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The effect of aerobic training on the immune system of aging men

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ABSTRACT

The purpose of this study was to determine the effect of six months moderate aerobic training on the immune system of aged men using VO2max as indicator and some selective markers of immune system. 40 healthy aged males (60-70 years) were selected and randomly divided into two groups: experimental and control. Before the experiment measurements on VO2max, counts of CD4 and CD8 cells of all subjects were taken. Afterward the experimental group performed moderate aerobic training three times a week for 6 months (the first 3 months with intensity 35-45% Heart rate reserve and duration of 20-30 minutes and the second 3 months with 45-60% Heart rate reserve and duration of 30-40 minutes). The control group did not do any regular training exercises. The same variables were measured after 3 months (Mid-experiment) and 6 months (post-experiment) for all subjects. Statistical analyses used were ANOVA and student's t test. Moderate aerobic exercises increased VO2max significantly (19/5%) in the experimental group as compared to the control group and also between pre-, mid experiment phases with post-experiment phase of test group (P<%5). The number of CD4 and CD8 cells in the training group had increased significantly as compared to the control group and CD4/CD8 ratio in training group was significantly lower than the control group (the rate 8%)(P<%5). The results confirmed that moderate aerobic exercise may increase VO_{2max} and improve immunity system markers in aged men.

Keywords: VO2max, aerobic exercise, CD4, CD8.

INTRODUCTION

Human immune system consists of an effective defensive system which protects the body against invading agents(1). Decrease in immune response results in acute or chronic diseases such as AIDS, cancer or infectious diseases. The immune system declines with aging and elders are more susceptible to diseases, putting a lot of stress to aliening health budgets (2). It is believed that with aging, susceptibility to Immune-related diseases increases as T-cell

proliferation response deteriorates due to mutagenic stimulation, decrease of IL-2 by T-cells and B-cells, and infectious stimulation(3).

Boosts in the immune system efficiency protect elders from aging problems. Sports medicine research has shown that life style and genetic background play the most important roles on elders' health(4). Taking regular exercises (especially aerobic exercises) contributes greatly in boosting immune system efficiency and decreases susceptibility to chronic diseases(5). Regular sports with medium intensity improve high blood pressure, cardiac output and non-insulin dependent diabetes(6). Stamina aerobic exercises have been demonstrated to increase NK cells activities, the numbers and function of lymphocytes; even as there are contradicting studies which show no significant differences between athletics and non-athletics elders on proliferative chain of CD4 and CD8 cells(5, 7-9). Thus, this study was undertaken to examine the effect on the immune system of elders who undergo medium aerobic training for six months.

MATERIALS AND METHODS

Subjects

The call for volunteers was sent out by First Call Research at the University of Qom for elderly men aged 60 to 70 who were willing to take part in the research. A total of 109 elderly men volunteered. After the volunteers were informed of the objectives of the study, they underwent medical examination. A medical history questionnaire and a physical activity readiness questionnaire were accomplished for 83 people comprising healthy elderly and non-athletes. 40 subjects were randomly selected with replacement. Subjects were randomly assigned in to two control and training groups of 20 people. They completed the forms of consent which indicated their readiness to participate in this study for 6 months. The experimental group was trained during the study duration, while the control groups were not given any exercise routine and were allowed to resume their daily routine. The profiles of both groups are presented in Table 1.

Table 1.Subject characteristics

	Aerobic	**Control**
Age(year)	62±2	66±3
Weight (kg)	86±12	84±12
Fat (%)	25.23±2.2	25.82±2.38
Lean body mass	64.33±2.29	62.3±1.72
Vo_{2max}(ml.kg.min)	31.9±3.1	30.7±3.5

Calculated Maximum oxygen consumption

To estimate aerobic power of subjects, we conducted a Walking 1 mile Rockport test (10).

Aerobic power of subjects was calculated using the following equation:

VO2max (mL•kg-1•min-1) = 132.853 (0.0769 x 155.5) (0.3877 x 30.0) + (6.315 x 0) (3.2649 x13.56) (0.1565 x 145)

Training program

The aerobic exercise group followed a training protocol, three sessions a week for 6 months. Each session includes 8-minute warm-up exercise and cool down in the first three months, 20 to 30 minutes jogging with 35-45 percent of maximum heart rate reserve intensity (MHRR). Second in 3-6 months training period from 30 to 40 minutes of running with 45 to 60 percent increased maximum heart rate reserve. To suit each stage of the work for subjects exercise

intensity was controlled using a watch heart rate monitor Polar. The subjects in the control group did not do any training program and proceeded with their normal daily routine. All protocols were approved by the Graduate Council of faculty of Physical Education and Sports Science, Islamic Azad University Central Tehran branch.

