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Glycemic Control in Young Men Aged 18–30 Years with Type 1 Diabetes: The Role of Lifestyle and Physical Activity

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Abstract

Introduction: Type 1 diabetes mellitus (T1DM) is a chronic metabolic disease requiring continuous glycemic monitoring and intensive insulin therapy [1]. Early adulthood is a critical period characterized by lifestyle changes that may negatively affect metabolic control, particularly among young men [2,3,17].

Aim: The aim of this study was to analyze factors influencing glycemic control in young men aged 18–30 years with T1DM, with particular emphasis on physical activity and lifestyle behaviors [4,11,18].

Materials and Methods: A narrative review of scientific literature was conducted, including interventional (RCT) and observational studies assessing physical activity and glycemic control in young men with T1DM [5–10,12–16,18–24,30].

Results: Structured physical activity was associated with improvements in HbA1c, time-in-range (TIR), and glycemic variability. Aerobic exercise decreased HbA1c by −0.4% to −0.7% ($p < 0.001$; 95% CI −0.82 to −0.28), resistance training increased TIR by 6–10% ($p = 0.01$–0.03), and combined aerobic/resistance training provided the greatest benefits (HbA1c −0.55%; TIR +11–13%; $p < 0.001$). Observational studies confirmed inverse correlations between overall activity and HbA1c ($r = -0.32$ to -0.45; $p < 0.01$) [6,9,12,15,16,19–23,26,27,29].

Conclusions: Structured exercise, particularly combined aerobic and resistance training, exerts clinically meaningful effects on glycemic control in young men with T1DM. Individualized physical activity prescriptions should be integrated into diabetes management [1,4,7–30].

Keywords: type 1 diabetes, young adults, glycemic control, physical activity, HbA1c

Introduction

Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disorder characterized by the destruction of pancreatic β-cells, leading to absolute insulin deficiency and requiring lifelong insulin therapy [1,2]. The global prevalence of T1DM is increasing, particularly among young adults, and its management remains a significant clinical challenge [3,17]. Effective glycemic control is essential to reduce the risk of both acute complications (hypoglycemia, diabetic ketoacidosis) and long-term microvascular and macrovascular complications, including retinopathy, nephropathy, neuropathy, and cardiovascular disease [2,3,17].

Early adulthood, defined as the age range 18–30 years, represents a critical period in T1DM management. This life stage is associated with increased independence, transitions in education or employment, and shifts in social and lifestyle patterns, all of which can negatively influence adherence to diabetes self-management practices [6,9,11,16,17]. Studies show that young adults often demonstrate suboptimal glycemic control compared to older adults, with elevated HbA1c values and increased glycemic variability, placing them at higher risk of long-term complications [6,9,11,17,18].

Physical activity has been consistently shown to improve glycemic control, insulin sensitivity, and cardiovascular health in individuals with T1DM [4,5,7,12,18]. Both aerobic and resistance training, as well as combined exercise modalities, have demonstrated measurable benefits on HbA1c, postprandial glucose stability, and time-in-range (TIR) [7,8,15,19,21]. However, there remain important challenges, including risk of exercise-induced hypoglycemia, insufficient knowledge regarding safe exercise practices, and psychosocial barriers that may limit physical activity participation among young men [4,14–16,25,28].

Given the importance of lifestyle interventions and structured exercise programs in diabetes management, there is a need to systematically assess their impact specifically in young adult men with T1DM. Understanding which types and intensities of physical activity are most effective can inform individualized treatment strategies, optimize glycemic outcomes, and ultimately reduce long-term complication risk [5,6,12,18,20].

Aim of the Study

The primary aim of this study was to evaluate factors influencing glycemic control in young men aged 18–30 years with T1DM, with a particular focus on the role of physical activity, lifestyle behaviors, and adherence to diabetes self-management practices [4,11,18]. Specific objectives included:

To review the effects of different types of exercise—including aerobic, resistance, combined training, and high-intensity interval training (HIIT)—on glycemic parameters such as HbA1c, time-in-range (TIR), and glycemic variability [7,8,14,15,19–22].

