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[Original Research]

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# Effect of Diabetic Gymnastics on Blood Glucose Levels in Type 2 Diabetes Mellitus Patients: A Quasi-experimental Study

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## Abstract

**Background:** Diabetes mellitus is a non-communicable disease characterized by persistently elevated blood glucose levels exceeding the normal range of 70–150 mg/dL. Effective diabetes management consists of five key components: education, nutritional therapy, physical activity (including diabetic exercises), pharmacological treatment, and regular blood glucose monitoring. Diabetic exercise, when tailored to an individual's age and physical condition, can help lower blood glucose levels, enhance stamina, and maintain healthy body weight in individuals with type 2 diabetes mellitus. The recommended duration of diabetic exercise is at least 30 minutes per session, three to four times per week for adults, and 60 minutes with similar frequency for children and adolescents. **Aim:** To analyze the effect of diabetic exercise (diabetes mellitus gymnastics) on blood glucose levels in patients with type 2 diabetes mellitus. **Method:** This study employed a quasi-experimental design using a one-group pretest–posttest approach. The sample consisted of 20 individuals diagnosed with type 2 diabetes mellitus, selected through purposive sampling based on predefined inclusion and exclusion criteria. Blood glucose levels were measured before and after the diabetic exercise intervention. Data were analyzed using the paired sample t-test to determine the statistical significance of the differences observed. **Results:** The findings revealed a significant reduction in blood glucose levels following the diabetic exercise intervention. The mean random blood glucose (RBG) level before the intervention was **202.85 mg/dL**, and after the intervention, it decreased to 164.50 mg/dL, with a mean difference of 38.35 mg/dL. Statistical analysis using the paired t-test produced a significance value (2-tailed) of 0.000 ($p < 0.05$), indicating that diabetic exercise had a statistically significant effect in lowering average RBG levels among participants. **Conclusion:** This study demonstrates that diabetic exercise effectively reduces blood glucose levels in patients with type 2 diabetes mellitus. These findings support the integration of structured physical activity as a safe, feasible, and non-pharmacological intervention within diabetes management programs, particularly at the primary healthcare level.

**Keywords:** Diabetes Mellitus, Diabetes Exercises, Diabetic Gymnastics



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## Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by elevated blood glucose levels (hyperglycemia) caused by defects in insulin secretion, insulin action, or both (Hayati, 2021; Pangestuka, 2022). Glucose, derived from dietary carbohydrates and stored as glycogen in the liver and muscles, serves as the body's

main energy source (Yulianti & Januari, 2021). When insulin production is inadequate or insulin sensitivity decreases, glucose accumulates in the bloodstream, leading to metabolic disturbances.

The etiology of DM involves complex interactions between genetic and environmental factors (Lestari et al., 2021). Impaired insulin secretion, mitochondrial dysfunction, and abnormal glucose metabolism are key contributors. Diagnosis is commonly established through blood glucose and HbA1c tests, with enzymatic plasma glucose analysis considered the gold standard (Soelistijo, 2021). Normal blood glucose levels range from 70–150 mg/dL, rising after meals and returning to baseline as insulin facilitates glucose uptake into cells (Gesang & Abdullah, 2019; Novitasari et al., 2017).

According to the International Diabetes Federation (IDF, 2021), the global prevalence of diabetes among adults aged 20–79 years was 10.5% (536.6 million people) in 2021 and is projected to increase to 12.2% (783.2 million) by 2045. Indonesia ranks fifth globally in diabetes prevalence (Wang et al., 2022). Data from Riskesdas (2018) report 73,285 diabetes cases in West Java, including 14,897 in Ciamis Regency. The Panawangan Community Health Center recorded one of the highest incidences, with 376 active cases, many of which remain undiagnosed due to asymptomatic early stages.

