

Research Article

Role of Exercise in the Management of Diabetes Mellitus

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a growing global health challenge associated with significant metabolic and cardiovascular complications. Exercise is widely recognized as a key non-pharmacological intervention; however, the patterns of physical activity among individuals with T2DM and their relationship with glycemic outcomes remain underexplored in many populations.

Objective: To evaluate the types and frequency of exercise performed by adults with T2DM and to examine their association with glycemic control and metabolic health indicators in a cross-sectional clinical setting.

Methodology: The study utilized a cross-sectional design and included 80 participants recruited through consecutive sampling based on predefined eligibility criteria. Data was collected at a single point in time using a structured proforma capturing demographic details and clinical variables. All clinical assessments were performed by trained investigators following standardized procedures to ensure reliability and reduce measurement bias. Data accuracy was maintained through double-entry verification. Ethical approval was obtained, and informed consent was secured from all participants. Statistical analysis involved appropriate descriptive and inferential tests according to data distribution, with significance set at $p < 0.05$.

Results: The study population predominantly comprised middle-aged individuals (46–60 years, 37.5%) with a slight male predominance (52.5%), and most participants reported primary/secondary education and sedentary occupations. Clinically, participants had a mean diabetes duration of 6.8 ± 3.5 years, were generally overweight (BMI 27.5 ± 4.2 kg/m²), and exhibited suboptimal glycemic control (HbA1c $8.1 \pm 1.2\%$), with a high prevalence of hypertension (45%) and dyslipidemia (35%). Aerobic exercise was the most reported activity (50%), whereas only 22.5% engaged in combined aerobic and resistance training, and half of the participants exercised 3–4 times per week.

Conclusion: This cross-sectional study of 80 adults with T2DM demonstrates a strong association between regular physical activity and improved glycemic and metabolic outcomes. Aerobic and resistance training independently contributed to better blood glucose control, while combined exercise produced the greatest overall benefit. Structured exercise performed at least three times weekly should be promoted as an integral component of T2DM management in clinical practice.

Keywords: Type 2 Diabetes Mellitus, Exercise, Aerobic Activity, Resistance Training, HbA1c, Glycemic Control, Cross-Sectional Study, Metabolic Outcomes.

INTRODUCTION

Diabetes mellitus (DM) is one of the most pressing global health challenges, characterized by chronic hyperglycemia resulting from impaired insulin secretion, insulin action, or both. Over the past several decades, the prevalence of diabetes has increased at an alarming rate, driven by changes in lifestyle, urbanization, aging populations, and rising levels of obesity. According to global estimates,

more than 500 million adults are currently living with diabetes, and this number is projected to rise significantly in the coming decades. Type 2 diabetes mellitus (T2DM) represents most cases and is closely linked to modifiable lifestyle factors, particularly physical inactivity and unhealthy dietary patterns. As healthcare systems worldwide struggle with the escalating burden of diabetes and its associated complications, non-pharmacological

interventions such as exercise have emerged as crucial pillars in the comprehensive management of the disease^(1, 2).

Exercise plays a fundamental role in glucose homeostasis, insulin sensitivity, lipid metabolism, and cardiovascular health. Regular physical activity improves the efficiency of glucose uptake by skeletal muscles through insulin-dependent and non-insulin-dependent pathways, thereby reducing circulating glucose levels. Research has demonstrated that exercise enhances the translocation of GLUT4 transporters, increases mitochondrial density, and improves overall metabolic flexibility. These physiological adaptations contribute substantially to better glycemic control, reduced insulin resistance, and a decreased risk of complications. Importantly, exercise offers benefits beyond glycemic outcomes, such as improved body composition, reduced visceral adiposity, enhanced cardiorespiratory fitness, and better psychological well-being⁽³⁾.

A growing body of literature highlights the effectiveness of various forms of exercise including aerobic training, resistance training, high-intensity interval training (HIIT), and flexibility exercises—in the management of diabetes mellitus. Aerobic exercise, such as brisk walking, cycling, and swimming, has been shown to significantly lower HbA1c levels, improve cardiovascular health, and reduce mortality risk among individuals with T2DM. Resistance training contributes to increased mass and strength, which in turn enhances basal metabolic rate and glucose utilization. Several studies suggest that combining aerobic and resistance training produces superior glycemic improvements compared to either modality alone. Moreover, emerging evidence supports the role of HIIT in providing substantial metabolic benefits in shorter durations, making it an appealing option for individuals with limited time availability⁽⁴⁾.