To analyze observational and cohort data describing associations between overall physical activity levels and glycemic control in real-world settings [6,9,12,16,20,23,29].

To identify barriers and facilitators to physical activity in young men with T1DM, including psychosocial and lifestyle factors that may impact adherence to exercise recommendations [11,16,25,28].

To synthesize current evidence to provide guidance for individualized, evidence-based exercise interventions aimed at optimizing glycemic control in this high-risk population [4,7–15,18–21,24].

Materials and Methods

Sources of Data

A comprehensive search of PubMed, Scopus, and Web of Science databases was conducted. Keywords included: *"type 1 diabetes," "young adults," "physical activity," "glycemic control,"* and *"exercise interventions"*. Articles published in English between 2010 and 2025 were considered. Peer-reviewed journal articles, systematic reviews, and meta-analyses were included [5–10,12–16,18,19,24,30].

Inclusion and Exclusion Criteria

Inclusion criteria:

Males aged 18–30 years with T1DM

Reporting glycemic outcomes (HbA1c, TIR, glycemic variability)

Interventional (RCTs, crossover trials) or observational/cohort studies [5,7,15,19,21]

Exclusion criteria:

Type 2 or gestational diabetes

Case reports, editorials, or non-peer-reviewed publications

Studies not reporting primary glycemic outcomes [5,7,9,16,28]

Data Extraction

Two authors independently extracted data including:

Study design and sample size (n)

Participant characteristics

Type, frequency, and duration of physical activity

Glycemic outcomes (HbA1c, TIR, glycemic variability)

Statistical results (p-values, CI, correlation coefficients) [6–8,12–16,18–23,26–29]

Data Synthesis

Results were organized by study type (interventional vs. observational) and exercise modality (aerobic, resistance, combined, HIIT). Quantitative data were summarized in Tables 1A and 1B [7,8,12,14,15,19–23].

Statistical Analysis

Reported statistical measures (mean differences, r, p-values, 95% CI) were recorded. No new meta-analysis was performed. Statistical significance was interpreted according to thresholds reported in primary studies (typically $p < 0.05$) [7,10,12,15,19,20].

Results

Analysis of the literature demonstrated that structured physical activity consistently improves glycemic control in young men with T1DM.

Aerobic exercise (≥150 min/week) led to a reduction in HbA1c ranging from −0.4% to −0.7% ($p < 0.001$; 95% CI −0.82 to −0.28) in trials including **n = 350–1,200 participants** [7,10,15,19,21]. Improvements were observed after 8–24 weeks and were accompanied by enhanced insulin sensitivity, decreased fasting glucose levels (−0.6 to −1.2 mmol/L; $p < 0.01$), and reduced mean amplitude of glycemic excursions (MAGE −0.5 to −1.0 mmol/L; $p < 0.05$). Mild hypoglycemic episodes increased moderately [4,7,14,15,19,26].

Resistance training 2–3×/week improved postprandial glucose stability and increased TIR by 6–10% (p = 0.01–0.03; 95% CI 2.1–11.4%) in **n = 40–90 participants** [8,14,15,21,22]. CV decreased 4–6% ($p = 0.02$), improving overnight glucose stability.

Combined aerobic + resistance exercise demonstrated the greatest effects. Meta-analyses including **n > 1,500 participants** showed HbA1c reduction of −0.55% ($p < 0.001$; 95% CI −0.72 to −0.38), TIR increase of 11–13%, and CV reduction 4–6% (p = 0.02–<0.001) [7,12,15,19,21]. Combined programs improved cardiovascular fitness and muscle strength, supporting long-term adherence.

High-intensity interval training (HIIT) resulted in stable post-exercise glucose with only transient elevations in some participants ($p > 0.05$; n = 20–45) [4,14,19,20]. HIIT improved insulin sensitivity comparably to moderate-intensity continuous training. The effects of different exercise modalities assessed in randomized controlled trials, including aerobic, resistance, combined training, and HIIT, are summarized in Table 1.

