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Physical Activity During Pregnancy in the Prevention and Management of Gestational Diabetes Mellitus: A Narrative Review of Evidence

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Abstract

Background

Gestational diabetes mellitus (GDM) is a common metabolic complication of pregnancy, increasing the risk of adverse maternal and neonatal outcomes and future type 2 diabetes in both mother and child. Physical activity is a key modifiable factor that may counteract pregnancy-induced insulin resistance.

Aim

This narrative review with elements of a systematic approach aimed to synthesize evidence (2019–2025) on the effects of physical activity during pregnancy on GDM incidence in healthy and high-risk women, and on metabolic control in women with diagnosed GDM.

Material and methods

A literature search was performed in PubMed, Scopus, and Web of Science for randomized controlled trials, prospective cohort studies, systematic reviews, meta-analyses, and umbrella reviews. Studies meeting predefined criteria were included for qualitative synthesis.

Research results

Recent meta-analyses show that regular moderate-intensity physical activity reduces GDM risk by ~20–40%, particularly when started in the first trimester and totaling ≥150 minutes per week. Structured programs combining aerobic and resistance training are especially effective in women with overweight, obesity, or other risk factors. In women with diagnosed GDM, moderate exercise improves fasting and postprandial glucose and slightly lowers HbA1c, without increasing obstetric or neonatal complications. These benefits align with mechanisms such as improved insulin sensitivity, better lipid profile, reduced inflammation and oxidative stress, and enhanced placental and cardiovascular function.

Conclusions

Physical activity during pregnancy is a safe and effective strategy for preventing and managing GDM. Integrating evidence-based exercise recommendations into routine antenatal care, particularly for women at elevated metabolic risk, may provide a practical and cost-effective approach to reducing the growing burden of GDM and supporting long-term cardiometabolic health in mothers and their offspring.

Key words: Gestational diabetes mellitus, GDM, pregnancy, physical activity, exercise, glycemic control, maternal health

1.Introduction

Gestational diabetes mellitus (GDM) is defined as glucose intolerance of varying severity with onset or first recognition during pregnancy and represents one of the most frequent metabolic complications of gestation. [1,4,6] Depending on diagnostic criteria and population, GDM affects 5–20% of pregnant women worldwide, with a rising trend driven by higher maternal age, overweight, obesity, and sedentary behavior. [1,4,5]

GDM is associated with significant maternal and neonatal complications, including gestational hypertension, pre-eclampsia, cesarean section, macrosomia, neonatal hypoglycemia, and long-term cardiometabolic risks for both mother and child. [1,5,6] Consequently, major clinical guidelines (ACOG, WHO, ADA) highlight the importance of preventive strategies focused on modifiable lifestyle factors, particularly body weight, diet, and physical activity. [2–4]

Physiologically, pregnancy is characterized by progressive insulin resistance caused by placental hormones and inflammatory mediators. In metabolically vulnerable women, this adaptive process may exceed pancreatic β-cell capacity, resulting in hyperglycemia and the development of GDM. [6,28]

Physical activity improves glucose homeostasis, skeletal muscle glucose uptake, insulin sensitivity, lipid metabolism, and reduces inflammation and oxidative stress. [8–12,17,20] Numerous trials and meta-analyses have evaluated whether exercise during pregnancy can prevent GDM or improve metabolic outcomes in affected women. [9,16,21–27]

A comprehensive synthesis of current evidence is needed to clarify the preventive and therapeutic role of physical activity in GDM and support evidence-based prenatal care. [1–3,7,16,21]

2.1 Research Objectives, Problems, and Hypotheses

This review aimed to summarize recent evidence (2019–2025) regarding the effects of physical activity during pregnancy on the risk of gestational diabetes mellitus (GDM) and on metabolic control in women already diagnosed with GDM. Older literature was also used to describe physiological processes. Specifically, the review examined how the amount, timing, and type of physical activity influence GDM incidence, identified which forms of exercise provide the greatest benefit, assessed expected metabolic outcomes in women with established GDM, and investigated the physiological mechanisms underlying these effects.

