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Research Article

THE EFFCT OF RESISTANCE TRAINING INTENSITY ON ENZYMATIC AND NON ENZYMATIC MARKERS OF LIVER FUNCTION IN OBESE MALES

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ABSTRACT
Although many studies have investigated the effects of aerobic exercises on liver function, available evidence indicates that in this case, resistance training exercises are rare. On the other hand, it is unclear whether the intensity of resistance training can improve liver function. Accordingly, the aim of this study was to investigate the effect of eight weeks of resistance exercises with various intensities on liver function tests results in obese males. 32obese men that fit the criteria necessary for inclusion in the research were chosen and randomly divided into four groups:[(EX1:30%1-RM), (EX2:50%1-RM), (EX3:70% 1-RM)] and control. Three groups carried out the resistance exercises with different intensities three times every week. At the pre test, mid test and post test after 12-hour fast samples were collected from the subjects. The collected data was analyzed by variance analysis test with repeated measurements. At the end of the study, no significant changes were observed compared with pre-test in BMI, Weight, and WHR. BF%, ALT, GGT and AST were markedly reduced in experimental groups compared with control group (P<.05). However, no significant changes were produced in non-enzymatic markers (TB, ALB). There were no significant reductions between experimental groups in liver enzymes. These results indicate that resistance training improves liver function in obese men. Furthermore, resistance training with low intensity and higher repetition can be more beneficial.

Keywords: *Resistance Training, Intensity, Liver Function, Enzymatic and Non Enzymatic Markers*

INTRODUCTION
Obesity has reached epidemic proportions globally and is a major contributor to the global burden of chronic diseases and health problems. The data from National health and nutrition examination survey (NHANES) shows that more than 36% of U.S. men and women were obese in 2009–2010. Furthermore, studies show that more than 400 million people suffer from obesity disorder worldwide (Corey and Kaplan, 2014). Obesity alone or in combination with other diseases can cause health problems, especially there is a close association between obesity and the development of type II diabetes, coronary heart disease (CHD) and a definite and certain increase of different types of cancer, complications and consequences on respiratory system and osteoarthritis in large and small joints(Angulo, 2002). Also, studies have shown that obesity is a risk factor for liver disease which needs serious consideration and attention (Marchesini *et al.,* 2008). It has been reported that the prevalence of obesity in patients with non-alcoholic fatty liver disease (NAFLD) varies from 30 to 100 % (Angulo, 2002).
NAFLD shows an unmarked spectrum from mild to severe liver inflammation. In initial stages the complications created by this disease are moderate; it is possible that obese people might have this disease but be unaware of its existence. In the early stages of the disease, the treatment by non-pharmacological strategies such as exercise and physical activity are important. Researchers have shown that if it is left untreated, the disease develops into liver cirrhosis. In such a condition the patient confronts a high risk of liver defensive mechanisms collapse and may die from the disease. Nowadays there are numerous drug and non-drug ways to treat this problem. In the majority of the studies, weight loss has been considered through life style interventions and on the effect of weight loss, improvement in liver function tests have been reported (Andersen *et al.,* 1991; Okita *et al.,* 2001; Palmer and Schaffner, 1990; Ueno *et al.,* 1997). On the other hand, it has been established that increase in the level of physical activity and physical