Table 1. Effects of aerobic, resistance, and combined training in RCTs

Type of exercise	Sample size (n)	Main glycemic outcomes	Statistical effect	References
Aerobic	350–1,200	↓ HbA1c, ↓ mean glucose, ↑ hypoglycemia risk	HbA1c −0.4% to −0.7%; $p < 0.001$; 95% CI −0.82 to −0.28	[7,10,15,19,21]
Resistance	40–90	↓ glycemic variability, ↑ postprandial stability	TIR +6–10%; $p = 0.01–0.03$; 95% CI 2.1–11.4%	[8,14,15,21,22]
Combined	>1,500	↓ HbA1c, ↑ TIR, ↓ variability	HbA1c −0.55%; $p < 0.001$; 95% CI −0.72 to −0.38; TIR +11–13%	[7,12,15,19,21]
HIIT	20–45	Stable or transient ↑ glucose	NS; $p > 0.05$	[4,14,19,20]

Observational/cohort studies (**n = 120–2,000**) confirmed inverse correlations between physical activity and HbA1c ($r = -0.32$ to -0.45; $p < 0.01$) [6,9,12,15,16,20,23,29]. CGM-based registry studies reported TIR improvements up to 13%, mean glucose reductions 0.7–1.2 mmol/L, and CV reductions 4–6% ($p = 0.02–<0.001$) [12,15,20,23]. Associations between overall physical activity levels and glycemic outcomes observed in cohort, observational, and real-world CGM-based studies are presented in Table 2.

Table 2. Effects of overall physical activity in observational/cohort studies

Study type	Sample size (n)	Main glycemic outcomes	Statistical effect	References
Observational/cohort	120–420	↓ HbA1c correlation with activity level	r = −0.32 to −0.45; p < 0.01	[6,9,15,16,20,23,29]
Real-world CGM/registry	600–2,000	↑ TIR, ↓ glycemic variability	TIR +11–13%; CV −4–6%; p = 0.02–<0.001	

Overall, exercise modality, frequency, and duration significantly influence glycemic outcomes. Combined training offers the largest benefit, aerobic/resistance individually also help, and HIIT is practical for time-limited young adults.

Discussion

The present review synthesizes current evidence on the impact of physical activity on glycemic control in young men aged 18–30 years with type 1 diabetes mellitus (T1DM). The findings consistently indicate that structured exercise—particularly combined aerobic and resistance training—is associated with clinically meaningful improvements in HbA1c, time-in-range (TIR), and glycemic variability.

Reductions in HbA1c ranging from −0.4% to −0.7% observed in aerobic interventions are clinically significant, as even a 0.5% decrease in HbA1c is associated with a measurable reduction in the risk of microvascular complications. Resistance training demonstrated favorable effects on postprandial glucose stability and TIR, likely due to increased skeletal muscle mass and improved insulin sensitivity. Notably, combined training programs produced the most pronounced metabolic benefits, supporting current recommendations that integrate both aerobic and resistance modalities in diabetes management.

The observed increase in TIR (6–13%) is particularly relevant in the era of continuous glucose monitoring (CGM), as TIR has emerged as a complementary metric to HbA1c, reflecting short-term glucose dynamics and variability. Improvements in coefficient of variation (CV) further indicate enhanced glycemic stability, which may reduce the risk of hypoglycemia and long-term vascular complications. These findings align with contemporary diabetes care standards emphasizing individualized glucose targets and CGM-guided therapy optimization.

High-intensity interval training (HIIT) demonstrated metabolic benefits comparable to moderate-intensity continuous exercise, with relatively stable post-exercise glycemia. The transient glucose elevations occasionally observed following HIIT are physiologically explained by catecholamine-mediated hepatic glucose output. Importantly, HIIT may represent a time-efficient alternative for young adults facing academic, occupational, or social time constraints, potentially improving adherence to exercise recommendations.

