Journal of Physical Activity and Hormones
Vol 2, No. 4, Ser. 8 (December 2018), 015-026

Effect of eight weeks high intensity aerobic exercise on C-reactive protein levels in obese middle-aged men

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Received: 8 October 2018 / Accepted: 25 November 2018

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Abstract

Introduction: C-reactive protein (CRP) is a marker of chronic systemic inflammation frequently used in cardiovascular disease risk assessment. The aim of this study was to investigate CRP concentrations in middle-aged men after 8 weeks high intensity aerobic exercise.

Material & Methods: Twenty two sedentary obese middle-aged men (aged: 46.4 ± 2.3 years and body mass index (BMI): 32.8 ± 2.0 kg/m^2; ± SD) volunteered to participate in this study. The subjects were randomly assigned to training group (n=11) or control group (n=11). The training group performed high intensity aerobic training 3 days a week for 8 weeks at an intensity corresponding to 75-80% individual maximum oxygen consumption for 45 min.

Results: The results showed that the body weight, BMI, body fat percent and WHR were decreased and VO_{2max} was increased in the training group compared to the control group ($P<0.05$). After 8 weeks, the training group resulted in

a significant decrease (58.7 %) in the CRP in compared with the control group.

Conclusions: The results suggest high intensity aerobic exercise improves body composition and decreases CRP concentrations in obese middle-aged men.

Keywords: Aerobic exercise, CRP, Obesity, Inflammation, Cardiovascular heart disease

1. Introduction

Obesity is a public health problem and can be classified as a world epidemic that leads to an elevation in medical costs. Obesity and overweight have been shown to increase the risk of several well-known co-morbidities such as cardiovascular disease. Obesity is characterized by excess energy intake resulting in an expansion of adipose tissue depots, visceral adiposity, hypertrophy, hyperplasia, and adipocyte dysfunction (1). In obese individuals there are marked increases in the secretion of pro-inflammatory adipokines including C-reactive protein (CRP), IL-6 and TNF-α, and decreased production of anti-inflammatory adipokines such as adiponectin. This change in adipokine balance is a key component of pathogenic metabolic and immune responses and has impacts on angiogenesis, blood pressure and lipid metabolism, all of which are linked with cardiovascular disease (2,3).

One of the most commonly measured markers of inflammation in clinical settings is CRP (4,5). Plasma levels of CRP have been reported to be a strong independent predictor of risk of future myocardial infarction, stroke, peripheral arterial disease, and vascular death among individuals without known cardiovascular disease (4). Given the apparent importance of CRP among other inflammatory markers in the development of cardiovascular disease morbidity and mortality, it is critical to determine those factors that may help to lower and maintain optimal levels of CRP (6).

It is documented that physical activity has a role in preventing cardiovascular disease (7), mediated, in part, by changes in inflammation. Recently, great attention has been focused on the response

of inflammation to physical exercise. Several studies have not provided support for exercise intervention-induced reductions in CRP in adults (6,8).

A recent review, although concluding that assessing body composition distribution may assist in interpreting the effectiveness of interventions in improving circulating inflammatory markers in obese adults (9), does not provide enough evidence about the effect of physical exercise on reducing CRP levels. In contrast, other studies concluded that habitual physical exercise results in lower levels of CRP (8,10). Therefore, evidence about the impact of physical exercise on controlling the inflammation process is not clear, thus the aim of this study was to investigate CRP concentrations in middle-aged men after 8 weeks high intensity aerobic exercise.

2. Material & methods

Participants

Twenty two sedentary obese middle-aged men (aged: 46.4 ± 2.3 years and body mass index (BMI): 32.8 ± 2.0 kg/m^2; ± SD) volunteered to participate in this study. All the subjects were asked to complete a personal health and medical history questionnaire, which served as a screening tool. The subjects were given both verbal and written instructions outlining the experimental procedure, and written informed consent was obtained. Our participants were not engaged in any systematic exercise programs at least 6 months before the study, none of them had any disease or had been consuming any drugs that could affect bone metabolism. The subjects were randomly assigned to one of the training group (n=11) or control group (n=11). The study was approved by the Yasuj branch, Islamic Azad University Ethics Committee.

Exercise training

The training group performed high intensity aerobic training 3 days a week for 8 weeks at an intensity corresponding to 75-80% individual maximum oxygen consumption for 45 min. Each participant wore a heart rate monitor (Beurer, PM70, Germany) to ensure accuracy of the

exercise level. The control group was instructed not to change their physical activity and diet.