fitness associated with a reduced risk of metabolic disorders (Leon and Sanches, 2001). Normal liver function is of crucial importance for metabolism and might be affected by exercise training. The common available tests for investigating the liver function include enzyme; alanine amino transferase (ALT), aspartate amino transferase (AST), gamma glutamyl transferase(GGT), and alkaline phosphatase(ALP) and non-enzymatic markers serum total bilirubin(TB), serum albumin(ALB) and international normalized tests (Sagie et al., 2008). It has been reported that those people who do regular physical activity, have a lower level of ALT, GGT and AST (Limdi and Hyde, 2003). Exercise training has numerous beneficial effects on liver function and makes it improve metabolism and increase its antioxidant capacity (Aoi *et al.*, 2004). Following aerobic exercise training, it has been shown that liver enzyme markers decreased significantly in patients with NAFLD and caused an improvement in liver function (Gholami *et al.*, 2004; Johanson *et al.*, 2009; Baba *et al.*, 2006). Beneficial effects of aerobic exercise on liver function independent of weight loss have been reported. However, aerobic exercise strategy in obese individuals might not yield desirable effects due to the fact that these sorts of exercises demand high levels of cardiovascular and there is the likelihood of early exhaustion. Also the capacity of keeping on these exercises is low (Hallsworth *et al.*, 2011). The American College of Sports Medicine(ACSM), the American Heart Association and the American Diabetes Association have recommended resistance training as an integral part of exercise programs (Strasser and Schobersberger, 2010) and recently the benefits of resistance training has been confirmed for the treatment of obesity and metabolic disorders (Garber *et al.*, 2011). Also, the resistance training will require less cardiovascular demand and might have similar metabolic benefits to aerobic training (Hallsworth *et al.*, 2011). However, it has not been identified what intensity of these exercises can be more beneficial. Damor *et al.*, (2014) didn't report a significant change in liver enzymes (ALT, AST, and ALP) and total bilirubin in Asian Indian patients with NAFLD following 12 weeks of progressive resistance exercises with moderate intensity. Equally Hallsworth *et al.*, (2011) after eight weeks of resistance exercise (70-50% 1-RM) did not observe significant changes in ALT. Frajacomo and colleagues (2012), which have studied the effect of high-intensity resistance training on liver function in hypercholesterolemic mice, did not find any significant differences in the liver enzymes. On the other hand, Slentz *et al.*, (2011) Piano *et al.*, (2012) who studied the effects of aerobic and resistance training on liver function have reported that in combined exercises(aerobic and resistance) compared to other groups, significant changes have been produced in liver enzymes. Although many studies have investigated the effects of aerobic exercises on liver enzymes, available evidence indicates that in this case, resistance training exercises are rare. Also the findings have been inconsistent. On the other hand, whether or not the intensity of resistance training affects liver function is controversial. Accordingly, the aim of this study was to investigate: 1) the effects of resistance training, and 2) the effects of resistance training intensity (30%, 50%, and 70- 1RM) according to the ASCM (Garber *et al.*, 2011) on the enzymatic and non-enzymatic markers of liver function in obese individuals.

MATERIALS AND METHODS

Subjects: screening and selection criteria for participants: After advertising, the subjects (n = 71) that were willing to participate in this study were invited to the club to carry out the initial screening test. The participation criteria in this study were as follows: age range between 25-50 years, inactivity (lack of physical activity and regular exercise), and body mass index greater than 30kg / m^2. Of all the people who had come to the club for the exam criteria, 39 subjects did not meet the set criteria and those(n = 32) which had the required participation criteria after it was confirmed that they did not have a history of smoking, drinking any alcohol, diseases such as diabetes, hypertension and cardiovascular disease, after signing the consent form to participate in the research and matching based on BMI, body mass percentage and liver enzyme values were randomly divided into four groups(each group: n = 8), (control group and three experimental resistance training groups as the subjects).

Physiological Measurements: Subjects' descriptive data (height, weight, age, BMI, body fat percentage, waist circumference, hip circumference, WHR) were measured two days before the first training session

