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Research article

EFFECT OF EXERCISE TRAINING ON C-REACTIVE PROTEIN LEVELS: A FOLLOW UP STUDY

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ABSTRACT

Context: It is widely believed that physical fit individuals are at lower risk of developing coronary disease. Physical activity may exert some of its beneficial effect by reducing levels of inflammation. C-reactive protein (CRP), an inflammatory marker, is believed to be a mediator of atherogenesis & predictor of cardiovascular disease. Exercise training is suggested to reduce the levels of CRP levels. We evaluated effect of exercise training on levels of CRP by measuring and comparing these levels at regular intervals throughout the length of study. **Materials and Methods:** 40 male students of Physical education aged between 18 to 25 years, were followed up for the period of nine months with CRP levels being measured at the interval of every 3 months. The subjects underwent regular planned physical training for about 3 hours daily (1½ hours in the morning and 1½ hours in the evening with resting period according to individual needs), five days a week. **Results:** CRP levels significantly decreased from 3.73 mg/l to 3.11mg/l at the end of first 3 months. These levels further decreased to 2.72 mg/l at 6 months and 2.10 mg/l at 9 months (*P<0.0001*).**Conclusion:** The present study suggests that with increase in the duration of exercise training period, CRP levels reduce significantly.

Keywords: C-reactive protein, Exercise, Inflammation, Atherosclerosis

INTRODUCTION

Regular physical exercise reduces the risk of age-related diseases. Epidemiologic evidence suggest that chronic diseases, such as heart disease and diabetes type 2 can be prevented with regular physical exercise.[1] It has also been shown that inflammatory factors like C-reactive protein(CRP) is an important risk factor for atherosclerosis & cardiovascular disease events.[2,3,4] Elevated plasma levels of CRP have been associated with an increased risk of coronary heart disease, while regular physical exercise plays an important role in lowering CRP and in turn decreasing the risk of coronary heart disease.[2,5]Data from epidemiological and longitudinal studies suggest that increasing physical activity is an effective means of lowering systemic levels of inflammation [6,7] and this anti-inflammatory effect of physically active life style is irrespective of age.[8] Some studies implicate that high initial CRP levels in sedentary healthy adults are also reduced in response to exercise training. [6,7,8] On an average, high levels of CRP are seen in individuals who smoke, have high blood pressure, are overweight, and fail to exercise. [9]

Earlier study by Laka TA et *al.* has shown the beneficial effect of exercise in lowering CRP levels after 20 weeks of follow up. A cross sectional study by Kasapis C et *al.* reported inverse relationship between physical activity and CRP levels.[5] The present follow up study was undertaken to assess the effect of 9 months exercise training on CRP levels. In

this study, with the first reading taken as baseline, CRP is compared every 3 months for the period of 9 months duration of exercise training

MATERIALS AND METHODS

The present study is Longitudinal; constituting 40 newly admitted first year male students of physical education. Before starting the study work, permission was obtained from institutional ethics committee, NKP Salve Institute of medical sciences and research centre, Nagpur. All participants were given detailed information about the study and informed consent was obtained.

All the participants lie in age group between 18 - 25 years and were not previously involved in regular physical exercise. They were willing to start regular physical activity and continue it at least for the period of 9 months and follow up of 9 months. Subjects with history of asthma and/or autoimmune disease, those on steroids therapy/ immunosuppressive therapy and those with chronic diseases like diabetes, hypertension were excluded.

Exercise pattern: All the subjects were doing a regular planned exercise, about 3 hours daily, five days a week, about 1½ hours in the morning and 1½ hours in the evening. The type of exercise was aerobic with a daily schedule. Enough time was given for the students to adapt in initial 3 weeks. During this period intensity of training was increased gradually. .

1. First week
- 10 minutes: warm up
- 15 minutes: jogging
- 10 minutes: stretching

2. Second week
- 15 minutes: warm up
- 15 minutes for jogging and running each
- 15 minutes: stretching

3. Third week
- 15 minutes: warm up
- 30 minutes for jogging and 15 running.
- 15 minutes: stretching

The general scheme for exercise after 4th week, in the morning as well as in the evening, was as follows:

- 15 minutes: Warm up exercises
- 30 minutes each for running and jogging with resting period of one hour, divided according to individual needs.
- 15 minutes: stretching

Registration of subject for the study was followed by the detailed recording of medical history, personal history and family history. Also a detailed exercise history, other than mentioned above, if any, including place, daily hours, daily schedule and type of exercise and other exercise related activities like participation in other sports were obtained.

At the time of admission these students were not involved in exercise training, at this point of time the measured parameter (CRP) was considered as baseline measurement (**B**). Then these students were followed up for the period of 9 months with CRP being measured at the interval of 3 months; i.e. at 3 months (**3M**), 6 months (**6M**) and 9 months (**9M**) after commencement of exercise training period. Under all strict aseptic precautions, blood sample was collected from each subject and CRP was assessed with the help of quantitative turbidimetric test by using C-reactive protein Turbilatex kit (Euro Diagnostics Pvt. Ltd., Chennai.)

RESULTS

All the observations were compared by using one way analysis of variance with repeated measures (one way ANOVA with repeated measures, Tukey's Multiple Comparison Test and unpaired t-test) with the help of software Graph Pad Prism.

Table 1: showing levels of C-reactive protein at B, 3M, 6M and 9M.

