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The effect of regular exercise on insulin action in sedentary postmenopausal women

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Abstract

The purpose of the present study was to investigate the influence of a ten-week of exercise training on insulin, glucose and insulin resistance in healthy sedentary postmenopausal women. Twenty four postmenopausal women (aged 54.6±3.9 years) voluntarily participated in the study and randomly assigned into training (n=14) and control (n=10) groups. Subjects of training group were performed 10 weeks of exercise training including aerobic exercise (two sessions per week with 65-75 % MHR) and resistance exercise (two sessions per week with 55-65 % 1RM). Fasting blood glucose, fasting serum insulin measured at baseline and after training program. Insulin resistance calculated using glucose and insulin values. Data were analyzed using analysis of covariance test. There were no significant differences in fasting blood glucose, fasting serum insulin and insulin resistance between training and control groups after 10 weeks (P>0.05). In conclusion it seems that ten weeks of exercise training program has no effect on insulin action in healthy sedentary postmenopausal women.

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Introduction

Physiological changes such as changes in body composition like decrease of lean body mass (LBM) and body fat accumulation, lack of physical activity and reduced physical fitness, changes in sex steroid hormones and some other conditions such as menopause are factors contributing in dysfunction of insulin and occurrence of metabolic syndrome in the elderly (Zou *et al.*, 2008). In fact, natural process of aging increases the probability of insulin resistance (Sillanpää *et al.*, 2009) and hyperinsulinemia (Sudhaa *et al.*, 2008) in the elderly especially in postmenopausal women because of synchronism with reduction of physical activities, reduction of muscle mass and increase of body fat. Excessive fat accumulation leads to insulin resistance due to secretion of adipokines from adipose tissue or through changes in insulin signaling (Kim *et al.*, 2007). Among metabolic risk factors, changes of insulin hormone and hypersensitivity of tissues to this hormone is an important phenomenon in therapeutic approaches and metabolic disorders. Thereby, exhibition of appropriate therapeutic approaches such as weight loss, physical activities and medical methods (Gunter *et al.*, 2009) has a great importance to maintain normal level of insulin serum for postmenopausal women (Coon *et al.*, 1992; Sudhaa *et al.*, 2008).

There is a wide agreement that lifestyle changes such as increasing physical activities are the most important principle in prevention and treatment of metabolic risk factors in postmenopausal women (Frank *et al.*, 2005). Some researchers believe that regular exercise have a positive effect on function of endocrine glands and its changes during old ages (Broom *et al.*, 2007). Nevertheless, there are contradictions about the effects of exercise training on insulin action in postmenopausal women. For example, some researchers have shown that long-term aerobic exercise decreases the insulin concentration and insulin resistance in postmenopausal women (Friedenreich *et al.*, 2011). It is also reported that insulin concentration and the parameters of metabolic syndrome are improved in postmenopausal women with breast cancer (*et al.*, 2012). On the contrary, some researchers concluded that endurance training have no impact on insulin concentration in postmenopausal women (Poehlman *et al.*, 1994). It is reported in another study that exercise training have no impact on insulin concentration and insulin resistance in postmenopausal breast cancer survivors (Fairey *et al.*, 2003). On this basis and regarding given discrepancies, more research needs to be raised to consider the effect of different training methods on insulin action in sedentary postmenopausal women. Hence, this study aims to determine the effects of combined exercise training including aerobic and resistance exercise on the level of insulin and glucose and insulin resistance in healthy sedentary postmenopausal women.

Materials and methods

Subjects

Twenty four healthy sedentary postmenopausal women (age, 54.6±3.9 years and weight, 74.1±10.6 kg) volunteered to participate in this study. They had not participated in regular exercise training over the previous 6 months. Moreover, none of the participants were underwent diet therapy. Exclusion criteria included use of hormone replacement therapy, smoking, metabolic disorders, cardiopulmonary disease or other chronic diseases. Consents forms were signed by the participants after they had been familiarized with the aims and methods of the research; thereafter, they were randomly divided into the training (n=14) and control (n=10) groups.

Measurements

Physiological and biochemical variables were assessed before and after 10 weeks. Body weight and body fat percent were determined with the use of a body-composition analyzer (Omron, Finland). The maximal oxygen consumption (vo2max) was predicted by Rockport walking aerobic fitness test.

Blood samples were taken after an overnight fast at

baseline and 48 hours after the completion of the training program. Fasting blood glucose was measured by the oxidase method (Pars Azmoon, Iran). Serum insulin was measured by ELISA (Pars Azmoon, Iran). Homeostasis Model Assessment of Insulin Resistance (HOMA-IR) was estimated using fasting glucose and insulin levels. (HOMAIR = (fasting insulin (µIU/ml) × fasting glucose (mmol/l))/22.5 (Matthews *et al.*, 1985).

Exercise Protocol

The subjects of the training group participated in a combined aerobic and resistance training program over a period of 10 weeks. Each session of the aerobic exercise included 10 minutes warm up, 25-45 minutes walking or running at 65-75% of MHR and 5 minutes cool down. These subjects performed aerobic training two sessions per week. The main part of the exercise started with the intensity 65% of MHR for 25 minutes and gradually progressed to 75% of MHR for 45 minutes in the next sessions.

Resistance training was done with seven exercises (chest press, leg press, lat pull down, biceps and triceps curls, leg extension and flexion), 3 sets of 8-12 repetitions with a 2-3-min rest period between sets at 55-65% one maximal repetition (1RM). A10 minute warm up and 5 minute cool down was included at the beginning and the end of the resistance training. The training group took part in resistance training program for two sessions per week that was different from aerobic training days. The control group did not perform any physical exercises. The subjects were asked to maintain their usual diet during the study.

