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IMPACT OF SPINNING AND SWIMMING EXERCISES ON METABOLIC AND FUNCTIONAL PARAMETERS IN A FEMALE PATIENT WITH TYPE 1 DIABETES MELLITUS-A CASE STUDY

The review of the specialized literature highlights the essential role of regular physical activity in improving insulin sensitivity, glycemic control, and overall functional status in patients with type 1 diabetes mellitus (T1DM). Aerobic exercise, performed consistently and adapted to individual capacity, contributes to the regulation of glucose metabolism, enhancement of cardiorespiratory fitness, and improvement of quality of life. The present study included a 17-year-old female patient diagnosed with T1DM at the age of 10, undergoing a basal–bolus insulin regimen. The intervention program was carried out over a four-month period and consisted of two types of aerobic activity: spinning (two sessions per week, 45 minutes each, at an intensity of 60–75% of maximum heart rate) and swimming (two sessions per week, 40 minutes each). The working hypothesis was that the consistent inclusion of these moderate-intensity exercises would lead to improvements in metabolic control, reflected by reductions in blood glucose levels and glycated hemoglobin (HbA1c), as well as in functional capacity, indicated by a decrease in resting heart rate, without increasing the risk of hypoglycemia. HbA1c represents an indicator of average blood glucose levels over the previous 2-3 months and is essential in assessing metabolic control. The results demonstrated significant improvements in the analyzed parameters following the intervention period. The study concludes that regular, monitored, and individualized physical activity contributes to optimizing metabolic control, reducing HbA1c levels, increasing exercise tolerance, and improving the lipid profile, with the combination of spinning and swimming proving to be both effective and safe for patients with T1DM.

Keywords: impact; spinning; swimming; type 1 diabetes mellitus; case study

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1. INTRODUCTION

Diabetes mellitus is a metabolic disorder caused by defects in insulin secretion or insulin action, leading to chronic hyperglycemia and disturbances in carbohydrate, fat, and protein metabolism. Among its forms, type 1 diabetes mellitus (T1DM) is an autoimmune condition characterized by the destruction of pancreatic β-cells, resulting in absolute insulin deficiency and permanent dependence on exogenous insulin therapy. Maintaining optimal glycemic control is essential for preventing both microvascular and macrovascular complications (Bastaki, 2005). Patients with T1DM lack endogenous insulin secretion, and exogenously administered insulin suppresses hepatic gluconeogenesis and glycogenolysis even under conditions of declining blood glucose, thereby increasing the risk of hypoglycemia. During moderate-intensity physical exercise, counter-regulatory hormonal responses may be insufficient, whereas high-intensity effort can induce transient hyperglycemia or, in poorly controlled cases, precipitate diabetic ketoacidosis.

Consequently, appropriate dosing of physical effort and continuous patient supervision are essential components of safe exercise participation (Tache, 2021). Diabetes represents a particular metabolic state in which the organism is unable to properly utilize carbohydrates derived from food intake (Mihai & Catrinoiu, 2008). Therefore, the management of T1DM requires an individualized and comprehensive approach aimed not only at achieving glycemic compensation but also at developing long-term self-management skills and lifestyle adaptation (Mereuță et al., 2022). Current guidelines issued by the American Diabetes Association and the International Society for Pediatric and Adolescent Diabetes provide detailed recommendations regarding the type, duration, and intensity of physical activity for individuals with T1DM (Galassetti & Riddell, 2013). Regular physical activity plays a key role in improving insulin sensitivity, glycemic control, and overall functional status (Pham, 2025). Exercise is widely recognized as a cornerstone in the prevention and treatment of diabetes mellitus, contributing to enhanced aerobic capacity, muscle strength, body composition, balance, and cardiovascular health (Ozoymak-Akcin & Cetisli-Korkmaz, 2021). Physical activity represents any form of bodily movement performed by skeletal muscles that results in energy expenditure (Westerterp, 2013).

