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Physical Activity, Inflammation, and Cardiometabolic Health in Peri- and Postmenopausal Women: A Narrative Review of Exercise Evidence and Interventions

Kitalie Theus

Saybrook University, Pasadena, CA, USA, ktheus@saybrook.edu

Abstract: The menopausal transition is associated with changes in body composition, lipid metabolism, vascular health, and inflammatory activity that may increase cardiometabolic risk. Physical activity offers a prevention strategy, but the relative benefits of exercise prescriptions remain uncertain. This narrative review examined relationships among exercise type, dose, intensity, inflammatory biomarkers, and cardiometabolic indicators in perimenopausal and postmenopausal women. Evidence from randomized trials, observational studies, and research syntheses was organized by exercise modality, sedentary behavior, adherence, and measurement limitations. Behavioral and health literacy frameworks informed the interpretation of implementation needs. Aerobic and resistance training improved selected lipid, glucose, and inflammatory outcomes in studied populations, with several findings specific to postmenopausal women with obesity. Combined training showed benefits for selected cardiometabolic outcomes, but the evidence did not establish universal superiority. Walking interventions showed benefits for selected inflammatory outcomes, whereas lipid responses varied. One small trial found greater visceral fat reduction with interval training than with combined training, but interleukin-6 increased relative to combined training. Evidence was stronger for postmenopausal women, and findings should not be transferred uncritically to perimenopausal populations. Heterogeneity in protocols, populations, menopausal classification, and outcome measurement limits conclusions about optimal dose, intensity, timing, and comparative effectiveness. Narrative selection introduces potential bias. Individualized support should combine achievable activity goals, understandable exercise instructions, attention to sitting time, and strategies addressing pain, caregiving, disability, and environmental barriers. Future research should use standardized staging, objective activity assessment, and clearly specified biomarker outcomes to strengthen stage-specific recommendations while supporting sustained participation across diverse midlife populations.

Keywords: Postmenopausal Women, Physical Activity, Cardiometabolic Risk, Systemic Inflammation, Menopausal Transition

Introduction

The menopausal transition is associated with changes in ovarian hormone production, body composition, lipid metabolism, and vascular health. These changes interact with chronological aging, adiposity, health behaviors, and treatment exposures rather than producing an identical cardiometabolic trajectory in every woman. The American Heart Association identifies this transition as an important opportunity for cardiovascular prevention (El Khoudary et al., 2020).

Inflammatory responses also vary. In the Study of Women's Health Across the Nation (SWAN), some high-sensitivity C-reactive protein (hs-CRP) and interleukin-6 (IL-6)

trajectory groups increased from approximately 1 year before to 3 years after the final menstrual period (FMP), whereas other groups remained stable or declined. Baseline adiposity and race/ethnicity were associated with trajectory membership (El Khoudary et al., 2025). Consequently, neither a universal inflammatory rise nor a single peak at menopause adequately describes the evidence.

Perimenopause and postmenopause represent related but distinct reproductive stages. Perimenopause includes the period of changing menstrual patterns around the transition to menopause; natural menopause is recognized retrospectively after 12 months without menstruation when other causes do not explain amenorrhea. Evidence therefore requires interpretation using the staging criteria reported by each study rather than treating all midlife women as interchangeable (El Khoudary et al., 2020).

The World Health Organization (WHO, 2020) recommends regular aerobic and muscle-strengthening activity and limiting sedentary time. These general recommendations provide a foundation for care, but they do not establish a menopause-specific prescription that optimizes every inflammatory or cardiometabolic outcome. Reviews differ in populations, protocols, follow-up, and outcomes, and perimenopausal evidence remains comparatively limited (Bernal et al., 2025; Nunes et al., 2024).

To address these empirical gaps, this narrative review synthesizes current evidence on physical activity, systemic inflammation, and cardiometabolic health in peri- and postmenopausal women. The review explicitly addresses the following research question: Which types, doses, and intensities of physical activity are most strongly associated with improvements in inflammatory biomarkers and cardiometabolic indicators among peri- and postmenopausal women?