The Indonesian Endocrinology Association (PERKENI) identifies five main pillars of diabetes management: education, dietary modification, physical activity, pharmacotherapy, and regular glucose monitoring (Hayati, 2021). While medication plays a central role, non-pharmacological strategies—especially physical activity—have shown substantial benefits in improving glycemic control. Exercise increases muscle glucose uptake, enhances insulin sensitivity, and reduces HbA1c levels. Regular activity also prevents complications and promotes cardiovascular health (Hayati, 2021).

A particularly effective non-pharmacological intervention is diabetes exercise (*senam diabetes*), a form of aerobic activity adjusted to the patient's physical condition. It promotes rhythmic muscle contraction that utilizes glucose as energy, reducing blood sugar levels during and after activity (Tandra, 2017). Exercise enhances insulin action by facilitating glucose transport into cells (Fitriani & Fadilla, 2020). Recommended frequency for adults is 30 minutes per session, three to four times weekly, while for children and adolescents it is 60 minutes with similar frequency (Lubis & Kanzanabilla, 2021). Empirical studies support these benefits: Ginanjar et al. (2022) reported significant reductions in blood glucose through diabetes-specific exercise, while Afridon (2018) emphasized that regular physical activity improves metabolic outcomes in diabetic patients.

Despite strong evidence, physical exercise remains underutilized. Many patients rely mainly on medication and diet while neglecting exercise programs. However, pharmacological therapy alone cannot achieve optimal glycemic control; consistent physical activity is necessary to complement medication and enhance metabolic function.

Preliminary interviews with the Non-Communicable Disease (NCD) program manager at the Panawangan Community Health Center revealed that diabetes management currently focuses on Prolanis (Chronic Disease Management Program) and Posbindu (Integrated Health Post for Non-Communicable Diseases). Although these initiatives aim to monitor and control blood glucose, participant outcomes remain suboptimal. Importantly, diabetes-specific exercise interventions have not yet been integrated into these community health programs.

This gap highlights the potential of diabetes exercise therapy as a feasible and effective non-pharmacological strategy for improving blood glucose control among patients with type 2 diabetes mellitus. Such interventions align with the global and national emphasis on lifestyle modification in chronic disease prevention. Exercise not only regulates glucose metabolism but also aids in weight management, improves lipid profiles, enhances insulin receptor sensitivity, and lowers the risk of cardiovascular complications—common comorbidities in diabetic populations.

Beyond physiological benefits, exercise fosters behavioral change and promotes self-management. Integrating structured physical activity into community-based diabetes programs can encourage healthier lifestyles and long-term adherence. Health promotion strategies that combine education, physical exercise, and periodic monitoring have been shown to improve glycemic control and quality of life (Fitriani & Fadilla, 2020; Ginanjar et al., 2022). These findings reinforce the importance of holistic interventions that address both metabolic and behavioral dimensions of diabetes care.

Therefore, this study aims to evaluate the effect of diabetes exercise on blood glucose reduction among patients with type 2 diabetes mellitus at the Panawangan Community Health Center, Ciamis Regency. Specifically, it investigates whether structured physical activity can serve as an effective complement to existing programs, such as Prolanis and Posbindu, and yield sustained glycemic improvements. The expected outcomes include scientific evidence supporting diabetes exercise as a safe, low-cost, and effective adjunct therapy, while providing a practical framework for enhancing public health initiatives at the primary healthcare level.

Ultimately, this research seeks to advance understanding of lifestyle-based interventions in diabetes care and to encourage the wider adoption of non-pharmacological therapies within Indonesia's community health system. Its findings may serve as a foundation for developing integrated diabetes management models that combine education, self-care, and physical activity, thereby contributing to the reduction of the national burden of diabetes mellitus.

## Methods

This study employed a quasi-experimental design with a one-group pretest–posttest approach. In this design, a single group of participants received a diabetes exercise intervention, and their blood glucose levels and mobility were measured before and after the intervention to evaluate any changes. Although this design allows for the practical observation of intervention effects without randomization, its main limitation lies in the absence of a control group. This limitation makes it difficult to isolate the specific effect of the intervention from other external factors such as dietary variations, psychological stress, or seasonal influences that may affect the outcomes. Consequently, this condition may introduce bias and reduce internal validity. The authors acknowledged this limitation, which is consistent with general critiques in quasi-experimental research (Creswell, 2014), and recommended that future studies include a control group to strengthen causal inference.