Exercise represents a structured and repetitive form of physical activity that promotes health and functional well-being (Qiu et al., 2023). Among aerobic activities, swimming is considered a complete, low-impact exercise that engages multiple muscle groups and is particularly suitable for individuals with chronic metabolic conditions, including diabetes. Although the long-term benefits of physical exercise in individuals with T1DM are well established, the acute metabolic responses to exercise-especially exercise-induced hypoglycemia-remain challenging to manage in practice. These acute effects require careful coordination between insulin dosing, carbohydrate intake, and exercise intensity (Brugnara et al., 2012). Strategic inclusion of brief high-intensity bouts within aerobic exercise sessions has been shown to reduce the risk of hypoglycemia, while regular aerobic training contributes to improved glycated hemoglobin (HbA1c) levels (Tonoli et al., 2012). Hypoglycemia remains the most common complication of insulin therapy in individuals with T1DM. Given the brain's reliance on circulating glucose as its primary energy substrate, recurrent hypoglycemic episodes may impair cognitive function, although adaptive mechanisms can develop over time (Rooijackers et al., 2016).

Maintaining glycemic stability during exercise therefore represents a major therapeutic challenge, emphasizing the importance of adequate carbohydrate intake before and during physical activity (Scott et al., 2019). Modern technologies such as real-time continuous glucose monitoring (CGM) provide effective tools for preventing exercise-induced hypoglycemia and for optimizing nutritional and insulin-related adjustments (Riddell & Milliken, 2011). An effective therapeutic strategy must integrate individualized assessment, appropriate exercise prescription, and tailored insulin and dietary management to minimize metabolic risks (Branea, 2013). Beyond glycemic control, physical exercise contributes to improved lipid metabolism and reduced insulin resistance. In individuals with T1DM, lower intrahepatic fat content has been associated with increased lipid oxidation, reflecting adaptations related to the insulin–glucagon balance (Perseghin et al., 2005). Regular physical activity is also linked to improvements in lipid profile, aerobic fitness, and cardiorespiratory capacity (Laaksonen, 2003) and may support pancreatic β-cell health and the prevention of metabolic diseases (Zhang et al., 2022).

2. MATERIALS AND METHODS

The purpose of the work: To evaluate the effects of a combined aerobic exercise program-spinning and swimming-on metabolic and functional parameters in a female patient with type 1 diabetes mellitus, over four months. The study examined how regular physical activity may contribute to improved glycemic control, cardiorespiratory capacity, and lipid profile. Working hypothesis: Consistent inclusion of moderate-intensity spinning and swimming will lead to significant improvements in metabolic control (decreased blood glucose and HbA1c) and functional capacity (improved physical fitness and reduced resting heart rate) in patients with type 1 diabetes mellitus, without increasing hypoglycemia risk. Objectives: Monitor the evolution of blood glucose and HbA1c during the training program; determine changes in resting heart rate and overall functional capacity; evaluate exercise influence on the lipid profile; observe any hypoglycemic episodes during or after physical activity; analyze the patient's adaptation to the combined aerobic exercise program (spinning and swimming). Inclusion criteria: Female adolescent; confirmed T1D with prior onset; basal–bolus insulin regimen stable in the last 3 months; clinically stable without acute complications; no cardio-respiratory conditions or other chronic diseases contraindicating exercise; adequate capacity for aerobic activity; written informed consent from the patient and legal guardians; availability to participate during the full 4 months and comply with recommended monitoring. Participant and intervention: The study included a 17-year-old female patient, diagnosed with type 1 diabetes mellitus 10 years ago, treated with basal–bolus insulin. The intervention program lasted 4 months and included: Spinning: 2 lessons/week, 20-45 minutes/lesson, moderate intensity (60-75% of HRmax). Swimming: 2 lessons/week, 25-45 minutes/lesson (dryland warm-up, in-water warm-up, fundamental part, and cool-down), moderate intensity. The spinning activity took place at Wonder Gym, and the swimming activity at the Natation and Kinesitherapy Complex.

3. RESEARCH METHODS

The research methodology included: analysis of the specialized literature; observation method; case study method; testing method; table and graphical data analysis. Combined exercise program and general objectives: The combined exercise program applied in this case study (described in Table 1) was individualized according to the subject's age, medical status, and functional capacity. The intervention included spinning and swimming over a four-month period, with a frequency of two sessions per week for each activity. The general objectives of the combined program were: To improve glycemic control, by reducing mean blood glucose levels and glycated hemoglobin (HbA1c); To enhance cardiorespiratory capacity and general endurance; To reduce resting heart rate and perceived exertion during exercise; To optimize lipid profile and body composition.

