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Effects of eight weeks aerobic training, resistance training and concurrent training on the metabolic syndrome and HbA1c in men with type 2 diabetes

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Abstract

Introduction: Diabetes mellitus is a metabolic disease that is brought about by either insufficient production of insulin or the inability of the body to respond to the insulin formed within the system. The aim of this study was to exam the influence of 8 weeks of aerobic training, resistance training and concurrent training (combined of aerobic and resistance raining) on the metabolic syndrome, and hemoglobin A1C (HbA1c) in men diagnosed with type 2 diabetes.

Material & Methods: In this semi experimental survey, 40 men diagnosed with type 2 Diabetes at Clinic oil company Sirri Island who had the required qualifications were chosen for the survey and were divided into four groups including aerobic training group (Ag)(n=10), resistance training group

(Rg) (n=10) concurrent group (CCg) (n=10) and control group (Cg) (n=10). Aerobic, resistance and concurrent groups performed the exercises for 8 weeks under the supervision of skillful trainers. Fasting blood samples were obtained from the subjects prior to breakfast at the beginning and the end of the study to measure blood sugar (FBS), hemoglobin A1 c (Hb A1C), triglyceride (TG), High density lipoprotein Cholesterol (HDL), Low density lipoprotein Cholesterol (LDL) and insulin resistance (IR). To display central inclination index and distribution indices, descriptive statistics and Wilcoxson non parametric tests were used to examine the data distribution type and to compare the averages of the data prior to/and after the test in each group. Two-way ANOVA test (P<0/05) was used for statistical analyses.

Results: There was significant decrease in the level of HbA1c at the end of the study relatively in the CCg, Ag and Rg (p<0.05). IR also was decrease in CCg (P<0.05). FBS were decrease in CCg (P<0.05), however showed an increase in Rg (P<0.05). In all of the training groups TG and LDL levels did not significant changes. HDL in all training groups increased significantly (P<0.05). The Ag and CCg showed a decrease in WHR relatively (P<0.05).

Conclusions: Based on the results obtained, CCg decreased blood Hb A1c level, and resistance training diminished serum LDL levels and elevated the HDL level. Therefore, it appears that different types of exercise may be effective in controlling type 2diabetes.

Key words: Aerobic training, Resistance training, Concurrent training, Metabolic syndrome.

1. Introduction

The prevalence of type 2 diabetes is increasing worldwide in the 21st century. The main reason for the increase is the changes in lifestyle, specifically doing less exercise and consuming excessive calories.

According to World Health Organization (WHO), the number of people diagnosed with diabetes in the year 2014 was 422,000,000 (1). This number may rise up to 600,000,000 in the year 2036 if appropriate measures are not taken to prevent and cure this disease (NCD 2016) (2). Diabetes is diagnosed with metabolic disorders such as blood sugar build-up and is followed by some complications such as eye, neural and renal problems and also cardiovascular failures (3). Just as the main reason for the increased prevalence of type 2 diabetes is lifestyle changes, the cornerstones of treatment must also incorporate lifestyle changes to control and reduce the complications of type 2 diabetes. Physical activity has been recommended as one of the alternatives (1).

Investigators show that training such as walking, bicycling, jogging and running and resistance training like weight lifting result in reduction of HbA1c. Hb A1C is an indication of the amount of blood sugar within the past 2 to 3 months and helps physicians to diagnose and treat the illness more effectively. A decrease in the amount of HbA1C up to 1% diminishes the danger of cardiovascular disease up to 15 to 20 percent and eventually results in a reduction of the complications of micro vasculature up to 37 percent (4).

Most of the researches done so far have displayed the effects of aerobic and resistance trainings on the level of HbA1c (5-7). Little research has been carried out on the effects of concurrent training (aerobic and resistance) on the level of HbA1C. The results of a clinical investigation on 251 adult patients during 26 weeks of training showed that in comparison with aerobic and resistance trainings alone, concurrent training decreased HbA1c more prominently (8).

