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Effect of exercise modes with similar intensities on lipid-peroxidation and muscle-damage markers on sedentary males

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ABSTRACT

Depending on the intensity of a physical activity, exercise may impose negative effects on health. This study was conducted to evaluate the effect of the exercise modes with variety intensity levels on the serum concentration of lipid peroxidation and muscle damage markers in sedentary males. Eighty one sedentaryhealthy males were randomly divided intosix groups; three groups attending single-session aerobic exercise with low (n=14), moderate (n=14), and high (n=13) intensities, and three groups were subjected to single-session resistance exercise with low (n=13), moderate (n=13), and high (n=14) intensities. Data analysis showed that the mode of exercise has similar effect on the serum levels of malondialdehyde (MDA) and creatine kinase (CK). It was also found that the observed difference in the effect of low intensity levels of the modes of exercise was statistically significant, only for MDA post-test, not for CK. No significant differences were observed between the effect of both moderate and high intensity levels of aerobic and resistance exercise on both MDA and CK post-test. The results of this study suggest the low intensity level of aerobic and resistance exercise to be applied for more preparation, physical fitness and adaptation to prevent lipid peroxidation and muscle damage in sedentary males.
Keywords: Exercise Mode, Similar Intensity, Malondialdehyde, Creatine Kinase.

INTRODUCTION

Exercise intensity and the participant's condition for training determine the risk of oxidative stress during the exercise which may impose negative effects on health and exercise performance [1-3]. On the other hand, people try to add exercise on to their daily life simply to improve health and the quality of life and also to prevent a variety of life-style related diseases [4, 5].

Reactive oxygen species are continuously constructed in living cells and physical exercise results in oxidative stress and finally muscle damage [6]. As an indicator for oxidative damage, lipid peroxidation has undoubtedly been studied broadly so far [7]. Malondialdehyde (MDA) is produced by lipid peroxidation during maximal exercise to exhaustion and short periods of irregular intensity exercise [8]. Although, several studies [9-11]indicated that increased levels of MDA and CK following exercise. However, elevated MDA concentration after exercise is not reported by few studies [12, 13].

Regular exercise and resistance training is usually used among high school, college, and professional athletes, it is also popular among boys, girls, men, and women to enhance strength and performance in sports [4, 5, 14, 15]. This mode of exercise can cause mechanical injuries to muscle fibers and also increase in reactive oxygen in muscles resulting in proteolysis, inflammation, and an imbalance in calcium homeostasis [16]. Muscular damages by physical or biochemical injury can be detected by elevation of the serum level of creatine kinase (CK) [17]. Such a rise may result from the disruption of sarcometric Z-disk, accompanied by the release of this protein out of the cell and into the blood circulation subsequent to muscular injury [18, 19]. Currently, evaluation of the serum level of

CK, at rest and after exercise, has turned into a great deal among coaches and clinicians [20]. The serum level of both indicators for muscle damage, MDA and CK, has been shown to have a correlation during exercise [21].

The conflicting reports on the benefits [1, 22]) and the harmful effects [3, 23] of exercise suggest a concept known as the "exercise paradox" [24]. On the other hand, it is not clear which mode of exercise, aerobic or resistance may induce lipid peroxidation and muscle damage more significantly. Furthermore, this question arises that which intensity of the aerobic and resistance exercises is safer for sedentary males. Therefore, the present study was conducted to compare the effect of exercise modes on the rate of changes in MDA and CK as muscle damage markers in sedentary males.

