Research Article

A survey of two submaximal exercise training on a C-reactive protein in the elderly man

Sajad Ahmadi[1*], Masoud Rezaeikohan[2], Mohammad Fallahpoor Salekdeh[3]

Abstract

The purpose of this research is to survey the effect of eight weeks of sub-maximal training on the C-Reactive Protein (CRP) in elderly males. The subjects of the research consisted of 21 elderly males between 50-80 years old, divided into two groups (one experimental group and one control group), with VO_{2Peak} values of 51.14±2.7, 51.92±3.17, and 43.61±1.85 (based on the 1-mile (1609 meters) Track Jog test). The experimental group carried out Balke-Ware sub-maximal aerobic exercise 5 sessions a week for 8 weeks, while the control group did not participate in the training program. The results of the research showed that the average CRP levels decreased in the experimental group, while they increased in the control group. However, these differences were not statistically significant according to the paired sample T-Test results. On the other hand, a significant difference in Vo2 Peak was observed between the two groups ($p<0.039$ and $p<0.001$), with the experimental group showing higher values compared to the control group. Additionally, there was no statistically significant difference in HS-CRP levels between the subjects (experimental group 1, experimental group 2, and control group) before and after the training period. In general, it seems that a longer duration is required to observe better markers of inflammatory and cardiovascular effects of these variables. The pre-study hypothesis of cardiorespiratory fitness on CRP response confirms that assessing control and inflammatory markers of cardiorespiratory fitness in the elderly requires more time.

Key Words: **Submaximal exercise, C reactive protein, Aging, Physical activity**

1. PhD Student of Exercise Physiology, Faculty of Sport Sciences, Esfahan Islamic Azad University (Khorasgan). 2. Master student of Department of Wellness, Sport and Health, University of Bologna, Rimini, Italy. 3. Department of Health and Sport Medicine, Faculty of Physical Education and Sport Sciences, University of Tehran, Tehran, Iran.

*Author for correspondence: sa.sajad.ahmadi@gmail.com

S A: 0000-0001-7400-1557; M R: 0009-0000-4377-7782; M FS: 0009-0004-4609-7562

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Introduction

One of the most obvious changes in the demographics of the 21st century is population aging which has affected all the countries of the world, including Iran (Dadkhah, 2016). The estimates show that by 2030, the population of people over the age of 65 in Western societies will exceed 20% (Gaini & Rajabi, 2012), Iran also has become an elderly country by going through a demographic change according to the 2015 census with more than 7.27% of elderly people over 60 years old and this figure will reach 10.7% in the next 15 years. The elderly can be a period of vitality, joy, determination, will, greatness, honor, and glory. The elderly are a natural phenomenon in which the physical, mental, and psychological activities of the person have decreased, and these physiological changes are the same in different people, but the speed of doing it can be different (Dadkhah, 2016). One of the prominent physical changes of this era is the reduction and weakness of the cardiovascular system efficiency (Khalili et al, 2018).

Cardiovascular diseases are considered one of the most important life-threatening problems, especially for the elderly. Among the cardiovascular diseases that exist in the elderly is Arteriosclerosis. The reports indicate that the development of cardiovascular diseases has inflammatory backgrounds and general inflammation plays a pivotal role in the extension and progression of atherosclerosis (Ridker et al, 1998). Most researchers have identified high-sensitivity C-reactive protein (HS-CRP) as the most sensitive and powerful inflammatory indicator predicting subsequent cardiovascular risk (Hu et al, 2004). The Reports suggest that increasing the values of these indices, especially HS-CRP is associated with 2-5 times increase in the risk of cardiovascular events (Albert et al, 2002). So, serum levels of CRP and fibrinogen, compared to blood lipids, have been considered by researchers as strong predictors of cardiovascular events (Sohaili et al, 2018). Due to this view, it is likely that primary atherosclerosis spontaneously leads to a mild inflammatory response, which increases the acute phase proteins and other variables of the acute phase (Duey et al, 1998).