and the measurements were repeated two more times (mid test and post test) in accordance with the study protocol which had been approved by the Department of Exercise Physiology, college of Sport Science and Physical Education Islamic Azad University, Central Tehran Branch. Using a digital scale (seca769) made in Germany, participants height and weight was measured with minimal clothing and without shoes. Also the BMI was measured by this device. A non-elastic tape was used to measure the waist circumference in cm at the midpoint between the lower border of the rib cage and the iliac crest. Also, hip circumference was measured at the widest part of the hip region without applying pressure to the body. WHR was calculated by dividing the waist circumference by the hip circumference. The Yagamy caliper made in Japan was used for calculating body fat percentage by three-point-method (abdomen, thigh and breast) after three consecutive measurements of subcutaneous fat thickness in mm. The average of the obtained measurements after three times was considered as the reference number. Total size of the average of three points was placed at Jackson Pollack equation to calculate body density and through the obtained body density the body fat percentage of the subjects was measured (Heyward and Gibson, 2014). In order to get laboratory measurements of the subjects, anti-cubital blood samples were collected at 8:00 A.M. after an overnight fast (~12 hours) two days before the start of training (pre test), two days after a month of resistance training (mid test) and two days after the end of the study period (post test). By using appropriate kits and the Auto-Analyzer Tecnicon RA 1000 Apparatus, made in Tecnicon Company of America, blood samples were analyzed according to standard procedures to determine the concentration of serum ALT, GGT, AST, ALP and serum albumin and bilirubin. Also with using Dill and Castile (1974) equation changes in plasma volume at mid and post-tests were calculated.

Resistance Training Protocol: The subjects of the training groups (EX1, EX2 and EX3) were called to the club two days before the start of training to become familiar with the devices and the estimated 1-RM (Heyward and Gibson, 2014). Group EX1 (with intensity of 30% 1-RM), EX2 (with intensity of 50% 1-RM) and EX3 (with intensity of 70% 1-RM), performed ten exercises involving the major muscle groups on weight machines (squat, leg press, leg extension, leg curl, calf rise, chest press, seated row, biceps, triceps and shoulder press) for 8 weeks and 3 sessions per week, each session lasting 80 minutes. The exercises were done in 3 sets and each set with the order of groups EX1 ،EX2 and EX3 (20-30), (10-20) and (5-12) repetitions respectively. Every two weeks a new 1-RM was obtained and the continuation of training on new 1-RM was followed. The subjects performed 8 minutes warm-up using training tools and 7 minutes cool down (stretching movements) at the end of each resistance exercise session. The control group was asked to continue their daily lives and refrain from any extra physical activity or exercise training in the duration of research.

Nutrition assay: Before each test, the participants were asked to note their calorie intake through using the recall food form during 3 days (2 days during the weekdays and one day at the weekend) (Driskell and Wolinsky, 2011). They were instructed to note all items, and the amount of meals eaten during these three days. The analysis of participants dietary record was carried out by a Master of Nutrition and Dietetics through using nutrition software to determine the amount of obtained energy of macronutrients(protein, fat and carbohydrate).

Statistical analysis: Data were analyzed by SPSS software, version 17. Through Kolmogorov-Smirnov and Leven tests normality and homogeneity of the data were calculated respectively. Repeated measures analysis of variance (ANOVA) was used to compare changes over 8 weeks of intervention. If sphericity assumption of Makhly couldn't be met, to interpret the data Gzr Greenhouses correction was used. The post hoc Bonferroni test was performed to determine pair wise differences. To evaluate the difference between the pre-test variables one-way ANOVA test was used. The significance level for all tests was set at $p \leq 0.05$. All statistical data of the study were expressed as means ± standard deviations (SDs).

RESULTS AND DISCUSSION

Baseline characteristics: The results of the Kolmogorov-Smirnov and Leven test showed that at the beginning of the study the variables are homogeneous and have a normal distribution ($P > 0.05$). As shown in table 1, also ANOVA test revealed no significant difference between the mean values of

variables at the beginning of the study (P> 0.05). At the end of the eight-week study period, no significant difference in body weight average (P = .367) BMI (P = .301) and WHR (P = .392) among the groups was observed. Although the average weight and BMI in the mid test increased in EX1group compared to other groups However, this increase was not statistically significant. Compared to pre-test at the mid test, the mean of the body fat percentage of the subjects decreased by 0.69 (P = .001). Also the differences of the mean body fat percentage between post-test and pre-test and post-test with mid-test showed reductions (2.10 and P = .001) and (1.72 and P = .001), respectively. By comparing the mean of the body fat percentage among groups it was demonstrated that there were significant changes in experimental groups compared to control group (p = .009). It was found out that the greatest decrease was in group EX1 (p = .018).

