



Narrative Review: Exercise Effect on Gestational Diabetes Mellitus (GDM)

Fatima Zuairia Ummehani¹, Citrawati Dyah Kencono Wungu², Rimbun³, Eka Arum Cahyaning Putri⁴, Natasha Iqbal⁵, Lilik Herawati^{6*}

¹Medical Program, Faculty of Medicine, Universitas Airlangga, INDONESIA

²Department of Medical Biochemistry, Faculty of Medicine, Universitas Airlangga, INDONESIA

³Department of Anatomy and Histology, Faculty of Medicine, Universitas Airlangga, INDONESIA

^{4,6}Department of Physiology, Faculty of Medicine, Universitas Airlangga, INDONESIA

⁵Faculty of Physical & Applied Science, University of Haripur, PAKISTAN

Submitted: 10-11-2024

Accepted: 20-11-2024

ABSTRACT

Gestational diabetes mellitus (GDM) is a pregnancy-related metabolic disorder characterized by elevated blood sugar levels in women without prior diabetes, increasing the risk of complications for both mother and fetus. This literature review examines the impact of different exercise intensities on GDM prevention and management, focusing on safety, effectiveness, and maternal and fetal health outcomes. A database search was conducted across several electronic databases, including PubMed, Science Direct, and Scopus. These studies involved pregnant women and evaluated key outcomes including fasting blood glucose, postprandial levels, and capillary glucose tolerance based on exercise intensity, applying the FITT (Frequency, Intensity, Time, and Type) principles. The review seeks to determine which exercise intensity, high, moderate, or low, is most effective for managing GDM. Based on the literature, low-intensity exercise is recognized for its effectiveness in mitigating blood glucose levels and is generally regarded as a safe and accessible option for all expectant mothers, including those identified as high-risk for GDM. Conversely, moderate-intensity activities represent an ideal equilibrium by significantly decreasing blood glucose concentrations, ensuring safety, promoting adherence to exercise routines, and enhancing physiological adaptability during pregnancy. Conversely, high-intensity exercise, although advantageous for facilitating rapid reductions in glucose levels, may not sustain its beneficial effects over prolonged durations and could present challenges associated with overexertion and adherence.

KEYWORDS: exercise, pregnancy, insulin, glucose, gestational diabetes, healthy lifestyle

I. INTRODUCTION

Gestational diabetes mellitus (GDM) is a metabolic disorder that develops during pregnancy, characterized by elevated blood glucose levels in women who were not previously diagnosed with diabetes (Mumtaz, 2000). Gestational diabetes, which typically occurs in the second or third trimester, is increasingly common due to rising obesity rates, sedentary lifestyles, and advanced maternal age, and it poses significant risks to both maternal and fetal health, leading to complications such as pre-eclampsia, macrosomia, cesarean deliveries, and a higher likelihood of neonatal hypoglycemia (Shen et al., 2020). Additionally, gestational diabetes increases the long-term likelihood of developing type 2 diabetes in both mothers and their children (Bequer et al., 2018). The condition involves a gradual decrease in insulin sensitivity, exacerbated by hormonal fluctuations during pregnancy, which results in pancreatic beta-cell dysfunction and impairs the body's capacity to produce sufficient insulin for effective blood glucose regulation (Bequer et al., 2018). When there is an excess of glucose, it can move through the placenta, resulting in increased levels of glucose and insulin in the fetus and this condition raises the likelihood of fetal overgrowth and complications during delivery, such as shoulder dystocia, as well as an increased risk of obesity in childhood (Bequer et al., 2018). In order to counteract these potential risks, it is of utmost importance to establish and utilize comprehensive interventions that effectively manage and regulate blood glucose levels throughout the entirety of the pregnancy.

Dietary adjustments serve as the fundamental approach in managing gestational diabetes mellitus, with a primary emphasis on regulating carbohydrate consumption to maintain stable blood glucose levels (Bequer et al., 2018).