Baldoucci et al. (2004) monitored effects of concurrent training on the level of HbA1c and certain other metabolic factors in type 2 diabetic patients for one year. Change in the amount of HbA1c revealed that the concurrent training and the resistance one had produced a more significant decrease in blood sugar compared with the control (9). In addition, LDL and total cholesterol also decreased significantly in concurrent training, while HDL level increased (10).

Timothy et al. (2010) studied the effects of aerobic, resistance and concurrent trainings on the level of HbA1c in type 2 diabetic patients.

Their results showed a significant decrease in HbA1c level in the concurrent group, while the resistance and aerobic groups had no significant effect (11). Some researchers have demonstrated the effects of either aerobic training or resistance training alone on the level of HbA1c. Bruce and kriketos (2004) launched a survey on the sensitivity level of insulin in type 2 diabetic patients. The results of their survey demonstrated that training causes a drop in HbA1 c level from 7.9 % to 7% and the fasting plasma, blood glucose dropped from 8.3m mol to 7.9 m mol, although this change was not significant (5). Plasma insulin level was also decreased significantly and some factors such as total cholesterol, HDL and LDL did not show any changes (5). Eriksson et al. (2002) showed that 8 type 2 diabetic patients who had participated in progressive power trainings for3 month, demonstrated considerable improvement in the amount of HbA1c but did not show any significant change in serum lipid levels (8). Insulin resistance is a pathological condition in which cells of the body do not respond properly to the hormone insulin (12). It is well understood that regular physical activity is associated with substantial improvement in insulin sensitivity (13). As the before mentioned literature indicates, the effects of physical activity and its type in improving type 2 diabetic patients are still unknown. Therefore, the aim of this investigation was to find out if either aerobic, resistance or a concurrent of both trainings for a period of two months reduces HbA1c and the lipid profile of men with type 2 diabetes.

2. Material & Methods

Subjects and experimental design

This study is semi- experimental. Forty type 2 diabetic men attending Clinic oil company in Sirri Island in Iran for clinical diagnosis and treatment and were treated with standard doses of metformine or glibenclamide daily comprised our experimental group. The mean of their age, weight and height were (53.13 ± 5.46) years, (72.70 ± 6. 8) kg, and (168 ± 7.54) cm, respectively. They had a history of type 2 diabetes for (3.62 ± 1.16) years. Our inclusion criteria were having type 2 diabetes according to an endocrinologist report, age over 40 years, fasting blood sugar between 140-200 mg/dl, and doing no physical

exercise in the past 3 months. The exclusion criteria comprised of chronic illnesses, psychological disorders, type 1 diabetes and diabetic complications such as diabetic wounds, diabetic nephropathy or retinopathy. All the participations filled out a questionnaire (PAR-Q) on preparation for participating in physical activity (14). Informed consent was obtained from every person participating in the study. Subjects were divided into 4 groups of Cg, Ag, Rg and CCg base on their HbA1c at the beginning of study. Because three patients did not participate in the experimental protocol, therefore the final number of participate were: Cg (n= 10), Ag (n= 9), Rg (n=9) and the CCg (n=9). The different exercise groups performed their exercises for 30-60 min, 3 days per week for a period of 8 weeks under the supervision of a skillful trainer. Every session started with stretching exercise and jogging for 5-10 min and for a period of 5-10 min of cooling down at the end of the session. Exercises were done on even days at 8:00 pm. The exercise protocols of the 3 groups are summarized below:

1. The Ag did their exercise by walking on treadmill equipped with heart beat pacer and with a maximum of 60-65 % of their maximal heart rate using targets heart rate method. The physical activity of their groups lasted for 30 min per day during the first two weeks and increased to 45 min per day in the 3rd and 4th weeks and reached 60 min per day during the final weeks.

2. The Rg started their first two weeks with a minimum weight of 2 sets and a repetition of 8-10 times to get accustomed to weight lifting. From 3rd weeks onward, 3 sets were used for each muscle groups and each set was repeated 10-12 times and with 60-75 % of one repetition maximum (1 RM). Evaluation of the called weight was done by one repetition maximum through Berzike's formula (15). Resistance training included the bench press, shoulder press, curl triceps, dumbbell curls, and lateral pull down, leg press, leg extension, twists, decline press and sit-ups.

