

Effects of Short-term Exercise Program on Blood Glucose, Lipids, and HbA1c in Type 2 Diabetes

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ABSTRACT

OBJECTIVE: For decades, exercise has been considered as a cornerstone for managing diabetes. The current study aimed to determine the effects of short-term exercise on blood glucose, lipids and HbA1C in type-2 diabetes mellitus.

MATERIALS AND METHODS: A total of 61 diabetic patients were randomly selected. Later, subjects with capability of doing exercise took part in a special four-week exercise program. The blood glucose, lipid levels (before and after 4 weeks) and HbA1C (before and three months after exercise program) of 32 subjects were measured and compared in the time scales.

RESULTS: Our results showed a significant reduction in blood glucose and lipid concentrations. However, the reduction observed in HbA1C was not significant ($P=0.12$). Comparison of pre- and post-exercise results demonstrated a significant improved glycemic control.

CONCLUSION: The findings confirm the benefits of exercise training in type 2 diabetic patients. There are many studies which support the importance of physical activities program in controlling and preventing the common metabolic disorder and its complication.

KEY WORDS: Diabetes, Short-term exercise, Blood glucose level, HbA1C.

INTRODUCTION

Diabetes Mellitus (DM) is a multi-system disease and a serious health problem around the world (1). According to the World Health Organization, at least 285 millions have diabetes worldwide and the number of people suffering from diabetes is expected to be more than double by 2030 (1,2).

Diet, exercise, careful control, medication, and instruction are the five main components of management and care in diabetes (2, 3). For many years, exercise has been mentioned along with medication and nutrition as major principles in management of diabetes (4, 5).

Exercise is considered as an important element in treatment of diabetes reducing blood glucose, cardio-vascular risk factors, and cardiac complications. Cohort's studies have demonstrated that the physical activities and high levels of aerobic exercises result in considerable decline in cardiac complications and death (5, 7, 8).

Considering the effects of exercise on good diabetes control, clinical studies emphasize on the fact that a regular aerobic exercise has profound effect on preventing diabetes in people who are susceptible for diabetes. The studies show that the diet in itself, and the

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exercise or a combination of exercise and diet have a similar reducing effect on progress of condition from glucose intolerance toward diabetes (8, 9, 10). Many studies have shown that the exercise positively influences the glucose-control, fat-metabolism, and insulin-sensitivity. Thomas et al. (2006), reviewing 40 clinical trials, have reported the effectiveness of exercise on patients with type 2 diabetes (11, 12, 13). Considering the type and duration of exercise, experts recommend at least a 30-45-minute aerobic exercise three times a week. Boule and his colleagues recommend at least 150-minute/week physical aerobic exercise with 40%-60% or 50%-70% of maximum heart rate with a moderate intensity or 90-minute/week vigorous aerobic exercise with less than 60% or 70% of maximum heart rate (5, 14,15).

For a proper effect, exercise must be planned for 3-4 times a week. An intensive or mild exercise lasting four weeks will be accompanied by a decrease in incidence of CVD compared with the period during which the exercise duration was less (16, 17).

Considering the prevalence and the wide-spread expansion of diabetes, also its long-time treatment, and the individuals' direct role in controlling their disease, it can be concluded that the diabetic patients must be encouraged to obtain the necessary knowledge, perseverance, and optimism for their own healthy life. Thus, the patients will be satisfied to treat their complications over a longer time and a remedy program can be developed. Unfortunately, we are facing large number of diabetics without sufficient knowledge on importance of exercise in controlling their disease (in Iran). Therefore, the current study was an attempt to investigate the effect of short-term exercise program on blood glucose, lipid, and HbA1C levels. It is hoped that the results of this study could serve as a motivation for health practitioners in terms of education and disease control.

MATERIALS AND METHODS

This study was conducted on patients with type 2 diabetes ranging 30-55 years old living

in Qazvin (Iran) in the summer 2009. Initially, the patients were informed by written announcement and also the objectives of the study were made clear to the patients verbally by the researchers emphasizing non-compulsory nature of participating in the study.

Having obtained a signed consent form, the candidates were examined to investigate the presence of long-term complications of diabetes including neuropathy, retinopathy, hypertension, and so on. The subjects were requested to fill in a questionnaire consisting of demographic data, accurate record of the disease, and an EKG plus an approval letter issued by the clinic's physician on lack of any complications exempting the patients from attending the physical exercise classes. The subjects who qualified for the process went through para-clinical tests to investigate for the blood levels of glucose, triglycerides, cholesterol, LDL, HDL, and hemoglobin A1C. Later, an explanatory session on the method of how-to-do exercise was set up while they were given a handbook and a pamphlet on exercise & diabetes published by the Metabolic Research Center. Also, the patients were instructed on how to control and monitor their pulses. The subjects participated in a 45-50-minute exercise program for a period of four weeks, three times a week. Exercise activities were designed in a manner to increase the subjects' heart beat 40% to 60% with maximum heart rate while the magnitude was calculated based on ADA using the formula 220-age. The exercise plan started with short-duration and light movements and gradually increased in intensity. Each exercise session consisted of a 10-minute warm-up period, 35-minute aerobic exercise, and a 10-minute cool-down period. The number of central group heart rates was monitored to control the exercise intensity following warm-up phase (10, 18).

