

## Differences in Physical Activity Density Between Pregnant Women with Gestational Diabetes Mellitus (GDM) and Normal (Non-GDM) Pregnant Women: A Comparative Study

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### ABSTRACT

**Background:** Gestational diabetes mellitus (GDM) is a condition of impaired glucose tolerance that leads to high blood sugar levels and is diagnosed for the first time during pregnancy, with varying degrees of severity. Insufficient physical activity is one of the top global risk factors for premature death. During pregnancy, a lack of physical activity and excessive weight gain are independent risk factors for maternal obesity and related complications, including gestational diabetes mellitus (GDM).

**Objectives:** The aim of this study was to compare the physical activity density between pregnant women diagnosed with gestational diabetes mellitus (GDM) and those with normal pregnancies.

**Methods:** This study utilized an observational analytical approach with a comparative design. A purposive sampling technique was employed, with 32 participants in the case group and 32 in the control group. The research was conducted between August and October 2024 at the Obstetrics and Gynecology clinic of Airlangga University Hospital. Data were analyzed using the non-parametric Mann-Whitney Test.

**Results:** The analysis using the Mann-Whitney Test showed a significant p-value of 0.002, indicating a difference in the physical activity density between pregnant women with gestational diabetes mellitus (GDM) and those with normal pregnancies.

**Conclusion:** Pregnant women without gestational diabetes mellitus (GDM) have higher physical activity density compared to those with gestational diabetes mellitus (GDM). It is suggested that future research adopt an experimental approach, especially focusing on interventions to promote physical activity during pregnancy.

## Introduction

Gestational diabetes mellitus (GDM) is a glucose tolerance disorder first diagnosed during pregnancy, leading to hyperglycemia with varying degrees of severity. GDM typically develops in the second trimester and usually resolves after childbirth. According to the American Diabetes Association (2014), this condition arises due to physiological changes affecting glucose metabolism during pregnancy, including alterations in insulin secretion and sensitivity. In the first trimester, insulin secretion increases, while insulin sensitivity remains stable, decreases, or even increases. However, in the second trimester, insulin sensitivity gradually declines, reaching its lowest point in the third trimester, which can result in hyperglycemia and the development of



GDM. This condition generally improves after childbirth with the removal of the placenta, which restores metabolic balance (Alfadhli 2015).

The global prevalence of diabetes is steadily rising. In 2021, approximately 11.7% of the population in Southeast Asia had diabetes, with Indonesia ranking fifth in the world for the highest number of diabetes cases (Sun et al. 2022). In Indonesia, the number of individuals with diabetes in the 20–79 age group is expected to increase from 19.5 million in 2021 to 28.6 million by 2045. The International Diabetes Federation (IDF) estimates that 21.1 million live births worldwide involved women with hyperglycemia during pregnancy, with 80.3% of these cases attributed to GDM (Sun et al. 2022). In Indonesia, the prevalence of GDM ranges from 1.9% to 3.6%. Specific data on the prevalence of GDM in East Java Province remains limited. Nevertheless, the prevalence of GDM in Surabaya, as reported by Dr. Soetomo General Hospital in 2015, was 2,29%. The predominant type of diabetes associated with pregnancy was GDM, with a prevalence of 1.65%, while pregestational diabetes mellitus accounted for 0.62% (Sholehuddin 2017).

Gestational diabetes mellitus can lead to significant complications for both mothers and babies. Women with GDM are at an increased risk of hypertension (such as preeclampsia), prolonged labor, and cesarean deliveries. Babies born to mothers with GDM are also at higher risk of macrosomia, preterm birth, and birth trauma. Furthermore, the risk of perinatal death and the need for neonatal intensive care is higher. After childbirth, women who have had GDM are more likely to develop type 2 diabetes within the next 10 years (Hart and Im 2018, Dewi et al. 2023). Long-term complications can also include heart, kidney, nerve, and vision problems, which pose further health risks for the mother (Dewi et al. 2023). Therefore, proper monitoring and management of GDM during pregnancy are essential to prevent these complications.

