



Effects of Different Intensities of a Nine-Week Resistance Training on Serum Levels of Malondialdehyde in Young Sedentary Men

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Abstract

Background: The present study was conducted to investigate the effects of a nine-week resistance training program on serum levels of malondialdehyde (MDA) in 17 - 21 year-old sedentary men.

Methods: In the present quasi-experimental study, 36 volunteers with no history of physical and mental illnesses and regular physical activities were randomly assigned to three groups of 12 men, including progressive resistance training group, moderate resistance training group and control group. Thee experimental groups underwent nine weeks of resistance training with weights; the control group was, however, banned from any forms of exercise. The training programs comprised three 3-week courses. In the progressive group, the intensity and volume of training gradually increased during these courses once every three weeks, whereas the moderate group underwent the same level of moderate resistance training during the whole nine-week program. Ten cc of fasting blood was taken from the anterior brachial vein of the subjects before training at 9 AM, i.e. pre-test and 72 hours after each course, i.e. posttest. The blood samples were transferred to the laboratory to have MDA levels measured using the kits manufactured by the Zell-Bio Company. Repeated measures ANOVA and post-hoc Tukey test were used to analyze the collected data.

Results: The findings showed that the serum levels of MDA significantly decreased from 138.85 μM at pretest to 118.92 at mid-test and 102.38 μM at posttest in the progressive resistance training group and from 137.25 μM at pretest to 119.29 at mid-test and 114.43 μM at posttest in the moderate resistance training group compared to the controls. Although the decline rate was higher in the progressive group than in the moderate group, the difference was statistically insignificant.

Conclusions: The increasing intensity of daily resistance training with weights' from light to moderately severe appears to increase the compatibility of oxidative stress and decrease lipid peroxidation .

Keywords: Resistance Training, MDA, Oxidative Stress

1. Background

There are misconceptions about the health effects of resistance training with weights. Scientific studies conducted in recent decades have reported the beneficial effects of regular resistance activities, and showed that resistance training causes many health effects, including increasing muscle strength, and enhancing body composition and bone density (1). Moreover, growing evidence suggests that regular resistance training positively affects cardiovascular diseases associated with risk factors such as blood pressure, cholesterol, lipoprotein, and homocysteine levels (2).

The compatibility associated with oxidative stress and its effects are novel issues associated with the health effects of regular physical activity. Oxidative stress refers

to oxidative reactions caused by creating free radicals, i.e. molecules with uncoupling electrons in their exterior orbit and an appetite to react to and decay oxidation with cellular stretchers and macromolecules (3). Living organisms and cells for neutralizing these adverse effects present defensive mechanism involving enzymes, namely the antioxidant system (3). Oxidative stress also refers to a condition in which the level of cellular oxidants produced exceeds the physiological capacity of neutralizing organs (3). Physical exercise has many health benefits and long exercise periods have beneficial effects, including improving the antioxidant system capability and decreasing the number of free radicals generated (4). Intense physical activity, however, endangers human's health by generating excessive free radicals and through the oxidation of biological

macromolecules (4). The membrane's lipids degradation during oxidative stress leads to dangerous substances entering the intracellular space. Lipid peroxidation can be detected by measuring different indices such as MDA as the most important one.

MDA is the result of fatty acids oxidation with more than two double bonds. This molecule is a relatively stable aldehyde that may separate from its original location and emerge in other body fluids, making its measurement possible (4).

Although intense physical exercise is known to associated with the increased production of free radicals and oxidative stress, many studies have shown that the long-term compatibility caused by physical activities may eventually reduce oxidative stress and reinforce the antioxidant system (5). In addition to the known health effects such as improving the cardiorespiratory performance, reducing body fat and strengthening the skeletal system, regular physical activity appears to prevent a wide range of diseases associated with oxidative stress and free radicals such as cardiovascular disease, type 2 diabetes, Rheumatic arthritis, Alzheimer, Parkinson, and certain types of cancer (6). People who follow regular exercise programs benefit from reduced risks of diseases and enjoy a better quality of life (6).

Although research on oxidative stress compatibility is mainly focused on aerobic training, some valuable studies have recently examined the short and long-term effects of resistance training with weights on oxidative stress and the associated compatibility and determined the health effects and risks pertaining to resistance training (6, 7).

Azizbeigi et al. (7) compared the effects of resistance, endurance, and parallel training on antioxidant and oxidative stress levels in healthy young men, and found that the MDA level significantly reduced in all groups. Margonise et al. found that the increased intensity of resistance training can increase lipid oxidative stress levels in young men and change the direction of compatibilities and increase the plasma MDA level.

2. Objectives

Given the lack of research on the chronic adaptations of resistance trainings and contradictions of findings, the present research was performed to investigate the effects of different intensities of resistance training on MDA as a lipid peroxidation index.