Search Strategy and Methodological Approach

This narrative review synthesizes peer-reviewed exercise trials, observational studies, and evidence syntheses addressing physical activity, inflammation, and cardiometabolic health in peri- and postmenopausal women. Literature searches were conducted in PubMed/MEDLINE, Scopus, CINAHL, the Cochrane Central Register of Controlled Trials (CENTRAL), and Google Scholar. Publications from 2010 through 2026 were prioritized, with older foundational sources included when relevant. Findings were organized thematically. No formal systematic screening process or methodological quality appraisal tool was used.

Search concepts combined menopausal status, physical activity or exercise, and inflammatory or cardiometabolic outcomes. Keywords and phrases included:

- Menopausal status: “perimenopausal women,” “postmenopausal women,” “menopausal transition,” and “postmenopause.”
- Physical activity and exercise: “physical activity,” “exercise training,” “aerobic exercise,” “resistance training,” “combined training,” “moderate-intensity exercise,” and “high-intensity interval training.”
- Inflammatory and cardiometabolic outcomes: “systemic inflammation,” “chronic low-grade inflammation,” “C-reactive protein,” “CRP,” “interleukin-6,” “IL-6,” “tumor necrosis factor-alpha,” “TNF-α,” “adiponectin,” “metabolic syndrome,” and “cardiometabolic risk factors.”

Synonyms within each concept were combined using OR, and the three concepts were combined using AND. An example search string was: (“perimenopausal women” OR “postmenopausal women” OR “menopausal transition”) AND (“physical activity” OR “exercise training” OR “aerobic exercise” OR “resistance training”) AND (“inflammatory markers” OR “C-reactive protein” OR “interleukin-6” OR “cardiometabolic risk factors”).

Inclusion Criteria

Exercise evidence was selected for relevance to peri- or postmenopausal women and for reporting inflammatory or cardiometabolic outcomes, including hs-CRP, IL-6, tumor necrosis factor-alpha (TNF-α), adiponectin, lipids, fasting glucose, blood pressure, or waist circumference. Randomized controlled trials (RCTs), systematic reviews, and meta-analyses informed the intervention synthesis; observational studies supplied context. Syntheses that also included older women were retained with their population limitations made explicit. Behavioral theory and public health guidelines informed interpretation and implementation rather than serving as exercise trial evidence.

Exclusion Criteria

Findings were not used to support stage-specific conclusions when menopausal subgroups could not be distinguished. Multicomponent interventions were interpreted as exercise evidence only when their design permitted an exercise-specific comparison, such as a factorial analysis. Conference abstracts and nonscholarly reports were not used as primary intervention evidence. No new pooled effect estimates or formal study-quality ratings were calculated. Primary trials and reviews were discussed together without treating potentially overlapping study samples as independent evidence.

Theoretical Framework

Three complementary behavioral and health education models guide this synthesis: the Health Belief Model, Social Cognitive Theory, and Nutbeam's Health Literacy Framework.

Theory 1: Health Belief Model

The Health Belief Model (HBM) describes perceived susceptibility, severity, benefits, barriers, self-efficacy, and cues to action (Alyafei & Easton-Carr, 2024). Applied to exercise participation, it provides a rationale for discussing cardiometabolic risk without implying that every woman faces the same trajectory. Clinicians can explore anticipated benefits and barriers such as pain, fatigue, caregiving, and time demands. These theory-informed applications provide a framework for implementation but do not establish that HBM-based education itself changes inflammatory biomarkers in menopausal women.

Theory 2: Social Cognitive Theory

Bandura's (1986) Social Cognitive Theory (SCT) emphasizes reciprocal relationships among personal factors, behavior, and environment, including observational learning, self-efficacy, and outcome expectations. SCT provides a rationale for achievable goals, gradual progression, supportive feedback, and optional peer activity. These applications connect exercise evidence with participation support; the exercise studies summarized here do not independently establish the effectiveness of each proposed behavioral strategy.

Theory 3: Health Literacy Framework

Nutbeam's (2000) Health Literacy Framework categorizes health literacy into three distinct levels: functional, interactive, and critical literacy.

Functional Literacy: Refers to basic reading and numerical skills needed to understand health information, such as interpreting exercise frequency, duration, and target heart rate ranges.

Interactive Literacy: Encompasses advanced cognitive and social skills required to communicate effectively with healthcare providers, ask clarifying questions, and tailor exercise guidance to individual routines.