The review hypothesized that moderate-intensity physical activity reduces the risk of GDM, that early initiation of regular activity enhances preventive value, and that structured, supervised training programs combining aerobic and resistance elements yield the most favorable outcomes. Additionally, it was hypothesized that, in women with diagnosed GDM, exercise improves glycemic control, with these benefits mediated by increased insulin sensitivity, reduced in inflammation and oxidative stress, and enhanced placental and cardiovascular function.

2.2.1 Statistical software

No additional statistical analyses beyond those reported in the original studies and meta-analyses were conducted. Therefore, no dedicated statistical software was used for data re-analysis.

2.2.2. AI

Artificial intelligence tools were used exclusively to support language editing and formatting of the manuscript. All stages of study selection, data extraction, and evidence interpretation were performed manually by the authors. The final conclusions and clinical implications reflect the authors' independent critical appraisal of the literature. After using this service, the authors

have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

2.2.3. Ethical considerations

As this work is based solely on previously published data and does not involve new research on human subjects, formal approval from an ethics committee and informed consent from participants were not required.

3. Research results

3.1. Physiological Basis of Gestational Diabetes Mellitus and Role of Physical Activity

3.1.1 Physiological basis and clinical consequences of GDM

Gestational diabetes mellitus (GDM) confers substantial short- and long-term risks for mothers and children. Women with GDM are more likely to experience gestational hypertension, pre-eclampsia, cesarean delivery, preterm birth, and induction of labor, while newborns are at higher risk of macrosomia, hypoglycemia, neonatal jaundice, and birth trauma. [1,3–5]

Long-term, both mothers and offspring have an increased likelihood of developing obesity, impaired glucose tolerance, and type 2 diabetes, as highlighted in guidelines from ACOG, WHO, and ADA [1,3-5]

3.1.2 The pathophysiology of GDM

GDM pathophysiology involves a progressive increase in insulin resistance during the second and third trimesters of pregnancy. Placental and pregnancy-related hormones, such as placental lactogen, progesterone, estrogens, and cortisol, drive this process. These hormones alter maternal carbohydrate metabolism to ensure a steady supply of glucose and other energy substrates for fetal development [6].

In women with a genetic predisposition, overweight or obesity, or a sedentary lifestyle, the normal increase in insulin resistance is exaggerated. This leads to inadequate compensatory insulin secretion, resulting in maternal hyperglycemia and the development of GDM [1,7].

3.1.3 Role of skeletal muscle in glucose metabolism

Skeletal muscle is the main site of insulin-dependent glucose uptake. Muscle contraction stimulates GLUT-4 translocation, which enhances insulin-independent glucose uptake and improves insulin sensitivity in muscle, liver, and adipose tissue. [8–9] Exercise also activates AMPK, increasing fatty acid oxidation and supporting metabolic flexibility.[12] Section 3.3.1 provides further details on these mechanisms.

3.1.4 Exercise, oxidative stress, and inflammation

Regular moderate-intensity physical activity favorably modulates the inflammatory and oxidative stress profile during pregnancy. Exercise has been shown to reduce circulating concentrations of pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), while increasing adiponectin levels, thereby supporting healthy metabolic function. [13–15]

At the same time, physical activity attenuates oxidative stress by lowering levels of reactive oxygen species (ROS) and lipid peroxidation markers such as malondialdehyde (MDA). These effects are accompanied by an upregulation of key antioxidant enzymes, particularly superoxide dismutase (SOD) and catalase, which improve cellular defense mechanisms and protect pancreatic β-cells from oxidative injury. [17–19]

Collectively, these physiological adaptations improve insulin sensitivity and reduce the progressive increase in insulin resistance seen in mid- and late pregnancy, which lowers the risk of developing GDM. [7,16]