Liver Enzyme and non enzymatic marker analysis:As shown in table 2 after 8 weeks of resistance training with different intensities significant differences among subjects in enzymes (ALT, AST, ALP and GGT) (p <0.05) were found. Pair-wise comparisons showed significant reduction in the ALT, AST and GGT enzymes at the mid-test compared with pre-test and in post-test compared with pre-test, and in the post-test compared with mid-test(p <.05).

ALP showed no significant difference at the mid test compared with pre-test (P> .05). But it diminished significantly on the pos-test compared with pre-test and on post-test compared with mid-test (p<.05). No Significant differences were observed between subjects in the mid test and post-test compared to the start of the research in TB, ALB and AST to ALT ratio (P>.05).

Between-group analysis showed that there was significant difference at the end of study in the ALT, AST and GGT enzymes (P <.05). In all exercise groups Compared with the control group in this enzyme a significant decrease was observed however, No significant differences were observed between exercise groups. Also Between groups Compared to pre-test no significant changes in ALP, AST to ALT ratio, ALB, TB in post test were observed (P> .05).

Diet analysis: As shown in table 3, the mean of energy intake among subjects in mid test and post-test compared with pre-test showed a significant difference (P = .000). In the mid and posttest the subjects in the experimental groups through the dietary recall reported a larger amount of energy intake compared with the control group (P = .000). But the comparison between experimental groups in the amount of the energy intake showed no significant difference in the mid and post-test (P> .05). The amount of protein, carbohydrate and fat intake among participants increased in mid and post-test. However, in experimental groups while there was an increase in the intake amount of carbohydrate, fat and protein compared with the control group, there was no significant change (p = .231 , P = .247 and P = .657) respectively.

It is suggested that NAFLD is one of the features of the metabolic syndrome and is more common among in obese people. Some scientific evidence has supported the role of weight loss through lifestyle modification in improving NAFLD (which usually is associated with the decrease of liver enzymes) (Gasteyger *et al.*, 2008).

On the other hand, Independent of losing weight, it has been found out that resistance exercises are a great replacement for aerobic exercises because they improve the strength and mass of muscles and metabolic efficiency and also are without danger and are safe (Larose *et al.*, 2010). Obesity was reported by many investigators to cause elevated levels of liver enzymes including ALT, AST, GGT and ALP (Corey and Kapalan, 2014; Angulo, 2002; Marchesini *et al.*, 2008; Andersen *et al.*, 1991; Okita *et al.*, 2001). Our subjects had mild elevation in AST, GGT and ALT at baseline. This study investigated the effect of eight weeks of resistance training with different intensities on the changes of enzymatic and non-enzymatic markers of liver function in obese men. The calculations that were done at the end of the study brought about significant changes among subjects respecting the mean values of some variables. While there was no significant decrease in the weight, BMI, and WHR of the subjects, there was significant decrease in the body fat percentage at the end of the study in experimental groups compared to control group. No, differences were observed on the diet between groups at the beginning of the study. However, in comparison with control group in the mid and post test the experimental groups reported more calorie intake. Probably, increase calorie intake in exercise groups were caused by the exercise effect.

Table 1: Physical characteristics of subjects at the beginning of the study

Variable	CO(n=8)	EX1(n=8)	EX2(n=8)	EX3(n=8)	P value One way ANOVA
Age(year)	36.37(5.6)	36.25(5.8)	37.5(5.1)	37.25(5)	0.957
Weight(kg)	92.5(.5)	95.5(6.3)	94(5.2)	96.62(6.7)	0.554
Height(cm)	174.5(5.4)	176.25(5.1)	175.37(3.8)	177.12(5.3)	0.750
BMI(kg/m^2)	30.39(.5)	30.65(.5)	30.53(.5)	30.78(.6)	0.571
WHR(cm)	0.99(.02)	0.98(.04)	0.99(.03)	0.99(.03)	0.925
BF%	28.63(1.4)	28.89(1.3)	29.1(1.6)	28.89(1.4)	0.816

