

Effect of Resistance Exercise Training on C-reactive Protein Level in Healthy Men in Jordan

*Mohammad Al Hindawi and Majed Mujalli **

ABSTRACT

The goal of our study was to investigate the effect of resistance exercise training on C-reactive protein level in healthy men in Jordan.

Methods a total of 20 male subject's mean age 45±5 years were investigated to evaluate CRP level after resistance training. Subjects were participated in supervise resistance exercise training for 11 weeks. CRP level was measured pre-post training.

Results: Mean CRP level was significantly decreased after exercise training was completed from 1.8mg/l to 1.6mg/l.

Body weight, HDL and BMI were all reduced after the training, from mean 85.10kg, 42.70 mi/dl and 27.43 kg/m² respectively to 84.6kg, 44.30 mi/dl and 25.69 kg/m² respectively.

There was no significant association between reduction in body weight or BMI, and body fat with CRP level.

Conclusions: These finding support the use of resistance exercise training as a modality to reduce the risk of cardiovascular disease development as defined by a decrease in CRP level in healthy men in Jordan.

Keywords: C-reactive protein, inflammation markers, resistance exercises training, cardiovascular disease.

INTRODUCTION

Cardiovascular disease (CVD) continues to be one of the leading causes of morbidity and mortality in the world according to the British Heart Foundation 2003, and both the Center for Disease and Prevention and by the American Heart Association. (2004).

As evidence continues to accumulate that inflammation plays a role in the pathogenesis of atherosclerosis (Lippy et al., 2002). Markers of inflammation such as C-reactive protein (CRP) are being used extensively in epidemiological research (Danesh et al., 2004). Recent research has shown it to be a more powerful predictor of cardiovascular risk than classical markers such as low density lipoprotein-cholesterol (Ridker et al., 2003). CRP is a critical component of the immune system, a complex set of proteins that our bodies make when faced with a major infection or trauma. CRP

was discovered nearly 70 years ago by scientists exploring the human inflammatory response. The role CRP plays in heart disease has only recently been uncovered. However, over a dozen major studies demonstrate that baseline levels of CRP in apparently healthy men and women are highly predictive of future risk of heart attack, stroke, sudden cardiac death, and the development of peripheral arterial disease (Ridker et al., 1997; Roost, 1999; Pasceri et al., 2000; Torzewski et al., 2000; Pearson et al., 2003; and Danesh et al., 2004). Normal values for CRP are not well defined, nonetheless from the data available, values less than 1.0mg/L are considered low risk, 1.0-3.0mg/L are considered medium risk, and greater than 3.0mg/L high risk (Pearson et al., 2003).

Recent investigations have observed the association between physical activities and reduce risk of (CVD). (King et al., 2003). Regular physical activity is associated with decrease in all cause of mortality especially CVD (Paffengren, 1997; Wannamethee et al., 1998 and Johansson, 1999). Much recent evidence has provided substantial support for exercise intervention-induced

* Department of Physical Education, University of Jordan, Amman, Jordan. Received on 14/6/2009 and Accepted for Publication on 20/4/2010.

reduction in circulating markers of inflammation (Targher, 1996; Lowe, 2002; and Wannamethee et al., 2002). These studies suggested that regular physical exercise might lower CRP levels in the body by reducing total fat, and can possibly be used as a means of reducing elevated CRP level (Visser et al., 1999; Geffken et al., 2001 and You et al., 2004).

Okita et al. (2004) found that a two-month aerobic exercise program significantly reduced CRP from 0,63 to 0.41 mg/l in 199 women. However, a number of studies have shown that exercise programs do not influence these markers of inflammation (Marcell et al., 2005; Nassis et al., 2005 and Hammet et al., 2004). A recent published meta-analysis concluded that aerobic training did not significantly alter CRP level (Kelley et al., 2006).