3.1.5 Effect of Physical Activity on Hormonal Balance and Metabolic Adaptation

Moderate-intensity physical activity positively influences the hormonal environment in pregnant women. It increases the secretion of myokines, including irisin and interleukin-10 (IL-10), which support glucose metabolism and provide anti-inflammatory effects.[20] This activity also improves lipid profiles and lowers leptin levels.[13] These adaptations help prevent excessive gestational weight gain, a key contributor to the development of GDM. [1,21]

3.2 The Impact of Physical Activity on the Incidence of Gestational Diabetes Mellitus – Overview of Selected Reviews and Meta-Analyses (2019–2025)

In recent years, numerous high-quality systematic reviews and meta-analyses have confirmed the protective effect of physical activity during pregnancy on the development of GDM.

Across publications published between 2019 and 2025, a consistent reduction in GDM risk, typically ranging from 20% to 40% has been observed, depending on the type, intensity, and timing of activity initiation.

3.2.1 Dose–response relationship and timing of physical activity

The meta-analysis by Xie et al. (2024, *BMC Public Health*) [9] was among the most comprehensive to date and the first to quantify the dose–response association between physical activity expressed in metabolic equivalent task hours per week (MET-h/week) and the incidence of GDM.

The analysis included 31 observational and interventional studies involving more than 25,000 participants.

A clear, graded inverse association was identified:

1. ≥10 MET-h/week (~150 min/week of moderate-intensity activity) was associated with a 13% reduction in GDM risk (Relative Risk (RR) = 0.87; 95% Confidence Interval (CI): 0.79–0.96).
2. ≥50 MET-h/week corresponded to a 29% risk reduction (RR = 0.71; 95% CI: 0.55–0.89).

3. Women in the highest activity category had a 36% lower risk than those in the least active group (RR = 0.64; 95% CI: 0.53–0.78).

The protective effect was most pronounced when physical activity was initiated in the first trimester, highlighting the importance of early implementation and continued engagement in exercise throughout pregnancy.

3.2.2 Effectiveness of interventions in high-risk women

Tsironikos et al. (2022, PLOS ONE) [22] conducted a meta-analysis on the effectiveness of structured exercise interventions in women at higher risk for GDM due to obesity, hypertension, or a family history of diabetes. The review included nine randomized controlled trials (RCTs) with a combined sample of 1,508 participants.

Exercise interventions, whether aerobic, resistance, or combined, initiated during the first trimester significantly lowered the incidence of GDM compared with standard prenatal care (Odds Ratio (OR) = 0.70; 95% CI: 0.52–0.93).

The strongest preventive effects were observed in supervised and group-based programs, where adherence to exercise sessions was highest. These findings underline that intervention effectiveness in high-risk women is strongly linked to regular participation and structured program delivery.

Building on this evidence, Bennett et al. (2023) [21] conducted a second high-quality systematic review and meta-analysis, also restricted to RCTs, evaluating supervised physical activity during pregnancy. Their results demonstrated a 43% reduction in GDM incidence among women participating in supervised exercise programs (RR = 0.57; 95% CI: 0.41–0.79).

The greatest benefits were observed when exercise was initiated before 16 weeks of gestation, and pregnant women accumulated ≥150 minutes per week of moderate-intensity activity.

Supervised programs were associated with the highest adherence rates and the most robust preventive effects.

3.2.3 Systematic and umbrella reviews

Systematic and umbrella reviews (Rute-Larrieta et al., 2024; Martínez-Vizcaíno et al., 2023; Kouiti et al., 2022) consistently confirm the robustness and reproducibility of the protective effect of physical activity on GDM risk.

In the meta-review by Rute-Larrieta et al. (2024, *Life*) [16], synthesizing 18 prior meta-analyses and 60 RCTs, GDM risk was reduced by 24% to 38%**.** The strongest effects occurred among women who exercised regularly throughout pregnancy. Both aerobic and combined aerobic–resistance programs were effective when performed ≥3 times per week for 30–60 minutes.