Blood sampling

To measure the number of cd4 and cd8 cells, blood samples were taken before the training, 3 months after the training and 6 months after the training. Before blood extraction, all subjects undertook 12 hours of fasting (from 7 pm to 9 am)., Ten (10 ml) venous blood was extracted from a vein of the anticubital in the spine. and collected in a sterile tube containing a blood anticoagulant (EDTA) before laboratory transfer.

Assessment of CD4 and CD8

CD4 and CD8 concentration using device flow cytometric analysis with a model of the company Becton Dickinson FACS CLAIBAR USA construction were evaluated

Statistical analysis

Statistical analysis of data was calculated for each group using means and standard deviation. Then Kolmogorov-Smirnov test was used to ensure normal distribution of data. The student's **t** test was used to evaluate between-group analysis of variance with repeated measure. ANOVA[3] for within-group evaluation according to the corrective procedure Green house-Giser (GG) were used. The T-test with Bonferony amendment was used to analyze significant differences observed by determining the difference location to reduce error paired samples. The significant level was P≤0/05 for all the calculations and all the statistical tests were conducted using SPSS software ((version 13, Michigan, USA).

RESULTS

All the measured variables are shown as Mean ± Standard Deviation (SD). The six-month aerobic training caused significant improvements in the VO2max in the aerobic group (p=0.001). After 3 to 6 months of training, VO2max significantly increased in comparison to pre value from 31.9±3.1 to 35.8±2.4, p=0.001 and 31.9±3.1 to 38.1±3.6, p=0.001 respectively. In the control group, the VO2max has not changed significantly. The VO2max of the control group as compared to the aerobic group was 31.4 ±4.2 vs. 35.8±2.4 after three months, and 31.7±3.5 vs. 38.1±3.6 after six months (Fig 1).

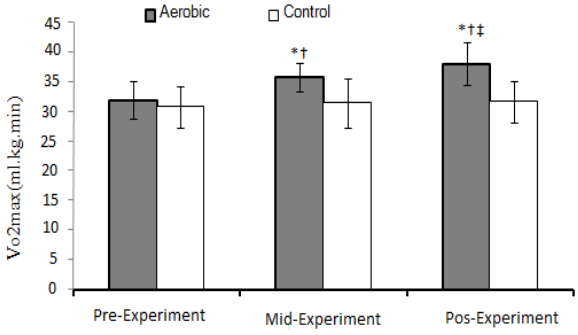

Fig1. VO2max in three control and experiment groups, in three different times, pre, mid and post experiment.
†Denote significant differences between experimental and control groups.
** Denote significant differences to pre experiment.; ‡ Denote significant differences to mid experiment*

Aerobic training increased the CD4 cell count. In spite of this increase which was found after three months, another significant increase occurred after six months' training in comparison with the pre value from 566±28.4 to 842±35.26,P=0.001. No significant change was observed at this time in the control group. Comprising CD4 cells count between two groups showed the elevation of CD4 cells count in aerobic group 842 ±35.26 vs. 601± 16.83,P=0.001 in comparison with control group after 6 months(Fig 2).

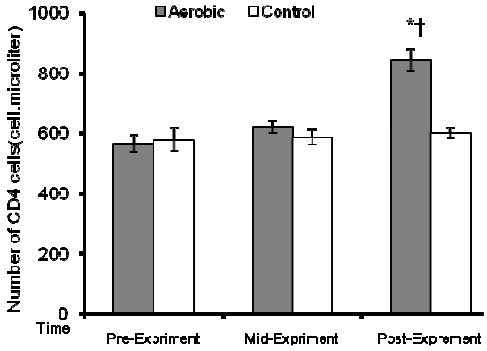

Fig2. Number of CD4 cells in three control and experiment groups, in three different times, pre, mid and post experiment.
*†Denote significant differences between experimental and control groups.; * Denote significant differences to pre experiment.*

CD8 cells count had the same pattern of changes in CD4 cells count within and between two groups (Fig 3).