3. The CCg started their first two weeks with 20 min of aerobic training and performing resistance training with minimum weight and 8-10 repetition to learn the exercise correctly. From the 3rd week on, they performed 30 min of aerobic training and 30 min of resistance training

or more if needed.10 to 12 repetitions for each set with 3 sets for each muscle with 60-75% of one maximum repetition were performed by this group.

Anthropometric measurements

All Anthropometric measurements were done on the subjects wearing light underwear and without shoes. Body weight was measured to the nearest 0.5 kg using a digital scale (Germany) that was calibrated with a 50 Kg weight when weights were determined. Height was measured to the nearest 0.5 cm against a wall – mounted tape (China). Body mass Index (BMI) was calculated by dividing the weight in kg by height in meters squared and was classified into four categories according to WHO protocol. Thus, underweight was defined as a BMI of under18.5, normal weight as BMI of 18.5 - 24.9, overweight as BMI of 25-29.9 and obesity as a BMI $\geq$ of 30.0 kg/m^2. (16). Waist circumference was measured in centimeters at the midpoint between the iliac crest and the rib cage17. Hip circumference was measured at the largest width of the buttocks with the subject in standing position and both feet together. All measurements were taken twice. Both measurements were rounded to the nearest 0.5 cm using a non- stretchable tape without compression of the skin. The mean of the two sets of values was recorded. Central obesity was also calculated and defined on the basis of waist hip ratio. The cut-off value of central obesity was >0.92. (17).

Blood samples

Blood samples were obtained in the morning after an 8-12 hr fast prior to the start of the study and again 8 weeks after at the end of the study under the same conditions. TG levels were measured by enzymatic kits (Mann Chemical Company) using an auto analyzer. LDL and HDL were measured by an Auto analyzer using commercial kits (Pars Azemoon Company, Teheran, Iran). Serum fasting blood sugar levels were measured by Selectra-E autoanalyzer using an enzymatic kit (Mann Chemical Company). Hb A1c was determined by an Affinity HPLC method (Younglee 9100 made in South Korea). Insulin resistance was calculated via HOMA-IR model.

Statistical analyses

To show the central tendency and variability, descriptive statistics was applied. The sample Kolmogorov - Smirnov test for normal distribution of data was used. Wilcoxson nonparametric test was used to determine the type of data distribution, and to compare the means of the data pre-test and post-test of any group, Two-way ANOVA was used. Statistical significance was set at ($P<0.05$). All data were analyzed by SPSS, software, version 20.

3. Results

Table 1 shows the serum levels of various analytes and risk factors in the four groups before and after 8 weeks of exercise. There was significant decrease in the level of HbA1c at the end of the study relatively in the CCg, Ag and Rg ($p<0.5$). IR also was decrease in CCG and Ag ($p<0.05$). FBS showed decrease in CCg and Ag ($P<0.05$) and increased in Rg ($P>0.05$). In all of the training groups TG and LDL levels did not change ($P>0/05$). HDL in all training groups increased significantly ($P<0/05$). The Ag and CCg showed a decrease in WHR relatively ($P<0.05$), ($P>0/05$), but no change was seen in Rg. No changes were seen in any factors in Cg.

Table 1. Comparison of before and after intervention values of measured variables (mean ± SD)

Experimental group		Factor analyzed (mean ± SD)		
		Insulin resistance	FBS (mg/dl)	TG (mg/dl)
Cg	Before	4.2±1.12	171.5±45	159.5±65
	After	4.25±1.1	168.2±49	157.2±49
	P value	0.06	0.06	0.86
CCg	Before	4.1±08	169.5±34	141.6±67
	After	2.69±1.012	157.2±39	144.2±51
	P value	0.001*	0.01*	0.59
Ag	Before	4.4±1.04	162.2±23	152.2±43
	After	2.9±1.011	151.1±29	150.3±38
	P value	0.001*	0.002*	0.662
Rg	Before	3.93±01	165.2±39	144.2±35
	After	3.89±1.015	179.3±44	148.4±15
	P value	0.08	0.02*	0.592