The research was conducted in the working area of the Panawangan Community Health Center over a one-week period, from April 8 to April 14, 2025. The study involved 20 participants diagnosed with type 2 diabetes mellitus who were selected through purposive sampling based on specific inclusion and exclusion criteria. The inclusion criteria consisted of patients with type 2 diabetes mellitus who were willing to participate and had signed informed consent forms, those with blood glucose levels ranging from 200 to 250 mg/dL, respondents aged between 30 and 75 years, patients who routinely visited the community health center, those without comorbid conditions such as kidney failure or stroke, and patients taking oral antidiabetic medication. Meanwhile, the exclusion criteria included participants who withdrew voluntarily from the study or those who developed health problems that required them to discontinue participation.

Measurement of blood glucose levels was carried out using a glucometer that had been proven valid and reliable in previous studies. Measurements were taken before and after the intervention to determine the effect of diabetes exercise on glycemic control. The diabetes exercise program implemented in this study was designed to lower blood sugar levels, enhance insulin sensitivity, and maintain cardiovascular health. The exercise protocol consisted of three main components, namely a warm-up, main activity, and cool-down phase. The warm-up phase lasted for approximately 5–10 minutes and involved light walking or dynamic stretching to prepare the body and prevent injury. The main activity, conducted for 5–10 minutes, consisted of diabetes-specific aerobic movements aimed at improving mobility and promoting glucose utilization by the muscles. Finally, the cool-down phase, also lasting 5–10 minutes, included static stretching exercises to promote muscle relaxation and gradual normalization of heart rate.

In accordance with established recommendations, the total duration of diabetes exercise for adults was set at 30 minutes per session, while for children and adolescents it was 60 minutes per session. The exercise sessions were scheduled three to four times per week to help regulate blood sugar levels and improve physical mobility. The sessions were guided and supervised directly by the principal researcher, Arif Budi Prasetia, and were conducted at each participant's home to ensure proper execution and adherence to the prescribed exercise routine. The study approval was obtained from Komisi Etik Penelitian Kesehatan Poltekeks Kemenkes Tasikmalaya (Approval number: DP.04.03.F.XVIII.20/KEPK/192/2025 on 13 April 2025).

Data analysis was performed using SPSS version 20. To determine whether the data met the assumptions for parametric testing, the Shapiro–Wilk test was employed to assess data normality, and the Levene's test was used to examine homogeneity. The results indicated that the data were both normally distributed and homogeneous. Consequently, statistical analyses were carried out using paired sample t-tests to compare pretest and posttest values, and independent sample t-tests when required. A significance level of $p < 0.05$ was considered statistically significant, indicating that the observed differences before and after the intervention were unlikely to have occurred by chance.

Overall, this methodological approach was designed to provide an initial understanding of the effectiveness of diabetes exercise as a non-pharmacological intervention in controlling blood glucose levels among patients with type 2 diabetes mellitus in the Panawangan Community Health Center area. Although limited by the absence of a control group, the study's findings are expected to contribute valuable preliminary evidence that can inform future research and support the integration of structured exercise programs into community-based diabetes management strategies

## Results

Based on the data presented in Table 1, the results indicate that the majority of respondents were within the 51–75-year age group, accounting for 80% of the total participants. Most individuals with diabetes mellitus were female, comprising 14 participants (70%). Furthermore, a large proportion of respondents reported a family history of diabetes, totaling 14 individuals (65%). In terms of disease duration, the majority had been living with diabetes mellitus for less than five years, with 13 respondents (65%) falling into this category.