According to The American College of Obstetricians and Gynecologists (ACOG 2020), key risk factors for GDM include obesity, lack of physical activity, a history of GDM in previous pregnancies, giving birth to a large baby ( $\geq 4000$  grams), as well as other factors such as hypertension, heart disease, and polycystic ovary syndrome. Physical activity during pregnancy has been shown to help reduce the risk of GDM by controlling excessive weight gain. However, many pregnant women are either unaware of or unable to engage in regular physical activity due to various barriers, both internal (physical and psychological) and external (work, family, time, and environment) (Weir et al. 2010). Inadequate physical activity and excessive weight gain during pregnancy are significant risk factors for maternal obesity and pregnancy-related complications, including GDM (ACOG 2015).

During pregnancy, the placenta secretes hormones such as estrogen, progesterone, cortisol, and human placental lactogen (HPL), which reduce insulin sensitivity. This leads to insulin resistance and an increased response from pancreatic beta cells (Chyad & Faris Shalayel, 2011). As the placenta grows, the production of these hormones increases, raising the risk of insulin resistance. Normally, the pancreas compensates by producing more insulin, but if it cannot meet the demand, gestational diabetes develops (Hopkins Medicine, 2019). One key risk factor for impaired carbohydrate metabolism is a lack of physical activity. Without muscle contractions, glucose uptake by cells becomes difficult, reducing insulin sensitivity and increasing the likelihood of insulin resistance. This can lead to elevated blood sugar levels during pregnancy, resulting in gestational diabetes (Stone, DiPietro, & Stachenfeld, 2021).

Previous studies have suggested that regular physical activity can provide protective benefits against the development of GDM. Research by Russo et al. (2015) showed that while physical activity has some protective effects against GDM, its effectiveness depends on factors such as type, duration, and adherence to an activity regimen. Additionally, Sari (2018) reported that among pregnant women who were physically active, none developed GDM, whereas 6.3% of those with low physical activity were diagnosed with GDM.



Universitas Airlangga Hospital, a type B teaching hospital and research center, plays an important role in advancing knowledge and technology in healthcare. Based on data from the hospital, there was a difference in the number of GDM cases between 2022 and 2023, with 101 GDM cases in 2022 and 62 cases in 2023. Meanwhile, the number of pregestational diabetes cases increased from 12 to 23. Given this background, the aim of this study was to compare the physical activity density between pregnant women diagnosed with gestational diabetes mellitus (GDM) and those with normal pregnancies at the Obstetrics and Gynecology Polyclinic of Universitas Airlangga Hospital. This study seeks to determine whether there are significant differences in physical activity patterns between these two groups.

## Methods

This study utilized an analytical observational study design with a comparative study approach. The sampling technique used is purposive sampling, targeting a population of third-trimester pregnant women during the period of August to October 2024. The total population of third-trimester pregnant women during the study period is not explicitly stated due to data limitation. However, the sampling process was conducted using the Lameshow formula for two proportion groups, resulting in a total of 64 participants. These participants were selected based on inclusion and exclusion criteria, consisting of 32 case samples pregnant women diagnosed with gestational diabetes mellitus (GDM), and 32 normal pregnant women (without GDM) as controls. Data collection regarding physical activity levels was conducted using the Global Physical Activity Questionnaire (GPAQ), developed by the World Health Organization (WHO) in 2021. This questionnaire is designed to assess various dimensions of physical activity, including work-related, transport-related, and recreational activities, providing a comprehensive overview of the participants' physical activity patterns. According to the research by Bull, Maslin, and Armstrong in 2009, the Global Physical Activity Questionnaire (GPAQ) used in this study has strong reliability (Kappa 0.67 to 0.73). The data were subsequently analyzed using the Mann-Whitney U Test, a non-parametric statistical method appropriate for comparing differences between two independent groups when the data do not meet the assumptions of normal distribution. This analytical approach enables the identification of statistically significant differences in physical activity levels between the two groups under investigation, contributing to a deeper understanding of the impact of gestational diabetes mellitus on maternal activity patterns.

