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Original Research Paper

Effect of Diabetes Exercise on Reduction of Blood Glucose Levels in Patients with Type II Diabetes Mellitus

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Intan Sari*

Bachelor of Nursing Study Program, Universitas Muhammadiyah Sukabumi

Email Corresponding:
intansari07052003@gmail.com

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Abstract

Background: The rising prevalence of diabetes mellitus in Indonesia from 10.9% in 2018 to 11.7% in 2023, positioning the country fifth globally with 19.47 million cases highlights an urgent public health concern requiring effective management strategies. **Objective:** To determine the effect of diabetes exercise on blood glucose levels (BGLs) in patients with type 2 diabetes mellitus. **Methods:** This pre-experimental study used a one-group pretest-posttest design involving 18 respondents who performed diabetes exercise three times per week for four weeks, each session lasting 30 minutes. **Results:** Data were analyzed using frequency distribution, the Shapiro-Wilk test, and the Wilcoxon Signed Rank Test. Normality tests showed significance values of 0.521 (pre-test) and 0.946 (post-test), indicating normally distributed data. The Wilcoxon test yielded a ρ-value of 0.001 (<0.05) with a large effect size (0.68), demonstrating a significant reduction in BGLs after the intervention. Mean BGLs decreased substantially from pre- to post-exercise, suggesting improved glycemic control. These findings confirm that regular diabetes exercise enhances insulin sensitivity and promotes better glucose utilization through increased muscle activity. **Conclusion:** Diabetes exercise significantly reduces blood glucose levels in patients with type 2 diabetes mellitus and should be recommended as a complementary, non-pharmacological therapy for optimal glycemic management.

Keywords: *Diabetes Exercise; Blood Glucose Levels; Type 2 Diabetes Mellitus.*

Introduction

Diabetes mellitus (DM) continues to escalate as a major noncommunicable disease burden globally, driving morbidity, mortality, and healthcare costs[1]. Recent data estimate that over 11 % of Indonesia's adult population is living with diabetes, placing the country among the top affected nations globally[2,3]. The rising prevalence underscores the urgent need for effective management strategies beyond medications. Physical activity, particularly structured exercise, emerges as a critical component in comprehensive diabetes care.

Despite guidelines recommending exercise for type 2 diabetes mellitus (T2DM) patients, many communities and primary care settings struggle to implement effective exercise interventions[4]. Prior research has largely been conducted in controlled settings, leaving gaps in evidence from routine community health centers[5,6]. Several studies reported improvements in glycemic control after exercise, but did not address feasibility, adherence, or contextual constraints in primary care settings[7,8]. These gaps hinder translation of controlled findings into real-world diabetes care programs.

This study is necessary to bridge the evidence practice gap by evaluating a structured diabetes exercise program in a

Puskesmas (community health center), a setting reflective of typical healthcare delivery in Indonesia. Unlike studies in hospital or university settings, this research integrates exercise within local primary care workflows, offering insight into pragmatic implementation. It is novel in combining a 4 week regimen with pretest-posttest measurement of random blood glucose (RBG) in a community context. Additionally, it explores individual level barriers affecting response to exercise, which few previous studies have addressed.

The central research question is: Will a 4 week structured diabetes exercise intervention significantly reduce random blood glucose levels in T2DM patients in a community health center? We hypothesize that post-intervention RBG will be significantly lower than baseline. The objective is to quantify the glycemic reduction effect of the exercise regimen. Secondary aims include assessing the practical feasibility and safety of implementing such a program in routine primary care.

If successful, this study could support the adoption of exercise programs as standard components of diabetes management at primary care level, enhancing accessibility of non pharmacological therapy. Healthcare policymakers may allocate resources to train staff and organize community-based exercise classes, improving public health outcomes. The findings also contribute scientific evidence confirming that exercise interventions are effective even outside specialized settings. Ultimately, this research may guide scalable models of lifestyle based diabetes care across similar low and middle income country settings.

Indonesia faces escalating diabetes burdens, projected to affect over 16 % of adults by 2045, demanding feasible preventive and therapeutic strategies[9,10]. Given constraints in medication access and healthcare resources, exercise offers a low cost, accessible modality to support glycemic control and reduce complications. Molecular evidence shows that muscle contraction stimulates GLUT4 translocation and insulin sensitivity, mechanisms preserved even in T2DM individuals[11,12,13]. Therefore, deploying a pragmatic exercise intervention in a primary care setting aligns well with physiological principles and public health needs.