3. Methods

The present quasi-experimental study was conducted on two experimental groups and a control group, each

comprising 12 volunteers. After completing written consent forms, the subjects were evaluated in terms of general health, daily physical activity, the normal range of BMI (18.5 - 24.5), history of cardiovascular diseases, respiratory and liver failure, hormonal disorders, anemia, diabetes, physical injuries, orthopedic status and history of regular exercises during the previous three months. The subjects were randomly divided into three groups of 12 subjects, including the progressive intensity resistance training group, the moderate resistance training and the control group. Before beginning the training program, the subjects' anthropometrical characteristics were measured and they were familiarized with the training program. The study began by taking 10 cc of fasting blood from the subjects' anterior brachial vein at 9 AM (pretest), which was repeated in all groups after 72 hours of rest to eliminate the effects of acute exercise. This process repeated for 9 weeks. The blood samples were transferred to the laboratory to have MDA levels measured using the kits manufactured by the Zel-Bio Company.

After a 10-minute warm up with light weights at the beginning of every week, the subjects' maximum strength was measured using the Berzinsky equation. The experimental groups underwent three sessions of resistance training, whereas the control group was avoided from training. Both experimental groups participated in the first and second training sessions (3 days a week, 4 sets of 10 with 70% of one maximum repetition strength with 60-second rest intervals). In the third course, the progressive resistance group underwent a heavier program (6 days a week, 6 sets with 80% - 90% of one maximum repetition strength with 120-second rest intervals), while the moderate resistance group repeated the second program course for three weeks. They performed leg press, leg curl, bench presses, shoulder with barbell, and biceps and triceps with a barbell. The upper and lower body were moved alternately.

The foods consumed three days before blood sampling provided by subjects using dietary recalls forms were analyzed and the calorie content and absolute and relative percentages of the macro nutrition of the foods were determined using the nutritional software nutrition-4.

The Kolmogorov-Smirnov test was used to confirm the normal distribution of dependent variables and Levene's test was used to affirm the homogeneity of variances. The means were compared using repeated measures ANOVA. Tukey's test was utilized due to the existing significant mean differences. The data were analyzed in SPSS. P values less than 0.05 were considered significant.

4. Results

Table 1 presents the descriptive characteristics of the subjects, Table 2 the results of repeated measures ANOVA and Table 3 the results of post-hoc Tukey test.

According to the results of repeated measures ANOVA and post-hoc Tukey test shown in Tables 2 and 3, the effect of group, time and the interaction between group and time were significant at the level of $P < 0.05$. In terms of the group effects, a significant decline was observed between the progressive and control groups and also between the moderate and controls. However, no significant changes were observed between the progressive and moderate groups though the range of decline was higher in the progressive compared to in the moderate group, i.e. 26.05% vs. 16.63%. In terms of the effect of time, a significant decline was observed between pretest and mid-test and also between pretest and posttest, while no significant differences were observed between mid-test and posttest.

5. Discussion

A course of intense-enough physical activity can increase oxidative stress and cause certain symptoms in body's natural fluids (5). This activity may be resistance aerobic or anaerobic endurance and speed activity (5). Although the exercise intensity is a major factor in developing oxidative stress, the prior preparation of subjects is a key factor in identifying the desired intensity of exercise. In other words, this intensity differs with the prior preparation levels of athletes and varies from one person to another (5). Other factors including nutritional status, rest and anxiety levels may also affect the oxidative stress range (8).

According to Homes theory, low-intensity and high-intensity activities may reduce physiological functions at both ends of a continuum (9). Moderate-intensity activities in the middle of this continuum can trigger physiological functions. Furthermore, the generation of small to moderate numbers of free radicals during moderate-intensity physical activities can improve physiological functions (3).

Prolonged physical activities may create compatibilities and affect the body's physiological response to oxidative stress range at rest and respond to acute physical activities (10). In other words, although an intense session of physical exercise may cause oxidative stress, the compatibilities created by prolonged periods of physical activity may modify the oxidative stress at rest in response to an acute exercise session (10).

However, the intensity of physical activity, duration of recovery periods between sets and training sessions, and

nutritional status of individuals are significant factors in achieving compatibilities (11, 12). Very intense training sessions without taking adequate rest and proper nutrition reduce physical functioning and disproportionately increase the risk of oxidative stress syndrome (13, 14).

The present results showed that nine weeks of very intense daily resistance training with weights significantly decreases the serum levels of MDA, which was consistent with the findings of Gaini and Sheykh al-Islami, who found a decrease in oxidative stress symptoms following long periods of resistance exercise, and with the findings of Ramel and Vincent (2, 15) suggesting that athletes and non-athletes have no significant differences in terms of MDA. This discrepancy can be explained by shorter training periods and unprepared subjects in Ramel and Vincent's study.

These findings were also inconsistent with those obtained by Margonise suggesting an increase in MDA and other indicators of lipid peroxidation during daily resistance trainings. This difference appears to be linked to the stepwise increase in the training intensity during preparation in the progressive intensity training group, which developed the oxidative stress compatibility.

