

## Effect of Frequency of Physical Exercise on Glycemic Control and Body Composition in Type 2 Diabetic Patients

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### Summary

**Background:** Diabetes and cardiovascular disease have emerged as key threats to human health, and the risk is increased in individuals with visceral obesity. The consensus is that physical exercise should be part of the treatment of diabetes mellitus (DM).

**Objective:** To compare the influence of guided and structured physical exercise programs (SPEP), three to five times per week, during a period of 20 weeks, on glycemic control and body composition of type 2 diabetic patients (DM2).

**Methods:** The research was conducted at the Universidade Federal de São Paulo (Federal University School of Medicine in São Paulo). At the clinical visit, patients from the Control Group (CG) n=17, mean age 55.8 years, were encouraged to engage in a physical exercise program. Patients from Group 3x (G3), n=14, mean age 57.4 years, were to engage in 1 hour of physical exercise, 3x/week, and Group 5x (G5), n=9, mean age 58.8 years, followed the same protocol but 5x/week. Mean of 5 years since diagnosis in all groups. Classes consisted of a 5-minute warm-up, 30-minute treadmill walk at 70% of maximum heart rate, and 10-minute relaxation. BMI, abdominal circumference (AC), percentage of body fat (BF), capillary glycemia (CG), fasting glycemia (FG), and glycated hemoglobin (HbA1c) were assessed.

**Results:** A comparison was made between the baseline time point (B) and the 20th week (20th). BMI in G3 (B:29.5±2.9 vs. 20th: 28.3 ± 2.2 Kg/sqm, p=0.005) and G5 (B:29.7±4.4 vs. 20th: 29.1 ± 4.3 Kg/sqm, p=0.025); abdominal circumference in G5 (B:100.5±11.9 vs. 20th: 933 ± 11.7 cm, p=0.001); BF in G3 (B:31±5.1 vs 20th: 26±5%, p=0.001) and G5 (B:32.4 ± 5.4 vs. 20th: 30.3 ± 6.9%, p=0.001); FG, G5 (B:150.8 ± 47.5 vs. 20th: 109.2± 30.5 mg/dL, p=0.034), showed statistically significant differences. CG did not show statistically significant differences for these variables. CG showed a tendency to drop after physical exercise in G5. HbA1c showed no statistically significant differences in the three groups.

**Conclusion:** G5 did better than G3 in most parameters assessed. However, results failed to show a decrease of HbA1c in DM2 patients. (Arq Bras Cardiol 2009;92(1):22-28)

**Key Words:** Diabetes mellitus, type 2; exercise; blood glucose; control; body composition.

### Introduction

Atherosclerosis is the most important cause of mortality and great morbidity among diabetic patients. Endothelial dysfunction is thought to play a key role in the initial lesion of atherosclerosis. Endothelial dysfunction has been documented in type 2 diabetes mellitus (DM2), where hyperglycemia is associated with increased oxidative stress, leading to increased formation of oxygen radicals such as superoxide that reacts with nitric oxide and causes its breakdown<sup>1</sup>.

Diabetes and cardiovascular disease have emerged as key threats to human health, and the risk is increased in individuals with visceral obesity<sup>2,3</sup>.

The consensus is that physical exercise should be part of diabetes mellitus (DM) treatment, as well as diet and medication. Unfortunately, this is not common practice, according to routine clinical visits. This is likely due to the lack of understanding and/or motivation in some of these individuals and their assistants. The very frequency of such recommendations by healthcare professionals is deficient<sup>4</sup>.

Among participating factors are genetic determinants, age differences, biotype, patient' physical fitness, duration, and modality of exercise<sup>5-8</sup>.

Studies have shown that the effects of physical exercise on glycemic control can be temporary, with a post-exercise drop in glycemia that is soon restored to pre-exercise values once physical activity is discontinued<sup>9,10</sup>.

Most studies conducted with the objective of obtaining good control levels of glycated hemoglobin (HbA1c) were not effective. One possible reason could be related to the frequency of exercise sessions (3x per week). It is known that

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the increase in insulin sensitivity levels associated with physical exercise lasts no longer than 72 hours<sup>5</sup>. One suggestion for avoiding this would be to increase the frequency of exercises so that the interval between sessions does not exceed this period.

On the other hand, reports of the impact of physical exercise frequency on DM2 body composition are scarce.

The aim of this study was to compare the effect that the frequency of a physical exercise program has on body composition and glycemic control in DM2 patients.