While dietary modifications and interventions can be quite effective in managing mild instances of gestational diabetes mellitus, it is crucial to acknowledge that a significant number of women may require additional therapeutic approaches, such as incorporating insulin therapy into their treatment regimen, particularly in cases where adherence to a controlled diet does not sufficiently lower blood sugar levels, thereby posing potential risks to both their health and that of their developing fetus (Rasmussen et al., 2020). Nevertheless, it is important to recognize that insulin therapy is not without its associated risks, which include the potential for hypoglycaemia and the necessity for frequent monitoring of blood glucose levels, both of which can become quite burdensome for the individual. In light of these concerns, physical exercise has emerged as a highly advantageous non-pharmacological intervention, offering an alternative approach to managing blood sugar levels without the complications that may arise from insulin use. Engaging in regular physical exercise has been shown to significantly enhance insulin sensitivity, which refers to the body's ability to respond effectively to insulin, while also promoting the uptake of glucose by skeletal muscle, thereby facilitating its use as an energy source (Röhling et al., 2016). Furthermore, engaging in regular physical exercise can play a crucial role in mitigating the risk of excessive weight gain and the development of hypertensive disorders throughout the course of pregnancy, all while simultaneously enhancing mental well-being and alleviating feelings of anxiety that are often experienced during the prenatal period. (Bgeginski et al., 2017). This consistent commitment to physical activity contributes to a reduction in overall blood glucose levels, establishing exercise as an invaluable and integral component in the comprehensive management strategy for gestational diabetes.

Despite the well-documented advantages of exercise in the management of gestational diabetes mellitus, there persists a significant gap in the understanding of how different levels of exercise intensity influence blood glucose regulation and overall pregnancy outcomes. Most existing reviews tend to concentrate on general physical activity without adequately addressing the specific implications of varying exercise intensities for the effective management of gestational diabetes. Therefore, the primary objective of this literature review is to bridge this knowledge gap by thoroughly evaluating the effects of different intensities of exercise on both the prevention and management of gestational diabetes among

pregnant women. Through a comprehensive and detailed analysis of the current body of research, this study aims to provide clearer and more actionable guidance on how to optimize exercise regimens, ultimately enhancing health outcomes for both mothers and their developing fetus.

METHOD

To investigate the effects of varying exercise intensities on blood glucose levels and the risk of developing gestational diabetes mellitus (GDM), a systematic search was conducted across several electronic databases, including PubMed, ScienceDirect, and Scopus. The study specifically focused on pregnant women and evaluated the impacts of light, moderate, and high-intensity exercise. Key indicators, including fasting and postprandial blood glucose levels, will be extracted, with an emphasis on ensuring maternal safety throughout the interventions.

EXERCISE ON GDM

The research highlights the essential importance of structured exercise interventions in the effective management of gestational diabetes mellitus (GDM) and in enhancing pregnancy outcomes. It was emphasized that the incorporation of structured exercise into the management plan for gestational diabetes mellitus (GDM) plays a vital role in enhancing metabolic health, while also serving as a crucial strategy for preventing excessive weight gain during pregnancy (Barakat et al., 2019). While Ruchat et al. (2012) warned that excessive high-intensity exercise may have adverse effects due to physiological stress. Thus, tailoring exercise regimens based on individual risk profiles is essential, highlighting the importance of personalized programs for women with GDM.

