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Influence of the intensity levels of resistance exercise on lipid peroxidation and muscle-damage markers

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ABSTRACT

The present study was carried out to assess the effect of different intensity levels of single-session resistance exercise on the serum levels of lipid peroxidation and muscle damage markers in sedentary males. Fifty healthy sedentary males were randomly divided into four groups, one control (n=10) and three treatment groups tested under low (n=14), moderate (n=13) and high (n=13 exercise intensities. The six repetition maximum test (6RM) was used to estimate current one repetition maximum (1RM) score for the back squat, bench press, lat pull-down, stand calf raise, arm curl and leg press. Following circuit resistance exercise using loads of 40%, 60% and 80% of 1RM. The amount of malondialdehyde (MDA) and creatine kinase (CK) were measured. The results revealed a significant effect of the intensity levels of resistance exercise on the serum levels of MDA (P = 0.001) and CK (P = 0.001) post-test when compared with the controls. The amount of MDA and MDA was shown to be increased by increasing the intensity level of the exercise, suggesting that resistance exercise performed at low intensity was most suitable for helpful sedentary males prevent lipid peroxidation and muscle damage.

Keywords: Single-session resistance exercise, Exercise intensity, Malondialdehyde, Creatine Kinase.

INTRODUCTION

During training or competition, muscles in athletes may be injured by the effects of oxidation [1, 2]. Similarly for untrained individuals, muscle damage is commonly experienced following unaccustomed exercise, especially if the exercise is exhaustive or includes eccentric muscle actions [3, 4]. Eccentric muscle actions stimulate the inflammation process which in turn generates oxygen free radicals and lipid peroxidation [5, 6]. Resistance training involves muscle contractions that may cause muscle damage. The notion that resistance exercise may increase the production of oxygen free radicals in active muscle sites is supported by two theories. The ischemia reperfusion injury [7].Asserts that a momentary decrease in blood flow and oxygen availability followed by ischemia is the results of intense muscle contractions. Subsequently, an abundant reintroduction of O_2 results in the formation of superoxide radical (O_2^{-}) through reperfusion. The second theory involves mechanical stress which is thought to account for the increase in free radicals [8].

Muscle damage has shown to be related to a temporary increase in the serum concentration of muscle proteins such as creatine kinase (CK) and myoglobin (Mb) [9-11]. Therefore, a temporary rise in the serum concentration of CK has been observed following exercise [12, 13]. The plasma levels of malondialdehyde (MDA), a metabolite of phospholipids peroxidation and superoxide dismutase (SOD), have been shown to have a relationship with CK markers [5, 14, 15]. Several studies [5, 16, 17] have reported increased levels of MDA and CK following exercise. However there were also studies that formed no indication of exercise-induced damage and ageing subsequent to exercise [18]. These conflicting reports about the beneficial [19] and the harmful[1] effects of exercise on muscles reinforces the need to conduct additional investigation on the effects of the intensity level of a single-session resistance session on serum levels of the MDA and CK markers in sedentary males.

MATERIALS AND METHODS

Participants
Fifty sedentary male students (21.37±1.52 yr) who participated in physical education courses were randomly selected. All the participants were non-smokers, had no history of regular exercise for at least six months, and did not consume supplements and antioxidant vitamins such as A, C, and E before and during the exercise session. Before starting the experiments, they were also examined for any cardiovascular or muscle injuries by the Sport Medicine Centre. All the participants were asked to avoid performing any strenuous physical activity three days prior to the exercise session.

Resistance exercise
The participants were randomly divided into a control group (n=10) and three treatment groups tested under low (n=14), moderate (n=13) and high intensity (n=13) conditions during single-session resistance exercise. Current one repetition maximum(1RM) scores for six exercises including the back squat, bench press, lat pull-down, standing calf raise, arm curl and leg press was estimated for each participant via 6RM testing [20]. The treatment groups were then subjected to the resistance exercises atlow(40% of 1RM), moderate (60% of 1RM), and high (80% of 1RM) intensities [21-23]. After warming up for 5 min on a cycle ergometer followed by dynamic stretching activities, the participants were subjected to three sets of the resistance exercises with 12 repetitions for each exercise [20, 22, 24-26]. A rest period of two minutes was given between sets [20, 24]. The participants then cooled down for 5-min performing stretching exercises.