## Methods

### Patients

This is a randomized prospective study conducted to evaluate 40 individuals with Type 2 diabetes mellitus (DM2). Patients signed Informed Consent Forms in order to participate in the research.

Inclusion criteria were: 1) diagnosis of DM2, according to the American Diabetes Association criteria<sup>11</sup>; 2) less than 10 years since diagnosis of DM; 3) both genders; 4) age between 40 and 65 years; 5) Body Mass Index (BMI): 25-35 kg/sqm; 6) fasting glycemia < 250 mg/dL; 7) arterial blood pressure (AP): systolic  $\leq$  160 mmHg and diastolic  $\leq$  100 mmHg; and 8) absence of chronic clinical DM complications which could be harmful or be impaired by the physical exercise program.

Patients enrolled in the study were divided into three groups: Control Group = CG (n=17): during the routine visits with the multidisciplinary team, these patients received orientation and were encouraged to engage in spontaneous regular physical exercising; Group 3x = G3 (n=14), patients who participated in three workout sessions per week, and group 5x = G5 (n=9) patients who participated in five workout sessions during 20 weeks (Table 1).

The study protocol was previously approved by the Research Ethics Committee of the *Universidade Federal de São Paulo* (CEP Protocol number 1293/00).

### Physical exercise program

The structured physical exercise program (SPEP) was conducted at the Respiratory Physiology Unit of the Pneumology Department under the supervision of physical education teachers.

At the start of the SPEP program, G3 and G5 patients attended a lecture when the program was explained, including its benefits, risks and recommendations to be followed to assure that physical exercises were performed safely.

SPEP was conducted in the morning after a routine meal in a workout room equipped with treadmills and stretching mats.

Classes were divided as follows: 1) warm-up (5 minutes): stretching exercises; 2) main exercises (30 minutes): walking on the treadmill, and 3) back to relaxation (10 minutes): stretching, relaxation and body consciousness.

At the beginning of the program, intensity of the physical exercise was kept at 60% of the maximum heart rate (max HR) predicted for the age (220 - age) for both groups (G3 and G5), and gradually increased until reaching the 70% of max HR target<sup>12</sup>.

**Table 1 – Baseline characteristics of DM2 patients**

Characteristics	Baseline		
	CG	G3	G5
n	17	14	09
Age (Years)	55.8±6.6	57.4±5.3	58.8±6.1
TDDM (Years)	5.8±3.1	5.4±2.9	6.0±3.0
BMI (Kg/Sqm)	27.6±5.8	29.5±2.9	29.7±4.4
Abdominal Circumference (Cm)	92.8±10.4	93.2±12.9	100.5±11.9
Systolic Arterial Pressure (MmHg)	13.4 ± 6.0	12.7±4.0	12.8±2.0
Diastolic Arterial Pressure (MmHg)	8.6±4.0	8.0±4.0	8.0±2.0
Percentage of Body Fat (%)	28.6±8.1	31±5.1	32.4 ± 5.4
Fasting Glycemia (mg/dL)	193.8±106.4	142.7±83.1	150.8±47.7
Postprandial Glycemia (mg/dL)	234.3±112.7	218±64.4	214±81.7
HbA1c (%)	9.0±3.1	8.2±1.9	7.7 ± 1.8

*\*data are presented as means and standard deviations; CG - Control Group; G3 - Group that participated in physical exercise classes 3 times per week; G5 - Group that participated in physical exercise classes 5 times per week; TDDM - time from diagnosis of DM; BMI - Body Mass Index; HbA1c - Glycated hemoglobin*

### Clinical and metabolic parameters

Capillary glycemia (Roche and Abbott meters for capillary glucose testing were used) and heart rate were measured before and after each SPEP session.

All patients enrolled in our study displayed glycemia levels within the recommended range (<250 mg/dL) before beginning each exercise session. Approximately 1,608 capillary glycemia tests were performed in G3, and 1,800 in G5.

Abdominal circumference (AC) was measured with a measuring tape placed around the smallest perimeter of the abdominal area with the patient standing and after normal expiration.

Body weight was measured to the nearest 0.1 kg using a calibrated scale, with subjects wearing light clothing and no shoes. Height was measured to the nearest 0.5 cm using a stadiometer, with subjects barefoot. BMI (kg/sqm) was calculated dividing the individual's weight (Kg) by the squared height in meters.

