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# Observation of the Glycemic Behavior of a Type 1 Diabetic during Strength Training in Different Intensities: A Case Study

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## Abstract

**Introduction:** Type 1 Diabetes therapy has historically followed the insulin/food/physical exercise triad. Today it is known that strength training (TF) has benefits such as decreased fasting glycemia, glycated hemoglobin, stimulates translocation of GLUT4 in skeletal muscle, increases insulin sensitivity, restoring metabolic control. The objective of this research was to observe the glycemic responses of a type 1 diabetic who underwent strength training at different intensities.

**Methods:** A 26-year-old woman with type 1 Diabetes Mellitus participated in this research, with a trained diagnosis time of 22 (twenty-two) years. The volunteer participated in three non-consecutive days of intervention at the first visit. The evaluation was performed with a test of Maximum Repetition (1RM) in the following exercises: Bench press; Knee extension on the device; Peck Deck; Front high pulley with cable; Leg 45°; Low row with triangle. On the second visit to the laboratory, the TF session was performed at 40% of 1RM. On the third visit, the session was performed at 80% of 1RM, capillary blood glucose was collected before, during and immediately after each strength training session.

**Results:** The results observed showed that the exercise of less intensity, at 40% of 1 RM, showed a greater drop in capillary glycemia during and immediately after the TF session.

**Conclusion:** Different intensities will result in different physiological responses. It is important to highlight the need for blood glucose monitoring before, during and after training.

**Keywords: Type 1 Diabetes; Blood Glucose; Strength Training**



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## Introduction

Type 1 Diabetes Mellitus (DM1) is concentrated between 5% and 10% of the total number of people with diabetes. In most cases, DM1 arises as a result of autoimmune destruction of pancreatic β cells causing complete deficiency in insulin production, being diagnosed more frequently in children, adolescents and young adults, equally affecting men and women, although its pathophysiology is not fully known. It is known that it is a polygenic disease, thus genetic and environmental factors trigger the autoimmune response [1].

The treatment of DM1 has historically followed the insulin/food/physical exercise triad. Currently, the triad should switch to insulin/diabetes monitoring/education, including education in nutrition, exercise and guidance for patients and their families [2].

Among the treatments, physical exercise offers different methods for controlling DM1, such as aerobic training, which is the most used, since strength training before 2005 was not suitable for DM1 [3]. Today it is already known that strength training has benefits such as decreased fasting blood glucose, glycated hemoglobin, visceral fat, and body weight; stimulates GLUT4 translocation in skeletal muscle, increases insulin sensitivity and, consequently, restores metabolic control [4]. Insulin injected by the DM1 carrier acts on the IRS-1 and IRS-2 receptors, promoting a cascade of intracellular signaling that results in the translocation of GLUT4 and the entry of glucose into the cell, physical exercise enhances the phosphorylation of IRS-2, which results in a greater PI3K activity causing an increase in Akt protein phosphorylation, which promotes an increase in the translocation of GLUT4 to the cell membrane, consequently greater glucose entry into the cell, decreasing circulating glycemic levels [5] strength training also minimizes cardiac risks, increases muscle strength and is a good strategy to improve health, physical fitness and performance [6], justifying its inclusion in the treatment of DM1.

However, studies relating strength training in isolation and type 1 diabetes are still scarce in the literature, in the same way studies that show the efficiency of different intensities under individuals with DM1 are a great gap in which little has been investigated. Comparing different intensities could clarify the benefits of strength training and provide support for practical applications and recommendations regarding the adequate and safe prescription of strength training for glycemic control in DM1, in addition, the little information on strength training related to DM1 demonstrates the need for further studies that address the topic, in order to elucidate the acute and chronic responses of DM1 through this training method [6,7]. In this sense, the objective of this research was to observe the glycemic responses of a type 1 diabetic who underwent strength training at different intensities.

## Materials and Methods

### Participants

This research was characterized as a case study and is linked to the Project Doce Vida - Supervised Physical Exercise Program for Diabetics, held at the Higher School of Physical Education at the University of Pernambuco. Participated in this research a woman aged 26 (twenty-six) years with type 1 Diabetes Mellitus, with a diagnosis time of 22 (twenty-two) years. The participant is trained.

### Instrumentation and data collection

The training was carried out at the Biodynamics Laboratory of the Higher School of Physical Education at the University of Pernambuco in the morning.

### Capillary glycemia

Capillary blood glucose was collected before, during and immediately after each strength training. Capillary blood glucose was measured before and after each workout, always on the little or ring fingers, discarding the first drop of blood, the second drop being used [8]. The glucometer, reagent strips, lancets and lancets used were from the Freestyle Optium Neo model from Abbott. The infectious material (gloves, lancets, tapes and paper towels) used for collection, was deposited in a specific box of hospital material.

