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# Blood Glucose Responses to Different Spinning Routines: A Case Report of a Type 1 Diabetic Woman

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**Abstract:** Type 1 diabetes mellitus is an autoimmune metabolic disorder characterized by a pancreatic cells inability to secrete insulin. Diabetic individuals are frequently treated with a multidisciplinary program which includes regular physical exercise. The Spinning cycling is an exercise mode currently practiced by different individuals in gyms and clubs. However, the impact of acute Spinning routines on the blood glucose levels in type I diabetic individuals has not been reported. Here, we reported the acute effects of continuous and intermittent Spinning exercise routines in the blood glucose responses of a diabetic woman (26 years old, 52.8 kg, 161.0 cm and 16.7% of body fat). Three different intensities ranging from 60 to 90% of heart rate reserve were investigated. Overall results suggest that such Spinning routines were able to induce decreases in the blood glucose levels in the type 1 diabetic woman investigated. In addition, continuous light and moderate Spinning routines induced the greater blood glucose concentrations reduction.

**Keywords:** Diabetes mellitus, exercise training, cycling.

## 1. INTRODUCTION

Type 1 diabetes mellitus (T1DM) is an autoimmune metabolic disorder characterized by a pancreatic cells inability to secrete insulin. The consequent inefficient insulin action derived from the impaired pancreatic cell function in T1DM individuals may alter the cellular glucose disposal and induce a symptomatic hyperglycemia (>120 $mg.dL^{-1}$) and ketoacidosis status, despite a hypoglycemic status (<50 $mg.dL^{-1}$) may also occur. This metabolic disorder is associated with cardiovascular morbidity, as well as neuro-, nephro- and retinopathies [1].

T1DM individuals are frequently treated with a multidisciplinary program that encompasses drugs, diet, educational and psychological attendance and regular physical exercise [2,3]. Regarding the physical exercise, regular exercise programs have been recommended as a mean to control the blood glucose levels as exercise plays an important role to reduce the peripheral cellular insulin resistance and improve the glycated haemoglobin levels [4,5]. In addition, regular physical exercise contributes to the body mass and blood pressure control, reducing the cardiovascular risk associated with the T1DM [5,6].

Despite the suggestion for a consensual positive relationship between the effects of regular physical exercises and the type 1 diabetes control, only few studies have reported the acute blood glucose levels responses to a physical exercise in type I diabetes individuals [7,8]. In addition to the knowledge regarding the chronic effects of exercise training, it seems important to explore the acute blood glucose responses to exercise as the acute exercise effects may influence the magnitude of chronic adaptations on glucose homeostasis [4,9].

Physical exercise programs encompass the practice of different exercise modes in either outdoor or indoor environments. Regarding indoor environments, one of the current exercise modes practiced is the Spinning cycling. This exercise mode simulates a road cycling exercise on a stationary cycle ergometer equipped with fixed gear. Furthermore, Spinning exercise routines are usually practiced in environments equipped with acoustical systems in order to increase the motivation to participants [10-12]. This self-paced high-intensity exercise mode [13] has been incorporated in physical exercise programs of clubs and gyms, and recommended for healthy and individuals with metabolic disorders such as T1DM people [14,15]. However, how this indoor exercise mode impact the acute blood glucose concentrations in T1DM individuals remains unexplored. Therefore, the purpose of this study was to report the acute effects of different Spinning exercise routines in the blood glucose responses, in a T1DM woman who was engaged in this exercise mode.

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## 2. CASE REPORT

A woman diagnosed with T1DM, with 26 years old, 52.8 kg of body mass, 161.0 cm of height and 16.7% of body fat was investigated. The woman was insulin dependent and had retinopathy and neuropathy when the study was carried out, although no heart disease, hypertension or vascular disorders was diagnosed. All diagnoses were made by an physician who monitored the clinical status of the woman. The woman had participated in indoor cycling exercise routines for the three consecutive years at the time when the data were collected. The Spinning exercise routines were performed 5 days per week (07:00 to 10:00 am) for 45 minutes (min) duration.