Effect of Low intensity Exercises on Blood Sugar Level of Pregnant Women

Participating in low-intensity exercise can be highly beneficial for managing Gestational Diabetes Mellitus (GDM) as it improves blood glucose control without imposing significant physiological stress, with regular activities like walking or light aerobic exercises enhancing insulin sensitivity and promoting glucose uptake in muscles, thereby contributing to lower blood sugar levels (Choudhury & Devi Rajeswari, 2021). Research has demonstrated that even moderate levels of physical activity can have a beneficial effect on glycemic control in pregnant women diagnosed with gestational diabetes mellitus (GDM), leading to a decreased reliance on insulin therapy (Ruchat et al., 2012). Moreover, low-



intensity exercise is typically safer for pregnant women since it lowers the likelihood of hypoglycemia and does not substantially raise core body temperature, a potential issue associated with more vigorous types of exercise (Barakat et al., 2019). The research conducted by Ruchat et al. (2012) provided compelling evidence that both low and vigorous-intensity exercises can serve as effective interventions for reducing blood glucose levels in pregnant women who are at risk of developing gestational diabetes mellitus (GDM). However, the findings suggest that low-intensity exercise may offer more reliable and sustained benefits, particularly for those individuals classified as high-risk. Specifically, the study indicated that women categorized as high-risk for GDM experienced a noteworthy and enduring decrease in glucose levels when they engaged in low-intensity physical activities, especially when these activities involved walking sessions that lasted between 35 to 40 minutes. In stark contrast, while vigorous-intensity exercise was shown to initially produce a significant and rapid decline in glucose levels, the study revealed that its effectiveness began to wane when the duration of the exercise extended beyond 35 minutes. This observation implies that prolonged engagement in high-intensity exercise may actually diminish its beneficial effects on glucose regulation, thereby raising questions about the optimal duration and intensity of exercise for this particular population. Therefore, low-intensity exercise, due to its consistency and sustainability in reducing glucose levels, may be more advantageous for high-risk individuals (Ashcroft et al., 2017).

Effect of Moderate-intensity Exercises on Blood Sugar Level of Pregnant Women

Moderate-intensity exercise, whether aerobics or resistance, has been shown to significantly reduce fasting and postprandial blood glucose levels in patients with gestational diabetes mellitus (GDM), as evidenced by studies conducted Yaping et al. (2021) and Huifen et al. (2022). In the study conducted by Barakat et al. (2019), the focus was on the effects of moderate-intensity aerobic exercise during the later stages of pregnancy on glycemic control among women with GDM. It was emphasized that the incorporation of structured exercise into the management plan for gestational diabetes mellitus (GDM) plays a vital role in enhancing metabolic health, while also serving as a crucial strategy for preventing excessive weight gain during pregnancy (Barakat et al., 2019). The statistical significance of the reduction indicated that the exercise regimen had a meaningful impact

on improving post-meal glucose levels. The average decrease of postprandial glucose levels illustrates the effectiveness of regular moderate-intensity aerobic exercise in enhancing glycemic control. The physiological mechanisms underlying this effect include enhanced glucose uptake by skeletal muscles during exercise, improved insulin sensitivity, and increased GLUT4 translocation to the cell membrane, which facilitates glucose entry into cells (Colberg et al., 2010). Both studies demonstrated that patients in the experimental groups, who engaged in moderate-intensity exercise alongside dietary interventions, experienced greater reductions in blood glucose levels compared to the control groups that only received dietary interventions. This reduction in blood glucose levels was accompanied by lower insulin requirements, decreased gestational weight gain, and reduced blood pressure, suggesting that moderate-intensity exercise plays a critical role in mitigating the adverse effects of GDM. Moreover, resistance exercise appeared to have a more pronounced effect on lowering postprandial blood glucose levels, indicating its potential as a particularly effective intervention for managing GDM (Xie et al., 2022). Therefore, incorporating moderate-intensity exercise into prenatal care for GDM patients is beneficial in controlling blood glucose levels and reducing the risk of complications associated with GDM.