### Blood pressure

Blood pressure was measured before and after each strength training session, using the OMRON HEM 7113 digital automatic blood pressure monitor.

### Initial evaluation and test of a maximum repeat (1RM)

The volunteer participated in three non-consecutive days of intervention. On the first visit to the Biodynamics Laboratory, the volunteer was familiarized with the training protocol. Soon afterwards, a test of Maximum Repetition (1RM) was performed in the following exercises: Bench press; Knee extension on the device; Peck Deck; Front high pulley with cable; Leg 45°; Low row with triangle [9]. The equipment was made by New Fit.

Before starting the 1RM test, the volunteer warmed up, in each exercise, from 10 to 15 repetitions, with an equivalent load of 40% to 60% of the maximum perceived strength [10]. Then, the load was increased to approximately, 60% to 80% of the maximum perceived force. After this warm-up, there was an interval of 2 min, while the load was increased to perform the 1RM test.

### Experimental sessions

On the second visit to the laboratory, the strength training session was performed at 40% of 1RM. On the third day, the session was performed at 80% of 1RM. Each day of intervention aimed to assess the impact of a strength training session on glycemic control. Glycemic responses were analyzed before, during and immediately after each session.

### Pre-intervention

Before each intervention, the volunteer remained seated in the laboratory for a period of 10 min, in a quiet room without noise interference and with a temperature between 23ºC to 24ºC [11].

### Intervention

Strength training intensities were established based on the ACSM and ADA classification for individuals with DM1 [12], with low intensity exercise with 40% 1RM and high intensity with 80% 1RM. The strength training sessions consisted of seven exercises in the same sequence as the 1RM test (Bench Press in the machine; Knee extension on the device; Peck Deck; Front high pulley with cable; Leg 45°; Low row with triangle). For the strength training session at 40% of 1RM, 02 sets were performed with 16 repetitions in each exercise, with a recovery interval of 60s between sets and 120s between exercises. For the strength training session at 80% of 1RM, 02 sets were performed with 08 repetitions in each exercise with an interval of 90s between sets and 120s between exercises. The duration of the repetition in each series of the strength training was 3s, being 1s in the concentric phase and 2s in the eccentric phase of the movement.

### Statistical analysis

A descriptive analysis of the variables was performed through the variation of the delta at baseline during and immediately after the intervention.

## Results

According to the observed results, the exercise of less intensity, at 40% of 1RM, showed a drop between the measurement of the pre-training moment and the measurement of the moment during the training, and continued to fall until the moment immediately after the training, showing a greater blood glucose drop compared to training at 80% of 1RM.

The strength training session at 80% of 1RM, showed an increase

**Table 1:** Variation of the capillary glucose Delta (Δ) with 40% of 1RM at baseline, during and after intervention of a RT session.

| Glycemia | Moment |
|---|---|
| Pre Workout | 143 mg/dL |
| During | 137 mg/dL |
| Δ | 06 mg/dL |
| During | 137 mg/dL |
| After | 100 mg/dL |
| Δ | 37 mg/dL |
| Pre Workout | 143 mg/dL |
| After | 100 mg/dL |
| Δ | 43 mg/dL |

**Table 2:** Variation in the capillary glucose Delta (∆) with 80% of 1RM at baseline, during and after the intervention of a RT session.

| Glycemia | Moment |
|---|---|
| Pre Workout | 267 mg/dL |
| During | 281 mg/dL |
| ∆ | 14 mg/dL |
| During | 281 mg/dL |
| After | 240 mg/dL |
| ∆ | 41 mg/dL |
| Pre Workout | 267 mg/dL |
| After | 240 mg/dL |
| ∆ | 27 mg/dL |

in capillary glycemia in the measurement during the training session, but, immediately after the training session, there was a decrease in capillary glycemia below the pre-training values. RT data at 40% and 80% are shown in Table 1 and 2.

## Discussion

The objective of this research was to evaluate the glycemic responses of a type 1 diabetic who underwent strength training with different intensities. Our findings showed a better acute response in low intensity exercise, at 40% of 1RM.

A study conducted by Silveira et al. [6] investigated the acute effects of different strength training intensities on glycemic fluctuations in individuals with DM1, using the intensities of 40%, 60% and 80% of 1RM, with capillary blood glucose measurements being taken at rest, immediately after exercise , 10 min after exercise, 20 min and 30 min after exercise, resulting in a lower concentration of glucose in all intensities up to 30 min after training, however, without showing a significant difference between the three training intensities during each training period time.

However, the study showed a significant difference between rest and 10 min after, 20 min and 30 min after training at the three intensities investigated, and during these periods of time, the glycemic drop at 40% of 1RM was moderate, unlike the fall between the highest intensities, 60% and 80% of 1RM, which revealed a fall in great magnitudes 30 min after the last exercise [6].