MATERIALS AND METHODS

Subjects.From a population of 600 students of Shahid Bahonar University of Kerman in Iran, 81 sedentary male-students (21.82±1.93 yr) who were healthy, had no history of regular exercise for at least 6 months and did not consume any supplements such as vitamin A, C, and E before and during the exercise session were randomly selected. They were also examined by the state Sport Medicine Centre for any cardiovascular or muscle injuries. All the participants were asked to avoid performing any strenuous physical activity three days prior to the exercise session. They were informed about the objectives of the study and gave informed consent before starting the experiment. Ethics approved was also obtained from the Kerman University of Medical Science ethical committee (EC/KNRC/2011-10101). All subjects were encouraged to maintain their normal diet before exercise protocol. Records were kept for the 3 days before exercise sessions, diet records were analysed for antioxidant vitamins including vitamin C, vitamin E, and vitamin A intake by Nutritionist IV software (N 4). And also asked and encouraged them to avoid strenuous and heavy physical activity the day before the experiment.The subjects were randomly divided into six groups, three groups of single-session aerobic exercise tested under low intensity (n=14), moderate intensity (n=14) and high intensity (n=13) levels of aerobic exercise and also three groups of single-session resistance exercise with low intensity (n=13), moderate intensity (n=13) and high intensity (n=14).

Exercise Modes:

Aerobic Exercise.after warming up for 10 minutes on a cycle ergometer and performing dynamic stretching activities, the participants were subjected to 20 min of aerobic treadmill running at low (40% HRR), moderate (60% HRR), and/or high (80% HRR) intensities. Functional capacity (HRR) was estimated continuously via calculations of the heart-rate reserve (HRR) using a polar belt (Polar Electro Oy Profiessorintie 5 FIN-90440 KEMPELE, Finland) to prescribe aerobic exercise intensity (American College of Sport Medicine ACSM). The target heart rates reserves (THRR) of the participants were estimated using the Karvonen formulas (Baechle & Earle, 2008). The participants were asked to go on the treadmill (h/p/cosmos 8 DE 83365, Germany) with zero slope angles and begin walking by pressing the start button. Based on the Balke modified protocol (1959), after each minute, the speed (km/h) was increased until the treadmill speed reached the required THRR, based on the intensity.

Resistance Exercise.During familiarization sessions, participants from the three resistance exercise levels (low, moderate, and high intensity) were asked to perform the 6RM test to estimate their current 1RM score for the back squat, bench press, lat pull down, stand calf raise, arm curl, and leg press. The 1RM value for each exercise was estimated using a 1RM table [25]. The participants were asked to rest for 48 h prior to the exercise session. The participants were subjected to six resistance exercises (back squat, bench press, lat pull down, calf raise, arm curl, and leg press) at a low intensity of 40% of 1RM, moderate intensity of 60% of 1RM or high intensity of 80% of 1RM [26-28]. All the resistance exercises were performed in three sets, with 12 repetitions for each exercise [25, 29, 30]. A 2-min rest period was given between the sets [25, 30]. As excessive warm-up and testing sets may fatigue the participant and compromise the accuracy of testing [25], a warm up consisting of 5-min cycling on a cycle ergometer followed by dynamic stretches were performed. Thereafter, the participants were cooled down and served refreshments.

Blood sampling and analysis

Blood samples (5 ml) were taken from an antecubital forearm vein pre-test while participants were fasting and post-test after performing the exercises. Sera were collected by centrifuging the blood samples at 1500×g for 10 min, transferred into clean tubes, and stored at -80°C for further analysis. The serum level of MDA was measured through a colorimetric method, where MDA in reaction with thiobarbituric acid produced a colourful complex which can be measured at the absorbance value of 532 nm. The serum concentration of MDA was calculated using a standard curve prepared using a two-fold serial dilution of 1 ml tetramethoxypropane ranging from 2.5 to 80 nmol/ml. Serum level of creatine kinase (CK) was then measured using an assay kit (Parsazmon, Iran) according to the manufacturer's instruction.

Statistical analysis

Dependent variables were analyzed using a multivariate analysis of covariance (MANCOVA); the pre-tests were controlled as a covariate. Statistical significance for MANCOVA was set at $p \leq 0.05$.

RESULTS AND DISCUSSION

The results of MANCOVA analysis suggested that there is no significant difference between the effect of aerobic and resistance exercise on the serum levels of both MDA [F (1, 77) = 3.583, P = 0.062] and CK post-tests [F (1, 77) = 0.594, P = 0.443] (Table 1 and Figure 1), meaning that MDA and CK post-tests were affected similarly by the exercise modes.