* Significant differences ($P<0.05$)

Table 1. (*Cont.*) Comparison of before and after intervention values of measured variables (mean ± SD)

Experimental group		Factor analyzed (mean ± SD)			
		LDL (mg/dl)	HDL (mg/dl)	Hb A1c (%)	WHR
Cg	Before	122.5±45	46.5±15	9.9±2.5	1±0.01
	After	123.2±49	45.2±19.2	10±1.6	1±0.03
	P value	0.04	0.07	0.46	0.55
CCg	Before	112.6±26	44.5±17	9.7±2.4	0.93±0.01
	After	111±31	42.1±15.3	8.3±2	0.87±0.02
	P value	0.14	0.04*	0.001*	0.02*
Ag	Before	114.1±41	44.1±15.3	9.3±2	0.89±0.0 2
	After	117.2±32	46.6±17.2	9.1±3	0.85±0.04
	P value	0.06	0.04*	0.002*	0.03*
Rg	Before	131.2±31	42.1±15.3	9.5±2	089±0.02
	After	129.2±22	45.1±16.7	9.1±2	088±0.06
	P value	0.142	0.03*	0.002*	0.06

* Significant differences ($P<0.05$)

4. Discussion

The aim of this study was to evaluate the effects of 8 weeks of aerobic, resistance and Concurrent training on the level of metabolic syndrome and HbA1c in men with type2 diabetes. The main finding of this study involving individuals with type2 diabetes is that any kind of Physical activity can provide benefits for type2 diabetics. Furthermore all the 3 kinds of training improve metabolic syndrome and HbA1c significantly. Lakka et al. (2007) and Shenoy et al. (2009) reported the same results (18,19), but the studies of Bruce and kriketos (2004), Eriksson et al. (2002) and Vincnt et al. (2006) are not agree with results of present study (5,8,20). Blood sugar in the AG and the CCg demonstrated reductions, respectively; however these reductions were not statistically significant. Blood sugar showed an increase in both the resistance and the control groups and was significant only in the control group ($P= 0.001$). Shenoy et al. (2009) and Sigal et al. (2007) reported the same results (19,21), but study of Bruce and kriketos (2002) and Balducci et al. (2004) are not in the same direction with present study(5,9). Elevation of blood sugar following resistance training is unexpected, however lowering of blood sugar in the other two training groups and the reduction of HbA1c in all three training groups are conceivable,

because following physical activity, muscle contractions , like insulin, transfer a great deal of glucose into muscle cells (22). It is also expected that physical activity will result in an increase in the level of GLUT-4, improving insulin function in glucose metabolism (23), although it is possible that resistance training in a beginner may cause muscular damage such as soreness and temporarily reduce the sensitivity to insulin and consequently result in an increase in blood sugar (24). Nevertheless the duration and intensity of the trainings, the primary level of subjects' readiness, the individual differences and the basal level of blood sugar are all among reasons for inconsistencies. The levels of TG in the Ag and Rg dropped, but such reductions were not statistically significant. Serum TG level increased in the CCg but not significant. LDL dropped in all four groups but was not significant (25). Mohebi et al. (2006) and Hollozy et al. (1986) reported that TG and LDL levels decrease after a period of exercise (25,26), on the other hand, ballduci et al. (2004) and Sigal et al. (2007) reported that they failed to find such effect after physical activity (9,21).

Several of the early studies observed significant improvements in glucose tolerance (27) which is in same direction as present study. It is may be exercise promotes weight loss, which reverses the insulin resistance which is the characteristic of obesity (28). It seems that the existing differences between the results of different studies lie in differences between the intensity and duration of each training session and the kind of exercise (29).

Conclusion

The results showed that 8 weeks of aerobic, resistance and concurrent physical activities will Change some metabolic risk factors such as HbA1C, HDL and WHR in men diagnosed with type 2 diabetes. However the levels of such reductions are different among different training groups. Finally one may imply that concurrent training is more effective than the aerobic or the resistance training in improving metabolic factors in patients with type 2 diabetes.

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Conflict of interests: No conflict of interests amongst authors.

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