

The role of exercise during pregnancy in reducing the risk of preeclampsia: a systematic review

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Abstract

Preeclampsia is among the most common hypertensive disorders of pregnancy and remains a leading cause of maternal and neonatal morbidity and mortality. Increasing evidence suggests that regular physical activity during pregnancy may confer a protective effect; however, findings across studies are not fully consistent. This study systematically reviewed existing evidence on the association between physical activity/exercise during pregnancy and the risk of preeclampsia, based on 12 eligible studies. The review was conducted in accordance with PRISMA 2020 guidelines. PubMed, Scopus, Web of Science, the Cochrane Library, Google Scholar, and national databases were searched without language restrictions. Observational studies, interventional trials, and evidence syntheses evaluating physical activity in relation to preeclampsia were considered. Study quality was assessed using RoB 2 and the Newcastle–Ottawa Scale, and due to substantial heterogeneity in exposure definitions and study designs, findings were synthesized narratively. Overall, most studies reported that light-to-moderate physical activity—particularly regular aerobic exercise or recreational activity initiated in early pregnancy—was associated with a lower risk of preeclampsia, whereas sedentary behavior and prolonged sitting were identified as independent risk factors. Some studies also suggested that physical activity may influence pathways implicated in preeclampsia, including angiogenic balance and inflammatory processes. In conclusion, physical activity during pregnancy appears to be a safe, low-cost, and feasible strategy that may reduce the risk of preeclampsia; nevertheless, well-designed interventional studies are needed to define the optimal type, intensity, and timing of exercise initiation.

Keywords: Preeclampsia, Physical activity, Prenatal exercise, Maternal health, Systematic review

Introduction

Preeclampsia is one of the most common and serious hypertensive disorders of pregnancy and remains a leading cause of maternal and perinatal morbidity and mortality worldwide (Brown et al., 2018; Fox et al., 2019;

Rana et al., 2019). Typically arising after 20 weeks of gestation, it is characterized by new-onset hypertension accompanied by proteinuria and/or evidence of maternal end-organ dysfunction. Preeclampsia affects approximately 2–8% of pregnancies, with substantially higher prevalence among women with established risk factors, including advanced maternal age, obesity, prior preeclampsia, multiple gestation, and pre-existing cardiometabolic disease (Brown et al., 2018; Poon et al., 2021).

The condition is associated with severe maternal and neonatal complications, such as preterm birth, intrauterine growth restriction, eclampsia, multi-organ failure, and increased neonatal mortality (Brown et al., 2018; Rana et al., 2019). Beyond pregnancy, women with a history of preeclampsia face elevated long-term risks of cardiovascular disease, chronic hypertension, stroke, type 2 diabetes, and chronic kidney disease (Fox et al., 2019; Rana et al., 2019). These short- and long-term consequences underscore the importance of effective prevention strategies and early identification of at-risk individuals.

Despite extensive research, the precise etiology of preeclampsia remains incompletely understood, and the disorder is widely regarded as a multifactorial, multisystem syndrome (Roberts & Hubel, 2009; Rana et al., 2019). In the widely accepted two-stage pathophysiological model, the first stage involves abnormal placentation, inadequate cytotrophoblast invasion, and insufficient remodeling of the spiral arteries, leading to reduced uteroplacental perfusion and increased oxidative stress. In the second stage, placental ischemia is thought to trigger the release of antiangiogenic factors, including soluble fms-like tyrosine kinase-1 (sFlt-1), alongside reduced placental growth factor (PlGF), ultimately contributing to systemic endothelial dysfunction, increased vascular resistance, and the clinical manifestations of disease (Poon et al., 2021; Rana et al., 2019).

In addition to these biological pathways, genetic, inflammatory, metabolic, and behavioral determinants—such as obesity, insulin resistance, sedentary behavior, and unhealthy dietary patterns—are associated with increased risk of preeclampsia (Brown et al., 2018; Fox et al., 2019; Aune et al., 2014). Accordingly, modifiable lifestyle interventions have received growing attention as feasible approaches to risk reduction.

