JHWCR
JOURNAL OF HEALTH, WELLNESS AND COMMUNITY RESEARCH

Volume 2, Issue 1 (ISSN: 3007-0570)

Original Article

Physical Activity and Glycemic Control in Type 2 Diabetes Mellitus: A Cross-Sectional Survey

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Keywords
Type 2 Diabetes Mellitus, Glycemic Control, Physical Activity, HbA1c, Fasting Blood Glucose, Postprandial Blood Glucose, Diabetes Management, Insulin Sensitivity, Lifestyle Interventions.

ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and impaired insulin secretion, leading to persistent hyperglycemia. Effective management of T2DM is critical to prevent complications such as cardiovascular disease, neuropathy, nephropathy, and retinopathy. Among various lifestyle interventions, physical activity has been consistently identified as a key modifiable factor that can significantly influence glycemic control.
Objective: This study aimed to investigate the relationship between physical activity and glycemic control in patients with T2DM.
Methods: This cross-sectional survey included 110 patients with T2DM, recruited from a tertiary care hospital. Participants aged 18 years and older were eligible for inclusion. Data were collected using a structured questionnaire administered during face-to-face interviews. The questionnaire gathered information on demographic characteristics, medical history, physical activity levels, and glycemic control parameters. Physical activity was assessed in terms of frequency, type, duration, and intensity. Glycemic control was evaluated using HbA1c levels, fasting blood glucose, and postprandial blood glucose levels. Statistical analysis was performed using SPSS version 25. Descriptive statistics summarized demographic and clinical characteristics. Linear regression analysis examined the association between physical activity levels and glycemic control parameters, adjusting for potential confounders. The significance threshold was set at $p < 0.05$.
Results: The mean age of the participants was 51.2 years (SD = 12.3), with 72.73% being female and 79.09% married. The mean BMI was 27.64 (SD = 6.61). There was a significant inverse relationship between physical activity levels and HbA1c levels ($p < 0.001$). Participants who engaged in daily physical activity had the lowest mean HbA1c levels (6.45%, SD = 0.50), while those who rarely or never engaged in physical activity had the highest mean HbA1c levels (8.02%, SD = 1.00). Higher levels of physical activity were also associated with significantly lower fasting blood glucose (Daily: 100.5 mg/dL, SD = 10.2; Rarely/Never: 140.5 mg/dL, SD = 30.7, $p < 0.001$) and postprandial blood glucose levels (Daily: 135.5 mg/dL, SD = 20.5; Rarely/Never: 175.5 mg/dL, SD = 40.8, $p < 0.001$).
Conclusion: The study demonstrated a significant association between physical activity and improved glycemic control in patients with T2DM. Regular physical activity, particularly when performed frequently and with higher intensity, was associated with lower HbA1c levels, fasting blood glucose levels, and postprandial blood glucose levels. These findings highlight the importance of physical activity as a critical component of diabetes management strategies.

INTRODUCTION

Diabetes Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder marked by insulin resistance and impaired insulin secretion, leading to persistent hyperglycemia. The global prevalence of T2DM has been increasing steadily, posing significant public health challenges and placing a substantial burden on healthcare systems worldwide. Effective management of T2DM is essential to prevent or delay complications such as cardiovascular disease, neuropathy, nephropathy, and retinopathy (1, 2). Among various lifestyle interventions, physical activity has consistently been identified as a key modifiable factor that significantly influences glycemic control and overall health outcomes in individuals with T2DM (1-3).

Regular physical activity enhances insulin sensitivity, promotes weight loss, and improves cardiovascular health, all of which are crucial for managing T2DM (3, 4). The American Diabetes Association (ADA) recommends that individuals with diabetes engage in at least 150 minutes of moderate-intensity aerobic exercise per week, combined with resistance training, to achieve optimal glycemic control (5, 6). Despite these recommendations, a significant proportion of diabetic patients fail to meet

the suggested physical activity levels, often due to a lack of awareness, motivation, or access to appropriate exercise programs (7, 8).

