

Physical activity and exercise during pregnancy in relation to gestational weight gain: A systematic review with synthesis without meta-analysis

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ABSTRACT

Background: Excessive gestational weight gain (GWG) is associated with adverse maternal and neonatal outcomes, including gestational diabetes mellitus, hypertensive disorders, increased birth weight, and postpartum weight retention. Physical activity and structured exercise are modifiable lifestyle factors that may help prevent excessive GWG, yet evidence varies by intervention type, intensity, duration, and adherence.

Objectives: This systematic review aimed to synthesize evidence from randomized controlled trials on the effects of physical activity and exercise interventions during pregnancy on gestational weight gain.

Methods: This systematic review followed PRISMA 2020 guidelines and used a Synthesis Without Meta-analysis approach. Searches were conducted in PubMed, ScienceDirect, Scopus, and Emerald for studies published between 2013 and 2023. Eligible studies were randomized controlled trials involving pregnant women receiving physical activity or exercise interventions. GWG was the primary outcome, while gestational diabetes mellitus, hypertensive disorders, neonatal outcomes, and adherence were secondary outcomes. Screening was conducted using Rayyan, and study quality was assessed using the CASP checklist.

Results: A total of 2,052 records were identified. After duplicate removal and eligibility screening, 27 full-text articles were assessed, and 4 randomized controlled trials were included. The included studies generally suggest that structured exercise during pregnancy may help reduce excessive GWG, although findings varied across populations and intervention characteristics.

Conclusions: Physical activity and structured exercise during pregnancy may help prevent excessive gestational weight gain, although their effectiveness depends on adherence, baseline BMI, and intervention characteristics. Integrating exercise counseling into antenatal care may support appropriate gestational weight gain.

KEYWORD: *exercise; gestational weight gain; physical activity; pregnancy; pregnant women*

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INTRODUCTION

The maternal mortality rate in Indonesia has increased from 2019 to 2021. Recorded 4,221 deaths in 2019, the maternal mortality rate experienced a massive increase into 7,389 deaths in 2021. Its surge was also caused by the COVID-19 pandemic, with a total of 2,982 cases. Bleeding and hypertension in pregnancy still dominate the causes of maternal death in Indonesia (1). Approximately 10% of pregnant women engage in physical activity or exercise even though they are in good health or meet the criteria for continuing to exercise (2). This means that few pregnant women maintain regular physical activity during pregnancy. One of the benefits of regular physical activity and exercise is improved metabolic processes. Nutrient absorption during pregnancy is influenced by the mother's metabolism. The body's metabolism can be optimal when fluid, nutritional, and physical activity needs are met (3). Women with a higher quality of life also report higher levels of physical activity (4). Other studies report that physical activity is a lifestyle factor that can be modified and helps prevent pregnancy complications (5,7) e.g., Gestational diabetes (7,9), prenatal and postnatal

depression (7,10,11), reduces labor pain (12,13), optimizes absorption of nutrients and diet (14), improves sleep quality, and improves the relationship between mother and fetus (15).

Most pregnant women do not engage in physical activity or exercise due to a lack of knowledge about its importance, fatigue, or work or other children (15,16). The same is true of the phenomenon the author observes in people's lives in the Klaten district: as soon as a woman learns she is pregnant, she immediately or gradually reduces physical activity, even sports. They believe that these activities can affect the health of their pregnancy. Pregnant women are motivated to engage in physical activity when they receive support from their social environment, especially from their partners (16). Husbands who understand the importance of physical activity and sports certainly support their wives in maintaining it. Even husbands play a role in choosing the type of exercise for their wives, for example, changing from risky sports to safer types of sports.