Table 1.MANCOVA on the effects of exercise modes on MDA and CK post-test score

DV	Exercise mode			MDA pre-test			CK pre-test		
	df	F	Sig	df	F	Sig	df	F	Sig
MDA post-test	1	3.58	0.062	1	32.35	0.001*	1	1.67	0.200
CK post-test	1	0.59	0.443	1	0.13	0.723	1	19.34	0.001*

**Significant at P < 0.05*

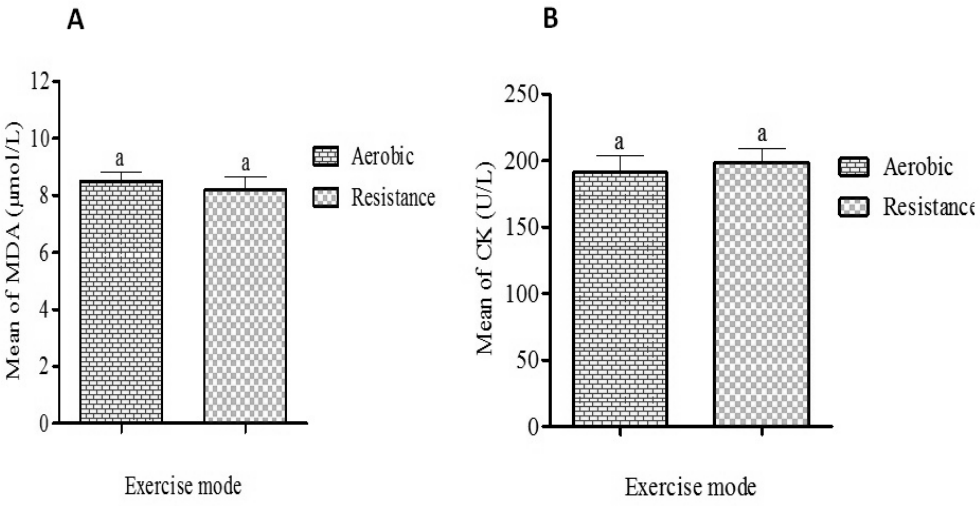

Figure 1: (A). The rate changes of MDA immediately after exercise mode; (B). The rate changes of CK immediately after exercise mode.

Table 2. MANCOVA on the effects of exercise modes with similar intensities on MDA and CK post-test score

Comparison	DV Post-test	Intensity level			MDA pre-test			CK pre-test		
		df	F	Sig	df	F	Sig	df	F	Sig
ALIL vs. RLIL	MDA	1	5.56	0.027*	1	12.03	0.002*	1	1.03	0.321
	CK	1	3.48	0.075	1	0.02	0.885	1	14.81	0.001*
AMIL vs. RMIL	MDA	1	0.98	0.332	1	5.88	0.024*	1	0.15	0.706
	CK	1	0.28	0.605	1	1.74	0.200	1	10.61	0.003*
AHIL vs. RHIL	MDA	1	0.38	0.546	1	25.34	0.001*	1	0.12	0.736
	CK	1	0.23	0.633	1	0.11	0.747	1	1.02	0.324

Note: ALIL: Aerobic low intensity level; RLIL: Resistance low intensity level; AMIL: Aerobic moderate intensity level; RMIL: Resistance moderate intensity level; AHIL: Aerobic high intensity level; RHIL: Resistance high intensity level; MDA pre and MDA post-tests (µmol/L) = malondialdehyde pre and post-tests (micromoles per liter); CK pre and post-tests (U/L) = Creatine kinase pre and post-tests (units per liter).
**Significant at P < 0.05*

MANCOVA-based analysis also indicated that the MDA and CK post-tests respond differently to similar intensity levels of the exercise modes. As shown in Table 2, the observed difference in the effect of low intensity level of aerobic and resistance exercise was statistically significant, only for MDA post-test [F (1, 23) = 5.56, P = 0.027], not for CK [F (1, 23) = 3.48, P = 0.075]; in terms of MDA, the effect of the low intensity level of aerobic exercise (M = 8.19, SE = 0.63) was found to be higher compared to the low intensity level of resistance exercise (M = 6.81, SE = 0.86) (Figure 1). Lower increase in CK was detected in the low intensity level of aerobic exercise (M = 153.50, SE = 14.92) compared to that of the resistance exercise (M = 188.77, SE = 17.89), though it was not statistically significant. Data analysis revealed no significant differences between the effect of both moderate and high intensity levels of aerobic and resistance exercise on both MDA and CK post-test (Table 2). Higher CK level was detected in both moderate and high intensity levels of aerobic exercise, compared to the same levels of the resistance exercise