Critical Literacy: Represents high-level analytical skills used to critically evaluate health claims, distinguish evidence-based exercise guidelines from commercial misinformation, and advocate for supportive activity environments.

Review of the Literature

Theme 1: Menopause, Inflammation, and Cardiometabolic Risk

Menopause-related cardiometabolic risk varies by population. Eshtiaghi et al. (2010) reported an association between menopausal status and metabolic syndrome in Iranian women after considering age; this observational finding does not establish causation. Marapo et al. (2025) reported metabolic syndrome in 47.0% of perimenopausal and 61.4% of postmenopausal women attending a gynecology outpatient department at a tertiary institution in South Africa. These clinical-sample estimates are not global prevalence estimates. SWAN additionally demonstrated distinct inflammatory trajectories rather than a uniform rise in hs-CRP and IL-6 across the transition (El Khoudary et al., 2025).

Theme 2: Aerobic Exercise and Biomarker Outcomes

Aerobic exercise can improve selected cardiometabolic outcomes, but inflammatory responses are not uniform. In the yearlong ALPHA randomized trial involving postmenopausal women, aerobic exercise reduced CRP relative to usual inactivity (treatment effect ratio = 0.87, 95% confidence interval [CI] [0.79, 0.96], p = .005), without significant between-group effects on IL-6 or TNF-α. The CRP effect appeared related to fat loss and became nonsignificant after adjustment for change in dietary fiber intake (Friedenreich et al., 2012). The findings support an outcome-specific interpretation rather than a uniform effect across inflammatory markers.

Bernal et al. (2025) synthesized lipid outcomes across peri- and postmenopausal exercise trials. Their pooled analysis of 8-week aerobic protocols did not show significant lipid changes. In postmenopausal women with obesity, 16-week aerobic protocols increased high-density lipoprotein cholesterol (HDL-C) by 3.88 mg/dL (95% CI [0.56, 7.20]) and reduced total cholesterol by 22.36 mg/dL (95% CI [15.05, 29.67]) and low-density lipoprotein cholesterol (LDL-C) by 17.86 mg/dL (95% CI [9.75, 25.97]) relative to comparison groups. These pooled comparisons across selected studies do not constitute a randomized 8-versus-16-week comparison. Water-based aerobic exercise was one delivery format: a 12-week, twice-weekly trial in perimenopausal women with dyslipidemia reported favorable total cholesterol, LDL-C, and total cholesterol/HDL-C comparisons. Other aquatic and walking findings were mixed. Neither water-based delivery nor a universal duration threshold is established as superior.

Theme 3: Resistance Training and Biomarker Outcomes

Nunes et al. (2024) synthesized 20 RCTs involving postmenopausal and older women with overweight or obesity. Both lower-volume and higher-volume resistance training improved selected adiposity, metabolic, and inflammatory outcomes relative to nontraining controls. Higher-volume groups had larger pooled standardized effects for glucose and CRP than lower-volume groups, but only three included studies directly compared training volumes, and evidence certainty was low to very low. The comparison therefore relies substantially on differences across studies and does not establish a universal optimal volume. Volume incorporates exercises, sets, repetitions, frequency, and program duration; session frequency alone is not an adequate definition. Bernal et al. (2025) separately found that 12-week resistance programs improved HDL-C, LDL-C, and triglycerides in postmenopausal women with obesity. These findings support resistance training as an option without establishing its superiority to aerobic training for glycemic or inflammatory outcomes.

Theme 4: Combined Training, Walking, and High-Intensity Interval Training

Combined training integrates aerobic and resistance exercise and can address both cardiovascular and muscular activity goals. Tan et al. (2023) synthesized 39 RCTs involving 2,132 postmenopausal participants and found improvements in metabolic syndrome risk factors with exercise overall, including waist circumference and blood pressure. Subgroup

analyses supported moderate-intensity and combined training for several outcomes, but comparisons across studies are not equivalent to head-to-head randomized comparisons of every modality. Complementary exercise components and favorable subgroup findings do not establish that combined training is universally superior for all biomarkers, populations, or stages.