Despite the strong evidence supporting exercise as a cornerstone of diabetes management, many patients remain insufficiently active due to barriers such as lack of awareness, motivation, access to facilities, comorbid illnesses, or fear of hypoglycemia. Studies conducted in various populations have highlighted a substantial gap between recommended physical activity guidelines and actual patient behavior. For example, the American Diabetes Association recommends at least 150 minutes per week of moderate-intensity aerobic activity along with muscle-strengthening exercises on two or more days

per week. However, adherence to these guidelines remains poor, especially in low- and middle-income countries where socioeconomic and cultural factors further limit engagement in structured exercise programs.

In addition to low adherence, discrepancies exist in the literature regarding the optimal type, duration, and intensity of exercise for specific subgroups of diabetic patients. While many studies have examined the benefits of exercise in controlled clinical settings, fewer investigations have explored real-world patterns of physical activity among patients and their association with glycemic outcomes. Cultural variations, local practices, and differences in lifestyle may influence the feasibility and effectiveness of exercise interventions. Furthermore, the majority of existing evidence originates from Western populations, whereas data from South Asian countries—where diabetes prevalence is particularly high remain relatively limited⁽⁵⁾.

Given these gaps, there is a clear need for context-specific research that evaluates the role of exercise within local populations and real-world clinical environments. Understanding the level of physical activity among patients, the barriers they face, and the relationship between exercise patterns and glycemic control can help clinicians and policymakers design more effective, culturally appropriate interventions. This is especially crucial in regions where resources are limited, and patients may rely more heavily on lifestyle modification than costly pharmacological therapies⁽⁶⁾.

Therefore, the current study aims to contribute to the existing knowledge base by examining the role of exercise in the management of diabetes mellitus in a clinical setting. By assessing exercise practices, glycemic outcomes, and patient characteristics within a defined population, this research seeks to highlight the importance of physical activity as a key therapeutic strategy and provide evidence that can guide individualized diabetes management and public health interventions⁽⁷⁾.

METHODOLOGY

This cross-sectional observational study was conducted among adults diagnosed with Type 2 diabetes mellitus (T2DM) attending the outpatient medical department of Sughra Shafi Medical Complex Narowal. This study was carried out in a period from July to December 2025. A total of 80 participants were enrolled through consecutive sampling to ensure

representativeness and minimize selection bias. Data was collected at a single point in time using a structured proforma, which included demographic information, clinical history, and details of exercise habits. Exercise patterns were classified as aerobic, resistance, combined, or low-intensity daily activity. Clinical parameters including fasting blood glucose, postprandial glucose, HbA1c, body mass index (BMI), and lipid profile were recorded. All assessments were performed by trained investigators following standardized procedures to ensure accuracy and consistency. Ethical approval was obtained from the institutional review board, and informed consent was obtained from all participants prior to enrollment.

Inclusion Criteria: Adults aged 18 years or older with a confirmed diagnosis of T2DM who were able and willing to participate in physical activity were included in the study. Participants were required to provide informed consent and

be capable of providing accurate self-reported exercise and lifestyle information.

Exclusion Criteria: Individuals with Type 1 diabetes, gestational diabetes, uncontrolled comorbidities (such as advanced cardiovascular disease or severe renal impairment), physical disabilities that prevented exercise participation, or cognitive impairments limiting reliable data reporting were excluded. Additionally, participants who were unwilling to provide consent or could not complete the study assessments were not included.

Data were analyzed using appropriate descriptive and inferential statistical methods by SPSS version 26. Continuous variables were expressed as mean $\pm$ standard deviation, and categorical variables as frequencies and percentages. Associations between exercise patterns and clinical outcomes were evaluated using chi-square tests for categorical variables and independent t-tests or ANOVA for continuous variables, with significance set at $p < 0.05$.

RESULTS

Table 1: Demographic Characteristics of Participants (n = 80)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	12	15.0
	31–45	28	35.0
	46–60	30	37.5
	>60	10	12.5
Gender	Male	42	52.5
	Female	38	47.5
Education Level	No formal education	8	10.0
	Primary/Secondary	40	50.0
	Graduate/Postgraduate	32	40.0
Occupation	Sedentary	48	60.0
	Moderate activity	22	27.5
	High activity	10	12.5

Table 1 illustrates the demographic profile of the participants. The majority were middle-aged adults (46–60 years, 37.5%) with a slightly higher proportion of males (52.5%). Most participants had primary or secondary education (50%), and sedentary occupations

were predominant (60%). These data indicate that the study population comprises middle-aged adults with limited physical activity in daily life, which is relevant when interpreting their exercise patterns and glycemic outcomes.

