World Academy of Science, Engineering and Technology
International Journal of Sport and Health Sciences
Vol:10, No:8, 2016

The Effects of Eight Weeks of Interval Endurance Training on hs-CRP Levels and Anthropometric Parameters in Overweight Men

S. Khoshemehry, M. J. Pourvaghar

***Abstract*—**Inflammatory markers are known as the main predictors of cardiovascular diseases. This study aimed at determining the effect of 8 weeks of interval endurance training on hs-CRP level and some anthropometric parameters in overweight men. Following the call for participation in research project in Kashan, 73 volunteers participated in it and constituted the statistical population of the study. Then, 28 overweight young men from the age of 22 to 25 years old were randomly assigned into two groups of experimental and control group (n=14). Anthropometric and the blood sample was collected before and after the termination of the program for measuring hs-CRP. The interval endurance program was performed at 60 to 75% of maximum heart rate in 2 sessions per week for 8 weeks. Kolmogorov-Smirnov test was used to test whether two samples come from the same distribution and T-test was used to assess the difference of two groups which were statistically significant at the level of 0.05. The result indicated that there was a significant difference between the hs-RP, weight, BMI and W/H ratio of overweight men in posttest in the exercise group ($P \leq 0.05$) but not in the control group. Interval endurance training program causes decrease in hs-CRP level and anthropometric parameters.

***Keywords*—**Interval endurance training program, hs-CRP, overweight, anthropometric.

I. Introduction

NOWADAYS, in developing countries, the patterns of disease have changed from communicable diseases to non-communicable diseases like cardiovascular disease, diabetes, high blood pressure most of which are resulted from motion poverty and poor living habits and other factors. One of these diseases is cardiovascular disease predicted to be the most common disease of 2020 [1]. Basically, inflammation is the source of most diseases of the cardiovascular system especially heart feeder system [2]. Pathological changes of atherosclerosis begin in childhood and then later in life stages. Understanding the factors in the development of cardiovascular diseases can have an important role in preventing from the progression of the disease [3]. In the past decade, the idea of atherogenic inflammation and the role of local and systemic inflammation in the process of atherosclerosis and the problems related to it are the items widely accepted. Also, according to the studies done at the American Heart Association, inflammatory markers are considered as the major predictors of cardiovascular disease [3], [4]. Several studies have shown that cardiovascular diseases have inflammatory background; and indicators of systemic inflammation play a central role in the development and progression of atherosclerosis [5], [6]. High sensitivity C-reactive protein, HS-CRP, is one of the symptoms susceptible to inflammation. Currently, it is believed that HS-CRP is a sign of infection in clinical trials. Increase of HS-CRP levels of plasma is associated with increase of risk of coronary disease. On the other hand, measurement of plasma levels (HS-CRP) is associated with obesity, insulin resistance and metabolic syndrome [5]. This parameter is derived from the liver; and its production is irritated by general cytokines released from various sources [2]. CRP has a long half-life; and it has good relation with synthesis induced by chronic inflammation. This ability is lower than other inflammatory parameters. HS-CRP levels are directly representative of the reaction of the acute phase against the red blood cells that are indirectly representative of the acute phase. They reach the level 100-1000 times more than the basic level with the speed of 24-48 hours after inflammation [4]. Since the role of inflammation in the pathogenesis of cardiovascular diseases may be a mechanism of increased cardiovascular disease, so researchers in the field of sports, especially sport physiology, are led to find such practical solutions for reducing cardiovascular diseases and preventing from them by attention to the beneficial effects of aerobic exercise on prevention and reduction of inflammatory parameters [7]. Choobineh and et al. (2007) studied the beneficial effects of continuous and intermittent aerobic exercises on the HS-CRP reduction in Westar rats [8]. Also, Christos et al. (2005), in a paper, reviewed the impact of physical activity on serum HS-CRP levels and reported that there was an inverse relationship between the levels of HS-CRP, waist-to-hip ratio (WHR) and weight and regular exercises [9]. The findings of the study done by Wegge et al. (2004) revealed a significant decrease in plasma levels of HS-CRP after participating in a two-week weight control program including diet and daily exercise in postmenopausal women [10]. Akbarpour (2013) showed that performing resistance training significantly reduced HS-CRP in obese men [11]. Nayebifar et al. (2012), in the study, evaluated the effects of aerobic and resistance training on HS-CRP in overweight women; and their findings showed a significant reduction of CRP in both groups compared to the control group [12]. Muylaert et al. (2003) also found similar