MATERIALS AND METHODS

This review was reported using the "Preferred Reporting Items for Systematic

Reviews and Meta-Analyses” guideline and was written using the “Synthesis without Meta-Analysis” method. This systematic review was registered in the Health Research Ethics Committee, Faculty of Health Sciences, Universitas Muhammadiyah Klaten, number 88/KET/I.3.AU/F.5/I II/2025. This systematic review was designed using the PICOS framework to evaluate the effects of physical activity and exercise interventions during pregnancy on gestational weight gain. The population consisted of pregnant women without contraindications to exercise. The intervention included structured physical activity or exercise

programs conducted during pregnancy, including supervised exercise, aerobic exercise, resistance training, or motivational counseling to increase physical activity. The comparator was standard antenatal care, usual care, or no structured exercise intervention. The primary outcome of interest was gestational weight gain, including excessive gestational weight gain. Secondary outcomes included gestational diabetes mellitus, hypertensive disorders in pregnancy, neonatal outcomes, and adherence to the intervention. Only randomized controlled trials published in English between 2013 and 2023 were included.

Table 1. PICOS framework for evaluating physical activity and exercise interventions on gestational weight gain

PICOS Component	Criteria used in this review
Population	Pregnant women without contraindications to exercise
Intervention	Physical activity or exercise interventions during pregnancy, including supervised exercise, aerobic exercise, resistance training, or motivational counseling to increase physical activity
Comparator	Standard antenatal care, usual care, no exercise intervention, or control group
Primary Outcome	Gestational weight gain, including excessive gestational weight gain when reported
Secondary outcomes	Gestational diabetes mellitus, hypertensive disorders in pregnancy, neonatal outcomes, and adherence to exercise interventions
Study design	Randomized controlled trials

The literature search strategy in this study was carried out systematically, following the PRISMA 2020 guidelines to ensure transparency and replicability. The studies included for this systematic review were collected from four online databases, namely PubMed, ScienceDirect, Scopus, and Emerald, with a publication period of

2013 to 2023 in English. The keywords used for this systematic review were “pregnant woman”, “physical activity”, “exercise” and “weight gain”. These keywords are used in combination to search across the four databases. The Boolean “AND” was used for the PubMed literature search, with the following search terms:

"pregnant women" AND "physical activity" AND "exercise" AND "weight gain". Additionally, the use of quotation marks (" ") is applied for specific phrase searches, as well as truncation (*) to include word variations. The studies submitted to this systematic review met several criteria, including randomized controlled trials (RCTs), English-language articles, and interventions that promoted physical activity or exercise. This study was excluded if it was a non-randomized controlled trial. In addition, duplications, observational studies, review articles, case reports, and publications older than 10 years were excluded from the study.

The study selection process was conducted using Rayyan software to facilitate systematic and transparent screening (17). All records identified in the databases were imported into Rayyan, and duplicates were removed prior to screening. Title and abstract screening was then conducted according to predefined inclusion and exclusion criteria. Articles that did not meet the eligibility criteria were excluded at this stage.

Full-text screening was conducted for articles that passed the initial screening. The eligibility of each full-text article was assessed according to the PICOS framework, with gestational weight gain as the primary outcome of interest. Any uncertainty during the selection process was resolved through discussion and

rechecking of the inclusion and exclusion criteria. Although Rayyan was used to support the screening process, all exclusion decisions were manually verified to ensure that the included studies were relevant to the objective of this systematic review. Data extraction was performed separately using a structured extraction form that included author, year of publication, country, study design, population, intervention characteristics, comparator, gestational weight gain outcomes, related maternal and neonatal outcomes, and adherence information.

Data from selected studies were independently extracted by the authors. The collected data included the author's name, year of publication, study design, number of research subjects, interventions, and primary and secondary outcomes. The critical assessment used in this study is the Critical Appraisal Skills Program (CASP). CASP provides a critical appraisal checklist for assessing the validity, results, and relevance of studies. CASP helps researchers assess the quality of articles through aspects such as clarity of research objectives, appropriateness of methods, participant or data selection processes, validity of results, and relevance of findings to the research question. Using CASP, researchers can determine whether an article is at risk of bias, has methodological weaknesses, or has limitations that could affect the strength of the evidence (18).

