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Serum C-reactive protein and fasting glucose in response to moderate aerobic training program in overweight or obese women

Hakimi Azadeh*, Karami Nasim, Khaled Ismail Raana, Kazemloo Monireh

Department of Physical Education and Sport Sciences, Science and Research Branch, Islamic Azad University, Tehran, Iran

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Abstract

Obesity is associated with increased chronic inflammatory disease and high risk of cardiovascular disease morbidity or mortality. The objective of present study was to evaluate the effect of 3 months aerobic training on high sensitivity C-reactive protein (CRP) and fasting glucose in non-trained middle-aged women. For this purpose, pre and post training (12 weeks/3 times weekly) of fasting serum CRP and glucose concentration were measured in thirty four non-trained women (aged 37.59 ± 5.36 years; body mass index 31.78 ± 2.86 kg/m2) that divided into control and exercise groups by randomly. Student's paired 't' test was applied to compare the pre and post training values. Serum CRP levels were significantly decreased in response to exercise program when compared with baseline levels. Compared to pre-training, all anthropometrical markers decreased and fasting glucose concentration decreased significantly after exercise program in the exercise but not in the control groups. Change in serum was positively correlated with change in glucose concentration ($p = 0.002$, $r = 0.69$). According to the findings, we conclude that aerobic training for long time improves serum CRP and fasting glucose in overweight or obese women an their changes are dependent of each other.

***Corresponding Author:** Hakimi Azadeh ✉ azad.sport2012@gmail.com

Introduction

Review of research evidence shows that aging is associated with an increase in the chronic systemic inflammation (Grimble *et al.,* 2003). On the other hand, Obesity induces chronic inflammation and may further contribute to the age-related increase in the production of inflammatory cytokines (Trayhurn *et al.,* 2004). It is also important to note that Obesity is associated with several chronic morbidities including dyslipidaemia, atherosclerosis, hypertension and other abnormalities associated with metabolic syndrome. So dysregulated adipokine secretion from the expanded white adipose tissue of obese individuals contributes to the development of systemic low-grade inflammation, insulin resistance and metabolic syndrome (Moreno-Aliaga *et al.,* 2010).

Pro-inflammatory cytokines such as interleukin 6 and tumour necrosis factor-alpha and C-reactive protein are produced by human adipose tissue dependent on the degree of obesity (Moschen *et al.,* 2010) and their important role in obesity related diseases has been repeatedly reported (Eizadi[a] *et al,* 2011; Eizadi[b] *et al,* 2011). In addition to adipose tissue, skeletal muscles also express cytokines that have direct autocrine and paracrine effects (33 of 166). Among pro-inflammatory cytokines, a high level of C-reactive protein is known to be strongly predicted mortality and functional decline in older persons (Reuben *et al.,* 2002).

Marked evidence indicates that C-reactive protein (CRP) as an inflammatory cytokine, a sensitive physiological marker of subclinical systemic inflammation, is associated with hyperglycemia, insulin resistance, and overt type II diabetes (Hong *et al.,* 2007; Utzschneider *et al.,* 2006). According to the population studies, role of CRP as an inflammatory cytokine in the pathogenesis of type 2 diabetes and its relation with insulin resistance and glucose homeostasis has repeatedly been reported, although the physiopathological mechanisms underlying these associations are largely unknown. On the other hand, obese persons have increased levels of intramuscular cytokines (Saghizadeh *et al.,* 1996).

So far, several approaches have been proposed to balance cytokines in obese or its related abnormalities. Among them, the role of exercise including short or long term on these inflammatory mediators has been repeatedly studied. In this area, a recent study reported that a combined caloric restriction and exercise regimen resulted in weight loss and a reduction in some cytokines in skeletal muscle. But the contribution of weight loss, energy restriction, and/or exercise to the observed reduction was unclear in that investigation. This study was aimed to determine the effect of merely aerobic training on serum CRP in non-trained women and to determine the relationship between its changes with the changes of fasting glucose in response to exercise program in studied subjects.