S. Khoshemehry is with the Ministry of Education, Tehran, I. R. Iran, (e-mail: sheydamehry@gmail.com).

M. J. Pourvaghar, Associate Professor of Exercise Physiology, Faculty of Humanities, University of Kashan, Kashan, I. R. Iran (e-mail: vaghar@kashanu.ac.ir).

results [13]. Witkowska et al. (2005) and Gomes et al. (2010) have shown that there was an inverse relation between physical activity and cardio – respiratory fitness and HS-CRP levels. In other words, they concluded that physical activity and cardiovascular fitness decreases the HS-CRP level of blood [14], [15]. Katja et al. (2006) have shown that there is a strong relation between HS-CRP and obesity and overweight [16]. However, Jeffrey et al. showed that intense physical activity, weight loss and WHR result in increase in levels of HS-CRP [17]. On the other hand, Hiller (2002), Marcell (2005) and Playsans et al., (2006) have shown that doing aerobic exercise does not have a significant effect on the reduction of HS-CRP levels [18]-[20]. Therefore, given the importance of the subject and sometimes contradictory results and the important role of exercise in reducing inflammation and cardiovascular complications in obese and overweight, study is going to investigate the effects of eight weeks of interval endurance training on HS-CRP levels of serum in overweight men.

II. Procedure

This is a quasi-experimental study with experimental and control groups. After the announcement of the call, of the 73 people who had the conditions of their participation in the research, 28 overweighed male students with a body mass index (BMI) between 25 and 30 kg/m^2 were purposefully selected as sample by using researcher made questionnaire to gather information; and they were randomly assigned into two experimental and control groups; each of them consisted of 14 people. Inclusion criteria involves having physical health, lack of cardiovascular disease, body mass index between 25 and 30 kg/m^2, and non-smoking; and people with a history of drug use and regular participation in physical activity could not participate in the research project. Before beginning the study, all participants received a written consent form. Due to the long period of research, the investigators failed to control nutrition of participants. The measured anthropometric parameters of participants include height, weight, BMI and WHR. From 8 to 9 am, in the fasting state, about 5 cc of blood were collected from participants' anterior brachial vein. In order to measure HS-CRP, specialized binding site kits with an accuracy of 4.0 grams per liter was used; and it was measured by experts with immunoturbidometric method in milligrams/deciliter with full automatic Minines machine made in America [21].

A. Training Program

First session of exercise was taken 24 hours after initial blood sample. Training program consists of 8 weeks of interval endurance training in two sessions per week. In the first two weeks, participants do interval endurance exercise for 35 minutes at a distance of 200 meters by running with a maximum intensity of 60 to 75 percent of maximum heart rate. Participants do interval endurance exercise for 45 minutes at 70 to 85 percent of maximum heart rate in 6 next weeks. In compliance with the principle of overload, the 200-meter distance is added to the previous distance. After running the distance of 200 meters, participants walk; and after the active recovery, they start running the next 200 meters. Heart rates of participants are recorded up to 160- 170 beats at the peak of activity. Also, heart rates of participants are 90 to 100 beats at the time of recovery which are measured and recorded by using a polar watch from China [21]. No variable is applied in the control group. The control group do their daily normal life. At the end of 8 weeks and 24 hours after the last session of exercise, a second blood sample is done with similar conditions of the first blood sample. Also, anthropometric measurements are repeated similar to the pre-test. It should be noted that 2 sessions of interval endurance training in a week are considered as limits of the study which participants do not have the required time to attend more.

B. Statistical Analysis

In the statistical analysis, first, all quantitative variables are evaluated by Kolmogorov – Smirnov test in order to be normal. After verification, dependent and independent t-test is used to evaluate the differences between and within groups. Also, significance level for rejection or acceptance of hypotheses is $P\leq 0.5$; and all statistical analysis is performed with 17th version of SPSS.