Despite these findings, emerging data supports the ability of resistance training to reduce circulating levels of CRP in diseased populations (Brooks et al., 2007; Castaneda et al., 2004). However, there is no consensus on the influence of a program involving resistance training on CRP level in apparently healthy individuals in Jordan or in the Middle East.

Therefore, the current study was planned to determine the effects of resistance exercise training on C-reactive protein (CRP) concentration in apparently healthy men in Jordan.

We hypothesized that resistance exercise training induced C-reactive protein reduction among healthy individuals who have low to moderate baseline C-reactive protein level and who therefore are at increased risk of cardiovascular disease.

Experimental procedures

* All subjects were recruited through advertisements and flyers posted and distributed at the local hospital and fitness centers. This study was approved by the scientific committee for higher education at physical education college .Criteria for participation in the studies included the following CRP level ≥ 1.7 mg/L, nonsmokers, no known heart disease, no lipid modifying medications and aerobically active < 1 hour a week, not having chronic disease or taking medication that prevented their participation in structured exercise training, and any other condition that may interfere with interpretation of the study results. Individuals who participated in the study were volunteers and were not given any kind of remuneration. The subjects were informed about testing procedures, possible risks and discomfort that might

ensue and gave their written informed consent to participate in the study.

Table 1 Physical Characteristics of subjects

<i>Subjects Characteristics</i>	<i>Group 1</i>
<i>Age (yrs)</i>	45.7
<i>Weight (kg)</i>	85.10
<i>Height (m)</i>	1.775
<i>BMI (kg/m²)</i>	27.43
<i>BF (%)</i>	23.95
<i>Resting heart rate(bpm)</i>	79.50
<i>VO2 max(ml.min. kg)</i>	37.01

* Of 70 persons who responded to a public request for volunteers, 20 mean age 45 ± 5 yrs met the criteria who had serum CRP level that placed them on the risk of future heart attack (risk ratio ≥ 1.7 mg/L) (Ridker et al., 1997; Danesh et al., 1998 and Metine et al., 2006). These subjects table (1) were randomly assigned into to two groups group 1 (the experimental group 10 subjects) assigned to supervised resistance exercise program. Group 2 (control group 10 subjects) were sedentary untrained group. The control subjects reported average low physical activity (less than 2 hours weekly of walking) and were similar in age, BMI to the experimental group.

* During preceding tests day, the subjects refrained from training and maintained their normal diet. Laboratory tests were carried out on the same day in similar conditions for both groups. Room temperature was 23° C and relative humidity was 50%. Pre and post training venous blood taking from the arm were conducted in the morning and processed at the University of Jordan hospital Lab. The same medical staff collecting blood samples for both groups and in pre and post training. The primary outcome measure was plasma CRP concentration secondary outcome will be Total cholesterol triglycerides; high-density lipoprotein (HDL), Low density lipoprotein (LDL), BMI and fat% .Blood profile were compared at pre and post training program and have been completed for the mentioned variables. All variables were assessed at pre and post exercise training program by using the same study protocols and methods.

* All subjects underwent standard graded exercise cycle ergometer test using modified Bruce protocol. 12-lead electrocardiogram were recorded, Blood pressure (BP) using sphygmomanometer (ms-900) and heart rate (HR) was monitored. Subjects were exercised until

reaching their 90% of their maximal heart rate. Subjects who had abnormal exercise stress test were excluded from the study. The cycle ergometer test was terminated according to the guidelines recommended by the American College of Sports Medicine (Balady et al., 2000).

Body weight and height were measured with standard techniques and body mass index (BMI) was calculated as

an index of total body mass. Skinfold thickness at sites of supriliac, subscapular, triceps, and abdomen were measured on the right side of the body using a Holtain caliper (Holtain Ltd, Crymych, UK) and for each subject the average of two measurements was recorded. Percentage of body fat (%BF) was estimated using (Robergs, 2003) equation.

