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Original Article

Analysis of glycemic safety of a moderate-intensity resistance exercise session in type 1 diabetic people

Análise da segurança glicêmica de uma sessão de exercício resistido de intensidade moderada em pessoas diabéticas tipo 1

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ABSTRACT

Introduction: Type 1 diabetes is an autoimmune disease that results in the destruction of pancreatic beta cells, implying the use of insulin therapy to maintain adequate blood glucose levels. When stimulated by physical exercise, glycemic homeostasis becomes impaired, providing complications in the daily lives of this population, constituting a barrier to physical exercise practice. **Objective:** To evaluate the glycemic safety of a resistance exercise session of moderate intensity in people with type 1 diabetes. . **Methods:** 12 people with type 1 diabetes (7 male), performed a resistance exercise session of moderate intensity at 60% of 1 RM consisting of 7 exercises. Capillary blood glucose was assessed at the pre-session (GP), immediately after (G IA) and 20 minutes after (G 20). ANOVA for repeated measures was performed ($p < 0.05$). **Results:** In the absolute values of glycemia, no significant differences were found ($P = 0.061$). However, when checking the delta blood glucose variation, a difference was found between G IA and G20 vs. GP ($P < 0.05$). Clinically important reductions above 20 mg/dl (PI: ~ 37mg/dl; 20P: ~ 45mg/dl) without providing hypoglycemia. **Conclusion:** A moderate-intensity resistance exercise session proved to be safe from a glycemic point of view in people with type 1 diabetes.

Key-words: Diabetes Mellitus type 1, Resistance training, Exercise.

RESUMO

Introdução: A diabetes tipo 1 é uma doença autoimune que resulta na destruição das células beta pancreáticas, implicando no uso de insulinoterapia para manter níveis adequados de glicemia. Diante do estímulo do exercício físico, a homeostase glicêmica torna-se prejudicada, podendo incidir em complicações como hipoglicemia. Tais repercussões proporcionam empecilhos no dia a dia dessa população, constituindo uma barreira para prática de exercícios físicos. **Objetivo** dAvaliar a segurança glicêmica de uma sessão de exercício resistido de intensidade moderada em pessoas com diabetes tipo 1. **Métodos**: 12 pessoas com diabetes tipo 1 (7 homens) realizaram uma sessão de exercício resistido de intensidade moderada a 60% de 1 RM composta por 7 exercícios. A glicemia capilar foi avaliada no momento pré-sessão (GP), imediatamente após (G IP) e 20 minutos após (G 20). ANOVA

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para medidas repetidas foi realizada (p < 0.05). **Resultados:** Nos valores absolutos de glicemia não foram encontradas diferenças significativas (P = 0,061). Contudo, ao verificar o delta variação da glicemia foi encontrada diferença entre G IP e G20 vs. GP (P< 0,05). Reduções clinicamente importantes acima de 20mg/dl (IP: ~37mg/dl; 20P: ~45mg/dl) sem proporcionar hipoglicemias. **Conclusão:** Uma sessão de exercício resistido de intensidade moderada se mostrou segura do ponto de vista glicêmico em pessoas com diabetes tipo 1.

Palavras-chave: Diabetes Mellitus Tipo 1, Treinamento de Resistência, Exercício.

Introduction

Type 1 diabetes is a pathology caused by the progressive destruction of pancreatic beta cells. As consequence, the person with diabetes starts to depend on insulin therapy to control hyperglycemia [1]. Complications of the disease can present in acute form, such as hypoglycemia and diabetic ketoacidosis [2,3] or in a chronic form, such as cardiomyopathy associated with diabetes, nephropathy, retinopathy and peripheral neuropathy [4,5].