Walking may be an acceptable entry point for some inactive women, although accessibility depends on pain, disability, environmental safety, and available support. Son et al. (2023) reported significant reductions in body mass index and the inflammatory markers high-sensitivity C-reactive protein (hs-CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α) following a 12-week moderate-intensity walking program in postmenopausal women with obesity. The study described walking intensity using 7,000–9,999 steps/day and a cadence of 100 steps/minute. These study parameters do not establish an appropriate starting target for all peri- and postmenopausal women. Bernal et al. (2025) found no significant pooled effects of 24-week walking programs on triglycerides or HDL-C in the analyzed postmenopausal samples, illustrating that outcomes vary.

Nunes et al. (2019) directly compared high-intensity interval training (HIIT; n = 13) with combined training (n = 13) in postmenopausal women with obesity. HIIT produced a greater reduction in visceral adipose tissue, but IL-6 increased relative to combined training. Changes in visceral adiposity explained 56% of the variation in IL-6 changes within the HIIT group. This small trial supports a specific body-composition comparison, not a universal anti-inflammatory advantage or applicability to all menopausal stages. Intensity and impact are separate prescription features; high-intensity exercise need not be high-impact. Suitability and progression depend on health status and current capacity (WHO, 2020).

Theme 5: Sedentary Behavior and Cardiometabolic Risk

Sedentary time and insufficient exercise are related but distinct targets. WHO (2020) recommends limiting sedentary time and replacing it with activity, while acknowledging insufficient evidence to specify a universal sedentary-time threshold. In a randomized acute study of 22 postmenopausal women with overweight or obesity and dysglycemia, Henson et al. (2016) compared prolonged sitting with sitting interrupted by 5 minutes of standing or light walking every 30 minutes. Both interruption conditions reduced postprandial glucose and insulin responses; triglyceride responses did not significantly change. This evidence supports discussion of sitting breaks in a defined high-risk population, but does not establish long-term cardiovascular benefit, inflammatory changes, or an optimal break schedule for every woman.

Theme 6: Exercise Adherence and Patient Education

In ALPHA, greater achieved exercise adherence was associated with larger CRP reductions (p for trend = .021), but achieved adherence was not itself randomized. Fat loss and dietary change also affected interpretation, limiting causal conclusions about a universal dose-response relationship (Friedenreich et al., 2012). In a secondary analysis of the 24-month DAMA factorial trial, Masala et al. (2020) studied 234 healthy postmenopausal women aged 50–69 years with high breast density. Assignment to the physical activity intervention was associated with lower follow-up IL-1α and IL-6 levels than nonassignment, whereas CRP, TNF-α, and IL-1β did not significantly differ. The factorial comparison permitted evaluation of activity separately from diet, but the selected population limits generalizability.

Participation support extends beyond motivation. Applying SCT and health literacy principles suggests considering caregiving, cost, neighborhood safety, disability, pain, transportation, and access to suitable programs when developing activity goals. Home-based options, adapted movement, shorter sessions, or community support may be appropriate according to individual circumstances. These implementation recommendations do not

establish that any one delivery strategy produces a specified biomarker response (Bandura, 1986; Nutbeam, 2000; WHO, 2020).

Patient education can translate a prescription into understandable actions: what activity to perform, how often, for how long, and at what effort. Nutbeam's (2000) framework supports attention to understanding, communication, and critical appraisal rather than information delivery alone. Teach-back offers a practical way to explore understanding by asking patients to explain their plan in their own words. The present review does not establish that teach-back independently improves exercise adherence or inflammatory outcomes in menopausal women.

Theme 7: Gaps in Menopausal-Stage Classification and Biomarker Measurement

The reviewed evidence is substantially more extensive for postmenopausal women than for perimenopausal women. For example, Bernal et al. (2025) included only three trials involving perimenopausal participants. Clear reporting of staging criteria, time since the FMP, hormone therapy exposure, and relevant clinical characteristics would strengthen future comparisons. Findings from older-women syntheses do not necessarily represent effects specific to the menopausal transition (Nunes et al., 2024).

Intervention duration, exercise dose, baseline adiposity, outcome selection, and measurement procedures complicate comparison. The different CRP, IL-6, and TNF-α findings in ALPHA and DAMA demonstrate the importance of reporting biomarkers separately rather than combining them into a single claim of reduced inflammation (Friedenreich et al., 2012; Masala et al., 2020). Priorities for future studies include standardized menopausal staging, documentation of achieved activity and adherence, specified blood-sampling timing, and prespecified biomarker outcomes. Additional cytokine or lipid measurements require a rationale linked to the research question; a larger panel does not necessarily improve study quality.