Values are expressed as mean (SD). EX1 = the group that performed resistance training with 30% 1-RM, EX2 = the group that performed resistance training with 50% 1-RM and EX3 = the group that performed resistance training with 70% 1-RM. BF%= body fat percentage

Table 2: Enzymatic and non enzymatic markers of liver function changes observed after 8 weeks resistance training with various intensity in the study subjects

Variable	Group	Pre test	Mid test	Post test	P value Time	P value Group	P Value Time×Group
	Co	49.87(15.92)	49.62(15.21)	49.12(14.77)			
ALT(u/l)	EX1	50.12(15.22)	35.75(3.28)	23(1.06)	.001*	.050*	.001*
	EX2	51.75(11.05)	36.25(1.38)	31.5(3.5)			
	EX3	49.37(16.43)	38.75(6.87)	33.5(2.2)			
	Co	42.62(9.31)	48.62(14.33)	48.37(13.7)			
AST(u/l)	EX1	40.75(14.01)	31.12(9.44)	22.6(1.99)	.001*	.007*	.001*
	EX2	40.62(12.4)	32.62(2.38)	30.25(1.03)			
	EX3	41.62(12.16)	35.5(4.34)	32.87(1.64)			
	Co	71.62(29.5)	71.37(30.16)	70.75(30.06)			
GGT(u/l)	EX1	73.25(29.43)	31.37(3.29)	27.5(3.11)	.001*	.050*	.001*
	EX2	77.12(18.16)	42.5(2.75)	41.5(7.05)			
	EX3	70.37(24.9)	55.12(16.67)	49.75(14.46)			
	Co	63.5(27.79)	63.25(27.38)	63(27.64)			
ALP(u/l)	EX1	52.12(17.46)	48.5(16.91)	46.75(16.78)	.003*	.338	.023*
	EX2	69.6(19.9)	68.12(18.43)	68.5(18.24)			
	EX3	61.62(24.09)	62.62(21.4)	59.75(19.75)			
ALB(mg/dl)	Co	4.59(0.26)	4.57(0.26)	4.58(0.26)			
	EX1	4.46(0.2)	4.58(0.25)	4.65(0.17)	.189	.768	.498
	EX2	4.51(0.16)	4.51(0.11)	4.52(0.12)			
	EX3	4.59(0.22)	4.57(0.19)	4.58(0.18)			
	Co	0.48(0.11)	0.48(0.11)	0.48(0.12)			
TB(mg/dl)	EX1	0.47(0.1)	0.48(0.09)	0.47(0.09)	.349	.925	.341
	EX2	0.44(0.07)	0.45(0.07)	0.45(0.06)			
	EX3	0.47(1)	0.47(0.08)	0.47(0.07)			
	Co	.98(0.57)	1.10(.54)	1.105(.53)			
AST/ALT	EX1	0.89(0.42)	.87(.28)	.97(.14)	.153	.789	.884
	EX2	0.86(0.47)	.9 (.06)	.97(.14)			
	EX3	0.94(0.42)	.94(.2)	.98(.08)			
	Co	-----	-.17(.38)	-.27(.36)			
PV% change	EX1	-----	-.17(.44)	-.01(.54)	.781	.268	.202
	EX2	-----	.23(.38)	.02(.37)			
	EX3	-----	-.23(.67)	-.02(.2)			

CO = control, EX1 = the group that performed resistance training with 30% 1-RM, EX2 = the group that performed resistance training with 50% 1-RM and EX3 = the group that performed resistance training with 70% 1-RM. ***** *significant at* $p \leq .05$. *ALT= alanin amino transferase, AST= aspartate amino transferase, ALP= alkaline phosphatase, GGT=Gama glutamyl transferase, ALB= serum albumin, TB= total bilirubin, PV%= plasma volume percentage*

Table 3: Energy intake and nutrient analysis of the dietary records of the subjects at before, mid and after the training period. Data expressed as Mean (SD)