### 2.1. Treatment and Care

The treatment for the T1DM individual included drugs manipulation such as: a) insulin *glargine* 100 IU/ml: 20 units at 06:00 am; b) insulin *lispro*: 2 units before the breakfast (~06:00 am), 6 units before the lunch (~12:00 am) and 8 units before the dinner (~08:00h pm); c) *Enalapril Maleate* 5 mg, *gabapentin* 300 mg and *Sertraline* 50mg for cardiovascular, carpal syndrome and anxiety treatment. Furthermore, the individual's diet was controlled by a dietitian in order to provide ~1500 calories per day.

### 2.2. Spinning Routines Procedures

After clinical anamnesis and pharmacological profile evaluation the woman was recommended to follow a standard breakfast as well as the insulin injection (two units of insulin *lispro*) one hour before the Spinning routines. The Spinning routines were performed on an indoor cycle rogometer (Schwinn®, BikePro, 2005, Xiamen, China) adjusted according to the woman's body dimension, in a controlled temperature (~22ºC) and air humidity (~60%) room. The woman performed three Spinning sessions with variable intensity, in the mornings 7.0 am on different days (> 24 hours apart). In order to ensure a controlled pre-exercise metabolic status the Spinning exercise routines were performed only if the baseline blood glucose levels ranged $\leq$ 50 mg.dL$^{-1}$. This procedure was adopted to ensure a safe condition for the exercise routine's execution. In addition, individual was free to ingest water along the Spinning routines.

Three 50 minutes Spinning exercise routines were performed at intensities controlled according to the percentage of the reserve heart rate (%$HR_{RES}$; POLAR®, RS300X, 2006) such as: 1) intensity between 60-75% of the $HR_{RES}$ (119.3 ± 26.4 bpm) in the first session (S1); 2) intensity between 65-85% of the $HR_{RES}$ (129.0 ± 32.5 bpm) in the second session (S2); 3) intensity between 60-90% of the $HR_{RES}$ (133.4 ± 34.0 bpm) in the third session. The following equation [16] was used to provide the HR zone: %HR= [(Maximum HR- Rest HR) x % Intensity zone] + Rest HR]. While a continuous exercise type was used in the light (S1) and moderate (S2) intensity sessions, intermittent exercise was used in the heavy intensity session (S3) so that the individual was able to complete the total duration in every session. An additional baseline session was performed so that the individual remained seated under total rest on the indoor cycle ergometer for 50 minutes. The blood glucose levels responses during the baseline session were used to calculate the magnitude of the blood glucose responses during the Spinning routines. Blood samples (25 µL) were drawn from the ear lobe in order to measure the blood glucose concentrations (YSI, 2700 SELECT, 2002) before (~10 min), during the Spinning routines (every 5 min) and 10 minutes after the Spinning routines. Blood glucose concentrations measured before and after the Spinning routines were obtained while the individual was resting on the indoor cycle. All sessions were performed within a 2 weeks time interval.

## 3. RESULTS

Results of blood glucose concentration variations were reported in absolute (mg.dL$^{-1}$) and relative values (i.e. in percentage of the baseline deviation). Baseline blood glucose concentrations were 187.2, 218.3, 182.9 and 196.1 mg.dL$^{-1}$ for the S1, S2, S3 routines and baseline session, respectively. The blood glucose concentrations showed an increase throughout the baseline session (S4) (Figure **1**). Table **1** shows the blood glucose concentrations at the exercise endpoint and at 10 minutes after the Spinning routines. Although all the three Spinning routines were effective to reduce the blood glucose concentrations, absolute and relative analysis showed greater reduction in the blood glucose concentrations at the exercise endpoint in S1 (↓132.6 mg.dL$^{-1}$ and ↓70.3%, respectively) when compared to S2 and S3. However, greater absolute and relative reduction at 10 minutes after the Spinning routine was observed in S2, a decrease of 113.2 mg.dL$^{-1}$ and 51.8%, respectively. Decreases in blood glucose concentrations at the exercise endpoint and after 10 minutes of the Spinning routines were lower in S3, when compared to S1 and S2.