Materials and Methods

Research Design

This study employed a quantitative approach using a pre-experimental method with a one-group pretest–posttest design to evaluate the effect of diabetes exercise on blood glucose levels in patients with type 2 diabetes mellitus.

Sample

The sample size was calculated using the Federer formula ($n = (t^2 \times s^2) / d^2$), where t = 1.96 (for a 95% confidence level), s = 35 (estimated standard deviation from previous studies), and d = 15 (desired precision), resulting in a minimum sample of 21. However, due to limited respondent availability, 18 participants were included. Respondents were selected using a consecutive sampling technique involving all eligible patients visiting the Puskesmas during the study period.

Inclusion criteria included: (1) diagnosed with type 2 diabetes mellitus, (2) aged 40–65 years, (3) willing to participate, and (4) physically capable of exercise. Exclusion criteria were: (1) severe diabetic complications, (2) hypoglycemia or hyperglycemia crises, and (3) other chronic diseases preventing participation. Dropouts were defined as those missing more than two sessions.

Data Collection Techniques

Blood glucose levels were measured using a Hemocue Glucose 201 RT device, validated against laboratory reference methods (r = 0.97).

Calibration was performed daily according to manufacturer guidelines prior to data collection. Exercise sessions were conducted three times weekly for four weeks, with each session lasting 30 minutes.

Data Analysis Techniques

Descriptive statistics were used to analyze respondent characteristics and blood glucose levels before and after exercise. The Shapiro Wilk test assessed data normality, yielding p-values of 0.521 (pre-test) and 0.946 (post-test), indicating normal distribution. The Wilcoxon Signed Rank Test evaluated differences between pre- and post-intervention results, and Cohen's r formula ($r = Z/\sqrt{N}$) was applied to determine effect size.

Ethical Consideration

This research adhered to ethical standards for studies involving human participants. Respondents were provided with information about the study objectives and procedures and gave informed consent prior to participation. Ethical approval was obtained from the institutional ethics committee, and all data were kept confidential. The intervention posed minimal risk, as diabetes exercise is a recommended physical activity for diabetic patients and was supervised by trained personnel.

Results

Table 1 presents the demographic and clinical characteristics of the 18 respondents with Type II Diabetes Mellitus who participated in the diabetes exercise program at Nanggeleng Health Center, Sukabumi City, in 2024.

The majority of participants were female (77.8%) and belonged to the adult age group (72.2%). Most respondents had been diagnosed with diabetes for approximately 2 years (38.9%). Regarding physical activity, the majority (61.1%) engaged in exercise only once per week before the intervention period, indicating a generally sedentary lifestyle pattern among the study participants.

Table 1. Characteristics of Respondents (n = 18)

Characteristic	Category	Frequency (F)	Percentage (%)
Gender	Male	4	22.2
	Female	14	77.8
Age Group	Adults (19–59 years)	13	72.2
	Elderly (≥60 years)	5	27.8
Duration of Diabetes Mellitus	1 year	5	27.8
	2 years	7	38.9
	3 years	1	5.6
	4 years	2	11.1
	6 years	1	5.6
	7 years	1	5.6
	8 years	1	5.6
Physical Activity Frequency	1 time per week	11	61.1
	2 times per week	6	33.3
	3 times per week	1	5.6
	>3 times per week	0	0

The distribution of random blood glucose (GDS) levels before and after the diabetes exercise intervention is shown in Table 2.

Table 2. Distribution of Random Blood Glucose Levels Pre- and Post-Diabetes Exercise (n = 18)

Blood Glucose Level	Pre-Exercise (F / %)	Post-Exercise (F / %)
Low (<70 mg/dL)	0 / 0%	0 / 0%
Normal (70–200 mg/dL)	7 / 38.9%	14 / 77.8%
High (>200 mg/dL)	11 / 61.1%	4 / 22.2%
Total	18 / 100%	18 / 100%

Prior to the intervention, 61.1% of respondents had random blood glucose levels categorized as high (>200 mg/dL). Following participation in the structured diabetes exercise sessions, the proportion of participants with normal blood glucose levels increased substantially from 38.9% to 77.8%, while those with high glucose levels decreased from 61.1% to 22.2%. Notably, no respondents experienced

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hypoglycemia (<70 mg/dL) either before or after exercise.