Measurements

▶ *Anthropometric and body composition measurements*

Anthropometric measures including height, body mass, waist circumference and hip circumference were evaluated using standard techniques (11). Body mass index (BMI) and waist/hip ratio (WHR) were calculated. Then, body composition (percentage of total body fat) was assessed by skinfold thickness protocol. Skinfold thickness was measured sequentially, in triceps, suprailiac, and thigh by the same investigator using a skinfold caliper (Harpenden, HSK-BI, British Indicators, West Sussex, UK) and a standard technique (11).

▶ *Measurement of VO_{2max}*

VO_{2max} was determined by Rockport One-Mile Fitness Walking Test. In this test, an individual walked 1 mile as fast as possible on a track surface. Total time was recorded and HR was obtained in the final minute. VO_{2max} was calculated using formula (11).

▶ *Biochemical analyses*

Fasted, resting morning blood samples (10 ml) were taken at the same time before and after 8 weeks intervention. All the subjects fasted at least for 12 hours and a fasting blood sample was obtained by venipuncture. Plasma obtained was frozen at –22 ^{oC} for subsequent analysis. CRP levels were determined via an enzyme-linked immunosorbent assay (ELISA) kits (Monobind, China, Inc). The intra and inter-assay coefficients of variation for hs-CRP were $<0.68\%$ and a sensitivity of 0.01 μg/ml.

Statistical analysis

Results were expressed as the mean ± SD and distributions of all variables were assessed for normality. Paired-sample t-test and independent sample t-test were used to evaluate the changes of Plasma CRP levels before and after the intervention. The level of significance in

all statistical analyses was set at P≤0.05. Data analyses were performed using SPSS software for windows (version 17, SPSS, Inc., Chicago, IL).

3. Results

Changes in anthropometric variables

Anthropometric, body composition and physiological characteristics of the subjects at baseline and after training are presented in Table 1. Before the intervention, there were no significant differences in any of variables among the two groups. The results showed that the body weight (5.5%), BMI (5.5%), body fat percent (12.9%) and WHR (2.9%) were decreased and VO_{2max} was increased (12.9%) in the training group compared to the control group (P<0.05).

Table 1. Anthropometric, body composition and physiological characteristics (mean ± SD) of the subjects

	Control (mean±SD)		Training (mean±SD)	
	Pretraining	**Posttraining**	**Pretraining**	**Posttraining**
Height (cm)	174.7 ± 6.0	—	173.3 ± 4.0	—
Body mass (Kg)	100.8 ± 9.4	100.7 ± 9.1	98.1 ± 7.0	92.7 ± 5.5*,
BMI (Kg/m²)	33.0 ± 2.3	33.2 ± 2.2	32.6 ± 1.9	30.8 ± 1.6*,
Body fat (%)	27.7 ± 4.5	27.8 ± 4.5	29.3 ± 4.0	25.5 ± 4.5*,
WHR	1.0 ± 0.05	1.0 ± 0.05	1.02 ± 0.02	0.99 ± 0.02*,
VO_{2max} (ml/kg/min)	36.4 ± 0.9	36.2 ± 0.9	32.4 ± 2.3	36.6 ± 2.8*,

*P<0.01 for between-group differences.
,P<0.01, pretraining *vs.* posttraining values.

Changes in biochemical variables

Changes on CRP concentrations at baseline and after 8 weeks high intensity aerobic exercise are presented in Figure 1. Results showed that the training group resulted in a significant decrease (58.7 %) in the CRP in compared with the control group (P<0.05).

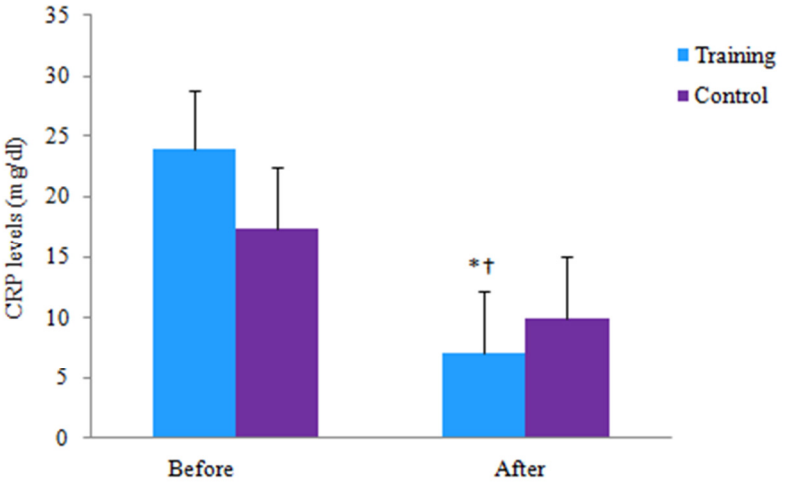

Figure 1. Changes on CRP levels after 8 weeks exercise

* P<0.01 for between-group differences.
† P<0.01, pretraining vs. posttraining values.