III. Results

According to Table I, the variables of age, weight, height, BMI and WHR of students participating in the study, in both experimental and control groups, had no statistically significant difference; and it showed that two groups were randomized perfectly ($P\geq 0.5$).Then, as Table II shows, eight weeks of interval endurance training on HS-CRP levels in overweight men makes a significant difference in the HS-CRP plasma in the experimental group ($P\leq 0.5$).Changes within group arising from statistical analysis showed that there were significant difference in the variable of HS-CRP between experimental groups in pre-test and post-test ($P=0.005$).Statistical analysis within the group in HS-CRP showed that after eight weeks of interval endurance training, HS-CRP levels of 51.7±1.14 reduce with more than ninety percent change. Also, changes within the groups showed that there were significant differences in the variables of body weight, waist to hip ratio and body mass index between the experimental and control groups in the pre-test and post-test ($P=0.0001$). According to Table II, after eight weeks of interval endurance training for overweight men, 6.13 percent of the body weight (5±0.02), 7.17 percent of BMI (1.92 ±1.9) and 13.43 percent of WHR of them in the experimental group were decreased. However, the results of the statistical analysis of two groups showed that there was significant difference between the experimental and control groups in the variables ($P\leq 0.05$); but in the control group who did not receive training program, there was no significant difference in changes within group in variable of HS-CRP ($P=0.89$), body weight ($P=0.08$), BMI ($P=0.43$) and WHR ($P=0.67$).

TABLE I
DESCRIPTIVE INDICES OF MEASURED VARIABLES IN BOTH EXPERIMENTAL AND CONTROL GROUPS

group	Control group		Experimental group	
variable	Pre-test Mean ± SD	Post- test Mean ± SD	Pre-test Mean ± SD	Post-test Mean ± SD
Age (years old)	2.4±21.35	2.4±21.35	1.2±22.4	1.2±22.4
Height (cm)	5.7±171	5.7±171	6.4±174	6.4±174
Weight (kg)	6.8±84.4	6.7±84.4	6.3±86.5	6.5±81.5
BMI (kg/m^2)	3.1±31.5	3.5±32.2	3.5±28.67	1.6±26.75
WHR (cm)	0.08±1.62	0.04±1.61	0.18±1.54	0.05±1.34

TABLE II
COMPARISON OF THE MEAN OF CRP LEVELS AND SOME ANTHROPOMETRIC INDICES IN BOTH EXPERIMENTAL AND CONTROL GROUPS BEFORE AND AFTER TRAINING

Variable	Group	Stage	Mean ±SD	T-dependent	P within group	P between group
CRP (micg/ml)	experimental	Pre-test	0.94±1.36	3.12	0.0005*	0.0003‡
		Post-test	0.43±0.23			
	control	Pre-test	1.17±1.40	0.13	0.89	
		Post-test	1.25±1.35			
Weight (kg)	experimental	Pre-test	86.5±6.3	0.11	0.048	‡0.36
		Post-test	81.5±6.5			
	control	Pre-test	84.8±6.8	0.45	0.087	
		Post-test	84.4±6.7			
BMI (kg/m^2)	experimental	Pre-test	28.67±3.5	0.03	0.07	‡0.0006
		Post-test	26.75±1.6			
	control	Pre-test	31.5±3.1	0.32	0.43	
		Post-test	32.2±3.5			
WHR (cm)	experimental	Pre-test	1.54±0.18	0.002	0.004	‡0.0001
		Post-test	1.34±0.05			
	control	Pre-test	1.62±0.08	0.37	0.67	
		Post-test	1.61±0.04			

* Statistical significance signs within the group; ‡ statistical significance signs between groups

IV. DISCUSSION

The results showed that eight weeks of interval endurance training has positive effects on HS-CRP levels and weight and WHR of overweight men. The results of this study are consistent with Choobineh (2007), Nayebifar (2012), Christos (2005), Katja (2006), Gomez (2010) and colleagues [9], [12]-[14], [16]. Nayebifar et al. (2011) reported that body mass index had significant reduction after 8 weeks of aerobic training with intensity 65 to 80% of heart rate reserve [12]. Also, Katja, et al. (2005) studied people from 25 to 74 years old; and they showed that aerobic training has an inverse relation with the CRP levels. In other words, they found that physical activity and cardio–vascular fitness decrease CRP levels [16] that correspond with the results of this study. Despite these, the results of this study do not match with the findings of Hiller et al (2002), Marcell (2005) and Plaisance (2006), [18]- [20]. Marcell et al., (2005) Hiller et al., (2002) showed that doing aerobic exercises respectively (16 weeks and 12 weeks) has no effect on CRP levels. To justify this, they have raised the possibility of insufficient 8 weeks [18], [19]. It is reported that Intense exercise activity with weight loss cause to increase CRP levels. Justification for this is that overtraining damage to tissues and muscles. This leads to inflammation and increased blood uric acid levels and CRP. In general, they concluded that Anti-inflammatory effects of exercise are independent from weight loss. This increase may be due to mechanical stress caused by repeated blows of feet to the ground and activation of endothelial cells [1], [19].