## Results

### Respondent Characteristics

	GDM		Non-GDM	
	Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)
<b>Age</b>				
<20 years	0	0	0	0
20-35 years	16	50	26	81,2
>35 years	16	50	6	18,8
<b>Last Education</b>				
Elementary School	9	28,1	3	9,4
Junior High School	5	15,6	2	6,2
Senior High School	16	50	21	65,6
Bachelor's Degree	2	6,3	6	18,8



**BMI (Body Mass Indeks)**

Underweight	1	3,1	0	0
Normal	0	0	10	31,2
Overweight	7	21,9	8	25
Obesitas	24	75	17	43,8

**Gravida**

Primigravid (1)	12	37,5	6	18,8
Multigravid (2-4)	17	53,1	23	71,8
Grandemultigravid (≥5)	3	9,4	3	9,4

**History makrosomia baby (>4000 grams)**

Yes	0	0	0	0
No	32	100	32	100

**History of GDM in previous pregnancies**

Yes	0	0	0	0
No	32	100	32	100

**Family History of Diabetes Melitus (DM)**

Yes	19	59,4	7	21,9
No	13	40,6	25	78,1

**Family History of Hypertension**

Yes	24	75	9	28,1
No	8	25	23	71,9

**Family History of Heart Disease**

Yes	8	25	4	12,5
No	24	75	28	87,5
Total	32	100	32	100

Based on Table above, half of the pregnant women with gestational diabetes mellitus (GDM) were aged 20-35 years (50%), while the other half were >35 years (50%). In contrast, most normal pregnant women were aged 20-35 years (81.2%), with a smaller proportion >35 years (18.8%). The majority of GDM cases had a high school education (50%), while a small portion had a bachelor's degree (6.3%). Among normal pregnant women, most had a high school education (65.6%), and a small percentage had middle school education (6.3%). Most GDM cases had an obese BMI (75%), with a small portion being underweight (3.1%). For normal pregnant women, most were obese (43.8%), and a smaller portion were overweight (25%). Regarding parity, most GDM cases were multigravida (53.1%), with a small proportion being grand multigravida (9.4%). Similarly, most normal pregnant women were multigravida (71.8%), with a small number being grand multigravida (9.4%). Neither GDM nor normal pregnant women had a history of delivering large babies (>4000 g) or previous GDM. Most GDM cases had a family history of diabetes mellitus (59.4%) and hypertension (75%), while most normal pregnant women had no family history of diabetes (78.1%) or hypertension (71.9%). A smaller proportion of GDM cases (25%) and normal pregnancies (12.5%) had a family history of heart disease.

**Physical Activity Density**

	GDM		Non-GDM	
	Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)



Low	25	78,1	12	37,5
Moderate	7	21,9	14	43,8
High	0	0	6	18,7
Total	32	100	32	100

The majority of pregnant women with gestational diabetes mellitus (GDM) had low physical activity levels (78.1%), with a smaller portion having moderate activity levels (21.9%). In contrast, most normal pregnant women had moderate physical activity levels (43.8%), followed by low activity levels (37.5%), and a small proportion with high activity levels (18.7%).

### Differences in Physical Activity Density Between Pregnant Women with Gestational Diabetes Mellitus (GDM) and Normal (Non-GDM) Pregnant Women

Physical Activity	N	Median	Min - Max	Mann-Whitney Test
				<i>p</i>
GDM	32	444	164 - 1240	0,002
Non-GDM	32	864	264 - 6840	

The analysis using the Mann-Whitney Test shows that the Asymp. Sig. (2-tailed) value is smaller than the significance level of  $\alpha = 0.05$  ( $0.002 < \alpha = 0.05$ ), indicating a significant difference in physical activity levels between pregnant women with gestational diabetes mellitus (GDM) and normal pregnant women.

## Discussion

### Respondent Characteristics

The study found that 16 pregnant women with gestational diabetes mellitus (GDM) were over 35 years old, aligning with Mishra et al. (2020), who identified maternal age  $\geq 30$  years as a significant risk factor for GDM (OR = 17.3). Similarly, Wu et al. (2022) found a strong association between maternal age and GDM, with an OR of 10.9 for women aged  $\geq 35$  years and 18.79 for those over 40 years compared to women under 25. In contrast, most normal pregnancies occurred in women aged 20-35 years, consistent with Rasjidi (2014), who identified this age range as the safest for pregnancy with minimal complications. The study also showed that 24 women with GDM were obese, consistent with Mishra et al. (2020), who reported a higher prevalence of GDM in women with a BMI  $\geq 30$  kg/m<sup>2</sup>. Wu et al. (2022) also linked obesity to GDM (OR = 3.7), while Wang et al. (2021) highlighted the relationship between pre-pregnancy BMI and GDM risk.