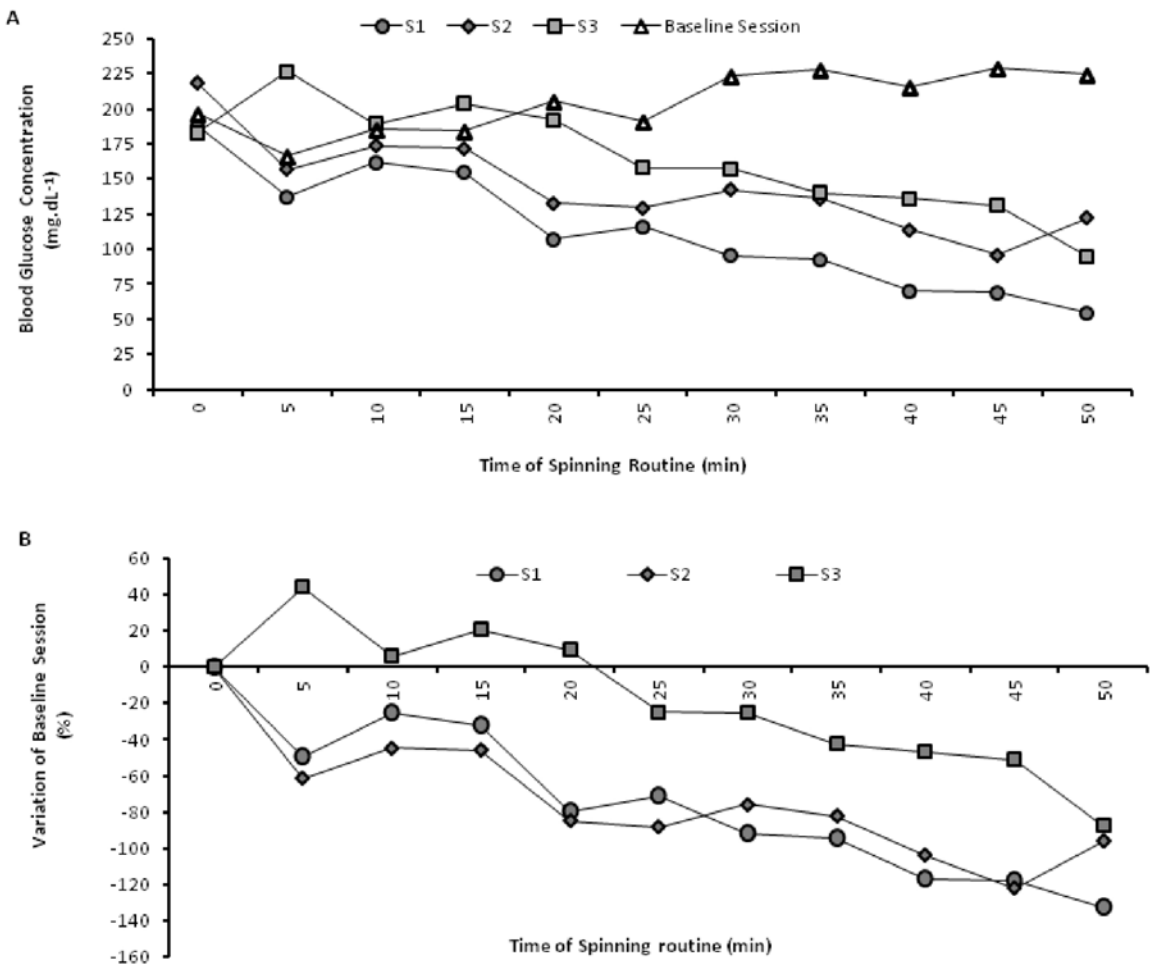


**Figure 1:** Panel **A** shows the blood glucose concentrations (mg.dL$^{-1}$) during the S1 (continuous light routine; 60-75% $HR_{RES}$), S2 (continuous moderate routine; 65-85% $HR_{RES}$), S3 (heavy intermittent routine; 60-90% $HR_{RES}$) and baseline session and Panel **B** shows the relative deviation from baseline session (%) during S1, S2 and S3 routines.