In healthy individuals, glycemic homeostasis in maintained by fast-acting hormones (Insulin, glucagon, adrenaline and noradrenaline) and slow and/or permissive hormones (Cortisol, GH and thyroid hormones T3 and T4) [6]. By stimulating physical exercise, there is a reduction in insulin action and a concomitant increase in the action of glucagon, promoting degradation of hepatic glycogen and release of glucose into the bloodstream for later uptake by active muscles [7]. Due to the type 1 diabetic person's dependence on the application of exogenous insulin, this control becomes impaired, increasing the risk of hypoglycemia (blood glucose <70mg/dl) during or after physical exercise [8,9].

The literature has pointed out the beneficial effects of physical training in people with type 1 diabetes. In addition to the physiological benefits, such as increased sensitivity to insulin action and glucose uptake through signaling induced by muscle contraction [10-12], psychological and social benefits also stand out, providing a lifestyle favorable to healthy habits [13]. However, despite the benefits promoted by regular physical exercise, many of these people avoid getting involved in the practice of physical training fearing possible episodes of hypoglycemia induced by exercise; this fear is one of the biggest barriers to the practice of physical activity in this population [14]. That occurs because during a hypoglycemic crisis, the individual is affected by symptoms of malaise, such as sweating, mental confusion, lethargy, and if left untreated, the condition can progress to coma and even death [15].

Due to the benefits of physical exercise, its prescription becomes a potent ally in glycemic control in type 1 diabetic people, and resistance exercise, as it is a widespread and easily accessible training modality, presents itself as an interesting alternative complementary therapy [16]. Thus, the present study aims to verify the glycemic safety of a moderate intensity resistance exercise session in type 1 diabetic people.

Methods

Sample, ethical aspects and criteria and inclusion and exclusion

An experimental study with 12 type 1 diabetic people (7 male), age 29,8 ± 7,4 anos, height 1,69 ± 0,09 m, body mass 70,9 ± 16,8 kg, body mass index 25,2 ± 4,4 kg/m² was performed. All participants were regulars in the extension project "Physical exercise as sugar diary" offered by the collegiate of physical education of the Federal University of San Francisco Valley (CEFIS-UNIVASF) – Petrolina/PE. The free and informed consent form. The Research Ethics Committee of UNIVASF under the protocol number: 3.349.261 approved this study.

The following inclusion criteria were adopted: Female and male type 1 people over 18 years and who do not have medical restrictions for physical exercise or any type of secondary diseases that may be aggravated due to research participation (secondary diseases that have been already diagnosed by the physician responsible for each diabetic; eg, peripheral and / or central vasculopathies, retinopathies and amputations). Participants were excluded from the study if they did not finish the session and or suffered any type of osteomyoarticular injury that prevented the practice of physical exercises or at the request of the physician responsible for each individual outside the scope of the research.

Study design

Two days before the resistance exercise session, the individuals underwent an assessment of anthropometric measurements (body mass, height and perimeters), body composition (skinfolds) and abdominal resistance test. Then, a 1RM estimation test was performed to measure the training load in each of the six exercises that would later be performed in the session (bench press, horizontal leg press, biceps curl on the low pulley, extension chair, machine development, adductor chair and the abdominal rectus solo - performed from the abdominal resistance test). Based on Brzycki's formula [17], 60% of 1RM of each exercise was determined for the training session.

Subsequently, on the day of the training session, when participants arrived at the weight training laboratory at the Federal University of San Francisco Valley - Petrolina / PE, the individuals were taken to a comfortable chair where they sat at rest for 10 minutes before the measurement of capillary blood glucose and blood pressure and, subsequently, they were released for the weight training session. The individuals underwent the training session with an approximate duration of 30 minutes, at the end of it, they were immediately seated in the chair and a new measurement of blood glucose and blood pressure was performed. After another 20 minutes of sitting at rest, a last measurement of blood glucose and blood pressure was performed and the individuals were released.

Body composition and anthropometrics variables

To verify the individuals' body mass and height, a digital weight balance with stadiometer, Lider brand, model LD-1050, was used. The individuals were positioned on the weight balance, with their backs to the wall, feet together and bare. The anthropometric tape of the Sanny brand, model TR-4010 was used to evaluate body perimeters and the clinical adipometer of the Sanny brand was used for skinfold measurements.