Percentage of body fat was calculated using the Pollock and Jackson protocol and measuring the following skin folds: triceps, suprailiac and thigh for women, and thorax, abdomen and thigh for men<sup>13</sup>.

Abdominal waist (AW) and BMI were measured by the same professional at all data collection time points.

Fasting glycemia and glycated hemoglobin were measured after a period of 8-12 hours, and postprandial glycemia 2 hours after a standardized 300 kcal snack (50g CHO).

Plasma glucose was determined using the GOD-PAP

method, considering 70-100 mg/dL as the reference values. Measurement of HbA1c was performed using high-performance liquid chromatography (TOSOH automated analysis of glycated hemoglobin, Shiba, Mianto-ku, Tokyo, Japan), with nominal values between 3.6 and 6.8%.

Over the period of the study, patients continued to take their regular medications, which are indicated on Table 2.

### Statistical analysis

Variable averages were compared using repeated measurement analysis of variance. Multiple comparisons were carried out in order to consider Fisher's significant smallest difference, as well as the Kruskal-Wallis non-parametric test. An  $\alpha = 0.05$  significance level was adopted for all tests.

## Results

The baseline evaluation of the study groups showed no significant difference among demographic, clinical, and metabolic characteristics (Table 1).

### Intragroup evaluation

#### BMI, abdominal waist, and percentage of fat

A significant BMI reduction in G3 was recorded starting at the 8<sup>th</sup> week of SPEP (B: 29.5 vs. 2.9, 8<sup>th</sup> week:  $29.0 \pm 2.7$  kg/sqm,  $p=0.013$ ), and continuing through the 16<sup>th</sup> week (8<sup>th</sup> week: 29.0 vs. 2.7, 16<sup>th</sup> week: 28.8, 2.6, kg/sqm,  $p=0.023$ ). In the 20<sup>th</sup> week of SPEP, BMI showed a statistically significant difference as compared to baseline BMI of G3 patients (B: 29.5 vs. 2.9, 20<sup>th</sup> week:  $28.3 \pm 2.2$  kg/sqm,  $p= 0.005$ ) and in G5 patients (B:  $29.7 \pm 4.4$  vs. 20<sup>th</sup> week =  $29.1 \pm 4.3$  kg/sqm,  $p=0.025$ ). CG patients showed no statistically significant differences in BMI over that period.

No significant differences were observed in patients' ACs (Control and G3 groups) over the entire period of the study.

Table 2 – Medications used

	CG	G3	G5
<b>Oral hypoglycemic agents</b>			
Glibenclamide	4	3	1
Metformin	8	6	3
Clorpropamide	1	-	-
Glimepiride	1	1	-
Glibenclamide/ Metformin	-	3	-
Glibenclamide/ Metformin/Acarbose	-	1	-
Glibenclamide/ Metformin	-	-	1
Glimepiride/ Metformin	-	-	1
Repaglinide	-	-	1
<b>Insuline</b>			
NPH	8	3	1

CG - Control Group; G3 - Group that participated in physical exercise sessions 3 times per week; G5 - Group that participated in physical exercise sessions 5 times per week

On the other hand, G5 patients' AC dropped after the 8<sup>th</sup> week of SPEP (B: 100.5 vs. 11.9, 8<sup>th</sup> week:  $93.0 \pm 10.8$  cm,  $p=0.001$ ), and showed no difference from the baseline value in the 16<sup>th</sup> week, but dropped again in the 20<sup>th</sup> week (B: 100.5  $\pm 11.9$  vs. 20<sup>th</sup> week =  $93.3 \pm 11.7$  cm.  $p=0.001$ ).

Systolic arterial pressure (SAP) and diastolic arterial pressure (DAP) showed no statistically significant changes in the CG and G3 groups. The G5 group showed a tendency towards a reduction, although not statistically significant (SAP - B:  $12.8 \pm 2.0$  mmHg vs. 20<sup>th</sup> =  $12.5 \pm 2.0$  mmHg, and DAP - B:  $8.0 \pm 2.0$  mmHg vs. 20<sup>th</sup> =  $7.6 \pm 3.0$  mmHg).

The percentage of body fat showed a significant reduction in the G3 and G5 groups as compared to the baseline values in the 20<sup>th</sup> week (G3 - B: 31.0 vs. 5.1 x 20<sup>th</sup> week:  $26.0 \pm 5.0$  %,  $p= 0.001$  and G5 - B:  $32.4 \pm 5.4$  vs. 20<sup>th</sup> week =  $30.3 \pm 6.9$ %,  $p = 0.001$ ). The CG showed no statistically significant changes in the percentage of body fat over the period of study.