Table 2. Pre and Post training M \pm St.d for the measured variables

<i>Variables</i>	<i>Mean and Sd pre-exercise training</i>		<i>Mean and Sd Pos-exercise training</i>	
<i>CRP ml/dl</i>	1.81 \pm	0.015	1.746 \pm	0.042
<i>Tc Ml/dl</i>	193.50 \pm	8.79	181.60 \pm	9.91
<i>BMI (Kg/m²)</i>	27.43 \pm	2.75	25.69 \pm	1.77
<i>LDL Ml/dl</i>	118.10 \pm	11.38	104.70 \pm	9.38
<i>VO₂Max (Ml.min.kg)</i>	37.67 \pm	3.48	42.4 \pm	3.97
<i>HDL Ml/dl</i>	42.70 \pm	9.17	44.30 \pm	6.18
<i>TG Ml/dl</i>	163.50 \pm	16.07	159.20 \pm	7.06
<i>HRrest (bpm)</i>	77.50 \pm	2.59	74.6 \pm	3.13
<i>FAT%</i>	23.03 \pm	4.09	21.2 \pm	1.91
<i>Weight (Kg)</i>	85.10 \pm	4.40	84.6 \pm	3.08
<i>B/P (mmhg) Systolic</i>	129.50 \pm	8.95	127.50 \pm	5.40
<i>B/P (mmhg) Diastolic</i>	82.50 \pm	5.40	82.60 \pm	3.53

Data are presented as the mean and S.D. BMI = body mass index, TC=total cholesterol, HDL=high density lipoprotein, LDL= low density lipoprotein, CRP=C-reactive protein.

* Training programs, performed at fitness one facilities, were designed to mimic exercise programs typically performed by sedentary individuals using commercial equipment (Nordic Track equipment; Nordic track, Glencoe, MN) designed for home use.

Exercising individuals are participated in supervised program about 60 minute exercise sessions 3 time a week for period of 11 week using commercially available resistance training exercise equipment (Nordic Flex Gold, Glencoe, MN). All subjects were instructed on the proper technique for each exercise by a trained instructor and were familiarized with the equipment before training. The

resistance training program consisted of three sets 10 lifts/set and a three parts. Subjects performed a brief warm-up period lasts for 10-15 minutes consisting of static stretching before and after each training session, the second part was a supervised exercise session which lasted about 45 minutes and was including resisting exercise for the major muscles including, military press, bench press, pull back, biceps curl, triceps push-down, leg curl and extension and sit up. The last part consists of 5 minutes cool-down exercise and stretching exercises. Subjects were trained with a partner and all training sessions were carefully supervised by the investigator and

the gym staff. Each subject was encouraged to perform each set and repetition with utmost effort. Increase in

strength was documented by comparing the average weight lifted during 10 repetitions.

Table 3: (T-test) results for the comparison of pre and pos training for the Exercising group

Variables	Mean	Std. Deviation	Std. Error Mean	t	df	Sig
CRP ml/dl	0.069	0.044	0.014	4.86	9	.0001 *
TC ml/dl	11.9	12.52	3.95	3.00	9	0.014 *
BMI Kgm2	1.86	3.81	1.20	1.54	9	0.15
LDL ml/dl	13.4	12.61	3.98	3.35	9	0.008 *
VO2max ml.min.kg	-4.73	5.90	1.86	-2.53	9	0.03 *
HDL MI/dl	-1.6	12.26	3.87	-0.41	9	0.68
TG MI/dl	4.3	14.36	4.54	0.94	9	0.36
HR Rest b.pm	2.9	4.55	1.44	2.01	9	0.07
FAT %	1.83	4.22	1.33	1.36	9	0.20
WEIGHT kg	3.4	5.44	1.72	1.97	9	0.07
BPS mmhg	2	6.32	2	1	9	0.34
BPD mmgh	-0.09	7.63	2.41	-0.04	9	0.96

* Significant

The target exercise intensity will be progress from 40-70% of 1MR. The control group subjects did not participated in any type of activity. The subjects were instructed not to change their lifestyle during the exercise intervention. Strength was increased by 18% during 11 weeks of exercise indicating the effectiveness of the training program.