4. Discussion

The aim of this study was to investigate CRP concentrations in middle-aged men after 8 weeks high intensity aerobic exercise. Our results showed that CRP concentrations were decreased after the intervention (58.7 %) in compared with the control group.

How exercise training reduces inflammation and suppresses CRP levels is not well defined. Physical activity is related to several confounders that are independently associated with lower CRP levels. For example, physical activity is inversely related to age, smoking, hypertension, BMI, and WHR, total and non–high-density lipoprotein cholesterol, triglycerides, and apolipoprotein B concentrations, whereas these factors are directly related to CRP concentrations (12). Similarly, physical activity is directly related to the proportion of white participants, education level, insulin sensitivity, alcohol consumption, and fruit and vegetable intake, all factors that are inversely associated with CRP (12). Despite the overlap between factors associated with physical activity and CRP, higher CRP levels persist in more active subjects in most studies even after adjustment.

Hepatic CRP production is stimulated by IL-6 and, to a lesser extent, by IL-1 and TNF-α. Individuals who are obese and/or hyperinsulinemic have increased adipocyte production of inflammatory markers, including CRP, IL-6, and TNF-α (13,14). A multidisciplinary program to reduce body weight in obese women through lifestyle changes, including a low-calorie diet, and increased physical activity, reduced IL-6, IL-18, CRP, and insulin resistance, whereas adiponectin levels increased (15). Adiponectin is a novel adipocytokine with anti-inflammatory and insulinsensitizing properties (16). Evidence also exists that leptin levels are reduced in physically active individuals independent of BMI (17) and that leptin is associated with CRP (18). Moreover, in centrally obese individuals, omental adipocytes produce more IL-6 than do abdominal subcutaneous adipocytes (19). Consequently, physical activity could decrease resting levels of IL-6 and TNF-alpha and, ultimately, CRP production, by reducing obesity and leptin and increasing adiponectin and insulin sensitivity (20). Once again, however, the relationship between increased physical activity and lower CRP persists even after adjusting for BMI, WHR, and fasting insulin concentration (17,21), suggesting that other factors contribute to the exercise-related anti-inflammatory effect.

Some of this effect may be mediated by modification of cytokine production from other sites, besides adipose tissue, such as skeletal muscles (22) and mononuclear cells (23). Exercise training reduces skeletal muscle TNF-alpha, IL-1-beta, and IL-6 expression in patients with heart failure (22). Furthermore, long-term exercise attenuates mononuclear cell production of atherogenic cytokines (IL-1-alpha, TNF-alpha, and interferon gamma) while augmenting the production of atheroprotective cytokines (IL-4, IL-10, and transforming growth factor-beta-1) (23). Thus, these multifocal effects of exercise drive the resting cytokine balance to an “anti-inflammatory” state.

Physical activity may also mitigate inflammation by improving endothelial function. Endothelial cells are known to secrete IL-1 and IL-6, whereas activated endothelial cells can increase the production of ILs and adhesion molecules inducing inflammation (24). Physical training reduces peripheral inflammatory markers associated with endothelial dysfunction, such as soluble intracellular and vascular adhesion

molecules, granulocyte-macrophage colony-stimulating factor, and macrophage chemoattractant protein-1 in patients with heart failure (25). Regular physical activity also improves endothelial function preserving nitric oxide availability (26). Although exercise acutely increases oxidative metabolism and thereby induces oxidative stress, there is evidence that long-term physical activity increases antioxidant defenses through the up-regulation of antioxidant enzymes (27). Furthermore, this antioxidant effect of exercise reduces the susceptibility of low-density lipoprotein to oxidation (28), which in turn helps further prevent endothelial injury and inflammation (39,30). In summary, it is likely that exercise training reduces CRP both directly by reducing cytokine production in fat, muscle, and mononuclear cells and indirectly by increasing insulin sensitivity, improving endothelial function, and reducing body weight. Additional research is needed to examine these mechanisms.

5. Conclusion

In summary, resistance training–induced change in body composition decreases CRP concentrations in obese middle-aged men.

Conflict of interests: There was no conflict of interest among authors.

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