



RESEARCH PAPER

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Aerobic training does not affect serum C reactive protein in smokers

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Abstract

A growing body of literature suggests that cigarette smoking is associated with systemic inflammation. This study was aimed to estimate the effect of aerobic training on serum C reactive protein (CRP) in smokers. For this purpose, thirty non-trained adult smoker men matched for age (41.6 +/- 4.2), height (175 +/- 5.7), and BMI (31.37 +/- 4.3) were divided into exercise or control groups by randomly. Pre and post exercise program (3 months/3 sessions per week) blood samples were collected after overnight fast in order to determine serum CRP in two groups. Student's t-tests for paired samples were performed to determine significance of changes in variables by exercise program. Aerobic program resulted in significant decrease in anthropometrical parameters such as body weight and body mass index in exercise group but not in control group. In contrast, we did not change in serum CRP by exercise training when compared to pre training. Based on these data, we can say aerobic exercise training has not anti-inflammatory properties in smokers, although measuring of CRP alone can not predict anti-inflammatory property of exercise training.

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Introduction

C - reactive protein (CRP) is a key inflammatory factor produced by the liver in response to acute infection or inflammation. Its plasma concentration in response to injury or infection has been found to increase to 1000 (Schultz *et al.*, 1990). This inflammatory cytokine is synthesized mainly by the hepatic ducts, and is regulated by IL- β , IL-6 and TNF- α . Lately CRP has been introduced a more appropriate indicator in predicting cardiovascular diseases than other cytokines (Nicklas *et al.*, 2005). Most recent findings consider measured CRP the only inflammation identification factor but it is frequently mentioned measuring other inflammatory markers along with CRP provides better information about the mechanisms involved in inflammation (Julia *et al.*, 2010).

Increased plasma CRP is known to be associated with coronary artery disease, obesity, diabetes, smoking and sedentary lifestyles (Bruun *et al.*, 2003). In a study of Greek men and women it was concluded that along with age, hypertension and diabetes, CRP is the most important factor connected with cardiovascular disease in this population (Panagiotakos *et al.*, 2008). In this context, recent resources report a relationship between dietary fiber and serum CRP (King *et al.*, 2005). Most studies report a negative relationship between CRP and adiponectin (63). In untrained subjects, baseline CRP levels increase through such mechanisms as increased oxidative stress or decreased insulin sensitivity (Pedersen, 2006). Despite disturbance of systemic levels of CRP in obese subjects and in some chronic diseases, the literature frequently reports increased systemic levels of it in smokers compared with non-smokers (Frohlich *et al.*, 2003; Bermudez *et al.*, 2002; Wannamethee *et al.*, 2005; Bazzano *et al.*, 2003; Lowe *et al.*, 2001). On the other hand, higher levels of this cytokine inflammatory in smokers than non-smokers are observed even years after quitting smoking (Dilyara *et al.*, 2007).

There are conflicting studies regarding the effects of exercise on CRP as some studies have observed no

change in its levels after long-term training programs (Kim *et al.*, 2008). Studies on the elderly people or patients with cardiovascular disease report the role of exercise intervention as an anti-inflammatory agent (Julia *et al.*, 2010). Six months of exercise 2 to 3 times per week on patients with cardiovascular disease led to significant reduction in serum levels of CRP (Smith *et al.*, 1999). But others have reported because a significant reduction in the levels of long-term training programs (Campbell *et al.*, 2008). However, despite numerous findings about the response of CRP to a variety of sports activities in other healthy populations and patients, although some of which are contradictory, few studies have been conducted on the direct effects of long-term exercise on inflammatory cytokine levels in the adult smokers. Hence, the present study aims to determine the effect of aerobic exercise training on serum levels of this inflammatory cytokine.