	Basal	3M	6M	9M
C-reactive Protein (mg/l)	3.7± 0.75	3.1± 0.78	2.7±0.67	2.1± 0.67
Significance	HS (P<0.0001)			

Table 1 shows the mean C-reactive protein (CRP) levels before (B), 3 months (3M), 6 months (6M) and 9 months (9M) of exercise training period. From the above table it is evident that the levels of CRP reduced significantly with increase in the duration of exercise training period with high statistical significance. The observations were also compared between all the groups. The results are as follows

Table 2: showing comparison of CRP between all the groups.

Tukey's Multiple Comparison Test	Mean Diff.	Significant? P < 0.05?	95% CI of diff
B vs 3M	0.6215	Yes	0.5063- 0.7367
B vs 6M	1.005	Yes	0.8895-1.120
B vs 9M	1.625	Yes	1.510-1.740
3M vs 6M	0.3833	Yes	0.2680- 0.4985
3M vs 9M	1.004	Yes	0.8883- 1.119
6M vs 9M	0.6203	Yes	0.5050- 0.7355

Table 3: comparison of CRP between all the groups with p value

Unpaired t test	P value
B vs 3M	0.0006
B vs 6M	P<0.0001
B vs 9M	P<0.0001
3M vs 6M	0.0212
3M vs 9M	P<0.0001
6M vs 9M	P<0.0001

From table 2 and 3, and graph 1 it can be seen that after comparing the CRP levels between all the groups, the levels of CRP decreased in response to increase in the duration of exercise training period. The results were found to be statistically significant.

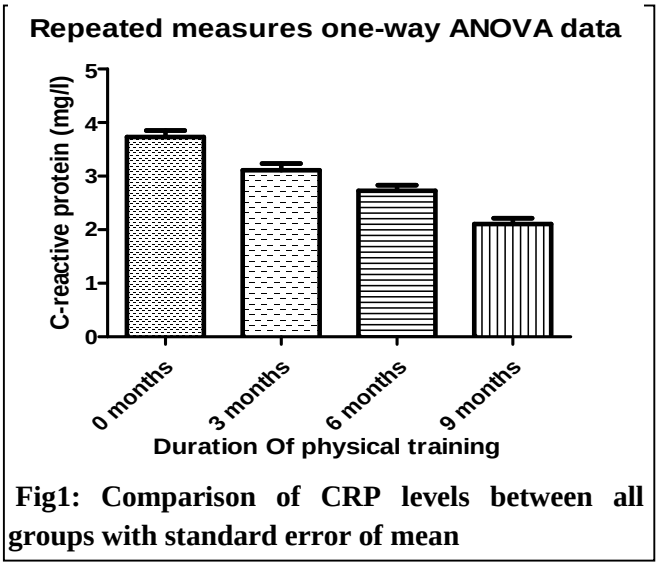

Fig1: Comparison of CRP levels between all groups with standard error of mean

DISCUSSION

In this 9 month long study we assessed the effect of physical training on CRP; a complex protein that our bodies produce when exposed to infection or trauma, also an important marker of inflammation.[9] Amount of CRP produced depends on many different factors. Higher levels of CRP are observed in smokers, hypertensive subjects, overweight individuals and people with sedentary lifestyle. [9] In our study we observed that the levels of CRP decreased in response to exercise training.

Present study is important from public health point of view. Large number of data suggest that individuals with high levels of inflammation are at increased risk of cardiovascular and metabolic diseases.[1, 2, 3, 4] Measurements of inflammatory markers like CRP, serum amyloid A and interleukin-6(IL-6) are highly predictive of future risk of atherosclerosis and cardiovascular disease events, stroke and the development of peripheral arterial disease.[9, 10] This possible inflammation lowering effect of exercise training can explain the benefits of regular physical exercise for preventing and treating cardiovascular and metabolic diseases.

The important aspect of this study is regular follow up of participants for 9 months and comparing the measurements at every 3 months interval. CRP levels started to decrease as early as at first 3 months. These levels further reduced at 6 month and 9 month interval, suggesting that, regularity as well as duration of physical training plays important role in reducing CRP levels.

How exercise training reduces inflammation and suppresses CRP levels is not well defined. Some studies suggest that adipocytes produce the inflammatory cytokines (IL-6, interleukin-1 (IL-1) & Tumour necrosis factor- α(TNF- α) and these cytokines lead to increased production of CRP by liver.[10, 11, 12] Thus higher levels of CRP are associated with adiposity caused by sedentary lifestyle. Long term physical exercise attenuates the production of atherogenic cytokines from monocytes and leucocytes and ultimately reduces the CRP production from liver. [13]

Leptin, a hormone secreted by adipocytes, is also believed to increase the levels of CRP. [14] Physically active individuals have less adipocytes, so less secretion of leptin and this may lead to decreased stimulation of hepatic CRP production. [15]

Romano M et *al.* suggested that oxidant injury causes vascular endothelial cell inflammation by increasing production of cytokines and elevating CRP production in liver; [16] physical activity is believed to counteract this effect by up regulating antioxidant enzymes and increasing defence against oxidant injury, leading to reduction in the production of

cytokines and CRP. [17] However, exact mechanism by which increase in physical activity reduces CRP and inflammation is not clear. Further studies are needed to explore these mechanisms.

CONCLUSION

Finding in our study suggest that, regular physical exercise has a possible anti-inflammatory effect as the levels of CRP decreased in response to exercise training. This decrease in the levels of CRP is found to be proportional to the duration of exercise training period.

Along with this future studies are needed to see whether these beneficial effects of physical activity on serum levels of CRP remain or revert back completely or partially to their previous levels after stopping the exercise or after a significant gap.

Conflict of Interest: Authors declare no conflict of interest.

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