RESULTS AND DISCUSSION

A total of 2,052 records were identified through database searches, comprising PubMed (n = 340), ScienceDirect (n = 1,580), Scopus (n = 20), and Emerald (n = 112). Before screening, 4 duplicate records were removed, and 580 records were automatically marked as ineligible. Therefore, 1,468 records were screened by title and abstract. During title and abstract screening, 1,441 records were excluded because they did not meet the eligibility criteria, including not focusing on

physical activity, not involving pregnant women, being review articles or protocols, or having other irrelevant reasons. A total of 27 full-text articles were assessed for eligibility. Of these, 14 articles were excluded because they were not relevant to the review objective, and 9 articles were excluded because they reported different outcomes. Finally, 4 randomized controlled trials were included in this systematic review and assessed using the CASP checklist. **Figure 1** presents the PRISMA flow diagram of the study selection process.

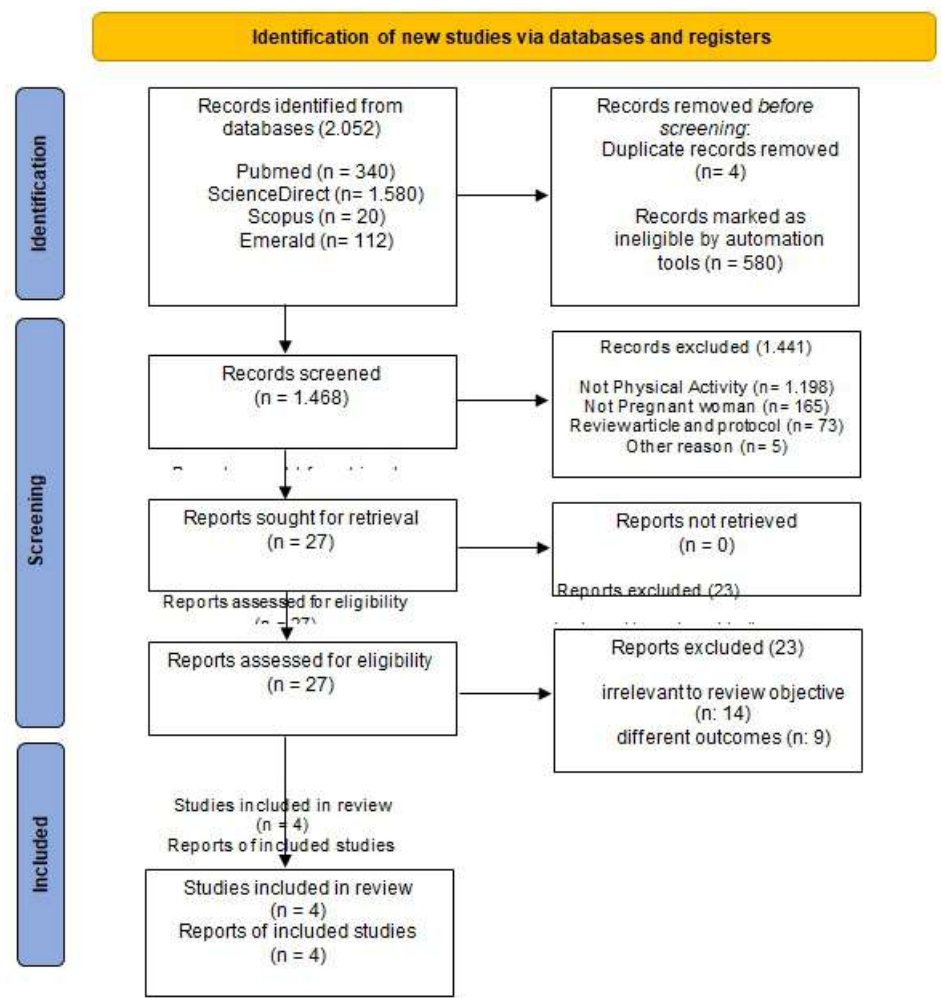


Figure 1. PRISMA flow diagram

Characteristics of included studies

The characteristics of the included studies are presented in **Table 2**. A total of four randomized controlled trials were included in this systematic review. The studies were conducted in Brazil, Denmark, Spain, and the United Kingdom, with publication years ranging from 2016 to 2023. The study populations consisted of pregnant women with varying

characteristics, including healthy pregnant women, women with low physical activity levels, and women with overweight or obesity before pregnancy.