C-reactive protein is a component of plasma made in the liver and increasing its production is a response to infectious diseases, inflammations, or tissue damage (Debidi Roshan et al, 2018). In completely healthy people, the level of CRP is usually very low and is at zero level while it increases to more than 200 mg/liter in inflammation and infection conditions (Van den Burg et al, 2000). Exercise and physical activity are one of the influencing factors on this index (Ernst et al, 1993). Recent studies have shown that CRP is a stronger indicator than LDL in predicting cardiovascular events (Albert et al 2002) As far as the opinion is concerned that the increase in plasma HS-CRP level is related to the increased risk of coronary diseases (Plaisance & Grandjean, 2006).

On the other hand, the risk of a heart attack in people whose CRP concentration is higher than 2.11 mg/L is three times more than in people whose level does not exceed 0.55 mg/liter. In addition, another number of reports show that regular physical activity reduces resting levels of CRP (Schachter et al, 2003). On the other hand, the research suggests that sedentary people are 36% more likely to suffer from coronary heart disease than active people (Rodnick et al, 1989). Thus, considering the significant relationship between physical activity and inflammatory indicators and that physical activity and regular exercise throughout life, especially in old age, is the factor maintaining and even strengthening the heart, lungs, nerves, and bones and also responsible for increasing aerobic capacity, it seems that sports activities can reduce mortality due to cardiovascular diseases in adults (Turk et al, 2004). Based on this and considering the general concerns regarding the health of the elderly as well as the access and use of various exercise sessions, this research has tried to study this issue by applying for two aerobic exercise programs under the maximum of three and five exercise sessions per week and to compare the effectiveness of these two types of aerobic exercise on C-reactive protein in elderly men.

Materials and Methods

Subjects and study design

This research was Quasi-experimental in which two experimental groups and a control group voluntarily participated among elderly men in a laboratory environment.

After identifying active elderly men by calling and explaining the research objectives, they were asked to come to the laboratory. Following a comprehensive study based on the standard physical health questionnaire and then completing the Beck physical activity questionnaire, people without any diseases and insufficiency were selected as the primary samples of the research. In the next stage and after the 48-hour prohibition of active subjects from performing any physical activity, in the medical diagnosis laboratory, with 14 hours of fasting, 5 ml of blood was taken from the brachial vein, and their serum was subj-ected to laboratory analysis for total cholesterol, triglyceride, HDL-C, LDL-C, and CRP tests. After getting the results, subjects whose values related to blood indices were not in the normal range were removed from the final list and the research started with 14 active Elders who exercised for an average of 3 hours a week and 7 inactive elders who had no sports history. Active subjects were randomly divided into 2 equal groups of 7 people and named experimental group 1 (3 sessions per week) and experimental group 2 (5 sessions per week) and 7 inactive samples also participated in this study as a control group. In the next stage and two days before the start of the main exam, by submitting a written request, the subjects were asked to follow a controlled diet during the two months of the test and until the final sampling. In the following stage, all the selected people were asked to be present at the medical diagnosis laboratory on the morning of the test day so that the original pre-test sample could be taken. In the afternoon of the same day, a one-mile TJ slow run test was performed on all the subjects to estimate the VO2peak level of the subjects. Then all the subjects were transferred to the sports science laboratory to estimate the values related to their height, weight, waist, and hip circumference, and the thickness of subcutaneous fat, subscapularis, and abdomen, respectively, by digital stadiometer and scale, measuring tape and calipers. Then, the subjects of the two experimental groups were asked to perform the ACSM walking test after recording the resting heart rate and blood pressure values of each person, respectively, through the pulse oximeter device and digital sphygmomanometer model MX3 Plus in a sitting condition and performing a 5-minute stretching and general warm-up test, and placing a special GPRS belt in the heart area, before performing the first session of the sub-maximal aerobic power test. In the afternoon of the next day and for 8 weeks, the subjects of the experimental group separately and in two groups, 3 sessions per week and 5 sessions per week, after recording the resting heart rate and blood pressure, as well as warming up, under the supervision of the researcher, performed the Balkvar treadmill protocol and after the activity is over, the total running time and heart rate of the activity were recorded based on the data obtained from the GPRS watch. At the end of each week, the weight of the active subjects was also estimated and recorded. In the post-test stage and after the completion of the exercise program, TJ slow running test was taken from all active and inactive subjects, and the variables of height, weight, waist and hip circumference, the thickness of subcutaneous fat above the skin, Subscapularis and abdomen were also measured. The final blood sample was taken from all subjects observing the fasting hours 24 hours later.

