Effect of Short-Term Exercise Program on Exercise Tolerance in Uncomplicated Type 2 Diabetic Patients

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ABSTRACT

Background and purpose: *The number of people with type 2 diabetes mellitus is rapidly increasing. Key factors contributing to this increase include obesity and sedentary lifestyle. The presence of type 2 diabetes has been associated with a reduction in cardiovascular function and diminished levels of general fitness. These changes appear to be associated with a decreased capacity for physical work. Interventions are needed in this population to reduce progression from impairment to physical limitation and thereby to disability. Regular exercise improves clinical risk factors, cardiorespiratory fitness and insulin resistance. Diet control and exercise are considered important components of the treatment strategy for adults with type 2 diabetes. The purpose of the study is to investigate the effect of short-term exercise program designed and supervised by the physical therapy consultant on fasting blood glucose (FBG) level, lipid profiles, blood pressure (BP) and body weight and to correlate the changes of these variables to the level of exercise tolerance in terms of exercise test duration (ETD).* ***Study Design:*** *A controlled clinical intervention trial.* ***Material and Methods:*** *Thirty-two overweight male patients with type 2 uncomplicated diabetes mellitus aged 45.6 ± 4.9 years were participated in this study. Subjects were nonsmokers and non-athletes. A careful complete medical history and clinical examination were done. Laboratory tests appropriate to the evaluation of each patient's general medical condition were performed. Patients were referred to practice a short-term exercise program under the supervision of the physical therapist. All patients underwent a thorough physical examination. To measure cardiovascular fitness, the graded exercise test on the electric bicycle ergometer was performed before starting the exercise program (initial assessment) and two days after the last exercise session (final assessment). The exercise program was performed using the stationary bicycle for 12 weeks.* ***Results:*** *On comparing the initial and final assessments, the results showed a significant ($P<0.05$) reduction of mean fasting blood glucose level (154.7 ± 64.1 to 135.1 ± 42.8 mg/dl) and triglycerides (126.2 ± 12.2 to 117.1 ± 11.3 mg/dl). While total cholesterol (202.7 ± 6.4 to 201.1 ± 6.2 mg/dl) but low-density lipoprotein (130.1 ± 5.2 to 128.2 ± 5.2 mg/dl) showed insignificant ($P>0.05$) reduction. The mean values of systolic blood pressure (139.4 ± 8.61 to 122.6 ± 7.23 mm Hg), heart rate (84.6 ± 5.1 to 76.8 ± 4.3 beat/minute) and high-density lipoprotein (43.3 ± 2.8 to 48.3 ± 3.2 mg/dl) were reduced significantly ($P<0.05$). While diastolic blood pressure (85.7 ± 4.22 to 83.4 ± 3.54 mm Hg) showed insignificant ($P>0.05$) reduction. The body weight (78.1 ± 5.82 to 71.3 ± 4.93 Kg) and body mass index (27.6 ± 0.77 to 23.3 ± 1.32 Kg/m^2) were also reduced significantly ($P<0.05$). Finally, exercise test duration (9.2 ± 2.4 to 14.6 ± 2.1 minutes) was increased significantly ($P<0.05$) as the result of practicing the exercise program.* ***Discussion and Conclusions:*** *Participation in regular short term exercise program improves glycemic control and insulin resistance. Exercise training can also significantly reduce the decline in maximal aerobic capacity, improve risk factors for atherosclerosis and decrease body weight. Physical activity can improve lipoprotein profile, reduce BP and improve cardiovascular fitness as demonstrated by the exercise tolerance test.*
Key words: *Type 2 diabetes mellitus, exercise, physical activity.*

INTRODUCTION

Diabetes mellitus is a chronic disorder that requires a long-term medical care both to limit the development of its devastating complications and to manage them as they arise[1]. The prevalence of type 2 diabetes is increasing in all populations worldwide[2]. Diabetes was defined according to criteria of the American Diabetes Association as fasting plasma glucose level of ≥126 mg/dl[1]. Diabetes is characterized by peripheral insulin resistance with an insulin-secretory defect that varies in severity. These defects lead to increased hepatic gluconeogenesis, which produces fasting hyperglycemia. It is considered as a risk factor for numerous complications that will form a large burden to patients, their families and health care system[3].