On the other hand, it is possible the contradictions in the research findings to be caused by the relationship between sports and the basic values of the index, type and intensity of exercise, fitness level of participants, training programs and the time of blood sampling, the impact of food and other factors. Possibly training with longer duration, higher volume of training or in combination with nutritional intervention could have more favorable effects on cardiovascular risk factors in overweight men by which closer perspective on future research will be achieved [2], [12], [21], [22]. The cytokine are the mechanisms through which regular exercise could improve HS-CRP. A potential major route is probably interleukin. In particular, there is some evidence about interference of tumor necrosis factor alpha (TNF-a) and interleukin-6 (IL-6). IL-6 and TNF-a are considerably released from adipose tissue, particularly visceral fat. Release from adipose tissue is increased by sympathetic stimulation. Since regular physical activity, may regulate sympathetic stimulation, perhaps, by reduction of TNF-a, stimulating strong IL-6, HS-CRP will reduce production [16], [23].

Among other mechanisms which can be pointed out, HS-CRP is indirectly affected by adipose tissue. At baseline, HS-CRP serum levels are higher in obese people; and because obesity is highly related to IL-6; andIL-6, itself, the prime mover of HS-CRP in the liver. Weight loss, WHR and body fat during physical activity may lead to a reduction in IL-6 and HS-CRP [23], [24]. Also, regular aerobic exercise increases nitric oxide from endothelial and improve endothelial function and increase antioxidant agents, which result in the reduction of systemic and local inflammation and finally reduce inflammatory cytokine production of smooth muscles in endothelial wall; and their ultimate impact is likely to reduce the production of HS-CRP inflammatory index of liver [21], [25].On the other hand, by strengthening the cardiovascular system of exercise and changes in the fuel and the process of lipolysis, the results of this study showed a significant decrease in weight, waist to hip ratio and body mass index, the favorable effects of exercise carried out can be inferred from the changes that are consistent with the study done by Christos and colleague (2005). The result of this process is the reduction of direct and indirect HS-CRP in the liver [9], [13], [14].

V. CONCLUSIONS

In general, according to the results of this study, which showed the effect of aerobic exercise on a significant reduction in the amount of HS-CRP serum as an index of inflammation in the prediction of cardiovascular disorders,

and by considering any factor that decreases the index, we concluded that aerobic exercise directly or indirectly reduce the risk of cardio-vascular disorders. Cautiously, it can be concluded that having the right fitness level by doing alternate aerobic exercise protocol, due to reduction in levels of WHR, BMI, body weight and HS-CRP serum can lead to the prevention from cardiovascular disorders.

ACKNOWLEDGEMENTS

This research is supported by the deputy of Kashan University and in a letter No. 8-159233. We also sincerely thank those who participate in this study.

REFERENCES

[1] FS. Lira, AS. Yamashita, MC. Uchida, NE. Zanchi, B. Gualano, EJR. Martins, et al. Low and moderate, rather than high intensity strength exercise induces benefit regarding plasma lipid profile. Diabetol Metab Syndr 2010; 2(31): 131-142.

[2] MA. Albert, RJ. Glynn, PM. Ridker. Effect of physical activity on serum C-reactive protein. Am Heart J 2004; 93: 221-225.

[3] ME. Bahram, M. Najjarian, M. Sayyah, H. Mojtahedi. The effect of an eight-week aerobic exercise program on the homocysteine level and VO_2max in young non-athlete men. Feyz 2013; 17(2):149-156.

[4] P. Mathieu, P. Poirier, P. Pibarot, L. Lemiux, JP. Despres, Visceral obesity: the link among inflammation, hypertension and cardiovascular disease. Hypertension 2009; 53(4): 577-584.

[5] DJ. Kim, JH. Noh, BW. Lee, YH. Choi, JH. Jung, YK. Min, et al. A white blood cell count in the normal concentration range is independently related to cardiorespiratory fitness in apparently healthy Korean men. Metabolism 2005; 54(11):1448-1452.