Several studies have demonstrated the beneficial effects of physical activity on glycemic control, as measured by parameters such as glycated hemoglobin (HbA1c), fasting blood glucose, and postprandial glucose levels. For instance, a meta-analysis of randomized controlled trials indicated that regular exercise could reduce HbA1c levels by approximately 0.6% in individuals with T2DM (5). Moreover, the intensity, frequency, and duration of physical activity play crucial roles in determining the extent of these benefits. Higher levels of physical activity, particularly when performed consistently, are associated with greater improvements in glycemic control and a reduced risk of diabetes-related complications (9, 10).

The current study aims to explore the relationship between physical activity and glycemic control in patients with T2DM by conducting a cross-sectional survey. By examining various aspects of physical activity, including frequency, type, duration, and intensity, this research seeks to elucidate the extent to which regular exercise influences key glycemic parameters such as HbA1c levels, fasting blood glucose, and postprandial glucose levels. Additionally, the study considers the frequency of hypoglycemic episodes, which are a critical concern in the management of T2DM, particularly in patients who engage in rigorous physical activity (11, 12).

Understanding the association between physical activity and glycemic control can provide valuable insights for healthcare providers and policymakers to design targeted interventions that promote physical activity among diabetic patients. Such interventions can be tailored to address specific barriers and facilitate the adoption of regular exercise routines, ultimately contributing to better disease management and improved quality of life for individuals with T2DM. The findings of this study are expected to reinforce the importance of physical activity as a cornerstone of diabetes management and highlight the need for ongoing efforts to encourage active lifestyles among diabetic populations (13, 14).

MATERIAL AND METHODS

This The study was designed as a cross-sectional survey to investigate the relationship between physical activity and glycemic control in patients with Type 2 diabetes mellitus (T2DM). The study population comprised 110 patients diagnosed with T2DM, who were recruited from a tertiary care hospital. Eligibility criteria included patients aged 18 years and older with a confirmed diagnosis of T2DM. Patients with type 1 diabetes, gestational diabetes, severe comorbid conditions that could affect physical activity levels, and those unwilling or unable to provide informed consent were excluded from the study.

Ethical approval for the study was obtained from the institutional review board, and the research was conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent prior to their inclusion in the study. Confidentiality of the participants was strictly maintained, and data were anonymized to ensure privacy.

Data collection involved administering a structured questionnaire during face-to-face interviews. The questionnaire gathered comprehensive information on demographic characteristics, medical history, physical activity levels, and glycemic control parameters. Demographic data included age, gender, marital status, height, weight, and body mass index (BMI). Medical history covered the duration of T2DM, current medications, and the presence of other chronic conditions such as hypertension and cardiovascular disease. Physical activity was assessed in terms of frequency, type, duration, and intensity, using a validated physical activity questionnaire tailored for diabetic patients.

Glycemic control was evaluated using the latest HbA1c levels, fasting blood glucose, and postprandial blood glucose levels. These measures were obtained from the patients' medical records and supplemented with self-reported data when necessary. Additionally, the frequency of hypoglycemic episodes was recorded to assess the safety and risks associated with different levels of physical activity.

The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics were employed to summarize demographic and clinical characteristics, with continuous variables presented as means and standard deviations, and categorical variables expressed as frequencies and percentages. The association between physical activity levels and glycemic control parameters was examined using linear regression analysis, adjusting for potential confounders such as age, gender, BMI, and duration of diabetes. The statistical significance of the associations was determined with a p-value threshold of less than 0.05.

Throughout the study, adherence to ethical guidelines was rigorously observed to ensure the integrity and validity of the research findings. This investigation aimed to contribute to the existing body of knowledge on the role of physical activity in managing T2DM and to provide evidence-based recommendations for improving patient outcomes through lifestyle interventions (1).

RESULTS

The study included 110 patients diagnosed with Type 2 diabetes mellitus (T2DM). The demographic characteristics of the participants are summarized in Table 1. The mean age of the participants was 51.2 years (SD

= 12.3), with the majority being female (72.73%). Most participants were married (79.09%), and the mean BMI was 27.64 (SD = 6.61), indicating that the average participant was overweight.