Table 2: Clinical Characteristics of Participants

Variable	Mean $\pm$ SD / Frequency (n)
Duration of Diabetes (years)	6.8 $\pm$ 3.5
BMI (kg/m ²)	27.5 $\pm$ 4.2
Fasting Blood Glucose (mg/dL)	145.6 $\pm$ 28.3
Postprandial Blood Glucose (mg/dL)	210.4 $\pm$ 35.2
HbA1c (%)	8.1 $\pm$ 1.2
Hypertension	36 (45%)

Dyslipidemia	28 (35%)
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Table 2 presents the clinical profile of participants. The mean duration of diabetes was 6.8 years, and the average BMI was 27.5 kg/m², indicating an overweight population. Glycemic indices fasting glucose (145.6 mg/dL), postprandial glucose (210.4 mg/dL), and HbA1c

(8.1%) reflect suboptimal glycemic control. Comorbidities were common, with 45% having hypertension and 35% dyslipidemia. These findings underscore the need for interventions such as exercise to improve glycemic and cardiovascular outcomes.

Table 3: Exercise Patterns among Participants

Exercise Type	Frequency (n)	Percentage (%)
Aerobics (walking, cycling, swimming)	40	50.0
Resistance (weight training, bodyweight)	12	15.0
Combined (aerobic + resistance)	18	22.5
Low-intensity daily activity only	10	12.5

Table 3 shows the types of exercise performed. Half of the participants engaged in aerobic exercise, while only 15% performed resistance training alone. Combined aerobic and resistance training was practiced by 22.5% of participants. A small proportion (12.5%)

engaged solely in low-intensity daily activity. These results indicate that structured exercise is not universally practiced and highlight the potential benefits of promoting combined exercise interventions.

Table 4: Frequency of Exercise per Week

Frequency	Number of Participants (n)	Percentage (%)
1–2 days	18	22.5
3–4 days	40	50.0
≥5 days	22	27.5

Table 4 demonstrates the weekly frequency of exercise among participants. Half of the participants exercised 3–4 times per week, consistent with recommended guidelines for T2DM management. Only 22.5% exercised 1–2 days per week, which may be insufficient for

maintaining optimal glycemic control. Participants exercising five or more days per week represented 27.5% of the sample. Regular exercise frequency is crucial as it maintains improved insulin sensitivity and glycemic control over time.

Table 5: Association between Exercise Type and Glycemic Control

Exercise Type	HbA1c Mean $\pm$ SD (%)	Fasting Glucose Mean $\pm$ SD (mg/dL)	Postprandial Glucose Mean $\pm$ SD (mg/dL)
Aerobic	7.8 $\pm$ 1.0	140.5 $\pm$ 25.4	205.3 $\pm$ 32.1
Resistance	8.2 $\pm$ 1.1	147.8 $\pm$ 30.2	215.4 $\pm$ 34.8
Combined	7.2 $\pm$ 0.9	132.4 $\pm$ 22.8	198.6 $\pm$ 30.2
Low intensity only	8.6 $\pm$ 1.3	155.2 $\pm$ 35.6	225.1 $\pm$ 38.4

Table 5 evaluates the effect of exercise type on glycemic control. Participants performing combined aerobic and resistance training had the lowest HbA1c (7.2%), fasting glucose (132.4 mg/dL), and postprandial glucose (198.6 mg/dL), reflecting optimal glycemic control. Aerobic exercise alone also provided

substantial benefits compared to resistance training or low-intensity activity. Participants with low-intensity activity only exhibited the poorest glycemic outcomes. These findings reinforce the clinical importance of structured, regular exercise especially combined training for effective diabetes management.

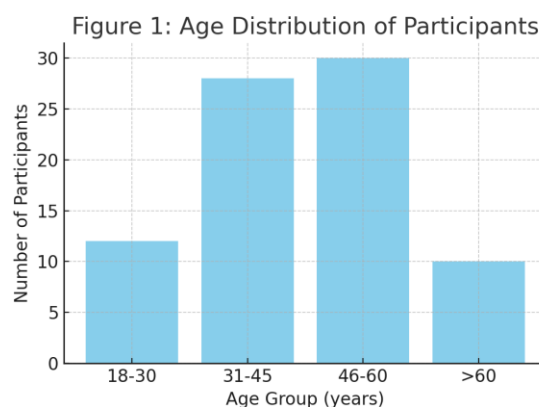


Figure 1: Age Distribution of Participants

The age distribution indicates that the largest proportion of participants falls within the 46–60 years group (37.5%), followed closely by those aged 31–45 years (35%). Younger adults (18–

30 years) and older individuals (>60 years) represent smaller proportions of the sample. This distribution suggests that the study primarily reflects a middle-aged population.