The major risk factors for type 2 diabetes mellitus are; age >40 years, obesity, family history of type 2 diabetes in a first-degree relative, cigarette smoking, hypertension (>140/90 mm Hg) or dyslipidemia (high-density lipoprotein cholesterol <35 mg/dl or triglyceride level >250 mg/dl)[4].

Diabetic patients, particularly those with type 2 diabetes are at considerable risk of excessive morbidity and mortality from cardiovascular, cerebrovascular and peripheral vascular disease leading to myocardial infarction, strokes and amputations. Cardiovascular complications are the major causes of morbidity and mortality in those patients, both men and women are at increased risk[3]. Glycemic control deteriorates further with time as complications ensue. Reduction of mean glycemia over time prevents or delays microvascular and macrovascular complications[5]. Approximately 20–60% of patients with type 2 diabetes will develop hypertension, depending on age, ethnicity, and obesity. Studies indicate an increased risk of cardiovascular diseases with an increase in the level of blood pressure (BP). So that all patients with diabetes should have BP measured at the time of diagnosis or initial office evaluation and at each scheduled visit[6].

The presence of type 2 diabetes has been associated with a reduction in cardiovascular function and diminished levels of general fitness. These changes appear to be associated with a decreased capacity for physical work[7]. Interventions are needed in this population to reduce progression from impairment to physical limitation and from physical limitation to disability. Disability is a key indicator of the degree of morbidity associated with diabetes and a core component of the impact of diabetes on quality of life[8].

Before increasing usual patterns of physical activity or an exercise program, individuals with diabetes mellitus should undergo a detailed medical evaluation with appropriate diagnostic studies. A careful medical history and physical examination should focus on the signs and symptoms of diseases affecting the cardiovascular system, feet and nervous system, and the presence of diabetes complications. Identification of areas of concern will allow the design of an individualized exercise prescription that can minimize risk to the patient[9].

Exercise has become a standard therapy for patients with type 2 diabetes. Regular exercise improves clinical risk factors, cardiorespiratory fitness and insulin resistance[10]. Walking is an inherently safe, convenient and accessible form of exercise that is suitable for all ages. Regular walking can improve cardiovascular capacity and endurance[7]. Regular moderate-intensity exercise for 30 minutes at least 5 times per week is recommended for most diabetic patients[11]. Regular exercise training may

improve heart rate recovery in healthy individuals and in patients with congestive heart failure or diabetes[12].

The possible benefits of physical activity for the patient with type 2 diabetes are substantial, and several studies[10,13,14] strengthen the importance of long-term physical activity programs for the treatment and prevention of this common metabolic abnormality and its complications. Physical activity is typically recommended to improve risk factor profiles for patients with type 2 diabetes. It may contribute to weight loss, glycemic control, improvement of insulin sensitivity, BP, and lipid profiles.

Most patients who develop type 2 diabetes are obese, and obesity itself is associated with insulin resistance, which worsens the diabetic state[15]. Medical nutrition therapy is an integral component of diabetes management and of diabetes self-management education. Short-term diet control induced weight loss in patients with type 2 diabetes is associated with improvements in insulin sensitivity, improved measures of glycemia and dyslipidemia and reduced BP. Although there is some controversy over the optimal diet for adults with type 2 diabetes mellitus, there is a consensus to increase consumption of fruits and vegetables and decrease daily consumption of saturated fats[16].

Diet control and exercise are considered important components of the treatment strategy for adults with type 2 diabetes. Appropriate use of diet and exercise can improve insulin sensitivity and glycemic control and decrease the need for oral medications or insulin[11].

The aim of this study was to investigate the effect of short-term exercise program on blood glucose level, lipid profiles, BP and body weight; and to correlate the changes of these variables to the level of exercise tolerance in terms of exercise test duration (ETD).