Diet Group	Food intake(Kcal)			PROT(g)			CHO(g)			FAT(g)		
	Pre	Mid	Post	Pre	Mid	Post	Pre	Mid	Post	Pre	Mid	Post
Co	2327 (4.89)	2333.5 (3.74)	2329.5 (3.81)	109.08 (11.68)	110.1 (11.02)	109.19 (11.63)	304.18 (18.23)	292.42 (28.31)	303 (16.34)	74.95 (6.19)	75.08 (6.32)	75.05 (6.17)
EX1	2332.12 (3.79)	2453.12* (4.85)	2463* (4.5)	115.14 (1.41)	121.25 (10.49)	121.6 (11.33)	308.26 (12.92)	324.27 (13.84)	325.57 (13.78)	70.95 (3.37)	74.68 (3.5)	74.91 (3.52)
EX2	2329.87 (5.4)	2455.62* (5.62)	2458.12* (4.58)	107.17 (10.17)	113.56 (10.96)	113.68 (10.82)	305.06 (28.11)	320.74 (29.66)	321.11 (29.94)	74.4 (6.81)	78.37 (7.02)	78.49 (7.07)
EX3	2331.62 (3.96)	2479.62* (15.72)	2472* (12.81)	112.93 (9.97)	116.05 (11.41)	119.73 (10.21)	304.6 (19.22)	323.91 (20.93)	322.99 (20.98)	73.49 (6.89)	78 (7.24)	77.93 (7.3)

***Significant difference at $p \leq .05$.*

As shown in figure 1, there was significant decrease in enzymatic markers (AST, GGT and ALT) of exercise groups compared to control group, and also better results were obtained in EX1 group in the enzyme markers in comparison with other groups. However, the results of resistance training with different intensities on non-enzymatic markers (TB, ALB) were not significant in the experimental groups compared with the control group.

This is probably due to the fact that these variables at baseline were within the normal range. Also no significant differences were observed between exercise groups. Little studies have been carried out on the effect of resistance training on the function of liver. The findings of this research are in parallel with the results of Bacchie *et al.,* (2013) which have studied the effect of aerobic and resistance training on the amount of the liver fat in diabetic patients with NAFLD and they did found out non significant reductions in GGT, AST and ALT of the resistance training group.

That is, Reductions were brought about in both studies. However, the decreases in our study were significant and this might be a result of the differences in training intensity. In another study (Slentz *et al.,* 2011) in which the effects of resistance training and aerobic exercises on liver enzymes, visceral and liver fat were investigated, it was reported that in comparison with aerobic exercises, resistance training exercises failed to produce significant changes in ALT and AST. However, in the combined exercise group (aerobic and resistance) a significant decrease in ALT was reported.

Also in another study (Damor *et al.*, 2014) which investigated effect of moderate intensity progressive resistance exercise on the amount of liver fat, there was no significant decrease in ALT, AST and ALP levels despite a significant decrease in liver fat. Hallsworth *et al.,* (2011) showed that eight weeks of resistance training (50-70% 1-RM) caused a 13% decrease of liver lipid despite no significant changes in ALT. Differences in methodology, the status of the participants (age, gender, daily physical activity, enzyme Concentration at the starting line, etc.) might be the reason for differences in the results. Of course it has been shown that liver enzymes in chronic liver diseases may be insensitive and non-specific (Mofrad *et al.,* 2003). With specific reference for resistance training, it has been shown that weightlifting exercise resulted in increase in liver enzymes; AST and ALT, though the underlying mechanisms are unknown (Sagi *et al.,* 2008).

The increase of AST and ALT markers because of muscle damage following intense exercise and especially eccentric muscle contraction may be occurred (Frajacomo *et al.,* 2012). However, has been shown that following the muscle damage the injury from the acute exercise induces adaptation in the muscle tissue that helps the muscle to be more resistant to subsequent strenuous or damaging exercises (Garber *et al.,* 2011). And this adaptation may be a good reason for significant decrease in liver markers of experimental groups at the end of our study.