Results

Statistical analysis was carried out using SPSS package (copy 10). The comparisons between pre-exercise and pos-exercise values were analyzed by anonparametric Wilcoxon’s test for statistically significant. Numerical values are expressed as mean ± SD. (Mann Whitney U) test was used to compare the two groups in pre and post measurements. A value of (p < 0.05) was considered statistically significant.

Experimental and control subjects were significantly

different from pre to post training values of CRP, LDL, HDL, TG,TC,VO2 max, Fat%, HR at rest, weight and B/P .

Table 2 show means and Sd for the investigated variables.

Mean C-reactive protein level measured pre exercise program was 1.87 mg/L. Measurement after post exercise was 1.82 mg/L there was significant drop in the concentration of CRP $p \geq 0.05$ in favor of the post training program.

Mean TC also was significantly drop from 210.30 ml/dl to 191.10 ml/dl, TG dropped significantly from 167.10 ml/dl before the training to 161.50 ml/dl after the completion of the training program. HR at rest also dropped from 79.30 b.pm to 76.90 b.pm. (Robert and roberge, 2000). Fat % reduced significantly from 23.95 to 21.94.

After 11 weeks of exercise training, there was no

significant difference in mean

BMI which dropped from 27.43 to 25.69, also VO₂max which increase from 37.13 to 38.67 ml.min.kg. HDL which decreased from 43.20 mi/dl to 43.10mi/dl.

Experimental group had lower weight, BMI, and body fat than the control group after the completion of the exercise program.

In the control group there were no significant changes in the variables investigated above.

The difference among the resistance groups was significant adjusting for all correlates of baseline C-reactive protein ($p < 0.001$). In the resistance group the difference in C-reactive protein change among the baseline C-reactive protein for the resistance group was statistically significant after adjusting for the correlates of baseline ($p < 0.001$).

Discussion

In this study, we investigated the effects of resistance training on CRP concentration level among a representative sample of apparently healthy middle aged men in Jordan. Specifically we tested the hypothesis that resistance training would induce reductions in CRP level and therefore reducing CHD of apparently healthy middle aged men in Jordan.

The results of this study revealed that CRP concentration are markedly lower in the resting state in resistance subjects compared with sedentary controls subjects.

The finding of the study indicated that resistance exercise was associated with a significantly lower odds of having elevated CRP level. Overall, these results suggest that resistance exercise may be associated with lower levels of systemic inflammation among healthy men who are 45 years or older. A training induced reduction in CRP is supported by a few similar investigations (Mattusch et al., 2005 and Okita et al., 2004).

Previous studies had similar results they reported that high activity level were associated with lower inflammation markers CRP (Tisi et al., 1997; Smith, 1999; Mattuch et al., 2000; King et al., 2003; Esposit et al., 2003; Tomszwek et al., 2003; Aronson et al., 2004 and You et al., 2004).

On the other hand, many interventions have shown less of a decrease, when active individuals were compared with inactive individuals; higher levels of physical activity have been associated with lower concentration of CRP (Aronson et al., 2004, Pischon et

al., 2003 and Reuben et al., 2003). There is an established relationship among CRP, percent body fat, fat mass and BMI (Khaodhiar et al., 2004). Although our results support the positive relationship between CRP and percent of body fat, it has been hypothesized body fat reduction may result in decrements in CRP concentration (Tchernof et al., 2002 and Dvorakova et al., 2006).