The interventions also varied across studies, including supervised exercise programs, aerobic exercise, combined endurance and strength training, and motivational counseling supported by health technology.

Table 2. Characteristics of included studies

Study	Country	Study Design	Study Population	Intervention (s)	Primary Outcome	Secondary Outcome
#1 (Silva, <i>et al.</i> , 2017) (19)	Brasil	Randomized Controlled Trial	639 healthy pregnant women, 213 in the intervention group (IG), and 426 in the control group (CG).	Exercise-based intervention was conducted three times/week for 16 weeks from 16-20 to 32-36 weeks gestation.	Preterm birth and pre-eclampsia	Gestational weight gain, gestational diabetes, birth weight, infant length and head circumference
#2 (Roland, <i>et al.</i> , 2023)(20)	Denmark	Randomized Controlled Trial	220 healthy pregnant women with gestational age no later than week 15 and whose PA level does not exceed one hour/week. Each participant was randomly put into one of these three groups: Structured supervised exercise training consisting of three weekly exercise sessions, motivational counselling supported by	Structure exercise, motivational counselling or standard care	Min/week of moderate to vigorous intensity PA as determined by a commercial activity tracker, collected from randomization until GA of 28 weeks and 0-6 days.	Gestational weight gain (GWG), complementary measures of PA: clinical and psychological health parameters in participant, partner and offspring: analyses of blood, placenta and breastmilk samples, process evaluation of interventions and personal understandings of PA.

			health technology or a control group receiving standard care.			
#3 (Barakat, <i>et.al</i> , 2019)(21)	Spain	Randomized Controlled Trial	456 pregnant women (Intervention group: 234, Controlled group: 222).	Moderate aerobic exercise performed three days per week (50-55 minutes per session) for 8-10 weeks to 38-39 weeks gestation.	Examine the influence of a supervised exercise program throughout pregnancy on maternal weight gain and incident of GDM.	The effect of exercise program on other maternal and neonatal outcomes was also examined.
#4 (Gamaes, <i>et.al</i> , 2016)(22)	United Kingdom	Randomized Controlled Trial	91 pregnant women with pregnancy body mass index (BMI) ≥ 28 kg/m ² . The Intervention / exercise group (n: 46) or control group, standard maternity care (n: 45).	The exercise group was offered thrice weekly supervised sessions of 35 min of moderate intensity endurance exercise and 25 min of strength training.	Assess whether regular supervised exercise training in pregnancy could reduce Gestational Weight Gain in woman with pre pregnancy overweight/obesity.	Examine the effects of exercise in pregnancy on 30 outcomes including Gestational Diabetes Mellitus incidence, blood pressure, blood measurements, skinfold thickness and body composition.

The following **Table 2** summarizes the characteristics of the studies included in this systematic review, including: study, country, study design, population, intervention, primary outcome, and secondary outcome. Although the included randomized controlled trials differed in their original primary outcomes, this review focused specifically on gestational weight gain.

Therefore, GWG-related data were extracted and synthesized as the primary outcome of interest, while other maternal and neonatal outcomes were considered secondary outcomes.

Because the included randomized controlled trials varied in their original primary outcomes, population characteristics, and intervention designs, a

narrative synthesis was conducted with gestational weight gain as the primary outcome of interest. The synthesis focused on whether physical activity or exercise interventions during pregnancy were associated with lower gestational weight gain or the prevention of excessive gestational weight gain. Related maternal and neonatal outcomes were considered supportive findings.

Although the included studies differed in population characteristics, intervention types, duration, and primary outcomes, all provided relevant information on gestational weight gain. In this review, gestational weight gain was treated as the primary outcome of interest, while other maternal and neonatal outcomes, such as gestational diabetes mellitus, hypertensive disorders, birth weight, preterm birth, and adherence, were considered secondary or supportive outcomes. Therefore, the synthesis focused on whether physical activity or exercise interventions during pregnancy were associated with lower gestational weight gain or the prevention of excessive gestational weight gain.