**Table 1: Blood Glucose Concentrations at the Exercise Endpoint and After 10 Minutes of the Spinning Routines**

| | | S1 | S2 | S3 | S4 |
|---|---|---|---|---|---|
| Spinning endpoint | BGC (mg.dL$^{-1}$) | 54.6 | 122.3 | 94.9 | 224.1 |
| | Variation (mg.dL$^{-1}$) | -132.6 | -96,0 | -88,0 | +28.0 |
| | Variation (%) | 70.3 | 56.0 | 51.9 | 114.2 |
| 10 minutes after | BGC (mg.dL$^{-1}$) | 100.4 | 105.1 | 163.2 | 284.1 |
| | Variation (mg.dL$^{-1}$) | -86.8 | -113.2 | -19.7 | +88.0 |
| | Variation (%) | 46.3 | 51.8 | 10.77 | 144.8 |

BGC is the blood glucose concentration. Continuous light and moderate Spinning routines were S1 (60-75% $HR_{RES}$) and S2 (65-85% $HR_{RES}$) and heavy intermittent Spinning routine was S3 (60-90% $HR_{RES}$). Measures were obtained at the exercise endpoint and 10 minutes after the Spinning routines.

Although the similar pattern in the initial rest blood glucose concentrations, different blood glucose responses occurred during the Spinning routines. The Figure **1** depicts these responses in absolute (mg.dL$^{-1}$) and relative (%) terms, during S1, S2 and S3 sessions. There was a greater reduction in blood glucose concentrations along the exercise in the continuous light (S1) and moderate (S2) sessions, when compared to the intermittent heavy session (S3).

## 4. DISCUSSION

The aim of this study was to report the acute effects of different Spinning routines, set at different

intensities, in the blood glucose responses in a T1DM woman. These results suggest that different Spinning sessions may reduce the blood glucose concentrations, and that continuous light and moderate Spinning routines may induce greater responses.

The success of the blood glucose concentrations control in T1DM individuals depends on different strategies such as exogenous insulin administration, diet and exercise programs regime [4]. This case report highlights the importance of an acute exercise to the acute blood glucose control in T1DM patient as the Spinning exercise routines, in combination with other factors (i.e. exogenous insulin and diet), reduced the blood glucose concentrations when compared to the use of exogenous insulin and diet in isolation. Considering that the day-to-day blood glucose control is sought in long term metabolic diseases treatment [4-6,17,18], interventions including indoor exercises such as Spinning may be profitable. The T1DM woman investigated in the present report presented tighter blood glucose levels during the days in which Spinning routines were performed.

Hopkins [19] observed that the mode of exercise, time of day and diet may affect the control of the glycaemia. Regarding the exercise mode, it was suggested that the continuous moderate exercise may be an adequate exercise mode for the blood glucose concentrations control. Our case report agrees with Hopkins' suggestion as the S1 and S2 Spinning routines, the light and moderate continuous exercises, induced greater decrease in the blood glucose concentrations than the intermittent heavy Spinning routine. These results may be related to the exercise intensity, rather than the exercise mode. The intensity used in the S3 session was apparently greater than the anaerobic threshold intensity, which may have led to a higher activation of the sympathetic nervous system, inducing a greater hepatic glycogenolisis and increasing the blood glucose levels when compared to than S1 and S2 [20]. Actually, similar results were found in health and type 2 diabetes individuals [21]. Thus, a higher glycolitic pathway may have precluded a greater reduction in the blood glucose concentration during the intermittent heavy Spinning routine [20].

The question which remains to be answered is whether the effects observed after acute Spinning routine may be observed in other T1DM patients as well as after long term Spinning routines. Given the specificity of this metabolic disorder the first question is difficult to be answered as the investigation of the exercise effects on blood glucose levels in T1DM patients is restricted to case report study designs. However, as suggested in different exercise modes it is possible to suppose that positive effects may occur in the blood glucose levels control after long term Spinning exercise routines [3,6,7,19,21]. Future studies using similar designs with different exercise protocols may help to address information to this issue.

In summary this case report suggest that Spinning routines, an indoor cycling exercise mode, could be used in addition to other forms of intervention to promote acute reductions in the blood glucose concentration in T1DM individuals. In this regard, continuous light and moderate Spinning routines may be convenient to induce greater reductions in the blood glucose concentrations than the intermittent heavy routines.

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