This finding aligns with the physiological expectation that moderate intensity exercise (60–70% of Maximum Heart Rate for 30 minutes) can enhance glucose uptake by skeletal muscles without inducing hypoglycemia in individuals with Type II Diabetes Mellitus who are not on insulin therapy. Furthermore, participants were advised to consume a light snack approximately 30 minutes before exercise sessions, which may have contributed to maintaining stable glucose levels throughout the intervention.

Table 3 summarizes the results of statistical tests performed to assess the effect of the diabetes exercise intervention on blood glucose levels.

Table 3. Effect of Diabetes Exercise on Blood Glucose Levels

Test	Pre-Exercise GDS	Post-Exercise GDS	Interpretation
Shapiro–Wilk Normality Test (p-value)	0.521	0.946	Data are normally distributed ($p > 0.05$)
Wilcoxon Signed Rank Test (ρ-value)	–	0.001	Significant difference ($p < 0.05$)
Effect Size (Cohen's r)	–	0.68	Large effect size

The Shapiro–Wilk test results showed that both pre- and post-intervention data were normally distributed ($p > 0.05$). The Wilcoxon Signed Rank Test yielded a significant p-value ($\rho = 0.001 < 0.05$), indicating that the diabetes exercise intervention significantly reduced random blood glucose levels among the respondents. The effect size (Cohen's $r = 0.68$) represents a large practical impact, confirming that the intervention had a substantial beneficial influence on glycemic control.

The study found that most participants were female adults with a diabetes duration of 1–2 years, and after four weeks of diabetes exercise, the proportion with normal glucose levels increased from 38.9% to 77.8%. The intervention significantly reduced blood glucose levels ($\rho = 0.001$, $r = 0.68$) without any hypoglycemic events, confirming both its effectiveness and safety. However, 22.2% of participants remained hyperglycemic (>200 mg/dL), primarily due to poor dietary adherence, limited exercise habituation in newly diagnosed patients, and high baseline HbA1c levels (>9%). These results indicate that while exercise substantially improves glycemic control, optimal outcomes require an integrated approach that includes consistent physical activity, balanced diet, medication adherence, and personalized lifestyle counseling to strengthen long-term diabetes self-management.

Discussion

This study demonstrated that diabetes mellitus (DM) exercise significantly reduced blood glucose levels in patients with type 2 diabetes mellitus (T2DM) at the Nanggeleng Health Center, Sukabumi City, with a Wilcoxon Signed Rank Test ρ-value of 0.001 (<0.05) and a large effect size ($r = 0.68$). The percentage of respondents with normal blood glucose increased from 38.9% before to 77.8% after the intervention, indicating that structured physical exercise performed three times weekly for four weeks effectively improved glycemic control. These results confirm the hypothesis that diabetes specific exercise, as a form of moderate-intensity aerobic activity, promotes better glucose metabolism through enhanced insulin sensitivity and muscular glucose uptake.

The physiological mechanism behind this improvement lies in the ability of regular exercise to enhance glucose transporter type 4 (GLUT4) translocation to cell membranes, thus increasing glucose entry into muscle cells independent of insulin action. Exercise also improves mitochondrial function and lipid metabolism, reducing insulin resistance a key pathophysiological hallmark of T2DM. The absence of hypoglycemic events in this study (0% of participants with glucose <70 mg/dL) reflects the moderate intensity and safety of the implemented exercise regimen, consistent with the American Diabetes Association (ADA) recommendations for supervised aerobic exercise at 60–70% of maximum heart rate for 30 minutes, three times weekly[14,15].