MATERIAL AND METHODS

Subjects

Thirty-two overweight male patients with type 2 uncomplicated diabetes mellitus were participated in this study. Patients were firstly diagnosed as diabetics with a mean fasting blood glucose (FBG) level of 154.7 ± 20.1 mg/dl, mean age of 45.6 ± 4.9 years, weight 78.1 ± 5.82 Kg, height, 168.34 ± 6.61 and body mass index (BMI) of 27.63 ± 0.77 kg/m^2. (Table 1) BMI was calculated as weight in kilograms divided by height in meters squared[17]. Participants were nonsmokers, non-athletes and classified as inactive; if they did not report a regular engaging in any of the following activities during the previous month; walking, swimming and aerobics. Patients with concurrent medical conditions preventing exercise were excluded from the study and a written informed consent was obtained from all participants.

Table (1): Anthropometric and Clinical Data of the Participants.

FBG, mg/dl	Age, years	Weight, Kg.	Height, cm.	BMI, kg/m^2
154.7 ± 20.1	45.6 ± 4.9	78.1 ± 5.82	168.34 ± 6.61	27.63 ± 0.77
Values are expressed as means ± standard deviation. FBG, denotes fasting blood glucose level; BMI, body mass index; mg/dl, milligrams per deciliter; kg, kilograms; cm, centimeters; Kg/m^2, kilograms per square meters.				

Material

- Mercury sphygmomanometer (Focal, PyMah Corporation, Japan).
- Stethoscope (Dual-head, Model 412 Silver, Bumjin Medical, Instruments Industry Co, Italy).
- A balance weigh scale (Healthometer, Model 402KGS Bridgeview, Illionis, USA).
- Electric Bicycle Ergometer (Lode's Instrument B.V, Groningen, Netherlands).

Methods

Clinical Examination:

A careful complete medical history and clinical examination were carried out by the internal medicine consultant focused on the signs and symptoms of diseases affecting the heart and blood vessels, kidneys, feet and nervous system; and to confirm the absence of diabetes complications. Laboratory investigations appropriate to the evaluation of each patient's general medical condition were performed. Levels of; FBG, total cholessterol, triglycerides, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) were investigated following an overnight fast of 12 hours in the initial and final assessments for all participants. Then patients were referred to practice a short-term exercise program under the supervision of the physical therapy consultant without prescription of hypoglycemic agents. Patients were asked to follow a diabetic controlled diet.

Physical Therapy Role:

All patients underwent a thorough physical examination including a questionnaire featured items on health habits, including smoking history and whether the participant was currently dieting to lose weight or following any other special dietary plan. Physical activity pattern was ascertained by self-report on the questionnaire. A list of leisure-time physical activities was presented. Height and weight were measured by using the balance weigh scale. Resting heart rate was counted manually from the left radial artery and the resting arterial BP was measured by using the mercury sphygmomanometer. Both heart rate and arterial BP were recorded in the initial assessment and in the final assessment after practicing in exercise program. The measurements were performed under controlled conditions in a quiet room and using the same protocol for all patients at the initial assessment, follow-up examinations and final assessment.

Exercise tolerance test:

To measure cardiovascular fitness, the graded exercise test by using the electric bicycle ergometer was performed before starting the exercise program (initial assessment) and 2 days after the last exercise session (final assessment). The exercise test included a proper warm-up period consisted of 5 minutes of aerobic activity in the form of stretching and breathing exercises. Then by using the bicycle ergometer, patient was asked to exercise at initially work rate of 10 Watt/minute and thereafter it was increased every 1 minute by 15 Watt/minute. The test was continued until the sense of moderate breathlessness or discomfort in the lower limbs was presented. After that, a cool-down period was performed similarly to the warm-up and lasted for about 5 minutes. The exercise test duration was calculated as the period of actual exercise test without including the periods of warm-up and cool-down.

Exercise Program:

The exercise program was performed by using the stationary bicycle for 12 weeks under the supervision of the physical therapy

consultant. Training started with three sessions per week, lasting 20 minutes each, at an intensity eliciting 70% of maximal heart rate. The duration and number of sessions were gradually increased so that the final two weeks of training consisted of four sessions per week at 80% of maximal heart rate for 40 minutes.[18] The physical therapy consultant supervised the exercise each session. Patients were taught a series of flexibility and breathing exercises and encouraged to perform them at home while maintaining their regular lifestyle including the diabetic controlled diet prescribed by the physician.