In recent years, physical activity has been increasingly emphasized as a non-invasive, low-cost, and scalable intervention to prevent pregnancy complications, including preeclampsia (Mottola & Artal, 2016; Witvrouwen et al., 2020). Regular physical activity may mitigate preeclampsia risk through several plausible mechanisms, including improved endothelial function, enhanced nitric oxide bioavailability, reduced peripheral vascular resistance, improved regulation of glucose and

lipid metabolism, attenuation of systemic inflammation, and healthier gestational weight gain trajectories (Mottola & Artal, 2016; Davenport et al., 2018; Witvrouwen et al., 2020; Rana et al., 2019). Moreover, reductions in visceral adiposity and improvements in cardiometabolic profiles may help disrupt the interrelated pathways linking obesity, inflammation, and oxidative stress.

Consistent with these observations, guidelines from the American College of Obstetricians and Gynecologists (ACOG), the World Health Organization (WHO), and Canadian recommendations generally advise that most healthy pregnant women engage in at least 150 minutes per week of moderate-intensity physical activity (ACOG, 2020; WHO, 2020; Bull et al., 2020; Davenport et al., 2018). However, adherence to these recommendations remains suboptimal in many settings, with barriers including cultural beliefs, fear of fetal harm, overly conservative counseling from some healthcare providers, pregnancy-related symptoms (e.g., fatigue and nausea), and limited access to safe or affordable exercise facilities (Davenport et al., 2022; Mottola & Artal, 2016).

Although numerous studies suggest a protective role of physical activity against preeclampsia, the overall evidence base remains somewhat mixed. While several randomized trials and cohort studies have reported statistically significant reductions in risk, other studies—particularly observational investigations with smaller samples—have not demonstrated a clear association (Aune et al., 2014; Witvrouwen et al., 2020). Prior syntheses (e.g., Davenport et al., 2018) support a potential protective effect, yet substantial heterogeneity across studies—such as differences in exercise type, intensity, duration, timing of initiation, and population characteristics—limits comparability and generalizability. In addition, certain modalities (e.g., yoga, aquatic exercise, light resistance training, and mind–body interventions) have been less frequently studied, and evidence for these approaches remains limited (Witvrouwen et al., 2020).

Moreover, methodological limitations in existing research—including reliance on self-reported activity measures, incomplete control for confounding, limited follow-up, and inconsistent definitions of both physical activity and preeclampsia—may contribute to inconsistent findings (Aune et al., 2014; Davenport et al., 2018). The emergence of newer studies, including biomarker-oriented investigations, contemporary interventional trials, and work focusing on sedentary behavior, further highlights the need for an updated and methodologically rigorous synthesis that integrates and critically evaluates this expanding literature (Witvrouwen et al., 2020; Fox et al., 2019).

Accordingly, this systematic review aimed to synthesize current evidence on the role of physical activity during pregnancy in reducing the risk of preeclampsia. By examining 12 eligible studies, we sought to provide an

evidence-based overview of how the type, intensity, and timing of physical activity may relate to preeclampsia risk. The findings may inform clinical guidance, educational interventions for pregnant women, and public health strategies to reduce the burden of preeclampsia and improve maternal and neonatal outcomes (Davenport et al., 2018; Witvrouwen et al., 2020; Fox et al., 2019).

Methods

This study was designed as a systematic review to examine the association between physical activity during pregnancy and the risk of preeclampsia, and it was reported in accordance with the PRISMA 2020 statement. A comprehensive literature search was conducted in PubMed/MEDLINE, Scopus, Web of Science, the Cochrane Library, and Google Scholar, as well as Persian databases (SID and Magiran). Searches were performed without language restrictions, and studies published up to [insert date of last search] were eligible.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms related to preeclampsia and physical activity, including: “preeclampsia”, “pregnancy”, “physical activity”, and “exercise”, using Boolean operators (AND/OR). The full search strings for each database are provided in [Supplementary Table / Appendix].

