



THE EFFECT OF AEROBIC EXERCISE ON FASTING GLUCOSE LEVEL IN PATIENTS WITH DIABETES

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ABSTRACT

Aim: To investigate the effect of aerobic exercise on the fasting glucose level in patients with type 2 diabetes (T2DM). **Material and Methods:** The study was performed on patients with T2DM diagnosed with degenerative arthritis who visited the physical therapy and rehabilitation polyclinic of the state hospital between March 2015 and June 2015. A total of 35 patients, age 40–70 years, who agreed to participate in the study were included. The patients were asked to fill a descriptive questionnaire to define their sociodemographic aspects. A 3-week high-intensity (four times a week, each session lasting 45 min) aerobic exercise training was included in their rehabilitation program. The effect of aerobic exercise training was evaluated by checking their fasting plasma glucose levels that were taken from peripheral blood (brachial vein) samples before and after the therapy. **Results:** The average age of the patients was 57.6 ± 6.9 years (min. 25, max. 70); 36.1% of the participants were males, and 63.9% were females. The average value of their visual analog scale (VAS) in the recreation period before the therapy and in the activity period was 4.3 ± 2.7 and 6.9 ± 2.2 , respectively. The average value of their VAS in the recreation period after the therapy and in the activity period was 2.2 ± 1.7 and 4.7 ± 2.23 , respectively. Hence, the present study showed a statistical difference between the average values of VAS before and after the therapy ($P < 0.05$). Moreover, the average value of the fasting plasma glucose level before and after the therapy was 163.9 ± 19.1 and 140.3 ± 16.3 mg/dl, respectively. Hence, the study demonstrated a statistical difference between the fasting plasma glucose levels before and after the therapy ($P < 0.05$). **Conclusions:** The high-intensity aerobic exercise has a positive effect on T2DM. Therefore, patients with T2DM should exercise at all the stages of the therapy, notably for prevention.

KEYWORDS: Aerobic exercise, diabetes mellitus, fasting plasma glucose, insulin resistance.

INTRODUCTION

Diabetes mellitus is one of the most important causes of disability and death owing to the complications emerging during the disease. Despite effective drug therapies and advanced clinical diagnostic methods, the incidence of type 2 diabetes (T2DM) and insulin resistance have increased in the last decades.^[1-3]

With exercise training, a significant recovery has been observed in glucose metabolism. Especially high-intensity aerobic exercises have led to the recovery of insulin sensitivity. In addition, the patients were found to be highly adapted to combined exercises. However, the practical applications of these exercise programs are insufficient in daily life and hence they need to be standardized worldwide.^[4,5] The present study aimed to investigate the effect of aerobic exercise on the fasting glucose level in patients with T2DM diagnosed with degenerative arthritis, and also the role of exercise in improving glucose metabolism.

MATERIAL AND METHODS

Sample area

The study was performed on patients with T2DM diagnosed with degenerative arthritis who visited the physical therapy and rehabilitation polyclinic of the state hospital between March 2015 and June 2015. A total of 35 individuals, aged 40–70 years, who agreed to participate in the study were included.

The power of the study was calculated using GPower 3.1 program. Taking specific parameters into account, the effect size was calculated as 0.824563. In 34 patients, the effect size was found to be 0.82, and the power of the study was estimated as $(1-\beta)$ 0.88 at 5% significance level.

Data collection and analysis

The patients were asked to fill a descriptive questionnaire to define their sociodemographic aspects. A 3-week high-intensity (four times a week, each session

lasting 45 min) aerobic exercise training was included in their rehabilitation program. The effect of aerobic exercise training was evaluated by checking their fasting plasma glucose levels that were taken from peripheral blood (brachial vein) samples before and after the therap.

The statistical analysis was performed using SPSS version 16 software. The relevance of variables to normal distribution was investigated using Shapiro–Wilk test. Student's *t* test was used for analyzing the variables that showed a normal distribution, and Wilcoxon test was used for the variables that did not have a normal distribution. A *P* value below 0.05 was considered as statistically significant.

RESULTS

The average age of the patients was 57.6 ± 6.9 years (min. 25, max. 70); 36.1% of the participants were males, and 63.9% were females. The individuals living in rural and urban areas were 32.2% and 67.8%, respectively. Eight percent of the women included in the study were illiterate and all the illiterate individuals are women.

The average value of their visual analog scale (VAS) in the recreation period before the therapy and in the activity period was 4.3 ± 2.7 and 6.9 ± 2.2 , respectively. The average value of their VAS in the recreation period after the therapy and in the activity period was 2.2 ± 1.7 and 4.7 ± 2.23 , respectively. Hence, the present study showed a statistical difference between the average values of VAS before and after the therapy ($P < 0.05$).