(Figure 2). In terms of MDA, moderate aerobic exercise was found to be more effective than the same level in the resistance exercise; however in the high intensity, higher serum level of MDA was detected in the resistance exercise (Figure 3).

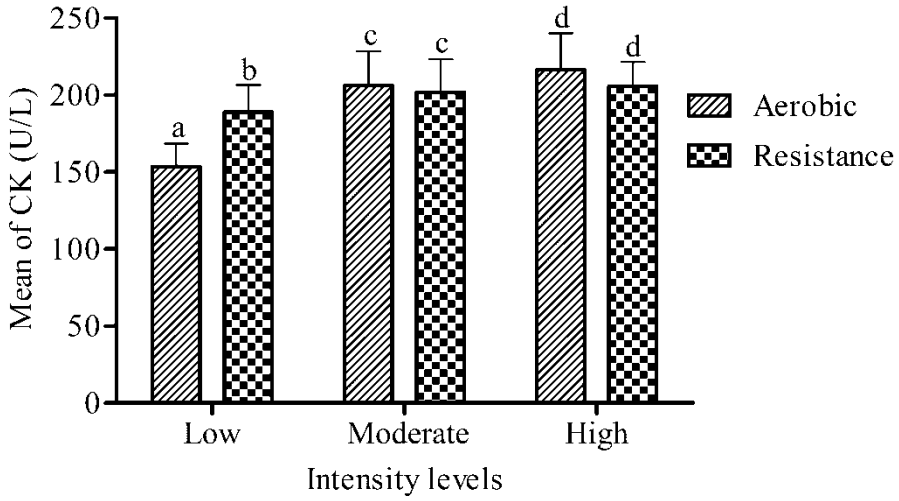

Figure 2. The rate changes of CK immediately after exercise modes with intensity levels.

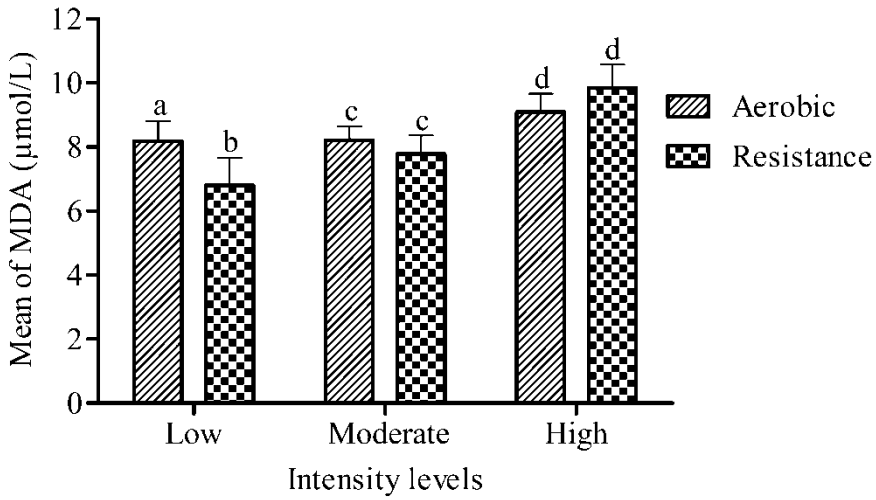

Figure 3. The rate changes of MDA post-test immediately after exercise modes with intensity levels.