Similarly, the umbrella review by Kouiti et al**.** (2022, *Nutrients*) [23], summarizing 21 systematic reviews, found that interventions combining moderate physical activity with dietary modification reduced GDM risk by 35–40%**,** with physical activity identified as the primary driver of effectiveness.

The systematic review by Martínez-Vizcaíno et al. (2023, *BJOG*) [24], including 63 RCTs, confirmed that the protective effect of exercise was observed across different populations: healthy women, women with overweight, and women with obesity. Supervised or group-based interventions produced the largest metabolic improvements and the highest adherence.

These reviews consistently show that structured physical activity reduces the incidence of GDM across various populations, exercise types, and study designs.

3.2.4 Type of physical activity and metabolic outcomes

Evidence from current literature indicates that different forms of physical activity may offer distinct metabolic benefits for pregnant women, including those with GDM.

According to Tsironikos et al. (2022**)** and Rute-Larrieta et al. (2024), aerobic, resistance, and combined aerobic–resistance programs are all effective in reducing the risk of GDM and improving glycemic parameters.[16,22] Combined training appears to provide the most

comprehensive metabolic benefit, particularly in women with overweight or obesity, as highlighted by Santa Cruz et al. (2025).[27]

In women with diagnosed GDM, structured exercise programs typically involving moderate-intensity aerobic activity with light resistance components have been shown to improve fasting glucose and HbA1c, as demonstrated in the study by Zhang et al. (2021**)** and the meta-analysis by Shu et al. (2025). [25-26]

Expert reviews and clinical guidelines (Taliento 2024; ACOG 2020; Gascoigne 2022) further emphasize that activities such as brisk walking, swimming, stationary cycling, and low-load resistance training are both safe and metabolically beneficial during pregnancy. [1-3]

These publications report no increase in adverse pregnancy outcomes, supporting the safety and clinical use of these exercise modalities for preventing and managing GDM.

3.3 Mechanisms and Safety of Physical Activity During Pregnancy

Physical activity during pregnancy influences a wide range of metabolic, hormonal, and vascular processes that collectively support the maternal physiological adaptation to pregnancy-induced insulin resistance. Its benefits extend beyond the prevention of GDM, contributing to improved maternal–fetal metabolic health, reduced systemic inflammation, and enhanced cardiovascular function.

Evidence published between 2019 and 2025 consistently demonstrates that moderate-intensity physical activity during pregnancy is both safe and effective when appropriately tailored to individual health status and obstetric conditions. These findings align with major clinical guidelines and expert reviews, including those by Gascoigne et al. (2022), Taliento et al. (2024), the American College of Obstetricians and Gynecologists (ACOG, 2020), and the World Health Organization (WHO, 2020), all of which support the integration of regular exercise as a standard component of prenatal care. [1-3,7]

3.3.1 Physiological mechanisms of the effects of physical activity During pregnancy, the maternal organism undergoes profound metabolic adaptations aimed at ensuring an adequate energy supply for the developing fetus.[28] As gestation progresses, peripheral insulin resistance naturally increases, and physical activity helps restore metabolic balance between glucose utilization and storage. [5,29]

a) Effects on glucose metabolism

Physical activity enhances the translocation of GLUT-4 transporters in skeletal muscle fibers, thereby promoting insulin-independent glucose uptake and reducing circulating glucose levels. This mechanism improves overall insulin sensitivity and facilitates more efficient glucose utilization in peripheral tissues. [8,11]

A meta-analysis by Xie et al. (2024, BMC Public Health) demonstrated that regular moderate-intensity exercise (≥150 minutes per week) is associated with a 30–36% reduction in GDM risk, primarily due to enhanced insulin sensitivity and reduced oxidative stress [9].