[6] S. Mora, IM. Lee, JE. Buring, PM. Ridker, Association of physical activity and body mass index with novel and traditional cardiovascular biomarkers in women. JAMA 2006; 295(12):1412-1419.

[7] AM. Witkowska, Soluble ICAM-1: A marker of vascular inflammation in and lifestyle. Cytokine 2005; 31(2):127-134.

[8] S. Choobineh, V. Dabidi-roshan, AA. Gaeini, The effect of continuous and intermittent aerobic exercise on the HS-CRP Wistar rats. Journal of Movement Science and Sport 2006; 5(9): 1-13.

[9] K. Christos, DT. Paul, The effects of physical activity on serum C-reactive protein and inflammatory markers. J Am Coll Cardiol 2005; 45(10): 1563-1569.

[10] JK. Wegge, CK. Roberts, TH. Ngo, RJ. Barnard. Effect of diet and exercise intervention on inflammatory and adhesion molecules in postmenopausal women on hormone replacement therapy and at risk for coronary artery disease. Meta 2004; 53(3): 337-381.

[11] M. Akbarpour, The Effect of Resistance Training on Serum Levels of Adipokine and Inflammatory Markers of Cardiovascular Disease in Obese Men. Qom University of Medical Science 2013; **7**(3):1-10.

[12] S. Nayebifar, M. Afzalpour, M. Saghebjoo, M. Hedayati, P. Shirzaee The effect of aerobic and resistance trainings on serum C-Reactive Protein, lipid profile and body composition in overweight women. Modern Care J 2012; 8(4): 186-196.

[13] SJ. Muylaert, TS. Church, SN. Blair, SN. Facsm. Cardiorespiratory fitness (CRF) and C-reactive Protein in premenopausal women. Med sci sports exerc 2003; 35(5):69.

[14] F. Gomes, DF. Telo, P. Souza-Heraldo, JC. Nicolau, A. Halpern, CV. Serrano, Obesity and coronary artery disease: role of vascular inflammation. Arq Bras Cardiol 2010; 94(2):255-261.

[15] KS. Heffernan, SY. Jae, VJ. Vieira, GA. Iwamoto, KR. Wilund, Woods JA, et al. C-reactive protein and cardiac vagal activity following resistance exercise training in young African-American and white men. Am J Physiol Regul Integr Comp Physiol 2009; 296: 1098-105.

[16] B. Katja, L. Tiina, S. Veikko, J. Pekka. Associations of leisure time physical activity, self-rated physical fitness, and estimated aerobic fitness with serum C-reactive protein among 380 adults. Atherosclerosis 2006; 185: 381-387.

[17] A. Jeffrey, J. Victiraia, M. Viera, K. Todd, Exercise inflammation and immunity. Neuro clinical 2006; 24: 585-599.

[18] WD. Hiller, BLM. Dierenfield, PS. Douglas, ML. Otool, EE. Fortess, DS. Yamada, et al., C-reactive protein levels before and after endurance exercise. Medicine Science Sport Exercise 2003; 35(5): 121-132.

[19] TJ. Marcell, KA. McAuley, T. Traustadottir, PD. Reaven, Exercise training is not associated with improved levels of C-reactive protein or adiponectin. Metabolism 2005; 54: 533-541.

[20] EP. Plaisance, PW. Grandjean, Physical activity and high-sensitivity C-reactive protein. Sports Medicine 2006; 36(5): 443-458.

[21] MJ. Pourvaghar, Impact of a 2-month aerobic exercise on CRP of overweight female students. Feyz 2013; 17(4): 380-386.

[22] JH. Wilmore, DL. Costill, Physiology of sport and exercise. 2nd ed. Published in human kinetic; 1999. P.76-84.

[23] CE. Donges, R. Duffield, EJ. Drinkwater, Effects of resistance or aerobic exercise Ttraining on interleukin-6, C-reactive protein, and body composition. Med sci sports exerc 2010; 41(2):304-313.

[24] PM. Ridker, JE. Buring, NR. Cook, N. Rifai, C-reactive protein, the metabolic syndrome, and risk of incident cardiovascular events an 8-year follow-up of 14719 initially healthy American women. Circulation 2003; 107(3): 391-397.

[25] E, Selvin, NP, Paynter, TP. Erlinger, The Effect of Weight Loss on C-Reactive Protein. Arch Intern Med 2007; 167(8): 31-39.