Recommendations for Clinical Practice and Future Research

Improve Patient Education Materials on Menopausal Metabolic and Inflammatory Risk:

Develop plain-language resources describing the association of menopause with cardiometabolic changes without implying an identical risk trajectory for every woman. Explain clinical measures such as blood pressure, waist circumference, glucose, and lipids, and distinguish research biomarkers from routine clinical monitoring. Tailor the information to patient priorities and questions (El Khoudary et al., 2020; Nutbeam, 2000).

Utilize Teach-Back Methods to Confirm Comprehension:

Consider teach-back as a practical communication strategy: ask patients to restate their chosen exercise type, frequency, duration, and effort, then clarify misunderstandings. This approach applies health literacy principles; its independent effect on biomarker outcomes was not established by the exercise studies reviewed here (Nutbeam, 2000).

Establish Interprofessional Referral Pathways:

Consider referral to appropriately qualified clinicians or exercise professionals when pain, disability, cardiometabolic conditions, or low baseline capacity complicate participation. Match support to clinical need and local availability rather than assuming that all women need the same program (WHO, 2020).

Deliver Structured Exercise Prescriptions (FITT Principle):

Specify frequency, intensity, time, and type (FITT) using a shared, achievable plan. WHO (2020) recommends 150–300 minutes/week of moderate-intensity aerobic activity, or 75–150 minutes/week of vigorous activity, or an equivalent combination, plus muscle-strengthening activity on at least 2 days/week for adults. These are general health targets, not menopause-specific biomarker thresholds. Begin with tolerable amounts and increase gradually when appropriate.

Address Sedentary Time Alongside Structured Activity:
Discuss feasible opportunities to interrupt prolonged sitting. Henson et al. (2016) tested 5-minute standing or light-walking breaks every 30 minutes in postmenopausal women with dysglycemia. The protocol provides an example of a tested sitting-interruption strategy, but the optimal frequency and duration of breaks remain uncertain. Adapt movement options to individual mobility and safety (WHO, 2020).

Leverage Digital Tools and Community Social Support:
Offer activity logs, optional step counters or reminders, peer support, and accessible community or home-based activities according to preference and resources. These theory-informed support options complement individualized care without making devices or group participation prerequisites for activity (Bandura, 1986; Nutbeam, 2000).

Enhance Provider Awareness of Stage-Specific Risks:
Use the menopausal transition as an opportunity to review cardiovascular risk and discuss sustainable activity. Future trials should directly compare modalities and doses, recruit perimenopausal women, report stage-specific outcomes, and evaluate whether feasible delivery strategies support long-term participation (Bernal et al., 2025; El Khoudary et al., 2020).

Limitations of the Review

This narrative synthesis did not use a reproducible systematic screening process, formal independent risk-of-bias assessment, or new meta-analysis. Source selection may therefore introduce bias and does not establish exhaustive coverage or uniformly high-quality evidence. Reviews may include overlapping primary trials and do not necessarily represent independent replications. Variation in populations, interventions, adherence, outcome assays, and menopausal definitions limits comparison. Evidence is stronger for postmenopausal women, often with obesity or other selected characteristics, than for perimenopausal women. Biomarker changes are surrogate outcomes and do not establish reductions in cardiovascular events. Behavioral recommendations reflect theory-informed interpretations rather than effects directly tested throughout the exercise literature.

Conclusion

Physical activity can improve selected inflammatory and cardiometabolic indicators in peri- and postmenopausal women, with the clearest evidence in the postmenopausal populations studied. Aerobic, resistance, combined, and walking programs offer different ways to support activity, but the evidence summarized here does not identify a universally superior modality or an optimal dose, intensity, or starting time. Responses differ by outcome, and improved adiposity does not necessarily imply that every inflammatory marker decreases. Individualized prescriptions can combine appropriate exercise, attention to sedentary time, understandable instructions, and realistic participation support. More direct comparative trials with standardized staging and measurement are needed to strengthen stage-specific guidance.

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