Measuring inflammatory indices

A bionic kit was used to determine the numerical value of CRP quantitatively which first, the buffer serum of the kit was diluted, the test was performed with each dilution, and the value of 0.1 mg was determined.

Statistical analysis

For the statistical analysis of the data collected from the Smirnoff Kalmograph test, dependent T-test, one-way ANOVA, and Tukey at the significance level of $P < 0.05$, SPSS version 15 software was used, and EXCEL software was used to draw graphs.

Results

According to the results of the Kolmogorov Smirnoff test, the homogeneity of the body measurement variables and blood indices of the research subjects, considering that in all cases it was $P>0.05$, the normality of data distribution was confirmed. Table 1 shows the amount of intra-group and inter-group changes of different variables in the experimental and control groups during different stages. As can be seen, 3 and 5 weeks of submaximal exercises has caused a significant decrease in weight, waist circumference, waist circumference to height circumference, body mass index, waist circumference to hip circumference, abdominal circumference to hip circumference, fat percentage, total cholesterol, LDL-C, and LDL-C/HDL-C compared to the control group ($P > 0.05$).

Furthermore, Triglyceride and HDL-C did not significantly change after three sessions and five sessions of submaximal exercise. However, the findings of the research during eight weeks suggest that 3 and 5 sessions of sub-maximal exercise caused a significant decrease in HS-CRP values of two active groups compared to the control group ($P < 0.05$). The following chart confirms this.

On the other hand, the statistical analysis of findings indicates that there is no significant difference between HS-CRP values of two experimental groups, three and five sessions of submaximal exercise. While the exercise program increased the VO_{2Peak} of the active groups. Similarly, there is a significant difference between VO_{2Peak} of two groups, three and five exercise sessions with the

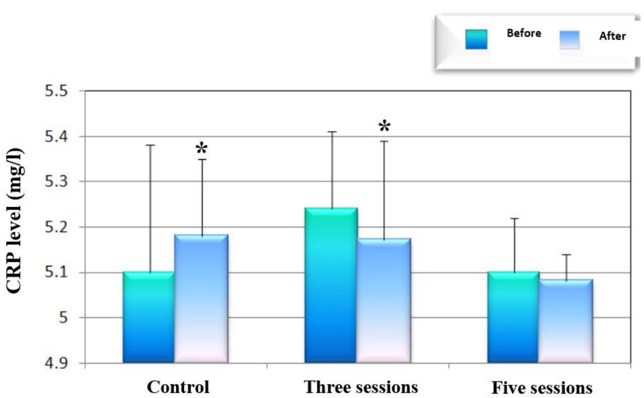

Figure 1. The amount of CRP index changes in subjects. Data were show as mean ± SD. * Compare to before (p<0.05).

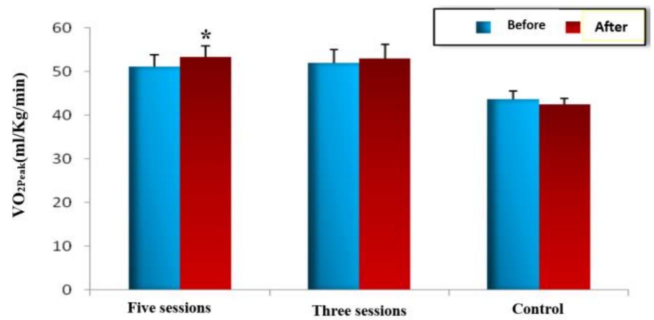

Figure 2. The amount of changes in peak oxygen consumption in research subjects. Data were show as mean ± SD. * Compare to before (p<0.05).

control group ($P < 0.039$ and $P < 0.001$). Although, no significant difference has been observed between VO_{2Peak} and CRP-HS of research subjects (experimental group 1, experimental group 2 and control) before and after an exercise program period.