Statistical Analysis

Data were collected and statistically analyzed by using mean, standard deviation and paired t-test at a level of significance of $P<0.05$ to test the difference of mean values of the studied variables between the initial and final assessment values.

RESULTS

The results showed that the mean level of FBG was reduced significantly ($P<0.05$), as it was 154.7 ± 20.1 mg/dl in the initial assessment and became 135.1 ± 12.8 mg/dl in the final assessment. The mean value of HDL was increased significantly ($P<0.05$), as it was 43.3 ± 2.8 mg/dl in the initial assessment and became 48.3 ± 3.2 mg/dl in the final assessment. While the mean value of triglycerides was reduced significantly ($P<0.05$), as it was 126.2 ± 12.2 mg/dl initial assessment and became 117.1 ± 11.3 mg/dl in the final assessment. The mean values of total cholesterol and LDL were reduced insignificantly ($P>0.05$) between the initial and final assessments, as they were 202.7 ± 6.4 mg/dl Vs 201.1 ± 6.2 mg/dl for total cholesterol and 130.1 ± 5.2 mg/dl Vs 128.2 ± 5.2 mg/dl for LDL. (Table 2 and Figure 1).

Table (2): The Studied Parameters in the Initial and Final Assessments.

Variables	Initial Assessment	Final Assessment	P Value
FBG, mg/dl	154.7 ± 20.1	135.1 ± 12.8	<0.05*
Cholesterol, mg/dl	202.7 ± 6.4	201.1 ± 6.2	>0.05
LDL, mg/dl	130.1 ± 5.2	128.2 ± 5.2	>0.05
HDL, mg/dl	43.3 ± 2.8	48.3 ± 3.2	<0.05*
Triglyceride, mg/dl	126.2 ± 12.2	117.1 ± 11.3	<0.05*
SBP, mm Hg	139.4 ± 8.61	122.6 ± 7.23	<0.05*
DBP, mm Hg	85.7 ± 4.22	83.4 ± 3.54	>0.05
HR. bpm.	84.6 ± 5.1	76.8 ± 4.3	<0.05*
Weight, Kg	78.1 ± 5.82	71.3 ± 4.93	<0.05*
BMI, Kg/m^2	27.6 ± 0.77	23.3 ± 1.32	<0.05*
ETD, min.	9.2 ± 2.4	14.6 ± 2.1	<0.05*

Values are expressed as means ± standard deviation. FBG, denotes fasting blood glucose level; LDL, low-density lipoprotein; HDL, high-density lipoprotein; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate; BMI, body mass index; ETD, exercise test duration; mg/dl, milligrams per deciliter; mm Hg, millimeter mercury; bpm, beats per minute; kg, kilograms; Kg/m^2, kilograms per square meters; min, minutes. *, denotes significant difference.

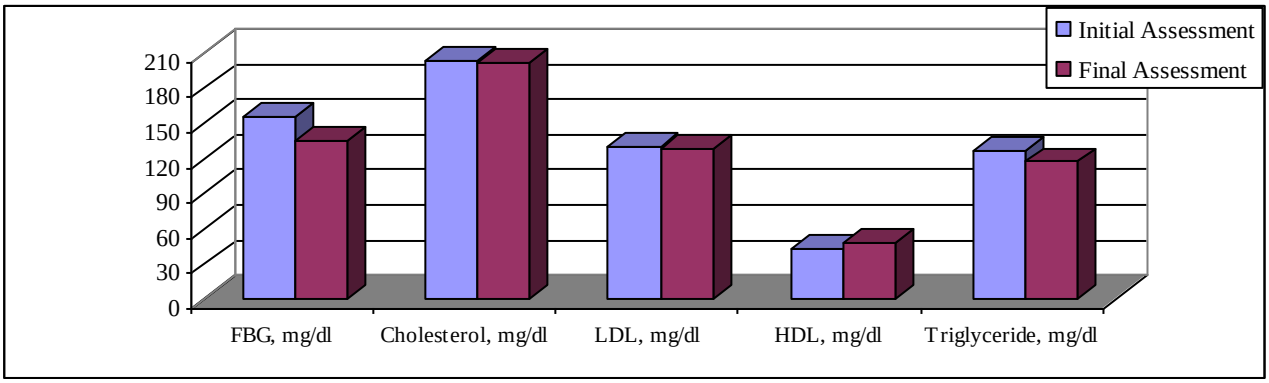

Fig. (1): Mean Values of Fasting Blood Glucose Level and Lipid Profiles in the Initial and Final Assessments.