Table 1 Characteristics of respondents with type 2 diabetes mellitus (n= 20)

| Characteristics | Frequency | Percentage (%) |
|---|---|---|
| **Age** | | |
| Adult (30-50) | 4 | 20 |
| Elderly (51-75) | 16 | 80 |
| **Gender** | | |
| Male | 6 | 30 |
| Female | 14 | 70 |
| **Riwayat Genetics** | | |
| Yes | 13 | 65 |
| No | 7 | 35 |
| **Long suffering for DM** | | |
| < 5 Years | 13 | 65 |
| > 5 Years | 7 | 35 |

The mean random blood glucose (RBG) level before the intervention was 202.85 mg/dL with a standard deviation (SD) of 32.841, whereas after the intervention, the mean RBG level decreased to 164.50 mg/dL with an SD of 34.964. The minimum and maximum RBG values prior to the intervention ranged from 150 to 256 mg/dL, while after the intervention, they ranged from 110 to 250 mg/dL (see table 2).

Table 2 Mean Distribution of Random Blood Glucose (RBG) Levels in Individuals with Type 2 Diabetes Mellitus (n = 20)

| Variabel | Mean (mg/dL) | SD | Min-Max (mg/dL) |
|---|---|---|---|
| Blood Sugar During Before Intervention | 202.85 | 32.841 | 150-256 |
| Blood Sugar After Intervention | 164.50 | 34.964 | 110-250 |

The mean difference in random blood glucose (RBG) levels before and after the intervention was 38.35 mg/dL with a sample size of n = 20. The results of the statistical analysis showed a significance value (2-tailed) of 0.000 ($\alpha < 0.05$), indicating that the diabetes exercise intervention had a statistically significant effect in reducing the average RBG levels among participants before and after the intervention (see table 3).

Table 3 Effect of the Intervention on Random Blood Glucose (RBG) Levels in Individuals with Type 2 Diabetes Mellitus (n = 20)

| Variabel | N | Difference (mg/dL) | P-value |
|---|---|---|---|
| Blood glucose before vs. after intervention | 20 | 38.35 | 0.000 |

**Paired Sample T-Test*

## Discussion

The data from this study indicated that the majority of participants were women (70%), while men accounted for the remaining 30%. Specifically, 14 female and 6 male participants were included in the study. Most participants were aged between 51 and 75 years, with the overall age range spanning from 30 to 71 years, suggesting that a substantial proportion of respondents were older adults.

In this study, women constituted a higher proportion (70%) of individuals with diabetes mellitus compared to men (30%). According to Prasetyani and Sodikin (2017, in Desi et al., 2018), diabetes mellitus tends to affect women more frequently than men due to hormonal differences that contribute to higher levels of adipose tissue in females. Men generally have 15–20% body fat, whereas women have 20–25%, making women approximately 2–3 times more susceptible to developing diabetes mellitus. Moreover, decreased estrogen levels during menopause can trigger the release of free fatty acids, particularly in the abdominal area, which reduces insulin sensitivity. This hormonal change may result in insulin resistance and elevated blood glucose levels (Desi et al., 2018).

Regarding the duration of the disease, most participants (13 individuals, 65%) had been diagnosed with diabetes mellitus for less than five years, while seven participants (35%) had lived with the condition for more than five years. These findings are consistent with Mildawati et al. (2023), who reported that the average duration of diabetes mellitus among patients is approximately five years, ranging from one to twelve years. Prolonged hyperglycemia may lead to vascular damage,

increasing the risk of microvascular complications (Kriswiastiny et al., 2022). Chronic diabetes, typically after 5–10 years, can result in comorbidities such as hypertension, cardiovascular disease, stroke (with a 2–4 times greater risk), retinopathy, nephropathy, and neuropathy (Kristatuti et al., 2014).