Figure 3 shows the amount of changes in LDL-C/HDL-C in the research subjects. This ratio in the active group of five sessions per week in the post-test stage compared to the pre-test showed a decrease of 21.34% equal to (mg/dl) 0.57. In this group, the LDL-C / HDL-C index decreased from 2.67 ± 0.47 mg/dl to 2.1 ± 0.11 mg/dl. Likewise, regarding the active group of three sessions a week, we can also mention a decrease of 7.2 percent in this index. Thus, LDL-C / HDL-C in this group decreased from (mg/dl) 2.75 ± 0.57 to (mg/dl 2.55 ± 0.61) which indicates the difference (mg/dl) of 0.2 of this variable in the post-test stage compared to the pre-test. The average change of this index from (mg/dl) 2.36 ± 0.48 to (mg/dl) 2.68 ± 0.31 in the inactive group shows an increase of 13.55% or 0.32 mg/dL ($P>0.05$).

Discussion

In this research, the effect of 8 weeks of sub-maximal exercise 3 and 5 sessions per week on the inflammatory index of CRP in active elderly men between 50 and 80 years old was examined. The results of the present research suggested that serum CRP values decreased by 0.39% and -1.33% in two experimental nodes (5 and 3 sessions of submaximal exercise), respectively while an increase of -1.56% was observed in the serum CRP va-

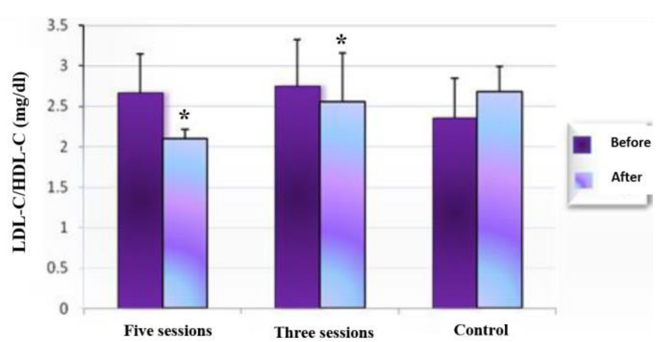

Figure 3. Changes in LDL-C/HDL-C index in research subjects. Data were show as mean ± SD.* Compare to before (p<0.05).

Table 1. The amount of changes in anthropometric, physiological, and blood variables of subjects in different stages of research (mean ± standard deviation)

Variables	Control group		Experimental group 1 (5 sessions per week)		Experimental group 2 (3 sessions per week)	
	pretest	posttest	pretest	posttest	pretest	posttest
Weight(Kg)	74.71±5.64	77.14±5.98	83.42±11.41	80.57±10.87	79.57±11.13	77.14±11.21
Peak O2 consumption (ml/kg/min)	43.61±1.85	42.43±1.44	51.14±2.7	53.24±2.59	51.92±3.17	53.03±3.22
Waist size (cm)	86.92±14.91	90±14.91	91.57±10.8	87.42±9.51	92.28±9.16	89.28±8.65
Body mass index (kg/m^2)	26.18±2.65	27.03±2.75	28.18±4.45	27.21±4.12	28.33±4.53	27.47±4.58
Waist to hip circumference(Cm)	0.89±0.012	0.9±0.012	0.912±0.06	0.90±0.047	0.94±0.092	0.94±0.095
Abdominal circumference to hips(Cm)	0.96±0.065	0.97±0.075	0.93±0.071	0.92±0.056	0.95±0.043	0.93±0.056
Waist circumference to height (Cm)	51.54±9.58	53.36±9.65	53.23±7.07	50.81±6.22	55.12±6.72	53.32±6.41
Body fat (%)	32.26±3.09	34.21±2.81	31.42±4.44	28.83±3.98	33.04±2.71	30.37±3.39
Triglyceride (mg/dl)	155±82.3	184.2±115.6	111.1±44.87	145.71±47.2	133.57±50.8	117.14±44.7
Total cholesterol (mg/dl)	154.28±22.2	170.85±28.8	158.14±10.6	152.42±10.9	179.14±31.9	167.85±34.4
HDL-C (mg/dl)	30±30.12	36.14±5.2	39±0.81	39.14±1.67	40±4.28	39.85±2.67
LDL-C (mg/dl)	83.42±22.53	98±22.33	104.57±20.4	82.28±6.89	111±28.85	102.42±29.1
LDL-C/HDL-C (mg/dl)	2.36±0.48	2.68±0.31	2.67±0.47	2.1±0.11	2.75±0.57	2.55±0.61