Statistical analyses

The statistical analyses were performed using SPSS 16 software. The normality of distribution was evaluated by Kolmogorov-Smirnov test. Analysis of covariance (ANCOVA) test was applied to compare the pre and post training values. A p values less than 0.05 was considered to be statistically significant.

Results

At baseline there were no differences in the age, body weight and other physiological variables between the two groups.

The characteristics of the subjects in each group before the training are presented in Table 1.

There were no significant differences in BMI ($F = 2.6$, $p = 0.11$), body fat percent ($F = 1.4$, $p = 0.24$), fasting blood glucose ($F = 3.1$, $p = 0.09$), fasting serum insulin ($F = 2.7$, $p = 0.11$) and insulin resistance ($F = 3.5$, $p = 0.08$) between training and control groups after 10 weeks.

Table 1. Physical and Physiological Characteristics of Study Subjects.

	Training group	Control group
Age (years)	54±2.6	55.5± 5.2
Height (cm)	154.1±2.8	153.2±4.9
Weight (kg)	73.4±11.7	75.1±9.3
BMI (kg/m^2)	30.9±4.9	32.1± 4.6
Body fat (%)	43.4±6.1	43.4±5.9
Vo2max (ml.kg^{-1}.min^{-1})	22.6± 5.6	19.1± 6.4

The findings indicated that combined training program had no significant effect on the BMI, body fat percent, fasting glucose, fasting insulin and insulin resistance in the training group after 10 weeks.

Discussion

In this study, effect of regular exercise on insulin action was investigated in sedentary postmenopausal women. The results showed that 10 weeks of combined training program had no effect on insulin levels and insulin resistance. These results are consistent with other studies (Poehlman *et al.*, 1994; Fairey *et al.*, 2003). On the other hand, there is no conformity between our finding and findings in study

by Nuri *et al* and study by Friedenreich *et al*. In the study by Nuri *et al*, improvement of insulin level in postmenopausal women with breast cancer occurred after 15 weeks of combined training including aerobic and resistance exercise (Nuri *et al*., 2012). Although the type of training program implemented in their study was similar to present study, but exercises were implemented on healthy postmenopausal women during a shorter period of time in present study which may be considered as probable causes for contradiction between results. Moreover, in the study by Friedenreich *et al* unlike the present study, a long-term exercise training program (for one year) was carried out (Friedenreich *et al*., 2011). According to different results, some various factors such as type, intensity and duration of exercise and also characteristics of subjects may influence the response of insulin to the performed exercises. Intensity of exercise is a very important factor to change insulin concentration. The level of insulin remains constant or perhaps slightly reduces in exercise intensities of less than 60% of maximal oxygen uptake. It seems that high intense exercise may improve insulin concentration during recovery period, but low intense activities may hold insulin concentration constant (Marliss *et al*., 2002). Given that exercise training in present study were in the range of low intense to moderate intense exercise and were carried out during a short-term period (10 weeks), it seems that intensity and duration of these exercise training were not sufficient to improve insulin level and insulin resistance in postmenopausal women.

Table 2. Anthropometrical and Biochemical Variables in Pre and Post Training.

	Training group		Control group	
	Pre-training	Post- training	Pre-training	Post-training
BMI (kg/m²)	30.9± 4.9	30.9±4.4	32.1±4.6	31.1± 3.3
Body fat (%)	43.4±6.1	43.3±6.1	43.4±5.9	41.7±5.7
Glucose (mg/dl)	85.4±16.7	87±11.7	82.9±11.5	79.8±9.5
Insulin (µIU/ml)	5.1±1.4	5.4± 1.1	5.7± 1.4	5±0.6
Insulin Resistance	19.2±7.2	21.1±6.5	19.6±10.6	17.4±2.3

The effects of physical activities on insulin sensitivity are also attributed to activation of glucose transporter system, glucose depletion, muscle and liver glycogen depletion and increased blood flow in skeletal muscles (Praet *et al*., 2009). Physical activity, in fact, improve the blood flow to the muscles, increase delivery of glucose to skeletal muscles by expansion of the capillary network (Behboudi *et al*., 2011; Bordenave *et al*., 2008; Holten *et al*., 2004) and confront with capability of lipids to create insulin resistance (Mc Breed, 2009). No change was occurred in glucose concentration of postmenopausal women in present study after 10 weeks of training. It seems that short duration of training and lack of control over some factors such as nutritional status of subjects are some probable reasons for no change in glucose. Studies have shown that high-intensity exercise (more than 80% of maximal oxygen consumption) rely on the glucose more than other fuels (Marliss *et al*., 2002). So, probably increasing the intensity of exercise may impact on the level of blood glucose. Based on research evidence, muscle contraction play an insulin-like role and send a large amount of glucose into the cell to be used for energy production (Cartee *et al*., 1989). Muscle contraction increase permeability of the cell membrane for glucose, probably due to increasing the number of glucose transporters in plasma membrane (Glut4). With exercise, the level of Glut4 increases in trained muscles leading to improved insulin action in glucose metabolism (Kern *et al*., 1990).

The findings of this study show that a short-term combined training program with moderate intensity has no effect on concentration of insulin and glucose and insulin resistance in sedentary postmenopausal

women. Despite of different results in various studies, regular physical activity is advised as an important way to improve the health of postmenopausal women.

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