Obesity is a factor that strongly related to high level inflammation, and is a strong predictor of CRP (Yudkin et al., 1999; Hak et al., 1999; Visser et al., 1999). And other inflammatory markers (Bao et al., 1993; Cacciari et al., 1998; Fergusson et al., 1998 and Shea et al., 1999). And it has been suggested that physical activity may reduce inflammation by reducing body weight and obesity level (Folson et al., 1999; Geffken et al., 2001; Abramson, 2002; Esposit et al., 2003 and You et al., 2004). However, the results of our study showed that physical activity was associated with lower weight. And probably the reduction in weight was responsible in the lower CRP level; however, there was no significant association between the reduction in body weight, BMI and CRP level in our study. That's probably is due to smaller sample size or the short duration of the study, longer intervention periods have been found to be more effective in reducing BMI and body fat percentage (Wolmore et al., 1999). The results of our study are also consistent with those reported by Okita (2004). Who found that there is no association between weight loss and reduction on CRP level.

Training response

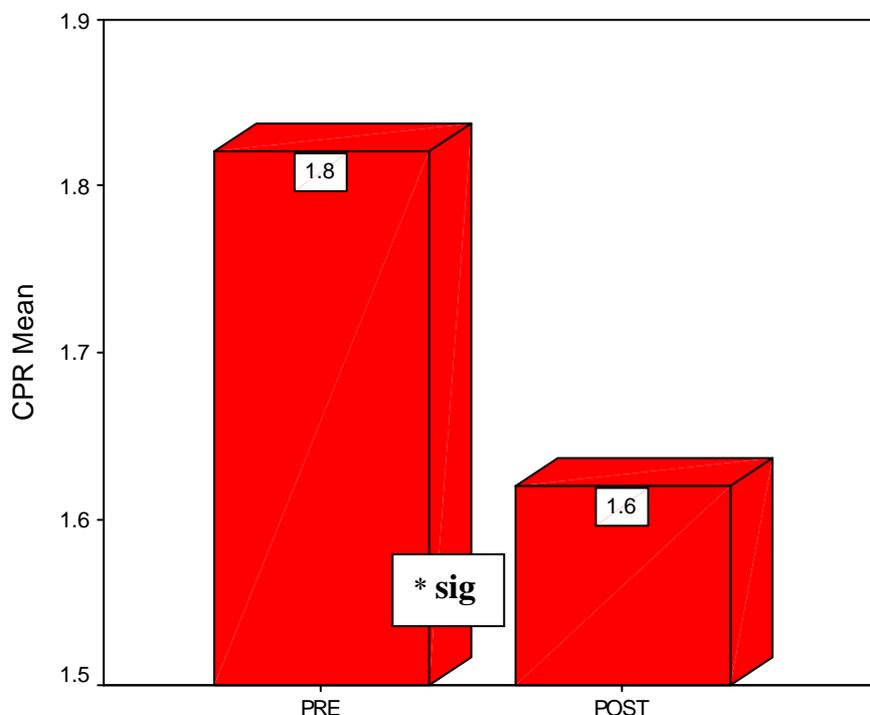
There is inverse relationship between regular physical activity and serum concentration of inflammatory markers, Dufaux (1984) reported the effects of exercise training on CRP and were significantly lower in swimmer and rowers. Tisi et al., 1997; Mattuch et al., 2000; Taaffe et al., 2000; Wannamethee et al., 2002; King et al., 2003; Pitsavos et al., 2003 and Albert et al., 2004). They examine the effects of exercise training on CRP level they demonstrated that CRP level were significantly reduced after endurance supervised training compared with controls. These intervention studies support the concept that exercise training reduces CRP level by altering the inflammatory process in consistent with our finding,

Other studies were in disagreeing with our finding. Two recent studies failed to confirm an independent inverse relationship between chronic physical activity and

inflammation markers (Rawason et al., 2003 and Verdaet et al., 2004). One explanation for the absence of an exercise effect in these studies may be the high proportion of sedentary subjects.

Other reported that Cardio respiratory fitness was inversely related to CRP level increase cardio respiratory fitness was associated with decreased CRP level (Church et al., 2002; Lamonte et al., 2002 and Isasi et al., 2003).