Blood sampling and analysis
Blood samples (5 ml) were taken from an antecubital forearm vein pre- and post-test. The samples were centrifuged at 1500×g for 10 min following which sera were collected and transferred into clean tubes and stored at -80°C. The serum levels of MDA were measured using a colorimetric method, in which MDA was detected in a colorigenic reaction with thiobarbituric acid (TBA) 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 CK levels was measured pre- and post-test using a glutathione activated kit (Parsazmon, Iran) with creatine phosphate as a substrate. The measurement was carried out at 340 nm using an analyzer (Technicon RA-1000-USA) at 37˚C.

Statistical analysis
Data was analysed carried out using a Multivariate Analysis of Covariance (MANCOVA) and the Bonferroni comparisons multiple tests. Statistical significance for MANCOVA was set at $P \leq 0.05$.

RESULTS

Data analysis showed a significant effect of the intensity levels of resistance exercise on MDA [F (3, 44) = 15.019, P = 0.001] and CK [F (3, 44) = 6.175, P = 0.001] post-test (Table 1). To determine the effect of the initial condition of the participants before the exercise on the post-test conditions, the serum levels of MDA and CK pre-test was applied as covariates. The effect MDA pre-test as a covariate factor was found to be significant on the MDA post-test [F (1, 44) = 35.480, P = 0.001]. No significant covariate (P = 0.125) was observed between the pre-test MDA and the CK post-test [F (1, 44) = 2.445, P = 0.125]. Likewise, as a covariate factor, the pre-test CK showed no significant effect on the post-test MDA [F (1, 44) = 1.916, P = 0.173]. These observations indicated a strong linear relation between the pre- and post-tests MDA and also CK. Thus, the observed difference between the MDA and CK post-tests may be due to the intensity levels of the exercise.

Table 1.MANCOVA on the effects of intensity levels of resistance exercise on MDA and CK post-tests scores

DV[1]	Intensity level			MDA pre-test			CK pre-test		
	df	F	Sig	df	F	Sig	df	F	Sig
MDApost-test	3	15.02	0.001*	1	35.48	0.001*	1	1.92	0.173
CK post-test	3	6.18	0.001*	1	2.45	0.125	1	4.19	0.047*

**Significant at P < 0.05 [1]Dependent variable*

The Bonferroni comparisons multiple tests indicated significant differences between the control and the treatment groups. However, the results showed no significant difference between the treatment groups on CK post-test (Table 2 and Figure 1). The difference between the low and moderate intensity levels of the exercise was found to be not significant, while a significant difference was observed between the low and high levels, and also between the moderate and high intensity levels of the resistance exercise on MDA post-test (Table 2 and Figure 2). The highest amount of MDA post-test was observed in the high intensity level of resistance exercise (M = 9.84, SD = 2.74 µmol/L) and the lowest in the control group (M = 2.69, SD = 1.312 µmol/L). The highest amount of CK post-test was detected in the high intensity level of the exercise (M = 205.71, SD = 58.20 U/L) and the lowest in the control group (M = 101.60, SD = 43.71 U/L).

Table 2.Evaluation MDA and CK among intensity levels of resistance exercise using Bonferroni test

DV[1]	**(I)Intensity Levels**		**(J)Intensity levels**	**Mean. Diff[2]**	**Std. Error[3]**	**Sig.**
MDA post-test	Control	vs.	Low	-3.137	0.805	0.002*
	Control	vs.	Moderate	-3.605	0.820	0.001*
	Control	vs.	High	-5.532	0.826	0.001*
	Low	vs.	Moderate	-0.467	0.734	1.000
	Low	vs.	High	-2.394	0.723	0.011*
	Moderate	vs.	High	-1.927	0.720	0.063
CK post-test	Control	vs.	Low	-83.997	26.076	0.014*
	Control	vs.	Moderate	-103.370	26.578	0.002*
	Control	vs.	High	-101.641	26.771	0.003*
	Low	vs.	Moderate	-19.373	23.790	1.000
	Low	vs.	High	-17.644	23.441	1.000
	Moderate	vs.	High	1.729	23.331	1.000