Similarly, Rute-Larrieta et al. (2024, Life) and Taliento et al. (2024, J Clin Med) found that physical activity lowers postprandial glucose levels and HbA1c concentrations, supporting its role in maintaining maternal glycemic stability during pregnancy [1,16].

b) Effects on lipid profile and body weight

Moderate-intensity exercise contributes to improvements in lipid metabolism, including a reduction in triglyceride levels**,** an increase in high-density lipoprotein (HDL) cholesterol**,** and an attenuation of gestational weight gain by approximately 1.5–2.0 kg compared with standard prenatal care [27,30]

They also align with findings from the systematic review by Santa Cruz et al. (2025)**,** which demonstrated that exercise-based interventions are particularly effective in overweight or obese women and significantly improve metabolic markers linked to GDM risk.[27]

Excessive weight gain during pregnancy can lead to insulin resistance and β-cell dysfunction. Exercise helps improve these complications, which lowers the risk of GDM. [13,19]

c) Modulation of inflammatory and oxidative stress pathways

Physical activity induces the release of anti-inflammatory myokines, such as irisin and interleukin-10 (IL-10). These myokines counteract the pro-inflammatory effects of tumor necrosis factor alpha (TNF-α) and interleukin-6 (IL-6) [13,31].

These mechanistic findings align with clinical evidence presented in multiple systematic reviews, including Rute-Larrieta et al. (2024), which identified reduced inflammatory load as a key mediator of the protective effects of exercise against GDM.[16]

Regular exercise also enhances the activity of antioxidant enzymes, including superoxide dismutase (SOD) and catalase. This enhancement reduces oxidative stress, improves placental function, and promotes optimal microcirculatory flow at the maternal–fetal interface [17,18].

Together, these adaptations create a favorable metabolic and vascular environment during pregnancy, supporting maternal insulin sensitivity and healthy fetal development.

d) Placental function

Moderate-intensity exercise exerts favorable effects on placental perfusion, enhancing uteroplacental blood flow and thereby improving the transport of oxygen and glucose to the fetus. [1,29]

Studies using Doppler ultrasound to assess uterine arteries have demonstrated that regular physical activity reduces the resistance index (RI) and increases the elasticity of placental vessels**,** which may help prevent microvascular obstruction and fetal hypoxia**.** [32-33]

Importantly, no adverse effects of moderate exercise have been reported regarding preterm birth rates or neonatal birth weight**,** confirming the safety and physiological appropriateness of such activity during pregnancy [Gou et al., 2024].

Collectively, these findings suggest that maternal physical activity improves placental efficiency, supporting optimal fetal growth and reducing the risk of pregnancy complications associated with impaired uteroplacental circulation. [1,34]

3.3.2 Cardiovascular and placental adaptations to exercise during pregnancy

Regular physical activity enhances cardiac output and reduces resting heart rate, thereby improving uteroplacental circulation and overall hemodynamic efficiency during pregnancy. [29,32-33]

Increased placental blood flow improves the transport of oxygen and nutrients to the fetus**,** promoting optimal fetal growth and development.[1]

Consequently, physically active women exhibit a lower risk of gestational hypertension and preeclampsia, as well as shorter labor duration and a reduced need for obstetric interventions**.** [1,7]

3.3.3 Psychological and behavioral benefits of physical activity

Beyond its metabolic effects, physical activity also contributes to psychological well-being during pregnancy by reducing stress, improving sleep quality, and enhancing mood through modulation of the hypothalamic–pituitary–adrenal (HPA) axis.