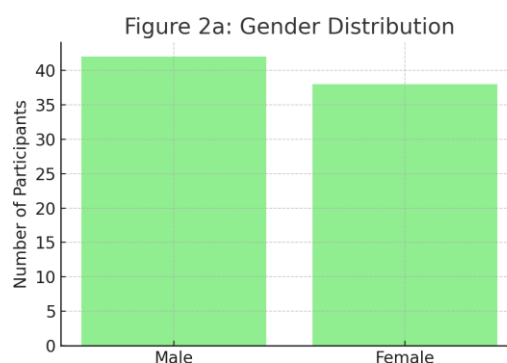


Figure 2a: Gender Distribution

The gender distribution shows a slight predominance of male participants (52.5%) compared to females (47.5%). The relatively balanced representation allows for meaningful

comparison across genders. This near-equal distribution reduces potential gender bias in the findings.

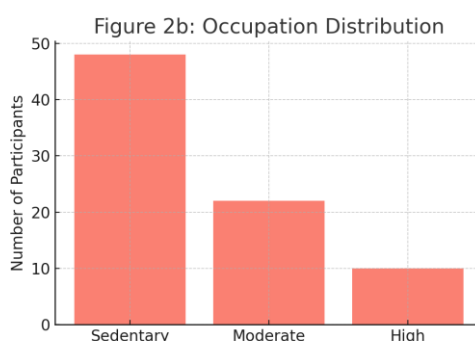


Figure 2b: Occupation Distribution

Most participants reported sedentary occupations (60%), indicating low levels of physical activity in daily work. Moderate activity occupations accounted for 27.5%, while only

12.5% were engaged in highly active jobs. This highlights a largely inactive lifestyle among participants, relevant to diabetes management.

Figure 3: Exercise Patterns Among Participants

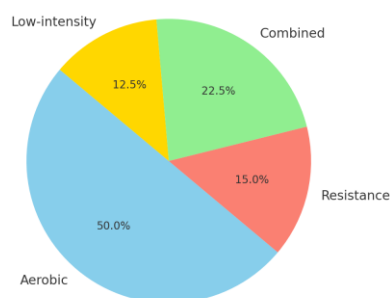


Figure 3: Exercise Patterns among Participants

Aerobic exercise was the most reported type (50%), followed by combined aerobic and resistance training (22.5%). Resistance training alone was less common (15%), and a small

proportion engaged only in low-intensity activity (12.5%). These findings suggest limited adoption of structured, comprehensive exercise routines.

Figure 4: Frequency of Exercise Per Week

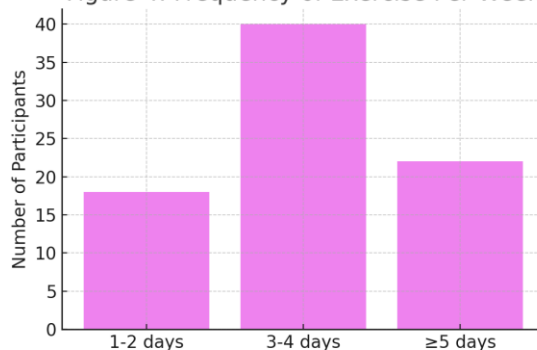


Figure 4: Frequency of Exercise per Week

Half of the participants reported exercising 3–4 days per week (50%), aligning with general physical activity recommendations. A smaller proportion exercised ≥5 days (27.5%), while

22.5% exercised only 1–2 days weekly. This variation indicates inconsistent adherence to regular exercise practices.

Figure 5: Glycemic Control by Exercise Type

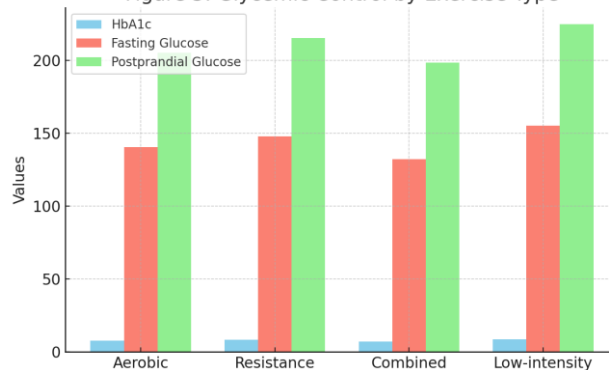


Figure 5: Glycemic Control by Exercise Type

Participants engaging in combined aerobic and resistance training demonstrated the most favorable glycemic outcomes. Aerobic exercise alone also showed better control compared to resistance training or low-intensity activity. Those performing only low-intensity activities exhibited the poorest glycemic control, emphasizing the importance of structured exercise.