Table 1

Presents the detailed structure of the four-month physical exercise program designed to optimize metabolic control, lipid profile, and body composition

Month	Activity type	Frequency	Lesson duration	Intensity	Main objectives	Indicative lesson content
Month I Functional adaptation	Spinning	2×/week	25-30 min	60% HRmax	Adaptation to aerobic effort; improved breathing control and coordination; prevention of hypoglycemia.	5 min warm-up -15 min steady pedaling -10 min cool-down. Focus on maintaining rhythm and pulse control.
	Swimming	2×/week	20-25 min	60% HRmax	Increase tolerance to aquatic effort; develop coordination and rhythmic breathing.	5 min warm-up exercises - 15 min freestyle or breaststroke - 5 min relaxation.
Month II Aerobic consolidation	Spinning	2×/week	30-35 min	65-70% HRmax	Improve cardiorespiratory capacity; stabilize post-exercise glycemia.	10 min warm-up -15 min varied-rhythm pedaling (easy/moderate intervals) - 10 min cool-down.
	Swimming	2×/week	20-25 min	65% HRmax	Develop endurance and swimming technique.	10 min technical drills (glide, back and front float) -10 min continuous swim -5 min relaxation exercises.
Month III Functional development	Spinning	2×/week	35-40 min	70-75% HRmax	Increase VO_2max; decrease resting heart rate.	10 min warm-up -25 min pedaling on simulated climbs -5 min cool-down. Continuous monitoring of pulse and glycemia.
	Swimming	2×/week	25-30 min	70% HRmax	Increase strength and respiratory capacity.	10 min technical drills -25 min combined strokes (breaststroke + backstroke) - 5 min floating/relaxation.
Month IV Optimization and evaluation	Spinning	2×/week	35-45 min	70-75% HRmax	Maintain progress; stabilize metabolic control; increase overall endurance.	10 min warm-up- 30 min sustained pedaling with variations -10 min cool-down.
	Swimming	2×/week	35-45 min	70-75% HRmax	Optimize functional performance and exercise capacity.	10 min technical drills -25-30 min continuous swim - 5 min in-water stretching.

The applied physical exercise program was structured over a four-month period and organized progressively into four monthly stages, with objectives and intensities adapted to the patient's functional level and the specific characteristics of type 1 diabetes mellitus. The program included two types of aerobic physical activity-spinning and swimming, each performed with a frequency of two sessions per week. During the first month (functional adaptation stage), the emphasis was placed on adapting the body to aerobic effort, improving breathing control and coordination, and preventing hypoglycemic episodes. Exercise intensity was maintained at approximately 60% of maximum heart rate (HRmax), while session duration ranged from 25-30 minutes for spinning and 20-25 minutes for swimming. Sessions included warm-up exercises, continuous moderate-intensity aerobic effort, and cool-down and relaxation phases. In the second month (aerobic consolidation stage), the objectives focused on increasing cardiorespiratory capacity and stabilizing post-exercise glycemia. Exercise intensity was progressively increased to 65-70% of HRmax, and session duration was extended to 30–35 minutes for spinning. Training sessions incorporated rhythm variations and light-to-moderate intervals, as well as swimming-specific technical exercises aimed at improving movement efficiency and exercise endurance. The third month (functional development stage) aimed primarily at increasing aerobic capacity and reducing resting heart rate. Exercise intensity ranged between 70-75% of HRmax, with session duration increasing to 35-40 minutes for spinning and 25-30 minutes for swimming. Spinning sessions included simulated climbs and sustained effort, while swimming sessions combined different strokes (breaststroke and backstroke), with careful monitoring of heart rate and blood glucose levels. During the final month (optimization and evaluation stage), the program was directed toward maintaining the achieved progress, stabilizing metabolic control, and increasing overall endurance. Both spinning and swimming were performed at an intensity of 70-75% of HRmax, with session durations of 35-45 minutes per session. Training content included sustained aerobic effort, controlled intensity variations, and cool-down and stretching exercises.

4. RESULTS

Assessments were performed at baseline, after two months, and at the end of the four-month intervention period. The evaluated parameters included metabolic variables (fasting blood glucose, glycated hemoglobin-HbA1c, and lipid profile) and functional parameters (resting heart rate, estimated aerobic capacity, body mass index, and body composition).