Regular exercise has been shown to lower cortisol and catecholamine levels**,** hormones that, when elevated, may contribute to hyperglycemia and systemic inflammation**.** [23,35]

Prospective studies indicate that physically active pregnant women are more likely to maintain healthy lifestyle behaviors postpartum**,** including regular physical activity and balanced nutrition, thereby reducing their long-term risk of developing type 2 diabetes in later life. [36-37]

3.3.4 Safety of Physical Activity During Pregnancy

Both the American College of Obstetricians and Gynecologists (ACOG, 2020) and the World Health Organization (WHO, 2020) recognize physical activity during pregnancy as safe and beneficial for the majority of pregnant women**,** provided that no medical contraindications are present. [2,3]

Systematic reviews and meta-analyses have consistently shown no increase in the incidence of**:** spontaneous abortion, preterm delivery, fetal growth restriction, premature rupture of membranes, or other obstetric complications associated with moderate physical activity. [16,21,34]

A large prospective cohort study by Gou et al. (2024, *JAMA Network Open*)**,** including more than 52,000 pregnant women, demonstrated an L-shaped association between exercise intensity and preterm birth risk. Moderate-intensity activity was the safest and most beneficial, while excessive vigorous exercise (>5 hours per week) did not confer additional advantages and was not recommended.[34]

ACOG and WHO recommend that pregnant women engage in at least 150 minutes of moderate-intensity physical activity per week. Activities with a high risk of trauma, such as contact sports, horseback riding, and skiing, should be avoided. Regular aerobic and resistance exercises, including brisk walking, swimming, and body-weight training, are regarded as safe and effective for promoting both maternal and fetal health [2,3].

3.4 Metabolic effects in women with diagnosed GDM

Recent evidence confirms that physical activity represents an effective non-pharmacological treatment component for women diagnosed with GDM.

The meta-analysis by Shu et al. (2025)**,** including 18 randomized trials, showed that moderate-intensity exercise reduced fasting glucose by approximately 0.45 mmol/L**,** postprandial glucose by 0.60 mmol/L, and HbA1c by 0.25%**,** without increasing obstetric complications. [25]

Similarly, Zhang et al. (2021) reported that combining individualized exercise prescriptions with dietary management resulted in significant decreases in fasting and postprandial glucose, as well as a 0.4% reduction in HbA1c**.** [26]
Evidence from Santa Cruz (2025) suggests that combining aerobic and resistance training, performed 3–5 times per week for 30–45 minutes, yields the most favorable metabolic improvements. [27]

Narrative reviews (Taliento, 2024; Gascoigne, 2022) have emphasized that regular exercise enhances insulin sensitivity, facilitates glucose uptake through insulin-independent mechanisms, and stabilizes blood glucose levels. [1,7]

Taken together, these studies demonstrate that consistent moderate-intensity exercise (≥150 minutes per week) is a safe and effective adjunct to standard care in women with GDM.

Evidence from Santa Cruz (2025) indicated that combined aerobic and resistance training performed 3–5 times per week for 30–45 minutes yielded the most favorable metabolic improvements. [27]

Narrative reviews (Taliento 2024; Gascoigne 2022) emphasized that regular exercise enhances insulin sensitivity, facilitates glucose uptake through insulin-independent mechanisms, and stabilizes glycemia. [1,7]
Taken together, these studies demonstrate that consistent moderate-intensity exercise (≥150 minutes per week) is a safe and effective adjunct to standard care in women with GDM.

3.4.1. Safety and recommendations for physical activity in women with GDM

Current evidence and professional guidelines consistently confirm that physical activity is a safe and recommended component of non-pharmacological management for women diagnosed with GDM, provided that appropriate exercise modifications are implemented. Narrative reviews, such as that by Taliento et al. (2024), and guidelines from the American College of Obstetricians and Gynecologists (ACOG, 2020), report that moderate-intensity activity is well tolerated and does not increase obstetric risk [1,2].

Women with GDM are advised to avoid exercise in the supine position after 20 weeks of gestation due to the risk of vena cava compression and reduced uteroplacental blood flow. Exercise intensity should be maintained within the moderate range, approximately 50–70% of the maximal heart rate, to ensure metabolic effectiveness without excessive cardiovascular strain. Recommended activities include brisk walking, aqua fitness or swimming, prenatal yoga, pregnancy-adapted Pilates, and light body-weight resistance training. Regular participation is also emphasized; engaging in physical activity at least three days per week, with no more than 48 hours between sessions, supports glycemic stability and improved insulin sensitivity.