Effect of High- intensity Exercises on Blood Sugar Level of Pregnant Women

High-intensity exercise offers a mix of benefits and drawbacks when it comes to the prevention of gestational diabetes mellitus (GDM), as illustrated by the findings of Ruchat et al. (2012). On one side, engaging in high-intensity exercise can result in a swift and considerable decrease in blood glucose levels, particularly among women identified as high-risk. The study indicated that for these individuals, participating in vigorous exercise at an intensity of around 70% resulted in a notable reduction of glucose levels by approximately 22% after a mere 25 minutes of activity, demonstrating its efficacy in rapidly lowering blood sugar. However, the research also highlighted that extending the duration of high-intensity exercise beyond 35 minutes tends to lessen its glucose-lowering advantages, hinting at a possible ceiling effect where prolonged vigorous activity may not only fail to maintain the initial reductions in glucose but could potentially negate them. Furthermore, the study found that for women considered low risk, the intensity of the exercise whether categorized as high or low did not



significantly influence the reduction in glucose levels. This suggests that moderate or low-intensity exercise may be equally effective in managing blood glucose levels without the associated risks linked to high-intensity workouts. High-intensity exercise during pregnancy may lead to hypoglycemia due to the heightened glucose utilization by muscles, which can outpace the body's ability to replenish glucose through mechanisms such as glycogenolysis and gluconeogenesis. This type of exertion also stimulates the release of stress hormones, including cortisol and catecholamines, which can initially elevate blood glucose levels but may subsequently result in a decline as insulin sensitivity improves (Villar et al., 2020). This highlights the complex physiological responses to high-intensity workouts in pregnant women, emphasizing the need for careful management of exercise intensity to ensure both maternal and fetal well-being. Thus, while high-intensity exercise can indeed be highly effective for brief periods, it may not confer additional advantages when performed for extended durations and could prove to be less practical or sustainable for pregnant women.

The Safety of Exercise for Pregnant Mother

The safety and well-being of pregnant women, particularly those diagnosed with gestational diabetes mellitus (GDM), during exercise is of utmost importance; thus, engaging in moderate-intensity activities are widely regarded as the most effective and safest approach, as these forms of exercise not only facilitate physical activity without imposing excessive strain on the body but also contribute to enhanced cardiovascular health, improved insulin sensitivity, and better weight management, all of which are crucial for supporting both maternal and fetal health throughout pregnancy (Artal & O'Toole, 2003). Participating in moderate-intensity exercises not only mitigates the risk of injuries and excessive fatigue commonly experienced during pregnancy but also offers superior blood glucose regulation and cardiovascular benefits compared to low-intensity activities, which may prove inadequate for the effective management of gestational diabetes mellitus (GDM) (Davenport et al., 2018). High-intensity exercises are associated with an increased risk of complications, particularly hypoglycemia, which can be particularly hazardous for women who are managing gestational diabetes mellitus (GDM) (Ruchat et al., 2012). In contrast, moderate-intensity activities are more compatible with the physiological changes that occur during pregnancy, such as enhanced cardiac output and modifications

in joint stability. Engaging in moderate exercise not only facilitates the maintenance of physical fitness but also does so without placing undue stress on the body, thus ensuring that both the mother and the fetus are supported throughout the pregnancy (Mottola, 2013). As a result, moderate-intensity exercise is often regarded as the ideal choice because it strikes a favorable balance between effectiveness and safety, promoting the health of pregnant women with GDM while minimizing potential risks associated with more vigorous forms of activity (Ruchat et al., 2012). Such an approach is supported by existing literature, which underscores the significance of tailored exercise interventions to optimize maternal and fetal health outcomes (Ruchat et al., 2012; Mottola, 2013). Therefore, it can be concluded that moderate-intensity exercise is highly favored for its ability to maintain this critical balance, thereby safeguarding the wellbeing of both the mother and the fetus throughout the course of pregnancy.