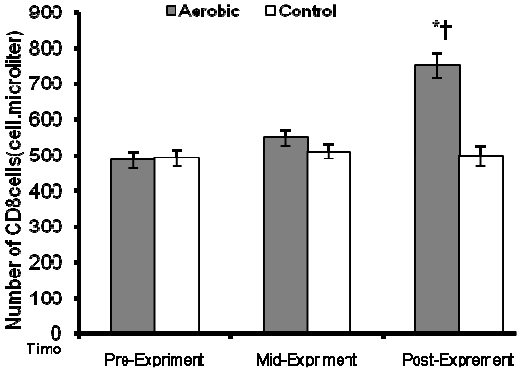

Fig3. Number of CD8 cells in three control and experiment groups, in three different times, pre, mid and post experiment.
†Denote significant differences between experimental and control groups.
** Denote significant differences to pre experiment.*

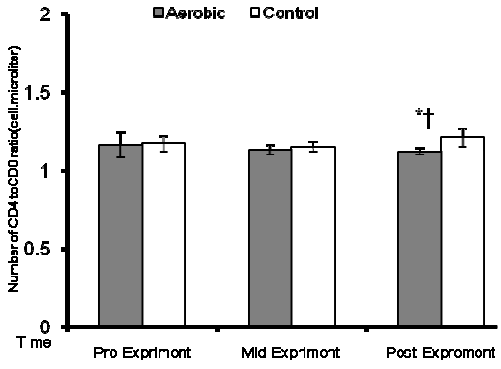

Fig4. Number of CD4 toCD8 ratio in three control and experiment groups, in three different times, pre, mid and post experiment.
†Denote significant differences between experimental and control groups.
** Denote significant differences to pre experiment.*

6 months of aerobic training, caused significantly decreases in CD4/CD8 ratio (1.16±0.08 to 1.12±2.0.02, p=0.002). After six month training, CD4/CD8 ratio in aerobic group significantly less than control group (1.12 ±0.02 vs. 1.21± 0.06, p=0.001) respectively (Fig4).

DISCUSSION

In this study VO_{2max} in the experimental group increased 12.2% and 19.5% in mid- and post experimental compared to pre-experimental phase but no difference was seen in the control group. There was an increase of 14.1% and 19.5% increase in mid- and post-experimental phases in the experimental group compared to the control group. These findings confirm that moderate aerobic activities increase the aerobic capacities of elders, resulting to the improvement of cardio-vascular performance. These findings are in line with previous findings (9-13). Cardio-vascular improvement is attributed to the increase in cardiac output (14), blood volume(15), increase in number of mitochondria(16),a-v O_2 differences(17) and development of capillary networks(18).

The results of this study showed that after six months, the number of lymphocytes cells (CD4 and CD8) increased in the experimental group taking moderate exercises as compared to control group(up to 34%). Cell numbers are expected to decrease due to aging process. After three months, there was no evidence of any immune system boosting, showing that the immune system is boosted only after a longer period of exercise. This finding is consistent with other studies, while other contradicting studies have made different observations. Other studies may have other variables such as: the age of participants, level of physical fitness, duration or the intensity of exercise. CD4/CD8 ratio in experimental group showed a 3.5% decrease in post experimental phase as compared to the pre-experimental phase and 8% decrease as compared to the control group ($P<0.05$); confirming the advantages of moderate exercises on immune system and previous findings(19-21).The mechanism of immune system improvement due to moderate activities is not clearly understood, but one of the factors considered is the increase in free radicals production(22, 23). Oxygen consumption increases up to 10 folds during exercise and so the number of free radicals increases dramatically. Thus, the immune system acquires more capacity to combat harmful free radicals available in blood, production of antioxidant enzymes such as superoxide dismutase, catalase and glutathione peroxides increases(22). This process leads to the adjustment of antioxidant enzymes performances, cell-mediated immune response and increase in the numbers of CD4 and CD8 cells(22). Decrease in sympathic system performance and β adrenergic receptors sensitvity due to aging may be compensated by moderate exercise and increase in secretion of catecholamine and stimulation of spleen(24), lymphatic nodes, and thymus and lymphatic cells with proliferation of T-cells and CD4 and CD8. Stimulation of β adrenergic receptors may result in CAMP activation and production of lymphocytes(9, 25, 26). Positive changes in Th1 to Th2 ratio has also been mentioned as an effective response due to sport activities(27).

CONCLUSION

This study results showed that, moderate aerobic exercises (of at least 6 months' duration increases maximum oxygen consumption and the number of CD4 and CD8 in healthy elders thereby improving the immune system function that protects elders against immune-system dependent diseases.

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