As an indicator of oxidative damage following exercise, especially in maximal exercise to exhaustion and short periods of irregular intensity exercise [8], lipid peroxidation has been undoubtedly studied broadly so far [7, 31]. Peroxidation of lipids, especially polyunsaturated fatty acids in the cell membrane causes a loss in fluidity and increases the permeability which can result in the loss of cytosolic proteins and enzymes, and structural sarcoplasmic reticulum. Both the above conditions may lead to oxidative damage which can be detected by elevation of the serum level of MDA and CK markers [32, 34]. Therefore, these markers are usually considered by coaches and clinicians as indicators for muscle damage in athletes [20].

There were a few previous investigations on the effects of the exercise modes and similar intensity levels of exercise on lipid peroxidation and muscle damage markers [9, 35]. The present study compared the effects of single-session aerobic and resistance exercises with different intensity levels on the rate of changes in MDA and CK. According to the results, both aerobic and resistance exercise increased the serum levels of MDA and CK, though the observed difference between their effects was not statistically significant.

The effect of the low intensity level of aerobic exercise on MDA serum level was statistically higher than the low intensity level of resistance exercise. Lower CK was detected in the low intensity level of aerobic exercise compared

to the resistance exercise; however, the difference was not statistically significant. Moreover, no significant differences were observed between the effect of both moderate and high intensity levels of aerobic and resistance exercise on both MDA and CK post-test. In a study by Guzel et al. (2007), the serum levels of MDA and CK were found to be increased significantly, immediately after exercise in both low and high intensity levels. In another investigation [36], compared to low intensity aerobic and low intensity resistance groups, the higher amount of muscle damage indicators such as CK and Myoglobin were detected in moderate-vigorous resistance group. In a conflicting report by Bloomer et al. (2005), in cross-trained males, no significant impacts of aerobic and anaerobic exercise were detected on MDA serum level. The observed divergent results may be due to the use of different intensity levels in different participants; Bloomer and colleagues used 70% VO2max for cycling and 70% 1RM for squatting in athletes, whereas, 40%, 60%, and 80% of Heart rate reserve (HRR) as well as 40%, 60%, and 80% of 1RM were employed in the present research. Differences in the duration, intensity, modes of exercise, training status of the participants, age, sex, and even the methods used for MDA and CK measurement may also influence the results.

Based on the literature and with attention to our findings, it can be suggested that the intensity and duration of both anaerobic and aerobic exercise may play an important role in increasing mitochondrial oxygen consumption [37, 38], resulting in the production of free radicals and lipid peroxidation and subsequent cell membrane damage [5, 18, 39]. ROS induced by exercise might happen during eccentric contractions, resulting in the disruption of normal permeability and the release of muscle component including CK [40]. Although, the mechanism of biochemical changes is not understood, free radicals are thought to initiate damage or facilitate the release of pro-inflammatory substances [13]. During eccentric or intense exercise, as demonstrated by Feasson et al. (2002), the disruption of sarcometric Z-disk may increase, leading to the leakage of CK out of the cell into the circulation.

The results of this study suggest that lipid peroxidation and muscle damage markers can be affected by exercise, both aerobic and resistance. This effect may be due to the fact that the participants were sedentary (non-athletes) with no history of regular aerobic exercise, and also that they did not consume supplements before and during the exercise. Antioxidant supplements can improve antioxidant defences supplied by superoxide dismutase (SOD) against pro-oxidant events [38, 41]. The participants also have no enough time for adaptation to a variety of factors such as metabolism and mechanical stresses which may increase mitochondrial activity resulting in the production of MDA and the leakage of CK into the blood circulation, and finally muscle damage [18, 25, 42, 43].

CONCLUSION

The present study revealed that there is no difference between the effects of aerobic and resistance exercise on the muscle damage markers, MDA and CK. Serum MDA level was found to be higher in the low intensity levels of the aerobic mode compared to the resistance, while serum CK level was higher in the low resistance mode. On the other hand, moderate and high intensities showed a same effect on the damage markers. In a word, MDA serum level was found to be more affected in aerobic mode, whereas higher levels of CK were detectable in the resistance mode. This study suggests the use of the low intensity levels of exercises, abandoning intensified exercises during preparation period and physical fitness, and starting the activities by low intensity exercises followed by gradually switching to more intensified ones.

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