-lues of the control group. The results of several studies demonstrate that some physical activities are associated with changes in CRP values (Ockene et al, 2004). The results of the current research are also in line with the findings of most researchers. The decrease of this index in the active groups and its increase in the inactive subjects in the present study may be due to the adaptation of the subjects of the experimental group to the recent exercise program and the high levels of CRP values in these subjects (Christos & Pau, 2005). On the other hand, points mentioned regarding the relationship between baseline CRP values and exercise effectiveness are not an absolute thing, and in this regard, other points should be taken into account. Although the issue of the effect of inflammatory diseases on this index was reported in several studies (Gielen et al, 2003), the reports are not consistent in this regard (Meng & Pierce, 1990).

It seems that in the present study, one of the possible reasons for the lower reduction of CRP in the experimental group (Akbari et al, 2018) compared to the experimental group (Khalili et al, 2018) can be related to the mechanical stress caused by the feet of these subjects hitting the treadmill and perhaps this factor can be attributed to the greater number of sessions of the experimental group (Akbari et al, 2018) during the week. Furthermore, some researchers believe that exercise intensity(70 to 80% VO_{2max}) is necessary to create significant effects on inflammatory indicators (Ockene et al, 2004).

In the present study, the intensity of exercise for both groups was about 60-70% of VO_{2max} of people and CRP values of both groups were reduced according to their exercise intensity, which indicates the effect of exercise intensity on the inflammatory index of CRP. Therefore, the growth of the exercise program used in this study was such that each of the subjects performed the test at a controlled heart rate in the range of 115 to 155 beats per minute and with an intensity of 60-70 percent of the maximum oxygen consumption And it is possible that the reduction of CRP values in the experimental groups can be justified by the nature of the modified Balcor program, which was designed at a submaximal level (O'Donovan et al, 2005).

The results of some studies indicate that there is a positive relationship between total cholesterol levels and CRP over time (Albert et al, 2002). These findings are in line with the results of the recent study. The findings of the current research also confirm these results. In other words, the observed changes in body weight and fat percentage of the subjects of all three research groups were in line with the changes in CRP. On the other hand, in another study, it was found that a low-calorie diet combined with exercise reduces subcutaneous fat and CRP levels compared to a low-calorie diet alone (Yarnell et al, 2005).

Investigations carried out indicate the existence of an inverse relationship between cardiorespiratory fitness and HS-CRP values (Phillips et al, 2003). The current exercise protocol is also designed according to the cost of oxygen consumption and is implemented with an intensity of about 60-70% of the maximum oxygen consumption. The findings of the current research, based on the lower values of HS-CRP in the exercise group are consistent with the mentioned research. Since the conducted studies indicate a direct relationship between training distance and calories consumed on some cardiovascular risk factors (Meng & Pierce, 1990), so in the present research, we tried to keep the training distance almost constant and study the effect of the number of training sessions per week on HS-CRP. Although the result of the present study indicated a significant decrease in HS-CRP values in both experimental groups compared to the control group, no significant difference was observed between HS-CRP values in the two groups, so it seems that the changes caused by HS-CRP training are influenced by another factor known as duration and intensity. The conducted studies suggest that endurance exercises have beneficial effects in the prevention and treatment of cardiovascular diseases and increase cardiovascular protection in humans and animals, and as a result, the quality of life (Cavalie et al, 2003). Duey et al stated that Six weeks of endurance exercises with moderate intensity (60 to 70% VO_{2max}) causes a relative and absolute increase in VO2max (Duey et al, 1998). The results of the current research confirm the above findings (Marcell et al, 2005).