The mean systolic blood pressure (SBP) was also reduced significantly (P<0.05) as it was 139.4 ± 8.61 mm Hg in the initial assessment and was 122.6 ± 7.23 mm Hg in the final assessment. While the diastolic blood pressure (DBP) showed insignificant (P>0.05) reduction, as it was 85.7 ± 4.22 mm Hg in the initial assessment and became 83.4 ± 3.54 mm Hg in the final assessment. The heart rate demonstrated significant (P<0.05) reduction as it was 84.6 ± 5.1 beat/minute in the initial assessment and became 76.8 ± 4.3 beat/minute in the final assessment. (Table 2 and Figure 2).

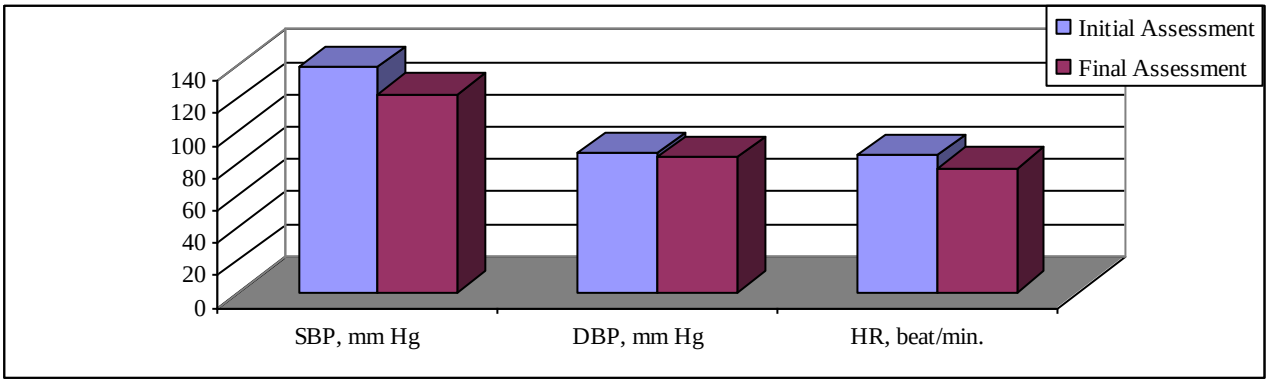

Fig. (2): Mean Values of Systolic and Diastolic Blood Pressures and Heart Rate in the Initial and Final Assessments.

Concerning the body weight, the results of the study demonstrated that there was a significant (P<0.05) reduction of its mean as the result of practicing the short-term exercise program where it was 78.1 ± 5.82 Kg in the initial assessment and became 71.3 ± 4.93 Kg in the final assessment. Consequently BMI was reduced significantly (P<0.05), as it was 27.6 ± 0.77 Kg/m^2 in the initial assessment and became 23.3 ± 1.32 Kg/m^2 in the final assessment. Finally, the exercise test duration showed a significant (P<0.05) increase as the result of practicing the exercise program, as it was 9.2 ± 2.4 minutes in initial assessment and became 14.6 ± 2.1 minutes in the final assessment. (Table 2 and Figure 3).