Given the key role of nutrition (16) in oxidative stress variations, nutritional information was recorded by the subjects 72 hours before every blood sampling. These data were analyzed in Nutrition-4, and showed that despite the significant increase in the total calorie intake and food macromolecules in the exercise group compared to in the controls, no significant differences were observed between the experimental and control groups in terms of relative percentage of food macromolecules. This finding reflects the control of nutrition effects exerted on oxidative stress.

Different mechanisms explain the reduction of lipid oxidation during long periods of physical activity, including the most important one, i.e. the increased number of mitochondria and changes in the enzymes of the electron transport chain which reduce free radical formations and the electron leakage to the outside of the chain (1, 17-20). This compatibility does not appear to be based on reducing the serum production, as an increased number of mitochondria and the enzymes of the electron transport chain are adaptive and can be effected by aerobic exercise (7, 12). The decreased activity of oxidase xanthine enzyme can be another mechanism contributing to reducing oxidative stress and serum MDA (21). The activity reduction of this enzyme is affected by increasing the capillary density, which is a compatibility mostly affected by aerobic exercise (22) and probably reducing and redistributing ischemia in resistance activities. Nevertheless, research suggests resistance training significantly affects the capillary density (20).

The increased muscle resistance against mechanical

Table 1. The Subjects' Pretestphysical Characteristics

Variable	Moderate Intensity Training	Progressive Training	Control
Age, y	0.95 ± 19.1	1.26 ± 19.1	0.99 ± 19.8
High, cm	4.22 ± 175	3.08 ± 175	4.01 ± 174
Weight, kg	6.15 ± 69.33	5.56 ± 68.33	1.34 ± 67.66
BMI, kg/m ²	0.95 ± 19.91	1.41 ± 19.78	1.34 ± 19.57

Table 2. The Results of Repeated Measures ANOVA in Groups and Time of Measurement

MDA, μ Molar	SD \pm Mean	RM ANOVA	P Value ^a
Progressive training		Group	< 0.001
Pre-test	3.41 \pm 138.85		
Mid-test	5.16 \pm 118.92		
Post-test	3.05 \pm 102.68		
Moderate training		Time	< 0.001
Pre-test	5.2 \pm 137.25		
Mid-test	5.02 \pm 119.29		
Post-test	4.98 \pm 114.43		
Control		Group at Time	< 0.001
Pre-test	4.27 \pm 135.8		
Mid-test	3.46 \pm 136.53		
Post-test	6.24 \pm 137.13		

^a The symptom of significant differences at a level of $P < 0.05$.

Table 3. The Results of Post-Hoc Tukey Test Following RM ANOVA

MDA, μ Molar	Significance
Progressive group	
Control group	< 0.001 ^a
Moderate group	0.01
Moderate group	
Progressive group	0.01
Control group	< 0.001 ^a

^a The symptom of significant differences at a level of $P < 0.05$.

stress, reduced activity of phospholipase A and reduced fragmentation in proteins carrying iron and zinc are others mechanisms contributing to decreasing the production of free radicals and the associated oxidative stress, as addressed in literature (10, 23).

The reduction in lipid oxidation could be due to mechanisms that elevates the production of endogenous antioxidants including glutathione, glutathione peroxidase, and superoxide dismutase. The incremental adjustment of endogenous antioxidants concentrations can reduce the

damaging effects of free radicals and oxidation of macromolecules.

MDA levels significantly decreased from the pre-test to post-test in the moderate intensity and progressive intensity groups. A five-week program appears adequately long to create oxidative stress compatibility. This decreasing trend continued from mid-test to post-test and was significant in both experimental groups. Comparing the post-test results showed an insignificant decrease in the intense exercise group compared to in the moderate exercise group. At the end of the fifth week, the lipid oxidation compatibility appears to have reached the peak progress in the moderate intensity exercise group, whereas in the progressive intensity group, the oxidative stress compatibility increased and the MDA concentration decreased given the extra load during the third period.

The reduced oxidative stress syndrome during long periods of exercise is consistent with a large body of literature (3, 15). The lower reduction of this symptom in the moderate intensity exercise group and significant differences between the moderate and severe exercise groups at post-test suggest that resistance training should be sufficiently intense and long to create compatibility in oxidative stress.

5.1. Conclusions

The findings generally suggest that daily and intense exercise activities are required to achieve compatibility and reduce lipids oxidation. The increasing intensity of daily resistance exercises with weights from light to moderately severe accompanying with an appropriate rest and nutrition can decrease lipid oxidation and other biological macromolecules.

Footnotes

Authors' Contribution: Farshad Ghazalian and Hojatalah Nik-Bakht designed the experimental set up of the study. Ali Zabet performed the experiments, analyzed the data and wrote the manuscript.

Conflict of Interests: The authors declare no conflict of interest regarding the publication of the present article.

Ethical Considerations: Before investigation, the testimonial form was resived from all subjects. All phases of exercise training were performed under the supervision of investigators.

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