT trial (NCT05697263) will be considered if it reports during the review window.

Keywords menstrual cycle; resistance training; periodization; muscle strength; muscle hypertrophy; eumenorrheic women; meta-analysis.

Dissemination plans Publication in a peer-reviewed journal and presentation at a scientific conference; the dataset and analysis code will be shared in an open repository.

Contributions of each author

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