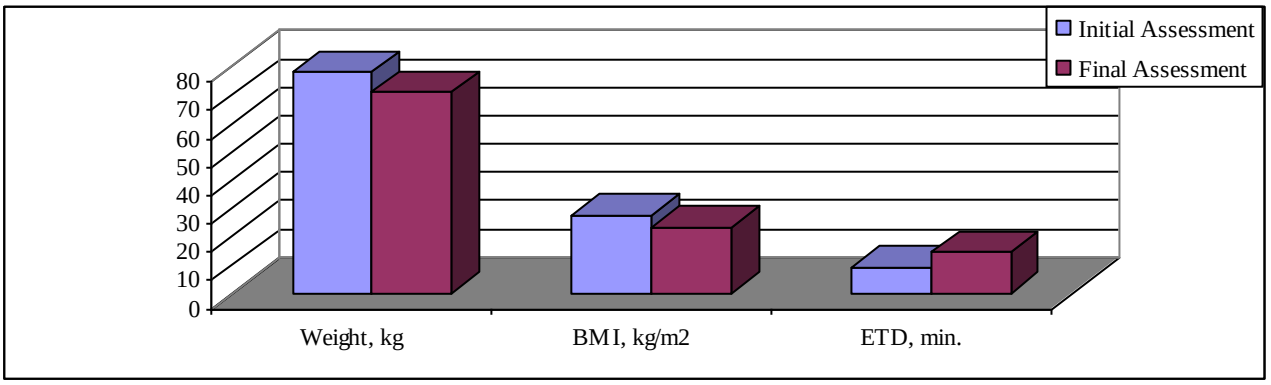

Fig. (3): Mean Values of Body Weight, Body Mass Index and Exercise Test Duration in the Initial and Final Assessments.

DISCUSSION

The number of people with type 2 diabetes is rapidly increasing. Key factors contributing to this increase include obesity and sedentary lifestyle. Aerobic exercise training improves both insulin sensitivity and activity of oxidative enzymes in muscle. Therefore, it has been shown that physical activity reduces the levels of fasting plasma glucose, BP and lipoprotein profile[18,19].

This study demonstrated a significant reduction in FBG level as the result of practicing the short-term regular exercise program denoting that the period of 12 weeks of exercise was sufficient to produce an improvement in the glycemic state. As aerobic exercise training improves both insulin sensitivity and activity of oxidatives enzymes in muscle[18] which will lead to lowering of blood glucose level. Traditionally, improvements in the glycemic state following short-term exercise and diet interventions have been associated with training-induced adaptations, such as weight loss and increased aerobic capacity. However, significant improvements in glucose tolerance and insulin action can occur independent of weight loss following exercise interventions as short as one week in duration in obese and glucose-intolerant populations[15,20,21].

Concerning the lipid profiles, which were checked during the study, it was found that the HDL increased significantly, and the triglycerides level was reduced significantly. The mean values of total cholesterol and LDL were reduced insignificantly indicating that they requiring long-term exercise program to produce a significant reduction. However, these results are of value for reducing the risk factors for developing cardiovascular complications in that population.

Because diabetes is associated with an increased risk of macrovascular disease, the benefit of physical activity in reducing known risk factors for atherosclerosis and consequently hypertension is to be highly valued[22]. SBP is a strong predictor of cardiovascular risk, particularly in subjects with diabetes. Treatment decreased both microvascular and macrovascular disease. The higher the BP, the greater the rate of loss of renal function, further suggesting benefit of treatment, with the most aggressive BP targets being applied to individuals with diabetes[17]. Evidence obtained from clinical trials in diabetic patients suggests a clinically

significant benefit in outcomes with reductions of BP below 140 mmHg for systolic and 80 mmHg for diastolic[6].

In this study, although the study population was within the normal range of BP; SBP was reduced significantly, while DBP showed insignificant reduction. These results indicating that the exercise program was sufficient in duration and intensity to reduce BP level and thereby reducing the risk for developing hypertension and atherosclerosis. The lower the levels of BP, the less likely to develop cardiovascular complications.

Adults with diabetes may show autonomic neuropathy leading to abnormal hemodynamic response to exercise. This will interfere with normal heart rate regulation during exercise by depressing maximal heart rate and BP and by increasing resting heart rate[23]. It was demonstrated that percentage heart rate reserve is an excellent indicator of percentage maximal aerobic capacity in individuals with diabetes, and can be used to prescribe and monitor exercise intensity[24].

In the present study, the resting heart rate demonstrated a significant reduction as the result of practicing the exercise program. The reductions in heart rate during rest indicating improved cardiac performance, which reflected on cardiovascular performance and regulation of autonomic imbalance. This was achieved by improvement of the cardiovascular fitness as showed by the exercise tolerance test[4].

Type 2 diabetic patients have a greater degree of adiposity than nondiabetic subjects[17]. Medical nutrition therapy for diabetic patients should be individualized, with consideration given to the individual's usual food and eating habits, treatment goals and desired outcomes. The goals of medical nutrition therapy that apply to diabetic patients are to attain and maintain optimal metabolic outcomes including; blood glucose levels, lipid profiles, body weight and BP levels that reduces the risk for macrovascular disease[16].