Materials and methods

Subjects

Thirty four non-trained healthy overweigh/obese woman (37.59 ± 5.36 yrs; BMI, 31.78 ± 2.86 kg/m2; 82.01 ± 7.83 kg) were matched according to bodyweight and BMI were enrolled to participate in this study. The objective of study was to investigate the effect of an aerobic program for 3 months (3 times per week) on serum CRP and glucose concentration in study subjects. There, the subjects were divided into exercise and control group by accidentally. Fifteen normal weight (35.2 ± 3.8 yrs; BMI, 22.03 ± 2.8 kg/m2; 56.4 ± 5.6 kg) were also selected in order to compare their mentioned biochemical variables with overweight/obese group. The study was conducted with the approval of the Ethics Committee of Islamic Azad University. After the nature of the study was explained in detail, informed consent was obtained from all participants.

Inclusion and exclusion criteria

Participants were included if they had not been involved in regular physical activity/diet in the previous 6 months. Subjects were reported to be nonsmokers, not currently taking supplements of any kind, and having no major health problems (i.e., diabetes, cardiovascular disease, etc.). Those that were on medications known to alter insulin sensitivity were excluded.

Table 1. Mean and standard deviation of anthropometrical and biochemical variables of normal weight and overweigh/obese groups in baseline and after intervention

Variable \ Group	Normal group	Exercise group Pretest	Exercise group post-test	Control Group Pretest	Control Group post-test
Weight (kg)	56.4 ± 5.6	82.01 ± 7.83	79.92 ± 8.12	81.60 ± 6.4	81.90 ± 7.12
Height (cm)	160 ± 5.1	161 ± 5.9	161 ± 5.9	162 ± 4.3	162 ± 4.3
Age (year)	35.2 ± 3.8	37.59 ± 5.36	37.59 ± 5.36	36.9 ± 4.51	36.9 ± 4.51
Abdominal circumference (cm)	83.4 ± 6.8	110 ± 8.7	107.18 ± 7.96	108.91 ± 6.81	108.73 ± 7.13
Hip circumference (cm)	96.3 ± 7.3	113.26 ± 7.51	109.85 ± 6.87	112.24 ± 7.12	113.03 ± 6.21
BMI (kg/m2)	22.03 ± 2.8	31.78 ± 2.86	30.96 ± 2.97	31.09 ± 2.45	31.20 ± 2.63
Body fat (%)	31.2 ± 4.8	45.26 ± 4.23	43.74 ± 4.25	44.90 ± 4.23	45.01 ± 5.11
Glucose (mg/dl)	74±8	92±10	83±12	94±7	93±11
C-reactive protein (ng/ml)	938 ± 874	6455 ± 2824	5320 ± 2549	6512 ± 2120	6481 ± 2100

Anthropometric measurements

Anthropometric measurements of height, weight, percent body fat, and circumference measurements were taken pre- and post-exercise training. Body weight and height were measured with the subject wearing light clothes. Abdominal obesity was determined as waist circumference measured in a standing position. BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m2). All anthropometrical measurement was repeated after aerobic program.

Biochemical measurements

Pre and post training of blood samples were taken following an overnight 12-hour fast. Blood samples were obtained in order to measuring serum CRP and fasting glucose. The subjects were advised to avoid any heavy physical activity 48 hours before the blood sampling. Post training blood samples were collected at 48 hours after last session of exercise program.

Then the subjects of exercise group were completed an aerobic exercise program (three months/3 times per week). Each session lasted 60-90 min at intensity in 60-80 of maximal heart rate. During their training period they performed different types of exercises included running on a flat surface and Kick pedal on a stationary bicycle for 3 times weekly. In this three months period, participants in the control group were barred from participating in any exercise training.