All retrieved records were exported to [software, e.g., EndNote/Zotero], and duplicates were removed. Two reviewers independently screened titles and abstracts, followed by full-text assessment of potentially relevant articles. Disagreements were resolved through discussion and, when necessary, consultation with a third reviewer.

Eligibility criteria

Studies were included if they:

1. involved pregnant women (any gestational age);
2. assessed physical activity/exercise (any type, intensity, or domain) and/or sedentary behavior; and
3. reported preeclampsia and/or hypertensive disorders of pregnancy as an outcome with extractable data.

Eligible study designs included randomized controlled trials, cohort studies, case–control studies, and evidence syntheses (systematic reviews/meta-analyses) that provided relevant extractable information. Animal studies, case reports, conference abstracts, studies lacking a clear definition of physical activity, studies not reporting preeclampsia-related outcomes, and studies with very low methodological quality were excluded.

Data extraction

Data were extracted using a standardized form, including: first author and year, study design, sample size, population characteristics, exposure definition (type/intensity/domain of physical activity), assessment method (questionnaire/structured assessment/objective measures), timing of exposure, outcome definition/diagnostic criteria for preeclampsia, and main

results (e.g., odds ratios [OR], relative risks [RR], hazard ratios [HR], or qualitative findings).

Quality assessment

Two reviewers independently assessed methodological quality. Risk of bias for randomized trials was evaluated using the Cochrane RoB 2 tool, and observational studies were assessed using the Newcastle–Ottawa Scale. Systematic reviews/meta-analyses were appraised using AMSTAR 2. Any discrepancies were resolved by consensus or adjudication by a third reviewer.

Data synthesis

Given substantial heterogeneity across studies in exposure definitions (type, intensity, duration), timing of initiation, and diagnostic criteria for preeclampsia,

quantitative meta-analysis was not feasible. Therefore, findings were synthesized narratively. Studies were grouped by design, physical activity domain/type, timing of exposure, and reported outcomes, and consistent patterns and discrepancies were summarized. Ultimately, 12 studies met the eligibility criteria and were included in the final synthesis.

Because this work was based on secondary analysis of published studies and did not involve direct interaction with human participants, formal ethical approval was not required. Principles of scientific integrity, accurate citation, and transparent reporting were followed throughout.

Table 1. Physical activity during pregnancy and risk of preeclampsia: a systematic review of 12 studies

Key findings relevant to physical activity and preeclampsia	Study design / population	Year	First author (et al.)	Row
Regular recreational activity (e.g., walking; light-to-moderate exercise) before and/or in early pregnancy was associated with a lower risk of preeclampsia; evidence quality was moderate and further trials were recommended.	Systematic review of observational studies	2012	Kasawara	1
Physical activity before and during pregnancy was associated with reduced preeclampsia risk, with evidence of a dose–response pattern; leisure-time activity showed a stronger protective association (~20–30% risk reduction).	Systematic review and meta-analysis (cohort & case–control)	2014	Aune	2
Recreational activity during the year before pregnancy and during the first 20 weeks was associated with a lower risk of preeclampsia compared with inactivity.	Case–control (201 cases; 383 controls)	2003	Sorensen	3
Leisure-time activity was associated with reduced risk; very heavy occupational work or prolonged standing was associated with increased risk. The most favorable profile was moderate leisure-time activity combined with non-strenuous work.	Cohort (occupational & leisure-time activity in early pregnancy)	2004	Saftlas	4
Higher total daily activity was associated with lower risk, whereas longer sitting time was associated with higher risk; the protective association persisted after adjustment for pre-pregnancy BMI.	Case–control (Iowa Pregnancy Hypertension Study)	2016	Spracklen	5
Leisure-time activity ($\approx \geq 4$ hours/week) in early pregnancy was associated with reduced risk of preeclampsia and gestational hypertension, with no evidence of increased risk at moderate intensity.	Case–control (Canada; first 20 weeks)	1989	Marcoux	6
Concluded that regular moderate-intensity activity before and during pregnancy may reduce preeclampsia risk through pathways such as improved endothelial function, lower inflammation, and healthier weight trajectories.	Narrative review (JEHS)	2025	Woźniak	7
Longer sitting time was associated with higher blood pressure and increased risk of hypertensive disorders of pregnancy; replacing sitting with light-intensity activity may reduce risk.	Systematic review (sedentary behavior)	2025	Pei & Marozoff	8