Another important finding of the present study was the observation of a significant difference in the values of HDL-C and LDL-C indices between the control and exercise groups, especially the 5-session training group. These non-aligned changes were also caused by training stress and on the other hand the increase of HDL-C and the decrease of LDL-C have caused small changes in the values of indicators related to inflammation in the training groups compared to each other and also compared to the control group. Since in the present study, submaximal aerobic exercises were used for 8 weeks with an intensity of 60-70% of the maximum oxygen consumption, It is likely that by increasing apoprotein A and decreasing apoprotein B, these exercises have increased HDL-C and decreased LDL-C, thus reducing inflammation (Powers et al, 1999).

The relationship between inflammation and blood lipids is another issue that helps justify the reduction of inflammation following sports activity. Given that the anti-inflammatory effect of sports activity and the role of obesity and blood fats (cholesterol) in the occurrence of atherosclerosis and the accompanying inflammation, it can be said that probably regular exercise training and lowering LDL-C has improved HS-CRP. Some research also showed that regular aerobic activity has reduced blood fats (cholesterol) in humans and animals (Bermudez et al, 2002). In the present study, it was found that both active groups demonstrated a significant decrease in LDL-C values after 8 weeks of submaximal aerobic exercise compared to the control group. On the other hand, regarding the relationship between physical activity and cardiorespiratory fitness and the relationship between these two with body fat mass and as a result blood fats in humans, pigs, rabbits, rats, and also the relationship between inflammatory indicators and blood fats(cholesterol) It can be said that submaximal aerobic exercise in the current research probably caused a decrease in body fat mass (Stauffer et al, 2004).

Conclusions

Although the exercise program in the present study did not show any significant changes in CRP, which is an index of risk, it emphasizes the need for a more continuous exercise program that is effective in addressing inflammatory variables in elderly individuals. Additionally, it is suggested that more attention should be given to controlling CRP levels to prevent possible cardiovascular failure and the uncertainty of relying solely on cardiorespiratory response. Therefore, it is recommended that elderly individuals, based on their condition and circumstances, engage in regular submaximal aerobic exercises to benefit from the supportive effects of exercise against the occurrence of cardiorespiratory diseases. However, further studies are needed to support these findings.

What is already known on this subject?

The elderly are a natural phenomenon, in which the physical, mental, and psychological activities of the person have decreased, and these physiological changes are the same in different people, but the speed of doing it can be different.

What this study adds?

A longer duration is required to observe better markers of inflammatory and cardiovascular effects of these variables.

Organ Cross-Talk Tips:

- Improved Vo2peak with various submaximal exercise modalities as a cardiovascular index may cross-talk with CRP as an inflammatory index in old age.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Animals had free access to standard food and water. All stages of keeping and slaughtering rats were carried out according to the rules of the Animal Ethics Committee of Islamic Azad University, Rasht Branch (ethical code: IR.IAU.RASHT.REC.1399.024).

Informed consent It was perform at first of study.

Author contributions

Conceptualization: S.A., M.F.S.; Methodology: M.R.; Software: S.A.; Validation: M.F.S.; Formal analysis: M.R.; Investigation: M.R.; Resources: M.F.S.; Data curation: S.A., M.R.; Writing - original draft: M.F.S.; Writing – review & editing: M.R.; Visualization: S.A., M.R.; Supervision: S.A.; Project administration: S.A., M.F.S.; Funding acquisition: S.A.

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