Statistical analysis

All values are given as mean and standard deviation. Normal distribution of data was analyzed by the Kolmogorov-Smirnov normality test. Statistical analysis was performed with the SPSS software version 15.0. Independent student t test was used for between groups comparison at baseline. Student's paired 't' test was applied to compare the pre and post training values. The relationship between changes of CRP and glucose was analyzed by computing Pearson's correlation coefficient. All statistical tests were performed and considered significant at a $P \leq 0.05$.

Results

Baseline and post training anthropometrical indexes and biochemical characteristics of exercise and control groups are shown in Table 1. These variables of normal weight group were also shown in Table 1. All values are represented as mean ± SD. The data of baseline showed that overweigh/obese group have higher serum CRP than normal weight subject ($p < 0.05$). Fasting glucose concentration was also significantly higher in overweigh/obese group than normal weight subjects ($p < 0.05$).

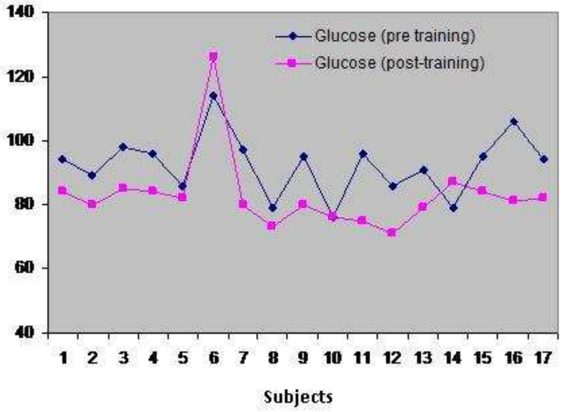

Fig. 1. The change pattern of fasting glucose before and after aerobic training in exercise subjects. Each number of horizontal axis represents one subject.

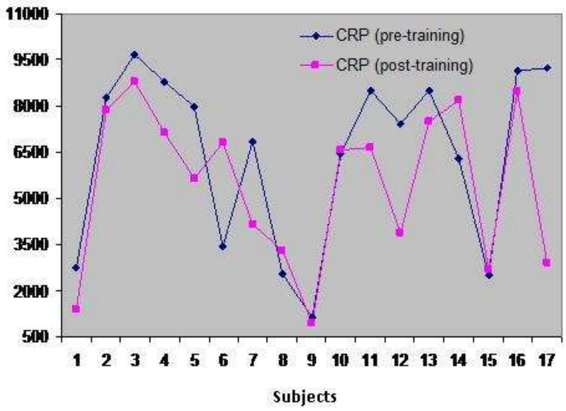

Fig. 2. The change pattern of serum CRP before and after aerobic training in exercise subjects. Each number of horizontal axis represents one subject.

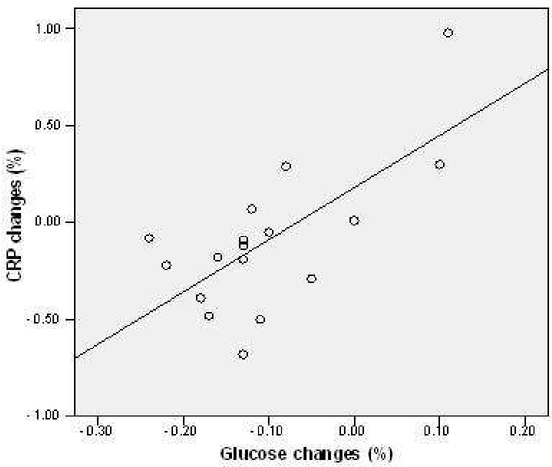

Fig. 3. The relationship pattern of between changes of fasting glucose and serum CRP after exercise program ratio to pre-training in exercise.

Based on Student's paired 't' test, compared to pre-training, all anthropometrical markers as body weight, BMI, body fat percentage and abdominal circumference decreased significantly ($p<0.05$) after exercise program in the exercise but not in the control groups. Aerobic exercise program also led to significant decrease in serum CRP in exercise subjects ($p = 0.028$) but not in the control groups (Fig 1). Moreover fasting blood glucose showed a significant decrease by exercise training in exercise group when compared to pre training ($p = 0.001$) but not in the control groups (Fig 2). The finding of Pearson correlation method showed that changes in serum CRP in response to exercise program was positively correlated with changes in glucose concentration ($p = 0.002$, $r = 0.69$, Fig 3).