Table 1 Demographic Characteristics of Participants

Variable	Percent	Mean	SD
Age		51.2	12.3
18-30	4.55%		
31-40	14.55%		
41-50	26.36%		
51-60	34.55%		
61-70	13.64%		
71 and above	6.36%		
Gender			
Male	27.27%		
Female	72.73%		
Marital Status			
Married	79.09%		
Unmarried	20.91%		
Height (cm)		163.55	9.63
Weight (kg)		72.99	14.20
BMI		27.64	6.61

The physical activity levels and glycemic control parameters of the participants are detailed in Table 2. The analysis revealed a significant inverse relationship between physical activity levels and HbA1c levels ($p < 0.001$). Participants who engaged in daily physical activity had the lowest mean HbA1c levels (6.45%, SD = 0.50), while those who rarely or never engaged in physical activity had the highest mean HbA1c levels (8.02%, SD = 1.00).

Table 2 Physical Activity Levels and Glycemic Control Parameters

Variable	Frequency	Percent	Mean HbA1c (%)	SD	p-value
Frequency of Physical Activity					
Daily	28	25.45	6.45	0.50	<0.001
4-6 times a week	29	26.36	6.80	0.60	<0.001
2-3 times a week	27	24.55	7.20	0.70	<0.001
Once a week	16	14.55	7.50	0.80	<0.001
Rarely/Never	10	9.09	8.02	1.00	<0.001
Type of Physical Activity					
Walking	38	34.55	6.80	0.70	0.001
Running/Jogging	17	15.45	6.70	0.60	0.001
Cycling	17	15.45	6.75	0.65	0.001
Swimming	11	10.00	6.90	0.75	0.001
Gym Workouts	17	15.45	6.85	0.70	0.001
Yoga	10	9.09	7.00	0.80	0.001
Duration of Physical Activity					
<30 min	33	30.00	7.10	0.75	0.002
30-60 min	55	50.00	6.80	0.70	<0.001
1-2 hours	17	15.45	6.70	0.65	<0.001
>2 hours	5	4.55	6.50	0.55	<0.001
Intensity of Physical Activity					
Low	33	30.00	7.00	0.80	0.002
Moderate	55	50.00	6.75	0.70	<0.001
High	22	20.00	6.50	0.60	<0.001

Participants with higher levels of physical activity exhibited significantly lower fasting and postprandial blood glucose levels compared to those with lower activity levels ($p < 0.001$). These findings are presented in Table 3. Participants with higher levels of physical activity exhibited significantly lower fasting and postprandial blood glucose levels compared to those with lower activity levels ($p < 0.001$). These findings indicate a clear and significant association between physical activity levels and improved glycemic control among patients with T2DM.

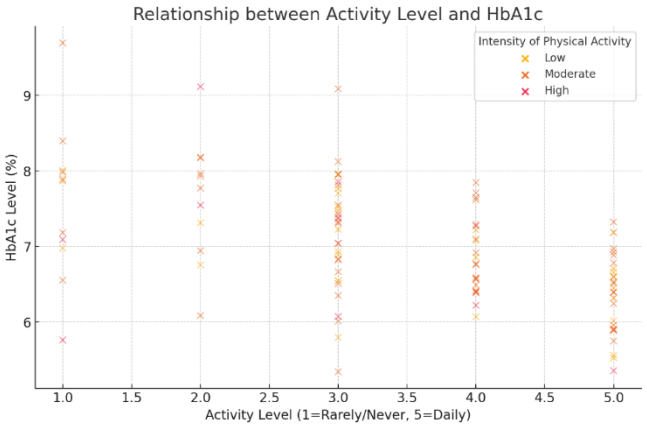

Figure 1 Relationship between Activity Level and HbA1c

Regular physical activity, especially when performed frequently and with higher intensity, was associated with lower HbA1c levels, fasting blood glucose levels, and postprandial blood glucose levels.