Furthermore, the researcher attended all sessions while equipped with a glucometer so that necessary measures could be adopted in case of any complication. The subjects were tested for blood glucose; triglycerides,

cholesterol, HDL, and LDL levels with fasting before and 4 weeks after the exercise program. Hemoglobin A1C level was measured at the beginning of exercise program. Furthermore, it was measured 3 months after the exercise program was completed. Fasting blood sugar (FBS) was measured by glucose oxides (GOD-PAP) method (pars Azmon : inter CV 0.84 and intra CV 1.28). Cholesterol, triglycerides (TG) and high-density lipoprotein (HDL) were measured by the enzymatic colorimetric method (pars Azmon: inter CV 211→1.22 and intra CV236→ 0.61, inter CV 177→1.04 and intra CV 106→1.82 and inter CV 44→1.8 and intra CV 56→0.73 respectively). This research project was approved by the medical research ethical committee of Qazvin University of Medical Sciences and was registered by Iranian Registry of clinical Trials (Registration ID: 138811073205N1).

The data were analyzed using SPSS/15 software and statistical tests were utilized including chi-square test, t-test, and paired t-test. A P-value of <0.05 was considered significant.

RESULTS

The present study was conducted on 32 patients with type 2 diabetes regularly participating in a 4-week exercise class of whom 25% were males and 75% females. The mean age, weight, and their standard deviations in our study group were 43.06±4.72 years and 71.74±10.38 kg, respectively. Most volunteers (76.5%) were controlling their illness with oral pills and 2.9% through diet and exercise. The subjects' mean blood glucose in pre-exercise program was 154±44/13mg/dl and that of the post-exercise program was 140/81±36/13mg/dl.

The pre- and post-exercise blood glucose concentrations indicated a significant difference (P=0.00). Moreover, there was a marked difference between the pre- and post-exercise triglycerides levels (P<0.05). Statistical tests were indicative of significant differences between the blood cholesterol and HDL-C and LDL-C levels before and after exercise plan was implemented (p=0.00).

(Table1). The HbA1C percentage was 7.88±1.49 mg/dl before the exercise plan and when it was re-evaluated 3 months later, no significant difference was established (P=0.32) in regard to pre- and post- exercise.

DISCUSSION

The present study findings showed a significant decrease in concentration of blood glucose in diabetic patients after four weeks of regular and controlled physical activities compared to the level of blood glucose in pre-exercise program. Physical activities exert positive effects on insulin function, glycemic control, and metabolic disorders commonly accompanied with type-2 diabetes (18, 19, 20). In this respect, our data are in agreement with that of Damasceno (2004) in which a significant reduction (p=0.003) in blood glucose level of diabetic patients following exercise was reported (21). Also, our results are consistent with the findings of two other studies by Gordon (2008) who reported reduced blood glucose (P=0.001) in the patients following a period of regular exercise (21, 22). However, comparing the mean difference in results of glucose concentrations of diabetic patients during pre- and post-exercise program is indicative of a greater difference between two measurements when compared with that of Hoamard (1991) in which an insignificant reduction in blood glucose level (p<0.01) was found (23). Moreover, the results of blood glucose changes in the present study are higher than those obtained in studies by Dela et al. (2004), Maiorana et al. (2002), Ronnema et al.

Table 1- Biochemical Characteristics of Study Groups Before and After 4-week Exercise Program

| Variable | Before | Post | T-Test | P-Value |
|---------------|--------------|--------------|--------|---------|
| FBS (mg/dl) | 154±44/13 | 140/81±36/13 | 3/38 | 0/002 |
| TG (mg/dl) | 171/9±39/06 | 165/9±33/2 | 2/182 | 0/037 |
| TC (mg/dl) | 174/7±48/5 | 161±58/82 | 3/03 | 0/005 |
| HDL-C (mg/dl) | 42/66±7/31 | 45/32±8/73 | -3/02 | 0/005 |
| LDL-C (mg/dl) | 105/37±20/56 | 99/89±17/66 | 3/91 | 0/00 |

* Values are presented as mean±SD.

(1986), and Baldi et al. (2003) (24,25,26,27). In these studies, despite a reduction in concentration of blood glucose in diabetic patients following exercise, no significant difference was observed in the level of blood glucose among two tests and control groups whereas in the present study there was only a single group in whom the effect of exercise on glucose concentration was investigated in the pre- and post-exercise program.