Additionally, 17 multigravida women in the study were diagnosed with GDM, supporting Mishra et al. (2020), who identified multigravida as a significant risk factor (OR = 11.3). Wu et al. (2022) further noted that pregnancies beyond the third significantly increased GDM risk (OR = 2.5). Despite these findings, no participants in the study had a history of delivering macrosomic infants ( $\geq 4000$  g), a known factor associated with GDM recurrence and macrosomia risk (Rahayu and Rodiani 2016). Regarding family history, 19 women with GDM had a family history of diabetes, consistent with Mishra et al. (2020), who reported an OR of 66.6 for GDM associated with a family history of type 2 diabetes. A meta-analysis by Ammutammima (2020) and research by Wu et al. (2022) also confirmed the strong link between family history and GDM risk across diverse populations. Finally, the study found no participants with a prior history of GDM, which aligns with Zhang et al. (2022), who noted that higher pre-pregnancy BMI, fasting glucose levels, and macrosomic births are independent risk factors for GDM recurrence. Liang et al. (2021) and



Kek et al. (2023) emphasized the heightened risk of future diabetes, hypertension, and metabolic syndrome in women with a history of GDM.

### Physical Activity Density

Low physical activity levels (<600 MET) before pregnancy significantly increase the risk of gestational diabetes mellitus (GDM). Tobias et al. (2011) found that higher total physical activity before and early in pregnancy reduced GDM risk by 55% compared to low activity levels. Women exercising 5 days per week in the 3 months before pregnancy had a 31% lower GDM risk, while those exercising 1-4 days weekly had a 7% reduction (Redden et al. 2011). Similarly, Xie et al. (2024) reported that increasing physical activity levels could lower GDM risk by 36%. According to Nasiri-Amiri et al. (2016), women with low early pregnancy physical activity, as assessed by a pregnancy activity questionnaire, had a significantly higher GDM risk (OR = 4.12) compared to those with higher activity levels. Sari (2018) also identified a significant relationship between physical activity and GDM (p-value = 0.042), while Mishra et al. (2020) reported a strong association, with an OR of 21.

Physical activity during pregnancy helps manage weight gain, but many women wait until postpartum to address weight loss. Awareness of the benefits of prenatal physical activity remains limited, with barriers including internal factors (physical and psychological) and external factors (work, family, time, and environment) (Weir et al. 2010). Obesity is a significant risk factor for gestational diabetes mellitus (GDM) and adverse outcomes such as stillbirth. Physical activity is safe and recommended for women with obesity, even those previously inactive, and can begin early in pregnancy. It is also safe for some high-risk pregnancies, including those with chronic hypertension and GDM (Cooper and Yang 2024). Moderate-intensity physical activity during pregnancy, when free of complications, reduces excessive weight gain, GDM risk, and supports cardiovascular health. Postpartum, it can alleviate depression and, combined with a healthy diet, aid weight loss (CDC 2024).

Regular physical activity lowers GDM risk and improves endurance for pregnancy and childbirth. Simple activities like brisk walking for 30 minutes, three times a week, or daily exercises with resistance bands are effective (Kleinwechter et al. 2014). Cilar Budler and Budler (2022) highlighted the benefits of aerobic exercises, lumbar stabilization and stretching, aquatic workouts, neural and tendon exercises, resistance, and strength training for maternal health during pregnancy, recommending moderate-intensity activity throughout gestation. Physical activity is an effective intervention for preventing and managing GDM, similar to its role in type 2 diabetes. Starting activity before or during pregnancy positively impacts maternal glucose and insulin metabolism, reducing GDM risk (van Poppel, Ruchat, and Mottola 2014).

### Differences in Physical Activity Density Between Pregnant Women with Gestational Diabetes Mellitus (GDM) and Normal (Non-GDM) Pregnant Women

This study aims to examine the difference in physical activity density between pregnant women with gestational diabetes mellitus (GDM) and normal pregnant women attending outpatient care at the Obstetrics Polyclinic of Airlangga University Hospital. The results indicate that normal pregnant women have moderate physical activity density, while pregnant women with GDM exhibit low physical activity density. Analysis revealed a significant difference in the physical activity density between these two groups. During pregnancy, the placenta secretes hormones such as estrogen, progesterone, cortisol, and placental lactogen (HPL), which decrease insulin sensitivity. This leads to insulin resistance and increased beta-cell responses in the pancreas (Chyad and Faris Shalayel 2011). As the placenta grows, more of these hormones are produced, increasing the risk of insulin resistance. Typically, the pancreas can produce extra



insulin to counter this, but if insulin production is insufficient, gestational diabetes occurs (Hopkins Medicine 2019).