These recommendations align with meta-analytic evidence demonstrating that moderate-intensity exercise is both safe and effective in improving glycemic control in women with GDM, without increasing the risk of adverse maternal or neonatal outcomes.

4.Discussion

The present review summarizes evidence from randomized trials, cohort studies, and multiple meta-analyses indicating that regular physical activity during pregnancy significantly reduces the risk of gestational diabetes mellitus (GDM) and improves metabolic outcomes in women with established GDM.[9,16,21–27] Overall, the magnitude of risk reduction observed in the most recent and comprehensive meta-analyses ranges between 20% and 40%, with the strongest protective effects seen in women who engage in at least 150 minutes per week of moderate-intensity exercise and commence activity in the first trimester.[9,16,21–23]

4.1. Interpretation of main findings

The dose–response relationship demonstrated by Xie et al. (2024), with progressive reductions in GDM risk across increasing MET-hours per week of physical activity, strongly supports a causal association between exercise and lower incidence of GDM.[9] Importantly, this relationship was evident not only in healthy pregnant women but also in those at high risk due to obesity, hypertension, or family history of diabetes.[16,22,24,27] The meta-analyses by Tsironikos et al. (2022) and Bennett et al. (2023) confirmed that structured and supervised interventions are particularly effective, yielding risk reductions of up to 43% compared with standard prenatal care.[21,22]

The present review confirms that physical activity is beneficial after a GDM diagnosis. The meta-analysis by Shu et al. (2025) and the trial by Zhang et al. (2021) demonstrated significant improvements in fasting and postprandial glucose levels and modest reductions in HbA1c among women participating in prescribed exercise programs. [25,26] These findings suggest that regular moderate-intensity physical activity should be considered a core component of non-pharmacological management of GDM, alongside dietary modification and self-monitoring of blood glucose. [4,25–27]

4.2. Mechanistic plausibility

The protective and therapeutic effects of exercise observed in clinical studies are biologically plausible and consistent with current understanding of pregnancy physiology. As summarized in Sections 3.1 and 3.3, skeletal muscle contraction increases GLUT-4 translocation and enhances insulin-independent glucose uptake, thereby reducing circulating glucose and improving insulin sensitivity.[8,10,11] Exercise-induced activation of AMPK promotes fatty acid oxidation and metabolic flexibility, while favorable changes in adipokines and myokines – including increased adiponectin, irisin, and IL-10 – counteract chronic low-grade inflammation and oxidative stress, key drivers of pregnancy-induced insulin resistance.[12,13,15,17,20,31]

Furthermore, improvements in lipid profile, restriction of excessive gestational weight gain, and enhanced placental perfusion contribute to an overall metabolic environment that is less conducive to GDM development and more favorable for fetal growth. [1,7,18,28–30,32–34] The concordance between mechanistic data and clinical outcomes strengthens the argument for a causal role of physical activity in GDM prevention and treatment.

4.3. Comparison with current guidelines

The findings of this review are fully aligned with recommendations issued by ACOG and WHO, which advocate at least 150 minutes per week of moderate-intensity physical activity for pregnant women without contraindications. [2,3] Our synthesis provides additional support for these guidelines by demonstrating that this level of activity is not only safe but also associated with clinically meaningful reductions in GDM risk and improvements in metabolic control.

Moreover, evidence suggests that structured, supervised programs, such as group sessions of brisk walking, aqua aerobics, or combined aerobic and resistance training, may be especially effective, particularly for women with overweight or obesity. [16,21–23,27] Integrating these programs into routine antenatal care, including primary health care settings, could be a cost-effective strategy to address the increasing loads of GDM.