Campos, Paixão et al. [5] conducted a case study with a type 1 diabetic in order to evaluate the hypoglycemic effect of resistance training with an emphasis on movement along the eccentric phase in an individual with an insulin infusion pump, the study lasted four weeks where the applicability of the training was three times a week.

Capillary blood glucose data were collected 15 min, 30 min and 45 min, during and after training. The study found a significant drop in glycemia during the training sessions, the authors associate the glycemic drop with a greater activity of the GLUT4 protein, physical exercise promotes an increase in energy expenditure and associated with this there is an increase in the AMP: ATP ratio, this mechanism promotes the activation of AMPK, which is associated with translocation of GLUT4 to the plasma membrane [5,6].

The activation of the AMPK enzyme may explain the reduction in glucose during the training intensities performed in this study, as it is one of the precursors of activation of GLUT4, in addition, exercise promotes the suspension of the mTORC1/S6K1 protein that is capable of phosphorylating IRS1 into serine and interrupting the insulin signaling cascade [1]. Thus, a greater phosphorylation of AMPK and Akt protein occurs, a mechanism that activates GLUT4 through an insulin-independent signaling cascade [5,13].

A study carried out with type 2 diabetes conducted by Moreira, compared the acute effect of strength training exercise of different intensities of lower cardiovascular-metabolic stress on glucose control, intensities of 23% 1RM and 40% 1RM were used, while end of the study it was concluded that both intensities were effective in reducing glycemia in individuals with type 2 diabetes, demonstrating that even at low intensities, the muscle contraction performed by exercise can promote GLUT4 translocation and in the reduction of capillary glycemia [14].

The increase in capillary glycemia during training to 80% of 1RM and a smaller drop immediately after training compared to a session at 40% of 1RM may be related to hormonal and metabolic responses antagonistic to the decline in blood glucose stimulated to high-intensity exercise [15]. Guelfi et al. [16] state that, metabolic and hormonal responses, elevated catecholamine and growth hormone levels, may contribute to avoiding a decline in blood glucose levels at the beginning of recovery, since these hormones stimulate increased hepatic glucose production and inhibits insulin-mediated glucose [16]. One study that compared responses to glucose levels in high-intensity interval aerobic training *vs.* moderate-intensity aerobic training demonstrated a drop in blood glucose in both protocols, but glucose levels in interval training high intensity remained stable during recovery due to the hormonal versus regulatory response, which it did not occur in moderate training, where glucose levels continued to fall [16].

Despite the benefits of physical exercise, one of the biggest concerns when relating physical exercise and DM1 patients is the risk of hypoglycemia [16,17]. However, unlike continuous mild to moderate exercise, in high-intensity exercise the occurrence of hypoglycemia does not is frequent [17]. Exercises with anaerobic component (weight lifting/resistance exercises, sprints and high intensity interval training) reduce the risk of hypoglycemia during and after physical exercise in DM1 [1].

Processes regulated by independent insulin mechanisms are generally preserved when people with diabetes engage in high-intensity work. These processes include normal increases in glucose production and disposition during and immediately after exercise, as well as a normal rate of decline in glucose production after exercise. Since glucose production is mainly controlled by catecholamine's, current data suggest that physically fit patients with insulin-dependent diabetes can exercise vigorously and exercise require high-intensity workloads [18] Catecholamines (epinephrine, nor epinephrine, dopamine) exhibit effects excitatory and inhibitory effects of the peripheral nervous system and actions in the Central Nervous System (CNS), in addition to modulation of endocrine function, such as insulin secretion and glycogenolysis rate [17,18].

The findings of the present study revealed that in strength training at 40% 1RM, glycemic levels showed a continuous drop in the moments during training and immediately after training, which occurred due to muscle contraction that is one of the factors responsible for the greatest GLUT4 activity. However, in the 80% 1RM strength training session there was an increase in capillary glycemia above pre-workout levels, which can be justified by the regulatory action of the hormones responsible for the production of liver glucose, even so, the higher intensity strength training was able to promote glycemic drop at the end of the training session to lower levels than with the pre-workout moment. Strength training can also be prescribed because it has a lower risk of hypoglycemia in addition to promoting increased muscle strength and cross section that only the high intensity of strength training can promote [13].

## Conclusion

It is concluded that in this case study, for this participant, both training protocols showed a drop in capillary glycemia values at the end of the training session, however the protocols showed different behaviors during the session, where the strength training at 40% of 1RM. The fall happened continuously, while in strength training at 80% of 1RM there was an increase in blood glucose during the session and then a fall in capillary blood glucose levels, which demonstrates that different intensities will result in different physiological responses. It is important to emphasize the need for blood glucose monitoring before, during and after training, in order to obtain greater safety for the diabetic and reduce the risks of hypoglycemic events.

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