### Capillary glycemia monitored during the Physical Exercise Program

There was a tendency towards a drop in capillary glycemia levels monitored after SPEP sessions in G5. These data are displayed on Figure 1.

### Fasting and Postprandial Glycemia, and HbA1c

Fasting glycemia values (B: 150.8 vs. 47.5 vs. 20<sup>th</sup>:  $109.2 \pm 30.5$  mg/dl),  $p= 0.034$ ) and postprandial values (B: 214.5  $\pm 81.7$  vs. 20<sup>th</sup> week:  $194.4 \pm 53.4$  mg/dL  $p=0.028$ ) showed a significant reduction compared to baseline only for the G5 evaluation performed at the 20<sup>th</sup> week. These data are displayed on Figures 2 and 3. The CG showed no statistically significant changes in fasting and postprandial glycemia values over the study period.

Glycated hemoglobin in the 20<sup>th</sup> week of SPEP showed no significant differences as to baseline values in the two SPEP groups (G3 - B:  $8.2 \pm 1.9$  vs. 20<sup>th</sup> week:  $7.4 \pm 1.2$  % and G5 - B: 7.7 vs. 1.8 vs. 20<sup>th</sup> week:  $7.4 \pm 0.7$ %), and in the control group (CG - B: 9.0 vs. 3.1 x 20<sup>th</sup> week:  $8.7 \pm 2.6$ %).

### Intergroup evaluation

The intergroup evaluation showed no statistically significant difference in the three groups. Table 3 displays data obtained on the variables for the 3 groups in the study periods.

## Discussion

This study has shown that a structured program of moderate intensity physical exercise (SPEP) can lead to a drop in BMI and in the percentage of body fat for a group of DM2 patients as of the 8<sup>th</sup> week of exercise. However, with an increased frequency to 5x per week, there may be additional effects such as reduction in abdominal circumference, mean capillary glycemic values, and fasting and postprandial glycemic values. The addition of twenty weeks of SPEP to a group of DM2 patients who were following a stable anti-hyperglycemic treatment was not enough to reduce HbA1c values.

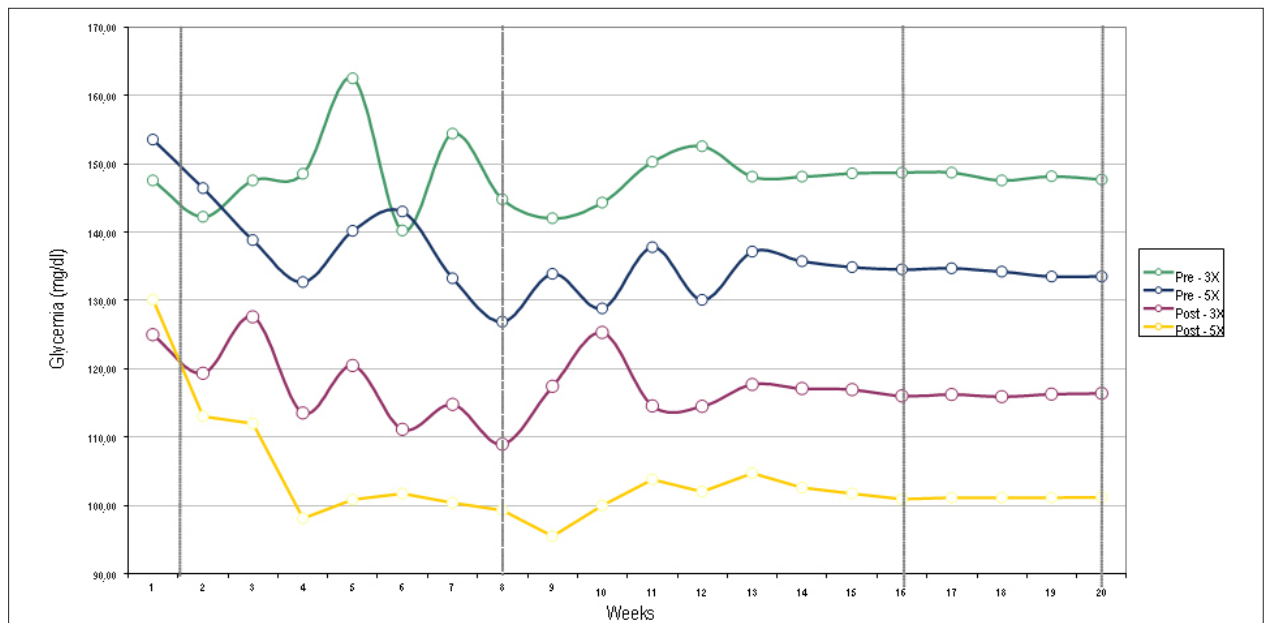


Figure 1 - Capillary glycemia levels before and after physical exercise of G3 (3x/week) and G5 (5x/week) patients.