Blood glucose, arterial blood pressure and heart rate

The heart rate was monitored during the session using a Polar cardiac monitor, model FT1. Subsequently, blood pressure was measured using a digital arm blood pressure meter of the OMRON brand, model HEM-7113 following the recommendations of the 7th guideline for arterial hypertension of the Brazilian Society of Cardiology [18]. Capillary blood glucose was measured by a qualified nurse at the pre-session moment (after 10 minutes of rest), immediately after and 20 minutes after the session using a Glucometer and lancets (Active Accu Check Roche), following the recommendations of the Society Brazilian Diabetes [8].

Training session

The weight training session was conducted and supervised by a qualified Physical Education professional. Composed of 3 sets of 10-12 repetitions at 60% of 1RM of the seven exercises previously described, with an interval of 50-60 seconds between each set, and a cadence of 3s (1.5 for eccentric contraction and 1.5 for concentric contraction). Ultra-fast insulin before the last pre-session meal was reduced according to guidelines [8].

Results

Analyzing the absolute blood glucose values, no statistically significant differences were found between the pre-session moments, immediately after and 20 minutes after the session ($P = 0.061$). However, when checking the delta glycemia variation between the three moments, a statistically significant difference was found between the moment immediately after and the moment 20 minutes post-session, in relation to rest ($P < 0.05$). The description of the study participants is shown in table I.

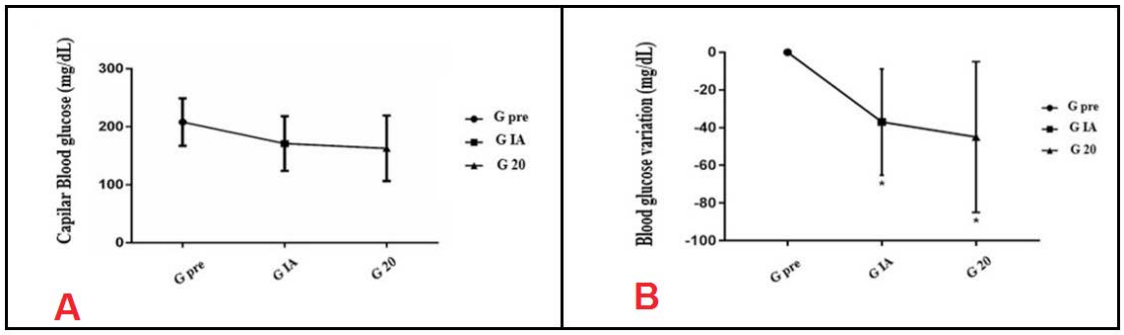
Table I. Sample data description.

	n = 12
Age (years)	29.8 (7.4)
Height (m)	1.69 (0.09)
Body mass (kg)	70.9 (16.8)
BMI (kg/m²)	25.2 (4.4)
HR (Bpm)	88 (8)
SBP (mmhg)	127 (13)
DBP (mmhg)	76 (6)
SSF (mm)	215.8 (65.6)
DT (years)	11.9 (4.9)

Legend: BMI: Body mass index; HR: Heart rate; Bpm: Beats per minute; SBP: Systolic blood pressure; SDC: Diastolic blood pressure; SSF: Somatory of skin folds; DT: Diagnosis time.

The following are the glycemic changes in the moments pre, immediately after and 20 min after a resistance exercise session of moderate intensity (Figure 1). Frame A shows glycemic safety without providing hypoglycemia. Frame B, in turn, reveals the significant differences in the variation delta in

relation to rest (p <0.05). In addition, the minimum detectable difference was verified after the session and after 20 minutes of the session, presenting clinical importance at these moments.



* Significant difference in relation to rest and MDD> 19.2 mg/dl with a clinically important reduction in relation to rest.