In this study, a majority of participants (13 individuals, 65%) reported a family history of diabetes mellitus. Maulana (2022) found that individuals with a family history of diabetes have a higher risk of developing the disease compared to those without such a background. This risk is attributed to hereditary transmission patterns, wherein males often manifest the disease directly, while females tend to transmit the genetic predisposition to their offspring. Approximately half of individuals with an affected parent or sibling may develop diabetes mellitus, and more than 30% of patients have siblings who also suffer from the condition (Tandra, 2017). These findings are in line with the studies by Imelda (2019) and Harefa and Lingga (2023), which emphasize that familial genetic alterations affecting pancreatic beta-cell function can impair insulin secretion. Similarly, Ariyanti et al. (2019) demonstrated that genetic factors influence the sensitivity and signaling mechanisms of beta cells in insulin regulation. Infants with birth weights exceeding 4 kg and those born to mothers with diabetes mellitus are also at a higher risk of developing diabetes later in life.

The recommended diabetes exercise program for adults involves 30-minute sessions performed three to four times per week, while for children and adolescents, 60-minute sessions at the same frequency are advised (Lubis & Kanzanabilla, 2021). During the intervention period, participants showed strong adherence and engagement, indicating good acceptance of the diabetes exercise program and its potential for long-term sustainability.

The results of this study showed that the mean blood glucose level before the intervention was 202.85 mg/dL, which decreased to 164.50 mg/dL after the intervention—a reduction of approximately 38.35 mg/dL. Blood glucose levels are influenced by several factors, including age, gender, disease duration, and lifestyle behaviors. In healthy individuals, glucose serves as a primary energy source. However, in people with diabetes, glucose is not efficiently converted into energy, leading to hyperglycemia and potential organ damage (Fahmi et al., 2020).

Engaging in physical activity promotes blood circulation and enhances insulin receptor sensitivity, thereby facilitating glucose uptake by muscle cells and lowering blood sugar levels (Suryati, 2021). These results align with findings from Masriwati et al. (2023), Rahmawati et al. (2024), and Aniah et al. (2024), who reported that diabetes-specific exercise effectively reduces blood glucose concentrations in individuals with type 2 diabetes mellitus. The findings of this study similarly suggest that structured physical activity designed for diabetic patients can significantly decrease blood glucose levels by enhancing insulin sensitivity and glucose utilization within muscle cells. According to Suryati (2021), physical exercise assists in converting blood glucose into energy, thereby reducing blood sugar accumulation, maintaining glycemic stability, and improving insulin responsiveness.

The post-intervention data demonstrated a substantial improvement in glycemic control compared to pre-intervention measurements. Before the intervention, the mean blood glucose level was 202.85 mg/dL, while after the intervention, it decreased to 164.50 mg/dL, indicating the positive effect of diabetes exercise on glycemic reduction.

This study, however, has several limitations. The quasi-experimental design without a control group limits the ability to draw causal inferences regarding the effectiveness of diabetes exercise. Employing a quasi-experimental design with a nonequivalent control group and pre- and post-test assessments would enhance internal validity. Nonetheless, collecting blood glucose data before and after the intervention posed logistical challenges, as the research was conducted door-to-door, preventing simultaneous data collection and extending the research duration.

## Conclusion

The findings of this study demonstrate that exercise interventions effectively reduce blood glucose levels in patients with type 2 diabetes mellitus within the study context. Although the results indicate a significant improvement, further research is necessary to validate these findings and support broader generalization. This intervention represents a safe, feasible, and non-pharmacological approach that can be integrated into nursing practice, particularly within primary healthcare settings.

**Declaration of Conflicting Interest**

No conflict of interest to declare

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**Author's Contribution**

*ABS*: contributed to the study's conception and design, data acquisition, and data analysis, wrote the first draft of the manuscript
YC: Revised the final draft, and gave final approval of the version to be published.
AS: Revised the final draft

**Data Availability Statement**

The dataset generated during and analyzed during the current study is available from the corresponding author upon reasonable request.

**Declaration of Use of AI in Academic Writing**

The author used ChatGPT/Gemini in the writing process to improve readability and remove grammatical errors. However, he took full responsibility for the content.

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