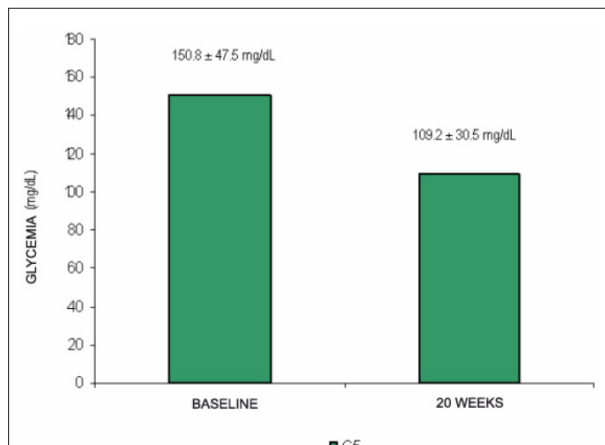


Figure 2 - Fasting glycemia over the 20 weeks of SPEP in the groups studied

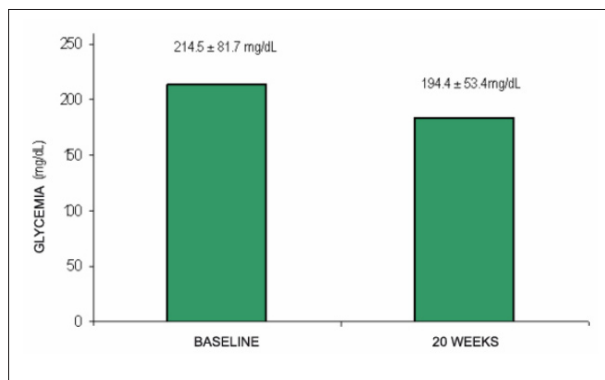


Figure 3 - Postprandial glycemia over the 20 weeks of SPEP in the groups studied

Therefore, these data corroborate the controversies observed in studies that analyzed just the effect of regular physical exercise on the metabolic control of DM2 patients<sup>5-8</sup>.

As per baseline BMI classification<sup>13</sup>, CG, G3, and G5 individuals were considered overweight. Despite the statistically significant drop observed in G3 and G5, the comparison between the baseline and 20<sup>th</sup> week values showed that individuals were still overweight at the end of the study.

One of the interesting findings in our study was that a reduction in BMI was observed as of the 8<sup>th</sup> week of SPEP in G3, which remained through the 16<sup>th</sup> and 20<sup>th</sup> weeks. As to G5, the reduction was observed only when baseline and 20<sup>th</sup> week values were compared. This delay in BMI reduction in this latter group may be due to an unconscious increase of calorie intake to compensate for the increase in physical activity.

We should take into consideration that physical exercise improves the metabolic profile and has anti-inflammatory effects in DM2 patients, even when no significant loss of body weight is achieved<sup>14</sup>.

A reduction in AC occurred only in G5. G5 baseline AC was greater than that recorded for G3, what can account for the greater drop in G5. Riddell (2007)<sup>15</sup> explains that DM2 patients lose visceral fat even when they do not lose body weight, thus explaining the reduction in abdominal circumference. It is known that a reduction in abdominal circumference is a strong indicator of a drop in cardiovascular risk<sup>16</sup>.

A study by Boulé et al.<sup>7</sup> also showed a reduction in abdominal circumference after a series of exercises. We know that a reduction in this variable is very important for diabetes patients, because there is a positive relationship among abdominal circumference, central obesity, insulin resistance, metabolic syndrome, and cardiovascular disease<sup>7</sup>.