Fasting blood glucose was assessed through capillary self-monitoring of blood glucose, using a portable glucometer. Measurements were performed in the morning, in the fasting state, before insulin administration and breakfast. The reported values represent the mean of three consecutive measurements, obtained on different days within the same week for each assessment time point. Glycated hemoglobin (HbA1c) was determined through laboratory analysis of venous blood samples, reflecting the average glycemic control over the previous 2–3 months. The lipid profile (total cholesterol and HDL cholesterol) was evaluated by biochemical laboratory analyses performed on venous blood samples collected under fasting conditions. Resting heart rate was measured using a heart rate monitor, under standardized conditions: in the morning, after a minimum of 10 minutes of seated rest, and at least 24 hours after the last exercise session, to avoid the acute effects of physical exertion. The reported values represent the mean of three measurements obtained on different days. Estimated aerobic capacity was assessed using a submaximal cycle ergometer test, based on monitoring heart rate responses to progressively increasing workloads. Body weight was measured using an electronic scale. Body fat percentage was estimated using anthropometric measurements and a validated online calculation tool (Body Fat Calculator, calculator.net). Muscle tone was assessed through functional clinical observation, based on muscle appearance, resistance to passive movement, and muscular behavior during functional exercises. The assessment had a qualitative character, using a descriptive three-level scale: medium, medium-high, and high.

In Figure 1 it can be observed that fasting blood glucose decreased from 142 mg/dl to 110 mg/dl, a reduction of approximately 22.5%, approaching values considered normal (<110 mg/dl). HbA1c decreased from 7.8% to 6.9%, indicating better medium-term glycemic control and approaching the generally recommended target for diabetes (<7%). These changes reflect a significant improvement in glucose metabolism. Final values close to 7% fall within general recommendations for diabetes management.

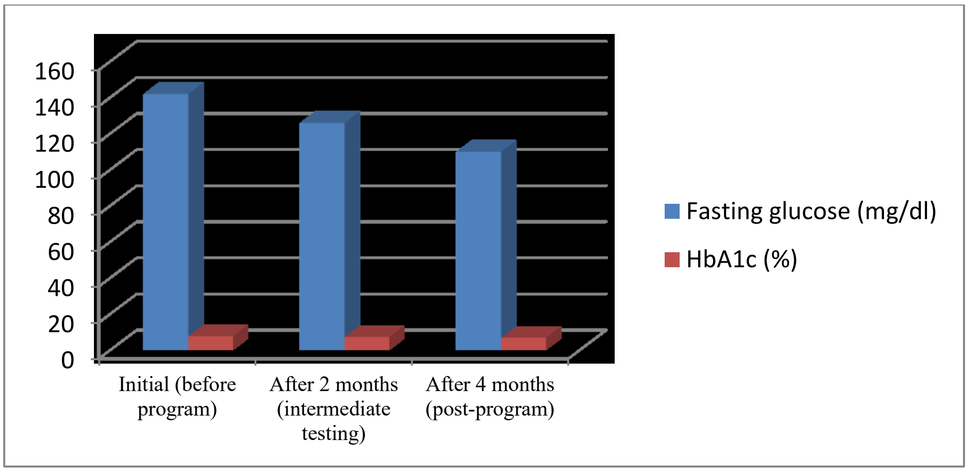

Fig. 1 Evolution of glycemic control parameters

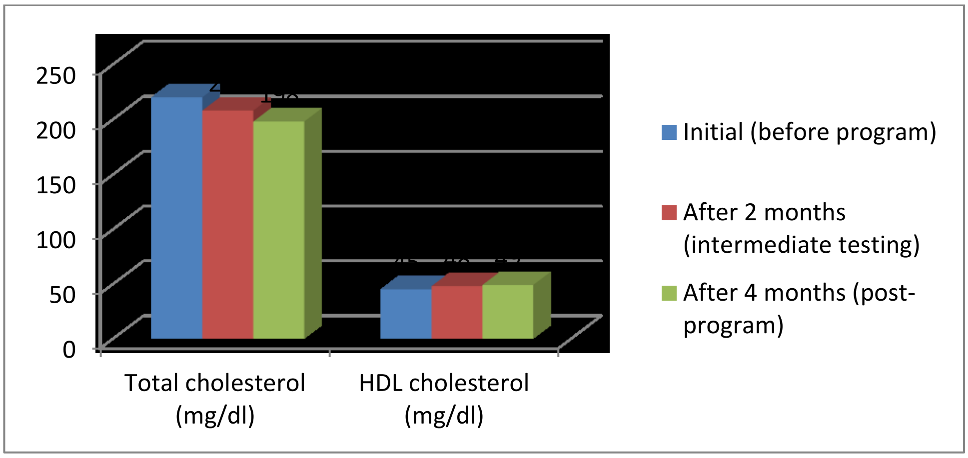

Fig. 2 Changes in lipid profile parameters

In Figure 2 it can be observed that total cholesterol decreased by approximately 10% (220-198 mg/dl), and HDL increased by approximately 9% (45-49 mg/dl). The change in parameters indicates a more favorable lipid profile and a reduced long-term cardiovascular risk.