Figure (1): CRP values pre-and post training for the exercising group



Exercise intensity

The effects of regular physical activity on CRP level concentration values in moderate intensity were significantly lower than strenuous exercise King et al., (2003) reported that moderate endurance activity (joggers and aerobic dancers) were significantly had lower CRP level similar to our finding.

Several studies were in disagreement with our finding they demonstrated marked increase in CRP level immediately and 24 h after strenuous exercise (Weight et al., 1994 and Sigel et al., 2002). During short exercise CRP increased temporarily and is directly related to exercise intensity and duration (Ostroski et al., 1999 and Pederson et al., 2000).

Ostroski, (1999) Pederson, (2000) suggested that exercise-induced muscle injury has been thought the primary stimulus for the increased CRP responded values returned to baseline 2 to 6 days after exercise. That was not the case in our study. In our study there was significant decrease in the CRP level after moderate intensity training,

Long term exercise or physical training appears to reduce the acute response to strenuous activity (Febbraio, 2002). Post run CRP were reduced by 40% after training. Longitudinal exercise training studies demonstrate a long-term anti-inflammatory effect, (Tisi et al., 1997) this anti-inflammatory response may contribute to the beneficial effects of habitual physical activity. The possible inflammation suppressing effect of exercise training may partly explain the effectiveness of regular physical activity in the prevention and treatment of cardiovascular diseases (Lakka, 1993; Paffengren, 1997; Wannamethee et al., 1998; Sacco et al., 1998; Hambrech et al., 2003; Laukkanen et al., 2001; Laaksonen et al., 2002 and 2005).

Aerobic exercise effect on CRP concentration demonstrate an inverse association between physical activity and CRP one of these studies. Wannamethee et al., (2002) examine change in physical activity over the course of 20 years and showed that inactivity men who become active had CRP values approaching those of men who remained at least lightly active conversely, those

who become inactive had CRP level similar to these who remained inactive, suggesting that physical activity has to be continuous to maintain its effects on CRP.

The role and the mechanisms in reducing CRP level with regular physical activity is not well defined exercise related to several confounders that are associated with lower CRP level including age, smoking, hypertension, BMI, total cholesterol and triglycerides. Those factors are directly related to CRP concentrations (Foreed, 2003) Individuals who are obese have increased the production of inflammatory markers including CRP (Visser et al., 1999; Yarkin et al., 1999; McLanghlin et al., 2002 and Esposit et al., 2003). Previous studies suggest that regular physical activity could suppress inflammation by reducing body adiposity level, (Geffken et al., 2001; Esposit et al., 2003 and You et al., 2004). Individuals with high BMI also associated with increased level of CRP (King et al., 2003; Tomszesk et al., 2003 and Aronson et al., 2004). By improving endothelial function preserving nitric oxide availability (Romano et al., 1997 and Taddei et al., 2000). The antioxidant effect of exercise reduces susceptibility of low density lipoprotein to oxidation (Shern, 1998). Which in turn helps further prevent endothelial injury and inflammation (Berliner et al., 1995 and Witzum, 1997). In summary, its likely that exercise training reduces CRP both directly by reducing cytokine production in fat , muscle and mononuclear cells

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and indirectly by increasing insulin sensitivity improving endothelial function and reducing body weight.

Conclusions and recommendations

Plasma C-reactive protein level are reduced in response to resistance exercise training in sedentary healthy men in Jordan .This finding may partly explain the effectiveness of regular physical activity in the prevention and treatment of cardiovascular diseases. A longer intervention could have resulted in a larger C-reactive protein reduction. A weakness of the study is the lack of female subjects in the study. For further studies we recommended that studies should be undertaken including females subjects.

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CPR

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	CRP						
	(Vo2 Max)						
5 +	45		20			70	
				-11			
1.82	1.87		CRP				
	+		CRP				
		.21.94	23.95		/ 191	/ 210.30	
			161.50		/ 167.10		
	21.94	23.95		84.60	85.10		
						25.69	27.43
						CRP	

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