**Significant at $P < 0.05$; [1]Dependent variable; [2] Different means; [3]Standard Error*

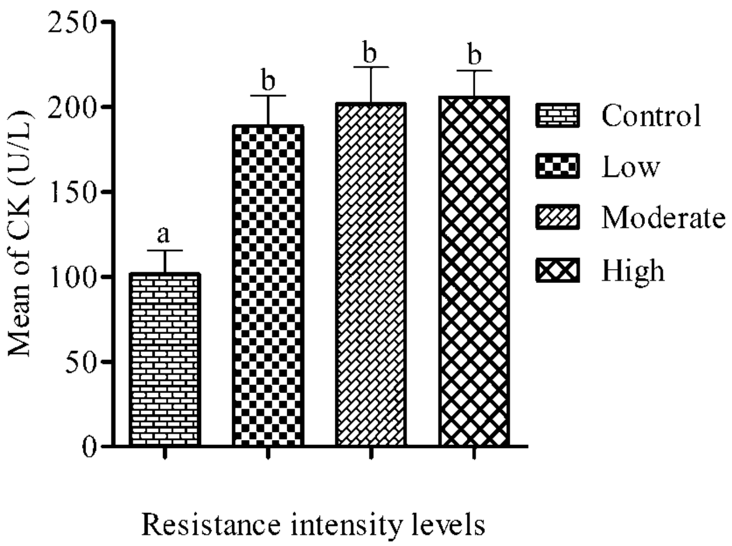

Fig.1.The rate changes of CK immediately after resistance exercise with intensity levels.

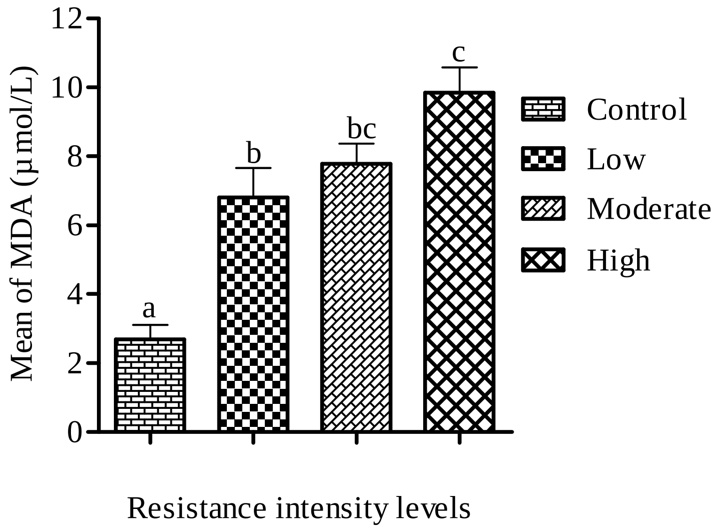

Fig.2.The rate changes of MDA immediately after resistance exercise with intensity levels.

DISCUSSION

This study presented the effects of a single-session of resistance exercise with different intensity levels on MDA and CK serum levels. The serum levels of MDA and CK were found to have increased when intensity levels similarly increased. As the participants were sedentary, the increase in MDA and CK levels may be due to a lack of adequate physical fitness. Being sedentary before the start of the experiment may also have increased the possibility of cell membrane damage and consequently muscle damage in the participants. These findings were in agreement with a previous study [5] that tested healthy inactive males with high (HR) or low(LR) intensity resistance exercise, and found that both MDA and CK levelswere increased in the both groups immediately after exercise, with the observed increase significantly higher in the HR group.

However, experienced resistance-trained male athletes also displayed increased MDA levels during exercise regardless of exercise intensity [27, 28]. Additionally, increased levels of MDA and CK ($P< 0.05$) were also reported in elite weightlifters after a week of intensive resistance-training [28] with a strong correlation between MDA serum level and CK activity. Another study utilising well-trained males [29], detected no change in the oxidative stress indicators (thiobarbituric acid and glutathione) after circuit resistance exercise, although a significant increase in CK serum level was observed. It appears that previous training experience does not play a part in reducingMDA and CK levels after resistance exercise.

When types of muscle contractions were examined, studies that utilised eccentric and isometric contractions [30] found increased levels of tissue- and serum- type CK-M. The current study had participants perform different muscle contractions (concentric and eccentric) but obtained similar increase in serum MDA and CK. These finding suggest that concentric and eccentric and eccentric, isometric contractions evoke similar increase in serum levels of MDA and CK.

Differences between this and other studies also include the duration of the exercise period. It was reported that a decrease in the serum level of lipid peroxidation was observed following a 6-month resistance training programme at low (50% of 1RM) or high (80% 1RM) intensities [31]. The single-session resistance training in the present study obtained opposing results most likely due to a lack of opportunity for chronic adaptations to occur in the participants. Reactive oxygen species (ROS) generation rate and oxidative stress increase may depend more on exercise intensity than exercise duration [32].

CONCLUSION

After a single-session of resistance exercise, both MDA and CK can be significantly affected by the intensity levels of exercise. The highest amount of MDA and CK post-tests were detected in high intensity levels of resistance exercise, indicating a high production of free radicals in skeletal muscles, resulting in the accumulation of MDA and

CK in serum. Therefore, low intensity resistance exercise can be suggested for sedentary males to avoid muscle damage.

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