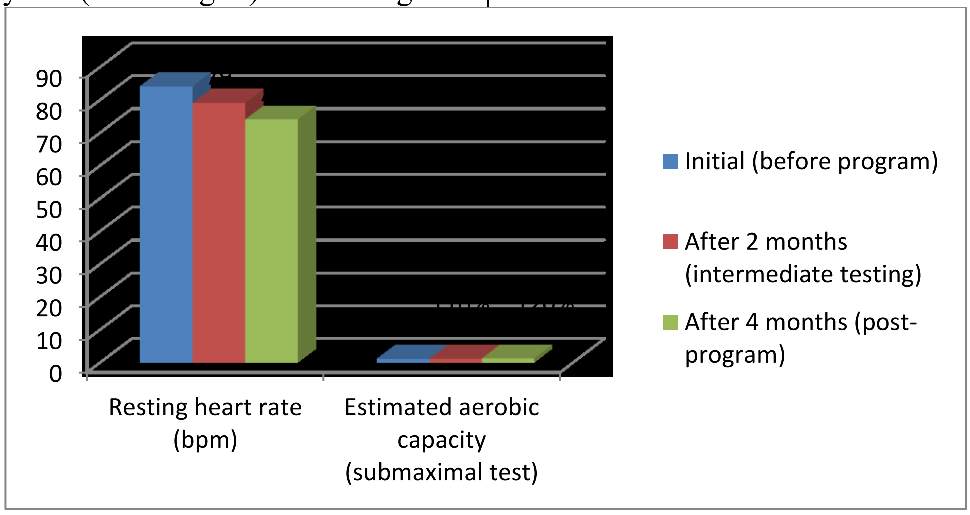

Fig.3 Changes in resting heart rate and aerobic capacity

In Figure 3 it can be observed that resting heart rate decreased from 84 to 74 bpm (approximately 12%), which reflects a positive cardiovascular adaptation to aerobic exercise and increased cardiac efficiency, while aerobic capacity increased from 100% to 120%, indicating a significant improvement in endurance and physical condition. This increase correlates with the decrease in resting heart rate and supports greater cardiovascular.

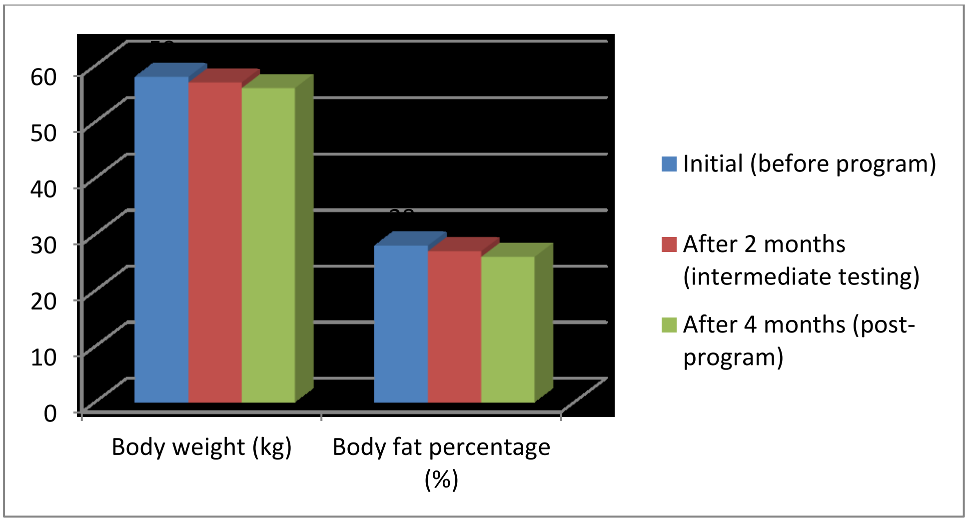

Fig. 4 Changes in body composition and muscle tone

In Figure 4 it can be observed that body weight decreased moderately, from 58 kg to 56 kg (approximately 3.4%), while body fat percentage decreased from 28% to 26%. Weight stability, in parallel with the reduction of body fat, suggests an increase in muscle mass. Muscle tone evolved from medium to high, with an approximate increase in muscle mass from 27% to 33% of body weight.