Synthesis of Key Findings

The findings of the included randomized controlled trials suggest that physical activity and structured exercise interventions during pregnancy may help prevent excessive gestational weight gain. Across the included studies, exercise programs were generally delivered as

supervised or structured interventions, commonly performed three times per week with light-to-moderate intensity. This intervention pattern was observed in the studies by Silva et al., Barakat et al., and Garnæs et al., which implemented exercise sessions approximately three times per week during pregnancy (19,21,22). These findings are also consistent with broader evidence indicating that physical activity during pregnancy is a modifiable lifestyle factor that may support maternal metabolic health and reduce pregnancy-related complications (7,13,14).

However, the effect of exercise on gestational weight gain was not entirely consistent across studies. Barakat et al. reported that supervised moderate aerobic exercise during pregnancy had a preventive effect on excessive maternal weight gain and gestational diabetes mellitus (21). In contrast, Garnæs et al., which focused on overweight and obese pregnant women, did not demonstrate a significant reduction in gestational weight gain, although some favorable maternal health outcomes, such as lower systolic blood pressure in late pregnancy, were observed (22). These differences may be explained by variations in baseline BMI, intervention duration, exercise intensity, supervision, and participant adherence (21,22).

The evidence also indicates that adherence is a key factor influencing the effectiveness of exercise interventions during pregnancy. Roland et al. emphasized

the importance of structured supervised exercise and motivational counseling supported by health technology to increase physical activity levels during pregnancy (20).

In addition, previous studies have shown that pregnant women often experience barriers to physical activity, including fatigue, physical discomfort, lack of time, limited knowledge, and insufficient social or professional support (15,16). Therefore, while exercise appears to be a promising strategy to prevent excessive gestational weight gain, its effectiveness depends on appropriate program design and sustained participant adherence (20,21,23). Secondary outcomes, including gestational diabetes mellitus, hypertensive

disorders, preterm birth, birth weight, and neonatal outcomes, should be interpreted as supportive findings rather than the main focus of this review. Silva et al. evaluated preterm birth and pre-eclampsia as primary outcomes, while gestational weight gain was assessed as a secondary outcome (19).

Barakat et al. examined gestational diabetes mellitus alongside maternal weight gain, whereas Garnæs et al. also considered several maternal and neonatal outcomes beyond gestational weight gain (21,22). These outcomes provide additional context regarding the broader maternal and neonatal benefits of exercise, but the primary interpretation of this review should remain centered on gestational weight gain.

Table 3. Synthesis of findings on gestational weight gain and related outcomes

Study	Population	Intervention Characteristics	GWG-Related Findings	Related Maternal/Neonatal Findings	Adherence/Implementation Notes	Interpretation For This Review
Silva Et Al., 2017 (19)	Healthy pregnant women	Exercise-based intervention three times per week for 16 weeks, from approximately 16–20 to 32–36 weeks of gestation	Gestational weight gain was assessed as a secondary outcome	Primary outcomes included preterm birth and pre-eclampsia; other outcomes included gestational diabetes, birth weight, infant length, and head circumference	The findings should be interpreted with attention to participant compliance during the exercise program	Exercise during pregnancy may support maternal outcomes, but GWG was not the primary focus of the original study

Roland et al., 2021 (23)	Pregnant women with gestational age no later than 15 weeks and low physical activity level	Structured supervised exercise, motivational counseling supported by health technology, or standard care	Gestational weight gain was included as a related maternal outcome	Primary outcome was moderate-to-vigorous physical activity measured using an activity tracker	This study highlights the importance of supervision, motivational support, and technology to improve adherence	Suggests that improved adherence through structured and supported interventions may contribute to better gestational weight gain outcomes.
Barakat et al., 2019 (21)	Pregnant women allocated to intervention and control groups	Moderate aerobic exercise three times per week, 50–55 minutes per session, from 8–10 to 38–39 weeks of gestation	Supervised exercise reduced excessive maternal weight gain	Exercise also had a preventive effect on gestational diabetes mellitus and other maternal/neonatal outcomes	Supervised and regular exercise throughout pregnancy supported intervention effectiveness	Provides direct evidence that structured exercise may prevent excessive gestational weight gain
Garnæs et al., 2016 (22)	Pregnant women with pre-pregnancy BMI \geq 28 kg/m ²	Supervised exercise three times per week, consisting of endurance and strength training	Exercise did not significantly reduce gestational weight gain among overweight/obese pregnant women	Some favorable maternal outcomes were observed, including lower systolic blood pressure in late pregnancy	The effect may have been influenced by adherence, baseline BMI, and challenges in maintaining exercise participation	Suggests that exercise effects on GWG may vary in overweight/obese pregnant women and depend on adherence and intervention feasibility