Concerning the body weight, the results of this study demonstrated that there was a significant reduction of its mean as the result of practicing the short-term exercise program. Although weight loss is the ideal, it should not be considered essential, and it should be realized that changes in eating habits and exercise without weight loss may be also beneficial. Additionally, small amounts of weight loss, can improve metabolic parameters in the short term[17,19]. These observations suggested that the combination of diet control and exercise should have effects on insulin and glucose metabolism that are greater than those of diet alone[15].

It has been shown that low cardiovascular fitness and physical inactivity are directly associated with diabetes[3]. Diabetes will lead to physical deconditioning that contribute to chronic fatigue, possibly as a result of a less active lifestyle. Exercise intolerance was demonstrated by a short exercise duration and lower aerobic capacity[25,26]. Higher heart rates and perceived exertion have been reported with submaximal exercise when compared with healthy active individuals[24,27]. In this study, exercise tolerance showed a significant improvement as reflected by the increase in exercise test duration at the end of exercise program compared to initial assessment.

Cardiovascular fitness may not only improve cardiac performance, metabolism and lipid profiles but also may enhance immune function and bone mineral density[10,28]. Long-term programs of regular physical activity are indeed feasible for patients with uncomplicated type 2 diabetes with acceptable adherence rates[9,14,16]. These studies have used an initial period of supervision, followed by

relatively informal home physical activity programs with regular, frequent follow-up assessments.

Physical activity counseling interventions have emerged as an alternative to structured programs. These interventions are a promising strategy for attracting sedentary people to increase physical activity. The aim of the consultation was to encourage patients to accumulate 30 minutes of moderate physical activity most days of the week[9]. A tool to improve motivation and adherence to exercise is to introduce several modalities of exercise from which the patient can choose. The more forms of exercise to which patients are exposed, the more likely it is that they will find one that fits their lifestyle[20].

Preparing the individual with diabetes for a safe and enjoyable physical activity program is as important as physical activity itself. The young individual in good metabolic control can safely participate in most activities. The middle-aged and older individual with diabetes should be encouraged to be physically active[1,2]. In all situations, any management plan should recognize diabetes self-management education as an integral component of care[16,28].

Conclusion

The main finding in patients with type 2 diabetes is that they had a low cardiovascular fitness level and were physically inactive. Before beginning any physical activity program, the individual with diabetes should be screened thoroughly for any underlying complications. Participation in regular exercise program improves glycemic control and insulin resistance. Physical activity can improve lipoprotein profile, reduce BP and improve cardiovascular fitness. Exercise training can also significantly reduce the decline in maximal aerobic capacity, improve risk factors for atherosclerosis and decrease central adiposity. It is recommended that BP targets should be 130-140 mm Hg for systolic and 80-90 mm Hg for diastolic pressure in diabetic patients. Even participation in moderate, accumulated physical activity, which does not necessarily improve cardiovascular fitness, has the potential to improve health.

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الملخص العربي

اثر ممارسة برنامج تمرينات رياضية قصير الأمد على درجة التحمل البدني لدى مرضى النوع الثاني من مرض السكري