Moreover, the average value of the fasting plasma glucose level before and after the therapy was 163.9 ± 19.1 and 140.3 ± 16.3 mg/dL, respectively. Hence, the study demonstrated a statistical difference between the fasting plasma glucose levels before and after the therapy ($P < 0.05$).

The values for walking pace, harmony, timed up and go test, and functional reach test were different before and after the therapy ($P < 0.05$).

DISCUSSION

T2DM contributes to the most of the preventable deaths. Dysregulation of insulin activity (insulin resistance) and secretion (insulin deficiency) occurs in the development of T2DM.^[6,7] A number of studies have been performed on the positive effects of exercise and physical activity on insulin sensitivity and glycemic control.^[8,9,10,11,12,13,15,16,17,18] The epidemiologic studies indicate that individuals who have a physically active lifestyle have a lower risk of having disrupted glucose tolerance and developing T2DM (insulin-independent). Additionally, physical activity has a preventive effect in individuals who have a high risk of developing DM.^[19-21] The exercise-related changes in insulin sensitivity in T2DM need to be investigated further.^[11]

The question is whether patients with diabetes are different from normal population in terms of functional capacity. Insulin resistance and disrupted glucose tolerance-related genetic factors are associated with decreased functional capacity to adapt to physical exercise. Decreased functional capacity has been shown in patients with T2DM even before the generation of glucose intolerance.^[5] Exercise increases the insulin sensitivity in peripheral tissues (especially skeletal muscle). The increased insulin activity is also associated with insulin-regulated glucose transporters, GLUT4, and the activity of enzymes regulating glucose phosphorylation, storage, and oxidation.^[4,15,16] Exercise also exerts positive effects on glucose metabolism and insulin sensitivity by enhancing the balance between oxidants and antioxidants.^[3]

Additionally, the intensity of the exercise programs is also important. The blood glucose level decreases in obese patients with T2DM after low-moderate exercise and this effect continues after the exercise. However, the blood glucose level increases in the first 1 h after short-term, high-intensity exercise due to the effects of the inversely regulating hormones.^[8] Since the patients with T2DM have a lower oxygen-carrying capacity (VO_2) compared with the healthy population, the intensity of exercise should be defined by taking this fact into account and increased slowly to a tolerable level. Extreme care should be taken while prescribing exercise to the patients with T2DM. A weekly 45-min exercise program was administered in this study. No complications occurred during the therapy.

Other question is whether short-term exercise is sufficient. Regular physical exercise provides physiological benefits such as an increased resting and submaximal heart rate, increased heart beat and cardiac output, increased oxygen extraction, and decreased resting blood pressure in patients with T2DM.^[12] Also, insulin-dependent glucose uptake, and insulin sensitivity in skeletal muscle and adipose tissue increase in the 72-h period after physical activity. However, it has been shown that this effect reverts after a period of time. Therefore, a regular exercise plan is advised for these patients.^[13]

Exercise has been considered as a cornerstone in the management of T2DM for a long time. Aerobic exercise is offered as the most effective exercise method. It has long-term, positive effects on glucose metabolism of middle-age and old men and women. This effect is thought to be related with changes in body composition including a decrease in the total and central lipid indexes.^[24,26] Mairona et al investigated the effects of combined aerobic and resistance exercises on the fasting plasma glucose level in 16 patients with T2DM. At the end of an 8-week program, a decrease was noted in the peak oxygen intake, exercise test duration, HbA1c level, and fasting plasma glucose level, hence highlighting the positive influence of exercise on the control of glycemic

index. Van Dijkve et al also showed that moderate-intensity exercise enhances 24-h glycemic control in patients with T2DM.

In our study, we saw that fasting plasma glucose values in patients with T2DM are significantly decreasing after treatment. In addition, we saw that VAS values decreased after treatment respect to in treatment and before treatment values. The pain in the patients with degenerative arthritis is the factor which decreases life quality in daily life.

CONCLUSIONS

Insulin resistance and T2DM have been one of the most important health concerns in the last decades. Exercise has been shown to have a positive effect on glycemic control and insulin sensitivity in patients with T2DM. However, there is not an agreement about exercise programs. Hence, modifications in lifestyle including exercise, weight loss, and diet control are recommended in the treatment of patients with T2DM. Moreover, the exercise programs should be standardized based on the daily needs of the patients.

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