In the current study, a significant reduction in the level of triglyceride in patients with diabetes was established which is consistent with the results of studies done by Maiorana et al. (2002), Ronnema et al. (1986), Lamppman et al. (1990), Yeater et al. (1990), as well as the study by Rigla et al. (2000) (25,26,12,28,29). It is worth mentioning that in the present research the triglyceride concentration in men failed to show a significant decrease following regular 4-week exercise which could be due to the small number of men in our study.

The present study showed that after 4 weeks of regular exercise program, the level of blood cholesterol and LDL reduced in diabetic patients. Consistent with our findings, Rigla et al. (2000) also reported a significant decrease in cholesterol level of patients with type 2 diabetes following a 3-month controlled exercise package (30).

Although, in several studies by Maiorana et al. (2002), Wing et al. (1988), and Ronnema (1986), a reduction in cholesterol level following exercise was found, this was shown to be insignificant (26,27,29). Rigla also emphasized that the regular and accurate performance of exercise could produce positive effect on reduction of blood lipoproteins of patients with higher levels of lipoproteins and recommended that the regular exercise could exert positive and valuable effects on cardiovascular risk factors of patients with diabetes (28).

In addition, the present study findings demonstrated a significant increase in HDL level of patients with diabetes following four weeks of regular exercise which is in agreement with a study by Rigla (2000) in

which a significant increase in HDL concentration was reported (29) after a regular exercise of 2-month period; however, no such significant increase in the level of blood HDL was found in several studies by Maiorana et al. (2002), Ronnema et al. (1986), and Thomas (2007) following exercise (25,26,31). It has to be mentioned that in our study, the changes in lipid concentration obtained for male group following exercise, was insignificant and the reason for this difference between the female and male groups could be due to lower tendency of men to participate in exercise and research programs. This was also pointed out by Wing et al. (1998), Bo et al. (2007), and Oldroyd (2001) who reported a higher level of enthusiasm for women regarding the regular attendance in exercise sessions compared to men (30,32,33).

Our results showed that the glycosylated hemoglobin level of diabetic patients reduced following a regular 4-week exercise (7.72 ± 1.32) but the reduction was found to be insignificant and that the rate of reduction was lower than those reported by Baldi et al. (2003), Dela et al. (2004), Maiorana et al. (2002), and a review article by Thomas (2008) quoting the results described by Raz et al. (1994) and Wing et al. (1988) (27,24,25,31,30). In this respect, perhaps the duration of regular exercise and the type of physical activities have affected the Hb1AC changes leading to inconsistency between the results of the present study and those found by others. In all studies mentioned earlier, the duration of exercise was between 3-6 months while in our study a 4-week exercise package was employed. In many studies including one conducted by Dela et al. (2004), a combination of aerobic exercises with intermediate intensity accompanied with an increase in intensity of exercise such as increase in severity of walking has been used. Likewise, in a study by Raz et al. (1994), a collection of aerobic movements, running, cycling, and swimming was used as the recommended exercise package. Obviously, a mixture of aerobic exercises and strengthening movements has been used and recommended

in many recent studies (24,31). Thomas et al. in their review of 13 clinical studies concluded that the exercise could significantly improve the glycemic control among the patients of test group by 60% reduction in level of glycosylated hemoglobin and emphasized that the decrease in concentration of HbA1C following exercise is dependent on continuation and the length of exercise as well as the intensity of physical exercises. Furthermore, the more severe is the physical activities, the more reduction exists in glycosylated hemoglobin even in the case of an exercise package of shorter duration (31).

It seems that a change in lifestyle and creating a more active way of life is of prime importance in controlling the complications and long-lasting treatment of diabetes. Undoubtedly, following a more dynamic life accompanied with a regular exercise program could result in more positive effects on health, prevention, and treatment of diabetes. Franks et al. (2007) describe that a modification in lifestyle could remarkably improve both the sensitivity to insulin and insulin secretion (34). Moreover, the regular exercise could change the lipid profile, reduce the weight, and produce valuable effects on both cardiovascular potentials and thromboembolic state (35). Controlled physical activities at mild to severe level could also reduce the occurrence of metabolic disorders in those with a family history of diabetes (36).

Considering the issues mentioned earlier and also the importance of exercise in management, control, and prevention of diabetes, it should be noted that: a) the physical exercise acts as a double-edged sword for diabetic patients and has to be

recommended for patients with great care, b) to establish an effective therapy through exercise, the clinical examination protocol should be validated by experts based on standard principles, and c) to systematically tackle the complications of diabetes, not only the exercise, dietary regimen, medication, education, and treatment follow-up are considered as essential principles of therapy and management of diabetes but also modification and improvement of lifestyle which is influenced by the patients' own motivation and knowledge could play a crucial role. The individuals' motivation to improve, constitutes a cornerstone on which the procedure to modify the lifestyle could be designed.

There are some limitations in this study; detailed information Glycemic condition after 3 months (FBS) were not collected, so Hb A1C after 3 months may indicate lack of exercise and /or proper diet. We were not sure whether there were any links between statically results and clinical outcome in diabetes subjects so performing further studies with more sample are recommended.

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