Discussion

White adipose tissue (WAT) metabolism and WAT-derived factors as adipokines play a key role in the development of abnormalities associated with metabolic syndrome. The American Heart Association and the Centres for Disease Control and Prevention in the USA suggests that CRP is the best and most clinically useful of the markers of inflammation currently available, with the following cut-off points for assessing CVD risk (Pearson *et al.,* 2003).

In this study, we observed higher serum level of CRP in overweight and obese than normal weight women. A growing body of evidence supports the notion that physical training is effective as a treatment in patients with chronic heart diseases, type 2 diabetes and symptoms related to the metabolic syndrome (Petersen *et al.,* 2006). Although some previous study showed no significant change in serum CRP after exercise program (Campbell *et al.,* 2008), but most studies have pointed to a reduction in this inflammatory cytokine by long term exercise (Tarmast *et al.,* 2012).In conjunction with the lack effect of exercise on CRP, A 12-month moderate-to-vigorous aerobic exercise intervention did not affect CRP levels in previously sedentary men or women with average risk CRP values at baseline (Campbell *et al.,* 2008).

Main finding of our study was significantly decreasing in serum CRP in exercise group compare to its baseline levels. High sensitivity C-reactive protein (hs-CRP) is an inflammatory mediator known to be related to systemic inflammation, cardiovascular diseases and type II diabetes (Eizadi[a] *et al.,* 2011). It has been demonstrated that CRP synthesis by the liver is regulated to a large extent by the pro-inflammatory cytokine interleukin-6 (Gillman *et al.,* 2000). Elevated levels of C-reactive protein and serum IL-6 is demonstrated to be strongly predict mortality and functional decline in older persons (Reuben *et al.,* 2002). On the other hand, C-reactive protein is an acute phase plasma protein, produced in response to general inflammatory episodes within the body (Black *et al.,* 2004; Pepys *et al.,* 2003). This inflammatory cytokine is secreted primarily by the liver cells, but can also be expressed by adipocytes and cultured coronary artery smooth muscle cells (Ouchi *et al.,* 2003; Calabro *et al.,* 2005). The authors noted that CRP may be easily and sensitively measured in a variety of clinical situations to monitor disease progression (Casas *et al.,* 2008). Data from a recent observational study indicate that CRP might be not only a biomarker of different cardiovascular diseases but may have direct effects on the pathogenesis of atherosclerosis and endothelial dysfunction (Szmitko *et al.,* 2003).

Significant reduction in serum CRP in response to exercise can be attributed to lose weight and body fat percentage. Because, aerobic training resulted in significant decrease in all anthropometrical markers as body mass index, body weight and body fat percentage in studied subjects. I seems that exercise induced loss weight is associated with decrease adipose tissue which in turn leads to decreased insulin secretion. Significant decrease in fasting glucose concentration was another finding of present study. On the other hand, we observed a positive significant correlation between changes in serum CRO and changes in fasting glucose.

In other words, in the present study which was conducted in the form of a 12-week exercise program on overweight and obese middle-aged women, the training program led to a significant reduction of both CRP and blood glucose in these patients. But in addition to the changes in these two variables being consistent with the biochemical exercise mentioned above the more significant finding is the correlation between the levels of changes of these two variables that occurred in response to exercise. In other words, a kind of correlation between changes in CRP and glucose has been observed in response to exercise that is important from this point of view. Hence, it may be concluded that the reduction in CRP is one main reason of the decrease in blood glucose following exercise. It's also possible that changes in CRP levels may have indirectly affected blood glucose levels by affecting such other inflammatory or non-inflammatory cytokines as adiponectin, IL-6 or TNF-α.

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