Figure 1. Absolute and relative variation (Δ) of capillary glycemia at rest (pre), immediately after (G IA) and 20 minutes after (G 20) a weight training session of moderate intensity in type 1 diabetic individuals.

Discussion

The aim of the present study was to assess the glycemic safety of a moderate-intensity resistance exercise session in people with type 1 diabetes. The main findings show that the variation in glycemic reduction (Δ) between the moments of the session was significant for the moment immediately after (G IP) and 20 minutes after the session (G 20), which correspond to a decrease of 17.8% and 21.7% respectively. Still, a clinically important reduction was found for the participants after a resistance exercise session with moderate intensity, without providing hypoglycemia

It is known that physical exercise improves insulin signaling and increases the uptake of glucose by the muscle in ways independent of insulin action. The muscular contraction itself, from the imbalance in the AMP/ATP balance and calcium signaling, promotes the stimulus for the activation and translocation of the GLUT-4 vesicles to the plasma membrane, allowing glucose to enter the intracellular medium [20]. The consumption of glucose, free fatty acids and other substrates increases during physical exercise, which may enhance the action of insulin, and the proportion of use of these substrates will depend on the intensity and duration of physical exercise. Thus, it is necessary that the dose of fast-acting insulin be adjusted before exercise, considering the characteristic and duration of the training session [21].

Intensity is an important factor and can modulate the glycemic response of individuals with diabetes differently. In the study by Cruz *et al.* [22], the authors demonstrated that light intensity in resistance exercise (40% of 1 RM) decreased glycemic levels in type 2 diabetic women for a period of 24 hours when compared to a high intensity session (80% of 1RM) and a control session. In the study by Yardley et *al.* [23] with type 1 diabetic people, which evaluated the glycemic response for 24 hours between aerobic exercise (60% VO_{2Max}) and resistance exercise (seven exercises with three sets of eight maximum repetitions), it was shown that resistance exercise caused a lower glycemic reduction during the session, however, over the 24 hours, it was associated with more prolonged reductions. Such behavior is similar to that found by Shetty *et al.* [7]

who, when comparing different intensities of aerobic exercise (35, 50, 65 and 80% VO_2 peak), demonstrated that the increase in intensity above 50% of VO_2 peak leads to higher glycemic levels.

The results of the present study demonstrated a drop in blood glucose throughout the session of moderate resistance exercise. However, in absolute values, there was a large intra-subject variation in glycemic behavior. This was already expected, since factors such as time of diagnosis, food and water intake influence glycemic control [21,24]. In addition, in this population, the genetic factor involved in the pathogenesis of the disease is very heterogeneous, with more than 60 gene polymorphisms providing an increased risk for the onset of the disease. Some authors even claim that each type 1 diabetic patient has their own type of diabetes [25]. Even despite such factors, there were no hypoglycemia.

In addition to the aforementioned factors, physically active type 1 diabetic people have a better metabolic profile than their sedentary peers [26], and the pathology should not be considered as an impediment to the practice of physical exercise. On the contrary, exercise should be encouraged in this population, requiring only precautions for greater safety [9]. As verified in the present study, only one session of resistance physical exercises can help to control the acute glycemic variation with clinical importance for practitioners.

Finally, the present study had some limitations, such as the lack of dietary control in the 24 hours prior to the session, the short post-session evaluation period (only 20 minutes) and the absence of a control group. However, the results have a high practical application, since the performance of a session of moderate resistance exercise with alternating exercises by segments can help regulate glucose without causing hypoglycemia and thus reduce the possible fear of the diabetic person of suffering hypoglycemia during and after physical exercise.

Conclusion

In conclusion, a session of resistance exercise of moderate intensity proved to be safe from the glycemic point of view in people with type 1 diabetes. In addition, it promoted a reduction in blood glucose values in relation to baseline values that varied between 17.8% and 21.7% with clinically important changes, which may be beneficial in the long term for this population.

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