Overall, the included studies suggest that structured and supervised exercise during pregnancy may help prevent excessive gestational weight gain, particularly when initiated early and maintained regularly throughout pregnancy. However, the findings were not entirely consistent. Barakat et al. reported a beneficial effect of supervised aerobic exercise on excessive maternal weight gain, whereas Garnæs et al. did not find a

significant reduction in gestational weight gain among overweight and obese pregnant women (21,22).

These differences may reflect variation in baseline BMI, intervention type, duration, intensity, supervision, and adherence. Therefore, exercise during pregnancy should be interpreted as a promising but adherence-dependent strategy for managing gestational weight gain (**Table 3**).

Program Effectiveness in Preventing EGWG and Improving Maternal Outcomes

Mechanistically and clinically, preventing EGWG through exercise during pregnancy makes sense because exercise affects energy balance, insulin sensitivity, and body composition. The RCT of Barakat et al. The study, which assessed GWG and the incidence of GDM, aligns with evidence that structured aerobic exercise throughout pregnancy can reduce the proportion of mothers with excess weight gain. In overweight/obese populations, the combination of endurance and strength training (20) also aligns with the literature emphasizing the benefits of combined exercise on glycemic control and body composition adaptations.

The literature also suggests that physical exercise during pregnancy not only targets GWG but also has the potential to improve glucose tolerance, cardiorespiratory fitness, muscle strength, and quality of life. Group-based and supervised programs have been reported to improve various maternal outcomes and increase adherence compared to unsupervised programs.

Therefore, the intervention characteristics in Table 1—predominantly supervised and structured—are expected to support program effectiveness, particularly on GWG and GDM outcomes.

Adherence Challenges and Influencing Factors

Despite strong clinical benefits, the literature indicates that most pregnant women do not meet the recommended minimum of 150 minutes of moderate-intensity aerobic activity per week. Declines in activity with advancing gestational age are common, and compliance with interventions in overweight/obese groups has been reported to vary widely.

Literature findings suggest that barriers to adherence are multi-level: Intrapersonal: physical complaints (nausea, fatigue, pain, swelling), time constraints, low motivation, and poor pre-pregnancy exercise habits; Interpersonal: insufficient social support and inadequate or inconsistent information/recommendations from healthcare providers; Environmental/organizational: access to facilities, cost, availability of childcare, and weather/geographical factors.

In this context, Roland et al.'s (20) design, which included motivational counseling and technological support, is important because it addresses the barriers of time, access, and the need for motivational reinforcement. Evidence also suggests that professional supervision and an engaging program structure can improve adherence. Furthermore, several studies comparing exercise modalities have found that resistance training may be more

comfortable and easier for some mothers to adhere to (e.g., because it can be done at home), which is relevant for modifying programs when physical complaints increase in the later trimesters.

Clinical and Policy Implications

The findings of this review have important implications for antenatal care, particularly in preventing excessive gestational weight gain. Physical activity counseling should be integrated into routine antenatal care to help pregnant women understand the recommended types, frequencies, intensities, and durations of safe exercise during pregnancy. Evidence from the included studies indicates that structured or supervised exercise may help prevent excessive gestational weight gain and improve related maternal outcomes when performed regularly during pregnancy (19,21,22).