**Table 3 – Variables for the 3 groups in the periods evaluated**

CG				
	Baseline	8 Weeks	16 Weeks	20 Weeks
BMI (Kg/Sqm)*	27.6	27.9	27.9	28.6
Percentage Of Body Fat (%)*	28.6	25.9	27.4	26.3
Abdominal Circumference (cm)*	92.8	93.9	93.9	94.7
Systolic Arterial Pressure (Mmhg)*	13.4	13.6	13.5	13.8
Diastolic Arterial Pressure (Mmhg)*	8.6	9.0	9.0	9.0
Fasting Glycemia (Mg/Dl)*	193.8	193.0	196.6	197.4
Post-Prandial Glycemia (Mg/Dl)*	234.3	298.5	271.3	256.0
Hba1c (%)*	9.0	8.7	8.2	8.7

CG - Control Group; BMI - Body Mass Index; Hba1c - Glycated hemoglobin; \* no statistically significant changes occurred over the periods evaluated

G3					
	Baseline	8 Weeks	16 Weeks	20 Weeks	p
BMI (Kg/Sqm)	29.5	29.0	28.8	28.3	0.005
Percentage Of Body Fat (%)	31.0	27.6	28.4	26.0	0.001
Abdominal Circumference (cm)*	93.2	92.7	90.8	91.8	
Systolic Arterial Pressure (Mmhg)*	12.7	12.6	12.6	12.5	
Diastolic Arterial Pressure (Mmhg)*	8.0	8.0	7.7	7.6	
Fasting Glycemia (Mg/Dl)*	142.7	132.2	124.2	141.1	
Postprandial Glycemia (Mg/Dl)*	218.0	236.7	191.7	206.5	
Hba1c (%)*	8.2	8.2	7.3	7.4	

G3 - Group That Participated In Physical Exercise Sessions 3 Times Per Week; Bmi - Body Mass Index; Hba1c - Glycated Hemoglobin; \* No Statistically Significant Changes Occurred; P - Statistically Significant Changes – Baseline Vs. 20<sup>th</sup>week

G5					
	Baseline	8 Weeks	16 Weeks	20 weeks	p
BMI (Kg/Sqm)	29.7	29.5	29.5	29.1	0.025
Percentage Of Body Fat (%)	32.4	30.4	30.7	30.3	0.001
Abdominal Circumference (cm)	100.5	93.0	93.5	93.3	0.001
Systolic Arterial Pressure (Mmhg)*	12.8	12.6	12.5	12.5	
Diastolic Arterial Pressure (Mmhg)*	8.0	7.5	7.7	7.6	
Fasting Glycemia (Mg/Dl)*	150.8	123.2	126.5	109.2	0.034
Postprandial Glycemia (Mg/Dl)*	214.0	199.1	175.0	194.4	0.028
Hba1c (%)*	7.7	8.0	7.3	7.4	

G5 - Group That Participated In Physical Exercise Sessions 5 Times Per Week; Bmi - Body Mass Index; Hba1c - Glycated Hemoglobin; P - Statistically Significant Changes – Baseline Vs. 20<sup>th</sup> Week; \* No Statistically Significant Changes Occurred

The positive relationship between AC, central obesity, insulin resistance, metabolic syndrome, and cardiovascular disease<sup>17</sup> makes the reduction in this variable one of the important objectives in the treatment of DM2.

Systolic and diastolic arterial pressures showed no statistically significant changes. In the G5 group, a tendency towards a drop in SAP and DAP was recorded. Arterial

hypertension is one of the leading risk factors for the onset and progress of chronic complications of DM2. Physical exercise is one of the pillars in the treatment of hypertension in diabetic patients, and a positive influence on the drop of arterial pressure in DM2 patients<sup>18</sup>. In our study, arterial pressure values were not very different from the reference values (SAP = 120-129 mmHG and DAP = 80-84 mmHg)<sup>19</sup>. Therefore,

this could be one reason why no significant reduction in these values was observed.

As to percentage of body fat, a significant drop was recorded for groups 3 and 5. In his 2007 study of changes in the level of physical activity and body composition of DM2 patients after an interventionist program, Mathieu et al<sup>18</sup> also reported a reduction in body fat percentage calculated from skin folds, and an improvement in patient fitness, thus reducing cardiovascular risks.

A drop in capillary glycemia right after the workout sessions indicated the acute effect of physical exercise. It was also possible to detect a smaller variation in capillary glycemic levels of G5 patients after physical exercise, but this variation was not statistically significant. In our study, the intensity or duration of the sessions may not have been enough to ensure significant acute changes in capillary glucose levels in this group of patients.