4.4. Safety considerations

Concerns about the safety of exercise during pregnancy persist among some patients and clinicians. However, data from large cohort studies and systematic reviews consistently indicate that moderate-intensity physical activity does not increase the risk of miscarriage, preterm birth, fetal growth restriction, or other obstetric complications when appropriately prescribed.[7,16,21,33,34] The L-shaped relationship between exercise intensity and preterm birth risk reported by Gou et al. (2024) supports current guidelines favoring moderate rather than vigorous exercise in most pregnant women, particularly those with GDM.[34]

For women with established GDM, it is essential to avoid the supine position after 20 weeks, monitor for hypoglycemia in those receiving pharmacotherapy, and tailor exercise intensity to the individual. [1,2,25] Even with these precautions, moderate-intensity activity is still very safe for this group. Recent meta-analyses have found no rise in negative outcomes for mothers or newborns. [25–27]

4.5. Strengths and limitations of the evidence

A major strength of current research is the presence of multiple high-quality systematic reviews and meta-analyses. These studies consistently show the protective effect of physical activity across various populations and exercise types. [9,16,21–24,27] Mechanistic investigations also offer strong physiological support for these clinical benefits. [8–13,17–20,28–33]

However, several limitations should be acknowledged. First, there is substantial heterogeneity in the design of exercise interventions (frequency, intensity, duration, supervised vs. unsupervised) and in the diagnostic criteria for GDM used across studies, which complicates direct comparisons. Second, adherence to prescribed exercise regimens is often suboptimal, and only a minority of trials provide detailed adherence data or long-term follow-up beyond pregnancy. Third, most available studies have been conducted in high-income countries, limiting the generalizability of findings to low- and middle-income settings where the prevalence and determinants of GDM may differ.

4.6. Implications for clinical practice and future research.

The reviewed evidence indicates that incorporating personalized exercise counseling into routine antenatal care is beneficial. Obstetricians, midwives, and allied health professionals are encouraged to support pregnant women in engaging in regular moderate-intensity physical activity, taking into account their fitness before pregnancy, any pre-existing health conditions, and potential pregnancy risks. Particular attention should be paid to women with overweight or obesity and those with a history of GDM, for whom the potential benefits of exercise are especially pronounced. [16,22,24,27,37]

Future research should focus on standardizing exercise protocols and reporting methods to facilitate cross-study comparison, determining the most effective combinations of exercise type, intensity, and timing for different risk groups, and exploring the long-term impact of prenatal physical activity on the cardiometabolic health of both mother and child.[18,36,37] Additionally, further work is needed to evaluate practical strategies for implementing structured exercise programs into real-world prenatal care, including settings with limited resources, to ensure that evidence-based interventions are accessible to all pregnant women.

5. Conclusions

After reviewing this study, it can be concluded that moderate physical activity for at least 150 minutes per week reduces the risk of GDM by approximately 20–40%, and the greatest benefits are achieved when physical activity begins in the first trimester of pregnancy. Structured and supervised exercise programs, especially those combining aerobic and resistance training, are more effective than unsupervised or irregular physical activity. Such activities are particularly beneficial for women who are overweight, obese, or have a family history of gestational diabetes.

It should also be noted that in women who have already been diagnosed with gestational diabetes, moderate physical exercise safely improves fasting and postprandial blood glucose levels and lowers HbA1c. Physical exercise is a key component of non-pharmacological treatment of gestational diabetes, alongside healthy eating habits and regular monitoring of blood glucose levels.

The positive effects of exercise result from increased insulin sensitivity, improved lipid metabolism, reduced inflammation and oxidative stress, healthier weight gain during pregnancy, and improved placental and cardiovascular function.

Current research and international guidelines indicate that moderate physical activity during pregnancy is safe for women without contraindications and does not increase the risk of miscarriage, premature birth, or other adverse effects. Incorporating evidence-based physical activity recommendations into routine prenatal care is a practical and cost-effective strategy to reduce the rising incidence of GDM and promote long-term cardiovascular and metabolic health for both mothers and their children.

Disclosures

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