يعتبر مرض السكري من الأمراض المزمنة الأكثر شيوعا علي مستوى العالم التي تتطلب الرعاية الطبية المستمرة. ويعتبر هذا المرض من عوامل الخطورة المسببة لمضاعفات متعددة والتي تمثل أعباء ثقيلة علي المريض والأسرة والمجتمع. ومن هذه المضاعفات ما يصيب الجهاز الدوري والقلب والمخ والأوعية الدموية الطرفية مما يسبب حدوث جلطة القلب والشلل وبتر الأطراف. ووجود مرض السكري يصاحبه هبوط في وظيفة الجهاز الدوري مما ينعكس علي مستوي التحمل البدني لدي المريض والذي يؤدي إلى نقص المقدرة علي بذل المجهود البدني. ولذلك يعتبر التدخل العلاجي لهذه الفئة من المرضى من الأمور الحيوية وذلك للحيلولة دون تحول هذه الأعراض إلى إعاقات مستمرة بما يؤثر علي مستوي معيشة المريض . أجريت هذه الدراسة علي اثنان وثلاثون مريضا من الذكور (متوسط أعمارهم 45.6 أعوام والوزن 78.1 كيلوجرام) مما يعانون من مرض السكري (متوسط مستوى السكر في الدم 154.7 مليجرام لكل ديسيليتر) النوع الثاني بدون مضاعفات وبدون الاعتماد على العقاقير . وكان المرضى من غير المدخنين وغير رياضيين ويعانون من زيادة في الوزن . تم فحص المرضى بواسطة استشاري الأمراض الباطنية فحصا شاملا وتم إجراء جميع الفحوصات المعملية اللازمة متضمنة قياس مستوى السكر والدهون في الدم . وتم استبعاد الحالات التي يوجد بها مضاعفات المرض وتحويل الحالات الأخرى إلى العلاج الطبيعي لاعداد وتنفيذ برنامج للتمرينات الرياضية. تم فحص المرضى بواسطة أخصائي العلاج الطبيعي متضمنا استبيان لمرض السكر وتم قياس الوزن والطول بواسطة استخدام الميزان وحساب معامل حجم الجسم وتم تحديد النبض وقياس ضغط الدم أثناء الراحة بواسطة استخدام جهاز الضغط الزئبقي. تم اختبار درجة التحمل البدني لقياس كفاءة الجهاز الدوري بواسطة استخدام الدراجة الثابتة . خضع جميع المرضي لبرنامج تمرينات منتظم لمدة اثنتي عشر أسبوعا بواقع ثلاث جلسات أسبوعيا تحت إشراف أخصائي العلاج الطبيعي وكانت شدة التمرينات في بداية البرنامج معتمدة علي التمرين في حدود نسبة 70% من أقصي مستوى نبض خلال اختبار التحمل البدني لمدة 20 دقيقة مع الزيادة التدريجية في نسبة النبض وفترة التمرين حتى تصل إلى 80% من أقصي نبض ولمدة 40 دقيقة ولمدة أربعة أيام أسبوعيا في آخر أربع أسابيع من فترة التمرينات . خلال فترة ممارسة برنامج التمرينات تم التنبيه علي المرضي بضرورة ممارسة تمرينات المرونة والتنفس بصورة منتظمة مع المحافظة علي المستوى المعتاد للنشاط اليومي ونظام الغذاء المحدد من قبل الطبيب . تم تجميع بيانات التقييم الابتدائي والنهائي وعمل الإحصاءات الطبية اللازمة ووجد أن هناك نقصان ذو دلالة إحصائية بعد ممارسة برنامج التمرينات الرياضية في مستوي السكر في الدم والدهون الثلاثية . ولكن وجد أن مستوي الكلي للدهون والدهون منخفضة الكثافة قد هبط بدرجة قليلة. وكان هناك زيادة ذات دلالة إحصائية في مستوى الدهون عالية الكثافة (الدهون النافعة). وقد أدي ممارسة التمرينات إلى نقصان ذو دلالة إحصائية في ضغط الدم الانقباضي ومعدل النبض. ولكن ضغط الدم الانبساطي قد قل بدرجة غير ذات دلالة إحصائية . وأدت ممارسة التمرينات إلى نقصان ذي دلالة إحصائية في وزن الجسم ومعامل حجم الجسم وأخيرا فقد أدي ممارسة التمرينات إلي زيادة كفاءة الجهاز الدوري عن طريق زيادة زمن اختبار قدرة التحمل البدنية . أثبتت هذه الدراسة أن ممارسة برنامج تمرينات رياضية قصير الأمد لمرضي السكري النوع الثاني تحت إشراف أخصائي العلاج الطبيعي يؤدى إلى نقصان مستوي السكر و الدهون الضارة في الدم وتقليل الوزن ومعدل النبض وضغط الدم وزيادة مستوى الدهون النافعة عالية الكثافة وزيادة قدرة التحمل البدنية مما انعكس بدورة علي تحسن كفاءة الجهاز الدوري و قدرة التحمل البدنية لدي هؤلاء المرضي .