Women with preeclampsia reported lower energy expenditure from physical activity and more sedentary time than controls; higher activity among cases was associated with longer gestation and higher birth weight.	Retrospective case–control (Tunisia)	2020	Raguema	9
Suggested that meeting pregnancy activity recommendations (≥ 150 min/week moderate-intensity aerobic activity) is associated with lower risk of preeclampsia and other adverse outcomes; emphasized safety in most low-risk pregnancies.	Expert review	2023	Gascoigne	10
Exercise interventions (mainly moderate-intensity aerobic programs) were associated with reduced risk of hypertensive disorders of pregnancy; benefits were also reported for gestational weight gain and selected metabolic outcomes.	Systematic review & meta-analysis of RCTs	2017	Magro-Malosso	11
Focused primarily on delivery outcomes; although preeclampsia was not a primary outcome, the authors concluded that exercise is safe and beneficial for multiple maternal and neonatal outcomes and may indirectly reduce hypertensive risk.	Systematic review & meta-analysis of RCTs (PLOS ONE)	2025	Abebe Andargie	12

Findings

The findings of this review, based on 12 evidence sources—including case–control studies (Sorensen et al., 2003; Marcoux et al., 1989; Raguema et al., 2020), cohort studies (Saftlas et al., 2004; Spracklen et al., 2016), and systematic reviews/meta-analyses (Kasawara et al., 2012; Aune et al., 2014; Gascoigne et al., 2023)—suggest that physical activity during pregnancy is generally associated with a lower risk of preeclampsia. Across most studies, women who were physically active, particularly those reporting regular leisure-time physical activity (LTPA), had a reduced likelihood of developing preeclampsia compared with inactive women. Early evidence (e.g., Marcoux et al., 1989; Sorensen et al., 2003) indicated that activity undertaken during the first trimester and early second trimester may be especially protective. Evidence syntheses published in subsequent years have broadly supported this pattern, although the magnitude of the association varied across studies and populations (Kasawara et al., 2012; Aune et al., 2014; Gascoigne et al., 2023).

Although exercise type, intensity, and duration differed across studies, a consistent pattern emerged in favor of light-to-moderate activity—particularly moderate-intensity aerobic exercise, structured walking programs, and recreational activity. In contrast, studies focusing on sedentary behavior reported that prolonged sitting and low overall activity levels were independently associated with higher risk of hypertensive disorders of pregnancy, including preeclampsia (Pei & Marozoff, 2025; Raguema et al., 2020). Collectively, these findings suggest that reducing sedentary time may be an important complementary target alongside increasing purposeful exercise.

From a mechanistic perspective, the overall evidence is consistent with current biological models of preeclampsia. Physical activity may plausibly reduce risk via improvements in endothelial function and vascular reactivity, including increased nitric oxide bioavailability, reduced peripheral resistance, enhanced uteroplacental perfusion, and modulation of inflammatory pathways. Some reports further suggest that physical activity may be linked to more favorable angiogenic and inflammatory profiles, supporting biological plausibility; however, the strength and directness of biomarker evidence varied across the included literature and should be interpreted cautiously. In addition, physical activity may contribute to risk reduction by improving glucose–insulin regulation, limiting excessive gestational weight gain, reducing visceral adiposity, and attenuating low-grade chronic inflammation—processes implicated in the obesity–inflammation–oxidative stress pathway relevant to preeclampsia (Gascoigne et al., 2023; Kasawara et al., 2012).