After the 13<sup>th</sup> week, a better control of glycemic levels measured before physical exercise sessions in both groups was recorded, indicating a residual effect of SPEP on baseline glycemia. Nevertheless, data in our study on the topic suggest that G5 had lower and more stable capillary glycemic levels than G3 (Figure 1). However, these differences were not statistically significant. Frequency of physical exercise seems to be an important factor in controlling baseline glycemia. These findings add to those of other studies reporting the acute effect of physical exercise, but the long-term effect was not as clear<sup>20-22</sup>.

The relationship between fasting glycemia and physical exercise programs is controversial. A recent study<sup>7</sup> showed that FG increases within 24 to 72 hours after a workout session (60% of max.  $\text{VO}_2$ , one-hour long, 3x week). In this program, patients with Type 2 diabetes were on a diet and used oral agents. In our study, a drop in fasting glycemia was observed only in G5.

A further discrepancy among these studies and in ours as well, may involve medication, particularly insulin and oral hypoglycemic agents taken by DM2 patients. For instance, there are studies<sup>17</sup> in which the oral hypoglycemic medications were interrupted 7 days before the beginning of the study. Since our patients did not interrupt the use of medication prescribed by their doctors, there may be different effects on fasting and postprandial glycemia.

In the groups evaluated, we found a reduction in HbA1c ranging from 0.3 to 0.8 percentage points. Despite being aware of the clinical importance of such a reduction, considering that a 1% drop in HbA1c value is associated with a 15%-20% reduction in cardiovascular events and a 37% reduction in microvascular complications<sup>3</sup>, in our sample this difference was not significant. Nevertheless, it is important to stress that by the 20<sup>th</sup> week, patients in groups G3 and G5 had reached HbA1c values close to suggested disease-control levels<sup>5</sup>.

Studies in medical literature<sup>7</sup> about the influence of physical exercise on HbA1c have reported heterogeneous results. A recent meta-analysis considered data from 14 studies, which reported a reduction of approximately 10% in HbA1c concentrations with physical exercise<sup>23</sup>.

The effect on insulin sensitivity is triggered by the physical exercise session itself, and remains for a relatively short time (no longer than 72 hours). Here we have a clear example of an acute and non-chronic effect leading to an important methodological issue, as some studies have retested their patients at different times elapsed since the last workout session and may have found, therefore, different effects<sup>23</sup>.

It is important to analyze that the effect on insulin sensitivity of one single workout session remains for 24-72 hours, depending on the duration and intensity of the exercise. That is because the duration of the increase in insulin sensitivity generally does not last longer than 72 hours. It is recommended that the interval between sessions does not exceed 72 hours<sup>5</sup>.

Reduced insulin resistance and increased sensitivity can be, above all, a response to each exercise session, rather than the long-term result associated with exercise training<sup>24</sup>.

Nonetheless, in the two experimental groups (G3 and G5), the interval between sessions was less than 72 hours including weekends. Even then, in our study, no improvement in HbA1c values (chronic effect on physical exercise) was observed.

Ligtenberg et al<sup>25</sup> reported a significant reduction of glycated hemoglobin in type 2 diabetes, but only with one year of training and not within 6 months. This suggests that a difference in glycemic control can only be achieved with regular physical exercising over a longer period.

Moreover, exercise intensity is also important to reduce HbA1c values. There are studies showing that it is important to encourage type 2 diabetes patients who already are engaged in physical exercise to consider increasing the intensity from moderate to high, which could result in additional benefits, especially concerning glycemic control.<sup>5, 26</sup>

Non-optimized dieting and therapeutic plans, added by physical exercise performed at only 70% of maximum heart rate due to the limitations of this group of patients may account for the non-reduction in HbA1c and the lack of continuous control of glycemia in DM2 patients.

Baseline HbA1c values should also be considered. It seems that the higher the HbA1c levels at the beginning of the treatment, the greater the drop of these levels will be. In our study, HbA1c values in G3 and G5 were not very different (0.9 to 1.3%) from the reference values. Therefore, this could be another reason why no significant reduction in these values was observed in our study. The small size of our sample may also account for the statistically non-significant drop in HbA1c.

## Conclusion

Our results show that the ideal frequency of a moderate intensity physical exercise program for DM2 patients, in the great majority of parameters evaluated, is five times per week (5x). However, results did not show a decrease of HbA1c values in patients with DM2.

### Potential Conflict of Interest

No potential conflict of interest relevant to this article was

reported.

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### Study Association

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