A lack of physical activity can negatively affect the metabolic system, making it difficult for glucose to enter cells. It can decrease insulin sensitivity, contributing to insulin resistance and elevated blood sugar during pregnancy, leading to gestational diabetes (Stone, DiPietro, and Stachenfeld 2021). Therefore, pregnant women with GDM are advised to engage in more physical activity to control glucose levels. Ehrlich et al. (2017) found that moderate-intensity physical activity significantly reduced post-meal glucose levels, improving the chances of achieving glycemic control in women with GDM. Russo (2015) showed a 28% reduction in GDM risk in the physical activity intervention group compared to the control group. This meta-analysis suggests that physical activity during pregnancy offers some protective effects against the development of GDM, but evaluating factors like activity type, timing, duration, and adherence is crucial for optimal obstetric guidelines.

Simple walking was effective in controlling casual blood glucose (CGL) in women with GDM. Participants who walked at least 6,000 steps daily had significantly lower CGL compared to those walking less. Therefore, it is recommended that pregnant women with GDM aim for at least 6,000 steps per day (Hayashi et al. 2018). The American College of Obstetricians and Gynecologists (ACOG) recommends at least 30 minutes of moderate physical activity daily for pregnant women, with a target of 60 minutes, five to seven days a week, for those with GDM as part of managing the condition (ACOG, 2020).

The "talk test" can be used to determine moderate-intensity physical activity:

- If a person can talk and sing without breathlessness, it's low intensity.
- If a person can talk comfortably but cannot sing, it's moderate intensity.
- If a person can barely say more than a few words without breathlessness, it's high intensity (BHC 2024).

Normal pregnant women are generally encouraged to remain physically active to support overall health, prevent hypertension, reduce the risk of GDM, and improve cardiovascular fitness. For women with GDM, the focus of physical activity is to control blood glucose levels and reduce insulin resistance, which is influenced by pregnancy hormones. Physical activity in these women should focus on glucose metabolism and preventing complications like preeclampsia or preterm birth. Thus, the intensity and frequency of physical activity need to be carefully managed to ensure optimal blood sugar control. Regular and frequent physical activity (not just intensity) is beneficial for both women with GDM and normal pregnant women, as long as it is performed under proper supervision. The frequency and duration of physical activity are critical in managing blood sugar and preventing complications.

**Limitations of the study:** This study used the Global Physical Activity Questionnaire (GPAQ), which relies on participants' recall from the past week, possibly introducing bias. The study employed an observational analytical design with a comparative approach, and for more accurate results, future research should adopt an experimental approach, particularly in intervention studies involving physical activity during pregnancy. Additionally, outcomes of childbirth for women with GDM should also be considered.

## Conclusion

The conclusion of this study shows that pregnant women with gestational diabetes mellitus (GDM) visiting the Obstetrics and Gynecology Clinic at Airlangga University Hospital mostly have low physical activity levels, with a small proportion having moderate activity levels. In contrast, normal pregnant women at the same clinic mostly engage in moderate physical activity, with a



small percentage showing high activity levels. Overall, normal pregnant women have higher physical activity levels than those with GDM.

It is recommended that pregnant women, according to the American College of Obstetricians and Gynecologists (ACOG) guidelines, increase their physical activity to 30 minutes per day at a moderate intensity to prevent complications, particularly GDM. Women with GDM should aim for 60 minutes of exercise at least five days a week (preferably seven days) to manage the condition. Healthcare providers, especially midwives, are advised to screen pregnant women for GDM and encourage physical activity based on ACOG guidelines. For future research, an experimental approach to physical activity interventions during pregnancy is recommended, along with assessing childbirth outcomes in women with GDM.

### Ethics approval and consent to participate

This study has obtained an ethical clearance certificate from the Ethics Committee of RSUA (Airlangga University Hospital) with approval number UA-02-24132, valid from August 1, 2024, to August 1, 2025.

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