A recurring theme across studies was the importance of exercise characteristics—type, intensity, and timing. Overall, structured moderate-intensity aerobic activity appeared to show the most consistent protective association (Sorensen et al., 2003; Saftlas et al., 2004). Earlier initiation (preconception or early pregnancy) was generally associated with stronger effects than late initiation. Intervention duration and frequency also appeared relevant, with programs lasting at least 10–12 weeks and performed approximately three sessions per week showing potentially greater benefit in some reports (Kasawara et al., 2012). Nonetheless, substantial heterogeneity was observed across studies in exposure measurement (self-report versus objective monitoring), population

risk profiles, intervention protocols, and diagnostic definitions of preeclampsia. These limitations underscore the need for more standardized methods and well-controlled trials using validated measurement tools.

Overall, the evidence indicates that physical activity during pregnancy is a modifiable factor that may reduce the risk of preeclampsia. Moderate-intensity aerobic activity, earlier initiation, reduced sedentary time, and structured exercise programs appear to be key features associated with lower risk, with implications for clinical guidance and public health strategies.

Discussion and Conclusion

This review synthesizes evidence from 12 studies spanning observational designs, intervention trials, and evidence syntheses, and overall suggests that physical activity during pregnancy is associated with a reduced risk of preeclampsia. Across most included sources, physically active women—especially those engaging in regular leisure-time activity—had a lower likelihood of preeclampsia compared with inactive or more sedentary women. Early work (Marcoux et al., 1989; Sorensen et al., 2003) indicated that activity performed in the first and early second trimesters may be particularly relevant, and later studies and reviews have largely corroborated an overall protective pattern (Spracklen et al., 2016; Saftlas et al., 2004; Raguema et al., 2020; Kasawara et al., 2012; Aune et al., 2014; Gascoigne et al., 2023).

The findings also highlight that both increasing activity and reducing sedentary behavior may be important. Evidence on sedentary time suggests that prolonged sitting can be independently associated with higher risk of hypertensive disorders of pregnancy (Pei & Marozoff, 2025; Raguema et al., 2020), potentially attenuating the benefit of low-volume activity. Therefore, recommendations may need to emphasize not only planned exercise but also reductions in sedentary time through feasible substitutions with light-intensity movement.

Mechanistically, the observed associations are consistent with current pathophysiological models of preeclampsia. Physical activity may improve endothelial function and vascular health, modulate inflammatory responses, and support healthier cardiometabolic profiles. These pathways include improvements in nitric oxide bioavailability and vascular reactivity, reductions in peripheral resistance, and better metabolic regulation and weight management. Some studies have also suggested links between physical activity and angiogenic/inflammatory biomarkers, which may support mechanistic plausibility; however, biomarker findings across the included literature were not

uniform and should be interpreted with caution until confirmed by larger, well-designed studies.

Across study designs, moderate-intensity aerobic activity appeared to be the most consistently supported modality, particularly when initiated before conception or early in pregnancy. Structured programs of approximately 30–45 minutes per session, three times per week, and lasting at least 10–12 weeks were frequently associated with favorable outcomes, although protocols varied. Other modalities (e.g., aquatic exercise and combined training) may also be safe and potentially beneficial, especially for women with physical limitations, but the evidence base remains comparatively limited.

Despite the generally consistent pattern, heterogeneity was substantial across studies with respect to physical activity assessment (self-report versus objective tools), participant characteristics (low-risk versus high-risk populations), intervention content, and diagnostic criteria for preeclampsia. These factors likely contribute to variability in effect estimates and limit direct comparability. Future research should prioritize rigorous randomized controlled trials, greater use of objective activity measures (e.g., accelerometry), standardized outcome definitions, and subgroup analyses to clarify optimal “dose” (type, intensity, frequency, and timing) and to determine whether effects differ across risk strata.

In conclusion, physical activity during pregnancy appears to be a safe, low-cost, and feasible strategy that may reduce the risk of preeclampsia. Integrating evidence-based physical activity counseling into routine antenatal care—alongside interventions that address cultural, structural, and clinical barriers—may help reduce the burden of preeclampsia and improve maternal and neonatal outcomes. Promoting and enabling appropriate physical activity during pregnancy should therefore be considered an important component of maternal health policy and practice.

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