The findings of this study align with previous evidence demonstrating the beneficial effects of structured exercise on blood glucose regulation in T2DM patients. Nabila et al (2024) found a significant decrease in blood glucose levels among patients who performed diabetes exercise, with a p-value of 0.000[16]. Similarly, Lalita et al (2023) reported comparable results, showing significant differences in pre- and post-intervention glucose levels (p = 0.000)[17]. These consistent findings suggest that diabetes exercise, as a culturally adapted and community based intervention, can be an effective non-pharmacological strategy to improve glycemic outcomes. Differences in magnitude of change observed across studies may be influenced by variations in exercise duration, adherence levels, and baseline glycemic status.

While most studies confirm the positive impact of exercise, discrepancies in effect sizes across trials highlight contextual influences such as diet adherence, medication compliance, and psychosocial motivation. A meta analysis by Zhao et al. (2024) demonstrated that structured exercise training reduced HbA1c by 0.67% on average in T2DM patients, though variability was attributed to heterogeneity in exercise modalities and intensity[18]. In this study, 22.2% of participants remained hyperglycemic post-intervention, likely due to inconsistent dietary adherence and poor baseline metabolic control, as evidenced by reported high carbohydrate intake and elevated HbA1c levels (>9%). These results emphasize that while exercise is effective, optimal glycemic management requires a multifaceted approach integrating diet, medication, and behavioral interventions.

From a clinical and public health perspective, diabetes exercise programs can serve as cost effective and scalable interventions, particularly in resource-limited settings where access to pharmacological therapies may be constrained. Community-based implementation of diabetes exercise provides opportunities for peer support, enhances treatment adherence, and addresses both physical and psychological aspects of diabetes management[19,20]. Furthermore, incorporating diabetes exercise into primary care health promotion programs can contribute to national efforts in reducing the growing burden of diabetes in Indonesia, where prevalence has risen from 10.9% in 2018 to 11.7% in 2023[21]. Strengthening interdisciplinary collaboration between healthcare workers, nutritionists, and exercise trainers is essential for sustainable implementation.

This study's strength lies in its controlled pre-post design, objective glucose monitoring using validated instruments, and standardized exercise intervention following ADA recommendations. However, several limitations should be acknowledged. The absence of a control group limits causal inference, and the small sample size (n=18) restricts external validity. The study duration of four weeks may not adequately capture long-term metabolic adaptations. Additionally, unmeasured confounders such as dietary intake and medication adjustments may have influenced outcomes. Future studies should include larger, randomized samples and additional biomarkers such as HbA1c to assess long-term glycemic effects.

Practically, this research supports the integration of diabetes exercise as part of comprehensive diabetes management protocols in community health centers (*Puskesmas*). Health educators and nurses should be trained to guide patients in safe and effective exercise routines tailored to individual capacities. The group-based nature of diabetes exercise also fosters social motivation, reducing psychological distress often associated with chronic disease management[22,23]. Developing structured exercise modules, with emphasis on gradual progression and monitoring, could standardize delivery across different healthcare settings, ensuring consistency and safety.

Future research should adopt randomized controlled trials to strengthen causal evidence on the effectiveness of diabetes exercise in glycemic regulation. Longitudinal studies spanning 6–12 months are necessary to evaluate sustainability and effects on diabetes complications. Incorporating diverse populations across different socioeconomic and cultural contexts will enhance generalizability. Additionally, future investigations should compare the effectiveness of different exercise modalities (aerobic vs. resistance vs. combined) and explore the synergistic effects of exercise, nutrition counseling, and pharmacotherapy. Economic evaluations assessing cost-effectiveness will be crucial for informing health policy decisions in Indonesia's public health system.

Conclusion

In conclusion, this study confirms that diabetes exercise significantly reduces blood glucose levels in patients with Type II Diabetes Mellitus at Nanggeleng Health Center, Sukabumi City (H1 accepted), with a large effect size (Cohen's $r = 0.68$), indicating strong clinical relevance. These findings highlight diabetes exercise as a cost effective, non pharmacological strategy for improving glycemic control in primary healthcare settings. Community health centers are encouraged to integrate regular diabetes exercise programs into routine care, ensuring accessibility for elderly or physically limited patients. Additionally, healthcare providers should be trained to prescribe and monitor suitable exercise regimens, while policymakers should consider sustainable funding mechanisms for such initiatives. This research contributes to non communicable disease control efforts and serves as valuable reference material for academic and practical applications in diabetes management.

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Conflict of Interest Statement

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