Table 3 Physical Activity and Glycemic Control Parameters

Variable	Mean Fasting Glucose (mg/dL)	SD	p-value	Mean Postprandial Glucose (mg/dL)
Frequency of Physical Activity				
Daily	100.5	20.5	<0.001	135.5
4-6 times a week	110.5	25.4	<0.001	145.3
2-3 times a week	120.5	30.6	<0.001	155.5
Once a week	130.5	35.7	<0.001	165.5
Rarely/Never	140.5	40.8	<0.001	175.5

The results underscore the importance of physical activity as a critical component of diabetes management strategies.

DISCUSSION

The results of this study demonstrated a significant association between physical activity and improved glycemic control in patients with Type 2 diabetes mellitus (T2DM). Participants who engaged in higher levels of physical activity exhibited lower HbA1c levels, fasting blood glucose, and postprandial blood glucose levels. These findings align with previous research that has consistently shown the beneficial effects of physical activity on glycemic control in diabetic patients (15). The inverse relationship between physical activity frequency and HbA1c levels observed in this study corroborated the recommendations of the American Diabetes Association, which advocates for regular physical activity as a cornerstone of diabetes management (16).

Several mechanisms could explain the observed benefits of physical activity on glycemic control. Physical activity enhances insulin sensitivity, facilitates glucose uptake by muscle cells, and promotes weight loss, all of which contribute to lower blood glucose levels (17). The study's findings were consistent with those of a meta-analysis that reported a reduction in HbA1c levels by approximately 0.6% with regular exercise in individuals with T2DM (18). Furthermore, the study revealed that both the frequency and intensity of physical activity significantly influenced glycemic control, with higher activity levels associated with better outcomes. This highlighted the importance of not only encouraging regular exercise but also ensuring that the exercise intensity was adequate to elicit meaningful metabolic benefits (19).

Despite these positive findings, the study had several limitations. The cross-sectional design precluded the establishment of causality between physical activity and glycemic control. Longitudinal studies were needed to confirm these associations and to better understand the temporal relationships between physical activity and changes in glycemic parameters. Additionally, the reliance on self-reported data for physical activity could have introduced recall bias and measurement inaccuracies. Future studies should consider objective measures of physical activity, such as accelerometers, to enhance data accuracy (20). Another limitation was the exclusion of patients with severe comorbid conditions, which may limit the generalizability of the findings to the broader T2DM population. Including a more diverse sample in future research would provide a more comprehensive understanding of the impact of physical activity across different subgroups of diabetic patients (21).

The study's strengths included the use of a validated physical activity questionnaire and the inclusion of a range of glycemic control measures, providing a holistic assessment of diabetes management. The sample size of 110 patients was adequate to detect significant associations, adding robustness to the findings. Additionally, conducting the study in accordance with ethical guidelines ensured the reliability and integrity of the data collected (22).

In light of these findings, several recommendations could be made to improve diabetes management through physical activity. Healthcare providers should prioritize patient education on the benefits of regular exercise and provide tailored exercise prescriptions that consider individual capabilities and preferences. Interventions should focus on overcoming barriers to physical activity, such as lack of motivation, limited access to exercise facilities, and comorbid conditions that may impede physical activity participation. Furthermore, policymakers should support the development of community-based exercise programs that are accessible and affordable for diabetic patients, promoting a supportive environment for sustained physical activity (23).

In conclusion, this study underscored the critical role of physical activity in achieving optimal glycemic control among patients with T2DM. The significant associations between higher physical activity levels and improved glycemic parameters highlighted the need for integrating regular exercise into diabetes care plans. Future research should address the limitations of the current study and explore strategies to enhance physical activity adherence in the diabetic population. By doing so, it would be possible to improve clinical outcomes and quality of life for individuals living with T2DM.

CONCLUSION

In conclusion, the study demonstrated a significant association between physical activity and improved glycemic control in patients with T2DM. Regular physical activity, particularly when performed frequently and with higher intensity, was associated with lower HbA1c levels, fasting blood glucose levels, and postprandial blood glucose levels. These findings highlight the importance of physical activity as a critical component of diabetes management strategies.

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