Young adulthood represents a transitional life stage characterized by increased autonomy, lifestyle variability, and psychosocial stress. This population frequently demonstrates suboptimal glycemic control due to irregular schedules, dietary inconsistency, and fluctuating adherence to insulin therapy. In this context, structured and supervised exercise programs may serve not only as metabolic interventions but also as behavioral stabilizers that promote routine, self-efficacy, and engagement in self-management practices.

Despite consistent evidence supporting exercise benefits, fear of hypoglycemia remains a significant barrier to regular physical activity in individuals with T1DM. The reviewed studies indicate that while mild hypoglycemic episodes may increase with aerobic training, appropriate insulin dose adjustments, carbohydrate strategies, and CGM-based monitoring can substantially mitigate risk. Education on exercise timing relative to meals and insulin administration is therefore essential to maximize benefits and minimize adverse events.

Importantly, although this review focuses on young men aged 18–30 years, many included studies involved mixed-gender and broader age populations. Nevertheless, extrapolation to young adult men is supported by physiological consistency across adult T1DM cohorts and the absence of evidence suggesting diminished exercise responsiveness in this subgroup. Future studies specifically targeting young male populations are warranted to confirm sex- and age-specific adaptations.

Overall, the synthesis of interventional and observational evidence suggests that exercise modality, frequency, and intensity significantly influence glycemic outcomes. Combined aerobic and resistance training appears to offer the greatest overall benefit, while HIIT provides a feasible alternative for individuals with limited time availability. Integration of individualized exercise prescriptions into standard diabetes care may contribute to improved metabolic stability, reduced complication risk, and enhanced quality of life in young men with T1DM.

Several limitations should be acknowledged.

First, this study represents a narrative review rather than a formal systematic review or meta-analysis. Although a structured search strategy was applied, no PRISMA flow diagram, risk-of-bias assessment, or pooled quantitative synthesis was conducted. Therefore, reported effect ranges reflect findings from individual studies and previously published meta-analyses rather than a newly calculated aggregate estimate.

Second, most included studies were not exclusively limited to young men aged 18–30 years. Many trials included mixed-gender populations and broader age ranges. Consequently, conclusions specific to young adult men are partially extrapolated from general T1DM populations.

Third, heterogeneity across studies—regarding exercise intensity, duration, insulin adjustment strategies, baseline glycemic control, and CGM use—limits direct comparability.

Fourth, publication bias cannot be excluded, as studies reporting positive effects of exercise on glycemic outcomes are more likely to be published.

Finally, long-term adherence and sustainability of structured exercise interventions were insufficiently addressed in many included trials, limiting conclusions regarding persistent metabolic benefits.

Conclusions

Structured physical activity significantly improves glycemic control in young men aged 18–30 years with T1DM.

Aerobic exercise: HbA1c −0.4–0.7% ($p < 0.001$), improves fasting/postprandial glucose, mild hypoglycemia risk [7,10,15,19,21].

Resistance training: TIR +6–10% ($p = 0.01$–0.03), CV −4–6% ($p = 0.02$), better postprandial control [8,14,15,21,22].

Combined training: HbA1c −0.55%, TIR +11–13%, CV −4–6% ($p < 0.001$–0.02) [7,12,15,19,21].

HIIT: stable post-exercise glucose, insulin sensitivity improvement, time-efficient [4,14,19,20].

Observational studies confirm activity-HbA1c correlation ($r = -0.32$ to -0.45; $p < 0.01$) and TIR improvement [6,9,12,15,16,20,23,29].

Individualized, structured exercise should be a core part of diabetes management. Exercise timing, type, and intensity must be adapted to meals and insulin dosing to maximize benefit and minimize hypoglycemia. Future research should optimize exercise prescriptions, adherence, and integration with digital glucose monitoring.

Author Declarations

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All authors have read and agreed with the published version of the manuscript.

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Conflict of Interest

The author declares **no conflict of interest**. The content of this review represents independent scholarly interpretation.

Ethical Approval

This article is a review of previously published studies and does not involve human participants or animals. Therefore, formal ethical approval was **not required**.

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