Method and Subjects

This study aims to determine effect of a three-month aerobic exercise program the effect on CRP levels in middle-aged smoker men. The statistical population of the study consists of adult male smokers (41.6 +/- 4.2 years of age). The research sample includes 30 men aged 38 to 44 participate in the studying as convenience sample. History of chronic and metabolic diseases such diabetes, asthma, renal disease, cardiovascular disease and cancer as well as mobility problems or orthopedic deformities constitute the criteria for exclusion from the study. The subjects are non-athletes and at least in the past 6 months have not engaged in any regular exercise program. After learning of the subjects of the research objectives, all the participants complete and sign consent forms. Smoking at least 10 cigarettes a day constitutes the criterion of being a smoker.

To begin with anthropometric indices were measured and recorded under laboratory conditions. Subjects were then randomly divided into two experimental groups (three-month aerobic exercise program) and control group (no exercise in three months) after anthropometric measurements, 8 mL of venous blood

was taken in fasting state to measure serum CRP. All subjects were advised to refrain from any heavy physical activity 2 days before blood sampling. After serum isolation blood samples kept frozen until analysis in the negative 76.

Then, the experimental group participated in a three-month aerobic exercise program of 3 sessions per week with 60 to 80 percent of maximum heart rate intensity. In the early sessions, training intensity and volume were in the lowest range and with increasing number of sessions the exercise gradually increased in intensity and volume. In each session, a workout program was performed including 5 to 10 minute warm up, then stretching, then aerobic exercise like running on a flat surface or treadmill and group exercise and in the final stage and the session was finished with cool-down. The subjects' maximum heart rate was determined using the formula of 220 minus age and the target heart rate was controlled and recorded using a polar pulse meter installed on waist circumference of each subject. In these three months, the control group did not participate in any training program.

Then, 48 hours after the last training session, the subjects attended the blood lab for repeated blood sampling to determine the effect of exercise on the variables and comparing them with a control group in a situation in a lab environment similar the first stage.

Serum CRP was determined by ELISA method, using a Diagnostics Biochem Canada Inc kit made by Canada. The Intra- assay coefficient of variation and sensitivity of the method were 5% and 10 pg/mL, respectively.

Data analysis

Statistical analysis was performed with the SPSS software version 15.0. Normal distribution of data was analyzed by the Kolmogorov-Smirnov normality test. Independent t-test was used to compare the means of variables between experimental and control groups at baseline. Student's paired 't' test was applied to compare the pre and post training values. P value of <0.05 was accepted as significant.

Results

In the methodology section, we mentioned that main objective of this study was CRP relation in response to three months aerobic exercise in smoker men. Body weight and other anthropometrical markers and serum CRP of two groups before and after exercise training intervention are shown in Table 1. At baseline, we did not observed significant differences in body weight, body mass index and other anthropometrical markers ($p \geq 0.05$). There was not difference in serum CRP in two groups at baseline ($p = 0.05$). Exercise intervention resulted significant decrease in body weight and other anthropometrical markers ($p \leq 0.05$).

Table 1. Mean and standard deviation of anthropometrical and serum CRP before and after intervention in studied groups.

Variables	Exercise Group		Control group	
	Pretest	post-test	Pretest	post-test
Age (year)	41.8 +/- 4.8	41.8 +/- 4.8	41.3 +/- 5.3	41.3 +/- 5.3
Height (cm)	174.9 +/- 6.5	174.9 +/- 6.5	175.1 +/- 6.7	175.1 +/- 6.7
Weight (kg)	95.4 +/- 4.5	91.2 +/- 3.3	95.8 +/- 5.4	94.5 +/- 5.6
Waist circumference (cm)	108.7 +/- 7.6	102.6 +/- 5.6	108.5 +/- 5.7	107.6 +/- 6.4
Hip circumference (cm)	107.6 +/- 7.8	101.3 +/- 6.5	107.2 +/- 6.3	106.6 +/- 5.7
BMI (kg/m ²)	31.51 +/- 4.2	29.8 +/- 2.3	31.24 +/- 3.2	30.82 +/- 3.4
BF (%)	31.33 +/- 3.4	29.1 +/- 3.4	31.5 +/- 3.9	30.98 +/- 3.5
CRP (ng/ml)	2231 +/- 211	2121 +/- 320	2213 +/- 133	2190 +/- 345

BMI, body mass index; BF, Body fat percentage; CRP; C Reactive Protein.