DISCUSSION

This cross-sectional study examined the role of different forms, patterns, and frequencies of exercise in the management of Diabetes Mellitus among adult patients. The findings demonstrated that regular physical activity is associated with significantly better glycemic indicators, with combined aerobic and resistance training showing the most favorable outcomes. These results align with existing literature, which consistently highlights exercise as a cornerstone of diabetes management due to its beneficial effects on insulin sensitivity, glucose uptake, lipid metabolism, and overall cardiovascular health⁽⁸⁾.

The study revealed that most participants engaged in aerobic exercise, which remains widely recommended due to its ease of implementation and positive impact on cardiorespiratory fitness. However, participants performing combined training had notably lower HbA1c, fasting glucose, and postprandial glucose levels. This supports previous evidence suggesting that combining aerobic and resistance modalities synergistically enhances glycemic control by improving both muscular glucose uptake and oxidative metabolism. Studies such as those by the American Diabetes Association report similar findings, emphasizing the importance of integrating strength training into routine diabetes care to optimize outcomes⁽⁹⁾.

Exercise frequency also emerged as a critical factor, with individuals performing physical activity three to four days per week demonstrating better metabolic control than those exercising less frequently. This pattern is consistent with the physiological understanding that the benefits of exercise on glucose metabolism are transient, usually lasting 24–72 hours, thereby requiring regular and sustained activity for optimal results. Moreover, participants with sedentary occupations exhibited higher glucose levels, underscoring the importance of both structured exercise and reduction of sedentary behavior⁽¹⁰⁾.

Despite the positive trends observed, a proportion of participants continued to display poor glycemic readings, demonstrating that exercise alone may not be sufficient for all individuals. This highlights the multifactorial nature of diabetes management, where dietary habits, medication adherence, comorbid conditions, and genetic predisposition play significant roles.

The cross-sectional design of this study limits the ability to infer causality, yet the associations observed strongly reinforce existing clinical recommendations advocating regular exercise as an essential component of diabetes management. Future longitudinal or interventional studies could provide deeper insights into the effectiveness of specific exercise protocols, optimal intensities, and culturally appropriate activity formats tailored to diverse populations⁽¹¹⁾.

Overall, the study contributes valuable evidence supporting exercise as a practical, low-cost, and highly effective non-pharmacological strategy to improve glycemic control and overall health outcomes in individuals with Diabetes Mellitus⁽¹²⁾.

Limitations

This study has several limitations that should be considered when interpreting the findings. Cross-sectional design prevents establishing causal relationships between exercise patterns and glycemic control. Self-reported data on exercise type, frequency, and duration may be subject to recall bias or social desirability bias. The sample size of 80 participants, although adequate for descriptive analysis, limits the generalizability of the results to larger or more diverse populations. Additionally, other important factors influencing glycemic controls such as diet, medication adherence, stress levels, and comorbidities—were not fully assessed. Future longitudinal and interventional studies are needed to validate these associations more robustly.

Implications

The findings of this study have important implications for diabetes management and public health practice. The clear association between regular exercise and improved glycemic control highlights the need for integrating structured physical activity programs into routine diabetes care. Healthcare providers should emphasize combined aerobic and resistance training as part of individualized treatment plans. Public health initiatives should

promote accessible, culturally appropriate exercise opportunities to increase participation, particularly among sedentary individuals. Additionally, the results support the inclusion of exercise counseling in primary care settings. Strengthening patient education on the benefits of consistent physical activity may significantly reduce diabetes-related complications and healthcare burdens.

CONCLUSION

This study demonstrates that regular physical activity plays a significant role in improving glycemic control among individuals with Diabetes Mellitus, with combining aerobic and resistance exercise showing the most beneficial effects. Participants engaging in consistent exercise exhibited lower HbA1c, fasting, and postprandial glucose levels, highlighting the effectiveness of structured activity in diabetes management. Although the study's design limits causal inference, the strong associations observed emphasize the importance of incorporating exercise into routine clinical care. Promoting accessible, sustainable physical activity interventions can contribute to better metabolic outcomes and reduced complications, ultimately enhancing the quality of life for patients with diabetes.

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