Supervised or structured exercise programs may be particularly useful for women at risk of excessive gestational weight gain, including those with overweight or obesity before pregnancy. However, adherence remains a major challenge, and the effectiveness of exercise interventions appears to depend on program design, supervision, motivation, and participant compliance (2022). Previous studies also show that barriers such as fatigue, limited knowledge, lack of time, physical discomfort, and insufficient social support may reduce pregnant women's participation

in physical activity (15,16). At the policy level, antenatal care programs should include clear physical activity recommendations as part of gestational weight gain management. Educational materials, professional counseling, partner support, and technology-based monitoring may help improve adherence and support appropriate weight gain during pregnancy (16,20). In the Indonesian context, integrating physical activity counseling into routine ANC visits may be a feasible strategy to reduce excessive gestational weight gain and related pregnancy complications, although adaptation to local maternal health services is needed.

Bias and Quality of the included studies

All studies had a low risk of selection bias. A review was conducted to assess the risk of bias using the CASP RCT Tools. There are 11 question points to assess, including: Q1. Does the study address clearly focused research questions? Q2. Was the assignment of participants to the intervention random? Q3. Were all participants who entered the study accounted for in the conclusion? Q4. Are all participants, investigators, people assessing/analyzing the results "blinded"? Q5. Were the study groups similar at the start of the trial? Q6. Apart from the experimental intervention, were each group treated the same (i.e., were they treated the same)? Q7. Are the effects of interventions reported comprehensively? Q8. How precise

are the estimates of treatment effects? Q9. Are the results applicable to the local population or in your context? Q10. Can the

results be applied to your local population/in your context? Q11. Are the benefits worth the losses and costs?

Table 4. CASP critical appraisal

Authors	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Silva, et.al. (19)	Y	Y	C	Y	Y	Y	Y	Y	Y	Y	Y
Roland, et.al. (23)	Y	Y	Y	Y	Y	C	Y	Y	Y	Y	Y
Barakat, et.al. (21)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Garnæs, et.al. (22)	Y	Y	Y	Y	Y	Y	Y	C	Y	Y	Y

Y = Yes, N = No, C = Can't Tell

Based on the **Table 4** methodological quality of the included studies was assessed using the Critical Appraisal Skills Program checklist for randomized controlled trials.

Overall, the included studies addressed focused research questions and used randomized designs, which strengthened the internal validity of the evidence (19,22). However, interpreting study quality should be cautious, as exercise-based interventions are difficult to blind, particularly for participants and intervention providers. Therefore, performance bias may still be present even when randomization is adequately conducted (19,21,22).

In addition, adherence to the exercise intervention varied across studies and may have influenced the observed effect on gestational weight gain. Roland et al. emphasized that maintaining physical activity during pregnancy requires structured support, supervision, and motivational strategies (20). Barakat et al.

showed beneficial effects of supervised exercise on excessive maternal weight gain and gestational diabetes, whereas Garnæs et al. reported that supervised exercise did not significantly reduce gestational weight gain among overweight and obese pregnant women (21,22,25). These differences suggest that baseline BMI, intervention characteristics, supervision, and participant adherence may contribute to heterogeneity in the findings (20,22,25).

The risk of bias assessment should therefore not only report whether each CASP item was fulfilled, but also provide a narrative explanation of key methodological concerns, including randomization, allocation concealment, blinding, completeness of follow-up, adherence, and outcome measurement. Because the number of included studies was small and the interventions were heterogeneous, the overall certainty of evidence regarding the effect of exercise on gestational weight gain should be interpreted with caution (19,22,25).

CONCLUSION AND RECOMMENDATION

Structured light-to-moderate intensity exercise during pregnancy may help reduce the risk of excessive gestational weight gain. However, its effectiveness appears to depend on adherence, baseline BMI, timing of initiation, and intervention characteristics. Therefore, exercise counseling and feasible activity programs should be integrated into routine antenatal care to support appropriate gestational weight gain.

LIMITATION

A limitation of this review is the lack of prospective registration in PROSPERO. This may limit the reader's ability to compare the planned methods with the methods ultimately reported. However, this limitation is not considered to detract from the overall quality of the review, as the systematic review procedures were described explicitly and transparently in accordance with the principles of systematic review reporting.

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