Serum CRP levels did not change by aerobic training when compared with pre-training in exercise group ($p = 0.321$, Fig 1). There were no changes in all variables in control groups.

Discussion

Although some previous studies, report higher levels of CRP in male smokers than non-smokers (Behbudi *et al.*, 2013), in the present study, the results of paired t-test showed that the serum levels of inflammatory cytokines did not change significantly in response to a three-month aerobic exercise program in the experimental group. In other words, the three-month aerobic exercise three times a week with an intensity of 60 to 80 percent of maximum heart rate would not affect CRP levels in male smokers. Although the bulk of the CRP is secreted by adipose tissues' cells its secretion by hepatocytes and respiratory tract, also has its special contribution in its systemic levels (Tonstad *et al.*, 2009). It is also possible that the inflammation caused by cigarette smoking affects the respiratory tract and hepatocytes to secrete more CRP by these tissues.

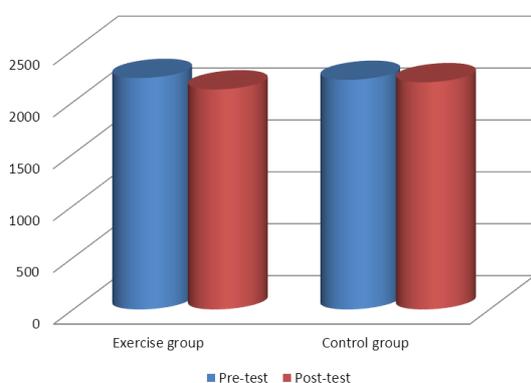


Fig. 1. The changes pattern of serum CRP concentration in control and exercise groups of studied subjects.

Clinical evidence suggests that those men who are constantly smoking tobacco or cigarettes have higher levels CRP than do non-smokers associated with increased inflammatory processes in this population (Merghani *et al.*, 2012). Studies have pointed to the fact that nitrogen oxides and other oxidants induced by tobacco smoking are associated with increased inflammation in the respiratory pathways (Valença *et*

al., 2009), which bring about increased mucus secretion and increased susceptibility to allergens and eventually lead to boosted eosinophil count and secretion of inflammatory mediators by respiratory tract and other tissues (Ronchetti *et al.*, 1990).

Finding the main reason for this inflammatory cytokine not changing significantly in response to the exercise program in the male smoker subjects appears to be a tough task, but the insignificant changes may be attributed to the small sample size of the sample, because the distribution of numerical values of CRP among the population and/or the high standard deviation alongside the small sample size in most studies, may be among the possible reasons for the insignificant changes of the findings. However, it has already been pointed out that in addition to its secretion by the respiratory tract, adipose tissue and coronary artery smooth muscle cells (Calabro *et al.*, 2005), it is mainly secreted by hepatocytes (Tonstad *et al.*, 2009). Hence, it appears that the rate of secretion CRP by the respiratory tract represents only a tiny proportion of the total levels of CRP in blood circulation and even if the three-month exercise has reduced its secretion from smooth muscle cells of the respiratory tract, it would not lead to significant changes in serum levels of total systemic blood circulation. Hence, it appears that the measurement of its tissue levels or the measurement of CRP gene expression in the respiratory tract in male smokers before and after the three-month training program may lead to important results concerning its response to exercise.

Furthermore, most studies having measured CRP levels in smokers report no reduction or CRP improvement immediately after the discontinuation of its consumption which is indicative of profound impairments of tissues caused by smoking, and its prolonged healing after smoking cessation (Yanbaeva *et al.*, 2007). In this context, a longitudinal study, while indicating higher levels CRP in smokers than in nonsmokers also revealed that even after five years from stopping smoking, this significant difference will still linger on

full recovery or normal CRP levels have only been reported in those who had stopped smoking for 20 years (Wannamethee *et al.*, 2005). In another study by Ferro Hilch et representing the longest recovery period after cessation of smoking it was determined that CRP levels were reduced from 1.92 milligrams per liter to baseline 1.25 milligrams per liter 30 to 55 years after cessation of smoking (Frohlich *et al.*, 2003).

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