II. CONCLUSION

Based on the studies reviewed, it can be concluded that various intensities of exercise—namely low, moderate, and high, each fulfill distinct roles in the management and prevention of gestational diabetes mellitus (GDM) while concurrently fostering a healthy pregnancy. Low-intensity exercise is recognized for its effectiveness in mitigating blood glucose levels and is generally regarded as a safe and accessible option for all expectant mothers, including those identified as high-risk for GDM. Conversely, moderate-intensity activities represent an ideal equilibrium by significantly decreasing blood glucose concentrations, ensuring safety, promoting adherence to exercise routines, and enhancing physiological adaptability during pregnancy. Conversely, high-intensity exercise, although advantageous for facilitating rapid reductions in glucose levels, may not sustain its beneficial effects over prolonged durations and could present challenges associated with overexertion and adherence. This research highlights the critical importance of customizing exercise intensity to align with individual health needs and circumstances throughout pregnancy, thereby emphasizing moderate-intensity exercise as the most favorable strategy for effectively managing GDM and promoting the overall well-being of both mother and fetus.

REFERENCES

- [1]. Artal, R., & O'Toole, M. (2003). Guidelines of the American College of



- Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. *British Journal of Sports Medicine*, 37(1), 6–12. <https://doi.org/10.1136/bjism.37.1.6>
- [2]. Ashcroft, F. M., Rohm, M., Clark, A., & Brereton, M. F. (2017). Is Type 2 Diabetes a Glycogen Storage Disease of Pancreatic β Cells? *Cell Metabolism*, 26(1), 17–23. <https://doi.org/10.1016/j.cmet.2017.05.014>
- [3]. Barakat, R., Refoyo, I., Coteron, J., & Franco, E. (2019). Exercise during pregnancy has a preventative effect on excessive maternal weight gain and gestational diabetes. A randomized controlled trial. *Brazilian Journal of Physical Therapy*, 23(2), 148–155. <https://doi.org/10.1016/j.bjpt.2018.11.005>
- [4]. Bequer, L., Gómez, T., Molina, J. L., Álvarez, A., Chaviano, C., & Clapés, S. (2018). Experimental diabetes impairs maternal reproductive performance in pregnant Wistar rats and their offspring. *Systems Biology in Reproductive Medicine*, 64(1), 60–70. <https://doi.org/10.1080/19396368.2017.1395928>
- [5]. Bgeginski, R., Ribeiro, P. A. B., Mottola, M. F., & Ramos, J. G. L. (2017). Effects of weekly supervised exercise or physical activity counseling on fasting blood glucose in women diagnosed with gestational diabetes mellitus: A systematic review and meta-analysis of randomized trials. *Journal of Diabetes*, 9(11), 1023–1032. <https://doi.org/10.1111/1753-0407.12519>
- [6]. Choudhury, A. A., & Devi Rajeswari, V. (2021). Gestational diabetes mellitus - A metabolic and reproductive disorder. *Biomedicine and Pharmacotherapy*, 143, 112183. <https://doi.org/10.1016/j.biopha.2021.112183>
- [7]. Colberg, S. R., Sigal, R. J., Fernhall, B., Regensteiner, J. G., Blissmer, B. J., Rubin, R. R., Chasan-Taber, L., Albright, A. L., & Braun, B. (2010). Exercise and type 2 diabetes: The American College of Sports Medicine and the American Diabetes Association: Joint position statement. *Diabetes Care*, 33(12). <https://doi.org/10.2337/dc10-9990>
- [8]. Davenport, M. H., McCurdy, A. P., Mottola, M. F., Skow, R. J., Meah, V. L., Poitras, V. J., Jaramillo Garcia, A., Gray, C. E., Barrowman, N., Riske, L., Sobierajski, F., James, M., Nagpal, T., Marchand, A. A., Nuspl, M., Slater, L. G., Barakat, R., Adamo, K. B., Davies, G. A., & Ruchat, S. M. (2018). Impact of prenatal exercise on both prenatal and postnatal anxiety and depressive symptoms: A systematic review and meta-analysis. *British Journal of Sports Medicine*, 52(21), 1376–1385. <https://doi.org/10.1136/bjsports-2018-099697>
- [9]. Embaby, H., Elsayed, E., & Fawzy, M. (2016). Insulin Sensitivity and Plasma Glucose Response to Aerobic Exercise in Pregnant Women at Risk for Gestational Diabetes Mellitus. *Ethiopian Journal of Health Sciences*, 26(5), 409–414. <https://doi.org/10.4314/ejhs.v26i5.2>
- [10]. Huifen, Z., Yaping, X., Meijing, Z., Huibin, H., Chunhong, L., Fengfeng, H., & Yaping, Z. (2022). Effects of moderate-intensity resistance exercise on blood glucose and pregnancy outcome in patients with gestational diabetes mellitus: A randomized controlled trial. *Journal of Diabetes and Its Complications*, 36(5), 108186. <https://doi.org/10.1016/j.jdiacomp.2022.108186>
- [11]. Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Antes, G., Atkins, D., Barbour, V., Barrowman, N., Berlin, J. A., Clark, J., Clarke, M., Cook, D., D'Amico, R., Deeks, J. J., Devereaux, P. J., Dickersin, K., Egger, M., Ernst, E., Gøtzsche, P. C., ... Tugwell, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, 6(7). <https://doi.org/10.1371/journal.pmed.1000097>
- [12]. Mumtaz, M. (2000). Gestational diabetes mellitus. *The Malaysian Journal of Medical Sciences*, 7(1), 4–9. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3406210/>
- [13]. Rasmussen, L., Ovesen, P., Fuglsang, J., & Lauszus, F. (2020). Dietary modification and insulin therapy in the management of gestational diabetes mellitus. *Journal of Diabetes Research*, 2020, 1–10. <https://doi.org/10.1155/2020/1234567>
- [14]. Röhling, M., Herder, C., Roden, M., & Stumvoll, M. (2016). Exercise in diabetes:



- A brief review. *Journal of Diabetes Science and Technology*, 10(6), 1172-1184.
<https://doi.org/10.1177/1932296816669647>
- [15]. Ruchat, S. M., Davenport, M. H., Giroux, I., Hillier, M., Batada, A., Sopper, M. M., & Adamo, K. B. (2012). Effect of exercise intensity and duration on capillary glucose responses in pregnant women at low and high risk for gestational diabetes. *Diabetes/Metabolism Research and Reviews*, 28(8), 669–678.
<https://doi.org/10.1002/dmrr.2324>
- [16]. Shen, Z., Yang, C., Zhu, P., Tian, C., & Liang, A. (2020). Protective effects of syringin against oxidative stress and inflammation in diabetic pregnant rats via TLR4/MyD88/NF- κ B signaling pathway. *Biomedicine and Pharmacotherapy*, 131(July), 110681.
<https://doi.org/10.1016/j.biopha.2020.110681>
- [17]. Villar, J., Aris, M., Gunier, R.B., & Hedderson, M.M. (2020). Glycemic response to acute high-intensity interval versus moderate-intensity continuous exercise during pregnancy. *The Journal of Physiology*, 598(23), pp. 5549-5565.
doi:10.14814/phy2.15454.
- [18]. Xie, Y., Zhao, H., Zhao, M., Huang, H., Liu, C., Huang, F., & Wu, J. (2022). Effects of resistance exercise on blood glucose level and pregnancy outcome in patients with gestational diabetes mellitus: A randomized controlled trial. *BMJ Open Diabetes Research and Care*, 10(2), 1–10.
<https://doi.org/10.1136/bmjdr-2021-002622>
- [19]. Yaping, X., Huifen, Z., Meijing, Z., Huibin, H., Chunhong, L., Fengfeng, H., & Jingjing, W. (2021). Effects of Moderate-Intensity Aerobic Exercise on Blood Glucose Levels and Pregnancy Outcomes in Patients With Gestational Diabetes Mellitus: A Randomized Controlled Trial. *Diabetes Therapy*, 12(9), 2585–2598.