All monitored parameters showed progressive and continuous improvements, without significant variations. The combined program of spinning and swimming generated evident metabolic, cardiovascular, and muscular benefits, suggesting that maintaining and continuing this type of intervention can contribute to overall health and to the prevention of risks associated with diabetes and cardiovascular diseases. The experimental program of means from spinning and swimming contributed to better glycemic control, a healthier lipid profile, increased cardiovascular efficiency, optimized body composition and increased muscle tone.

5. DISCUSSION

In the study conducted by the authors (Sideravičiūtė et al., 2006), a long-term swimming program improved body composition and aerobic capacity in healthy adolescents and those with type 1 diabetes. After 14 weeks, body fat percentage decreased significantly (healthy: 27.2-25.5%; diabetes: 34.8-32.1%), while body mass index remained unchanged. Aerobic capacity improved in both groups, and HDL increased only in healthy girls, suggesting benefits for cardiovascular endurance and reduction of body fat. In the study by the authors (Tunar et al., 2012), participants with type 1 diabetes had reduced activity time (<1 h/week), and fear of hypoglycemia limited effort at the beginning. No significant changes in metabolic control were observed, probably due to the duration and intensity of exercises. A combination of Pilates with aerobic exercises, such as running or cycling, could be more effective in the long term.

6. CONCLUSIONS

The patient recorded a clear decrease in blood glucose values and an improvement of overall metabolic control, indicating more effective diabetes management in the context of regular physical exercise. Constant participation in spinning and swimming sessions led to increased exercise tolerance, better physical endurance, and progressive adaptation of the body to aerobic activity. Monitoring of functional parameters highlighted a decrease in resting heart rate, a sign of improved cardiac efficiency and superior physical fitness. Regular physical activity contributed to balancing lipid metabolism and to a more favorable body composition, with a tendency toward reduction of adipose mass. Over the four months, the patient progressively adapted to physical demands, without exhibiting hypoglycemic episodes, confirming the safety and effectiveness of the combined program.

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Abstract

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ВПЛИВ ВПРАВИ ЗІ СПІННІНГОМ ТА ПЛАВАННЯМ НА МЕТАБОЛІЧНІ ТА ФУНКЦІОНАЛЬНІ ПАРАМЕТРИ У ПАЦІЄНТКИ З ЦУКРОВИМ ДІАБЕТОМ 1 ТИПУ – КЛІНІЧНИЙ ВИПАДОК

Огляд спеціалізованої літератури підкреслює важливу роль регулярної фізичної активності у покращенні чутливості до інсуліну, глікемічного контролю та загального функціонального стану у пацієнтів з цукровим *діабетом 1 типу (ЦД1). Аеробні вправи, що виконуються регулярно та адаптовані до індивідуальних можливостей, сприяють регуляції метаболізму глюкози, покращенню кардіореспіраторної підготовки та покращенню якості життя. У цьому дослідженні взяла участь 17-річна пацієнтка, у якої у віці 10 років діагностували ЦД1 і проходила базально-болюсний режим інсулінотерапії. Програма втручання проводилася протягом чотирьох місяців і складалася з двох видів аеробної активності: спінінг (два заняття на тиждень, по 45 хвилин кожне, з інтенсивністю 60–75% від максимальної частоти серцевих скорочень) та плавання (два заняття на тиждень, по 40 хвилин кожне). Робоча гіпотеза полягала в тому, що послідовне включення цих вправ помірної інтенсивності призведе до покращення метаболічного контролю, що відобразиться у зниженні рівня глюкози в крові та глікованого гемоглобіну (HbA1c), а також у функціональній спроможності, що проявляється у зниженні частоти серцевих скорочень у стані спокою, без збільшення ризику гіпоглікемії. HbA1c є показником середнього рівня глюкози в крові протягом попередніх 2-3 місяців і є важливим для оцінки метаболічного контролю. Результати продемонстрували значне покращення аналізованих параметрів після періоду втручання. Дослідження робить висновок, що регулярна, контрольована та індивідуалізована фізична активність сприяє оптимізації метаболічного контролю, зниженню рівня HbA1c, підвищенню толерантності до фізичних навантажень та покращенню ліпідного профілю, причому поєднання спінінгу та плавання виявилося ефективним та безпечним для пацієнтів з цукровим діабетом 1 типу.*

Ключові слова: вплив; спінінг; плавання; цукровий діабет 1 типу; клінічний випадок.