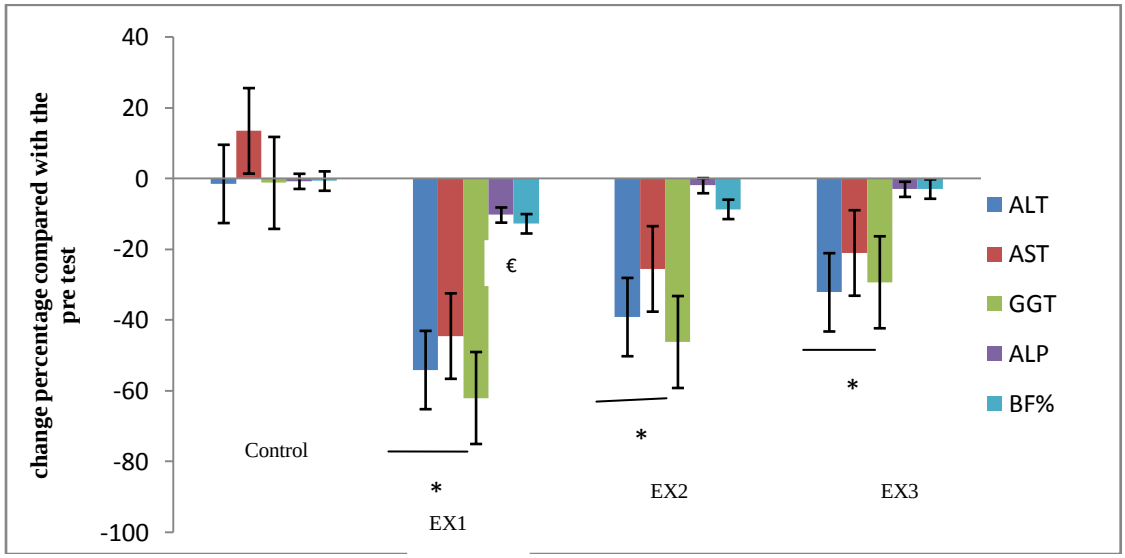

Figure 1: Changes Percentage in enzyme markers of liver function at the end of eight weeks compared with before training. CO = control, EX1 = the group that performed resistance training with 30% 1-RM, EX2 = the group that performed resistance training with 50% 1-RM and EX3 = the group that performed resistance training with 70% 1-RM. ALT= alanin amino transferase, AST= aspartate amino transferase, ALP= alkalin phosphatase, GGT=Gama glutamil transferase, BF%=body fat percentage. *: significant redaction compare with control group. €: significant reduction compare with control and EX3 groups

AST / ALT ratio is considered as a surrogate marker of hepatocyte necrosis and inflammation, where values> 1 refers to hepatic injury (Anderson *et al.*, 2000). In this study AST/ALT ratio showed no significant difference in participants at any time during measurements.

Although the participants were not examined in terms of histology and liver biopsy, there is the probability that improvement in hepatic enzyme followed by reduction of hepatic steatosis and necroinflamatory. Increase in liver enzymes (AST, GGT and ALT), which are markers of hepatocellular injury, are associated with insulin resistance, metabolic syndrome, and type II diabetes disease (Cho *et al.*, 2007).

On the other hand, the levels of liver enzymes is high in obese subjects and this condition is Associated with hepatic steatosis which occurs due to the increase of the effects of insulin in the liver. It is believed that fatty liver causes hepatic insulin resistance and involves in the development of hyperinsulinimia and systemic insulin resistance in obesity (Rantala *et al.*, 2000).

Studies have shown that resistance training causes an increase in insulin sensitivity and a reduction in liver fat, an improvement in insulin resistance, a reduction in visceral fat, subcutaneous fat and body fat mass (Damor *et al.*, 2014; Slentz *et al.*, 2011; Bacchi *et al.*, 2013; Hallsworth *et al.*, 2011).

It is also indicated that in patients with NAFLD (BMI = 30) compared with healthy subjects the amount of fat mass increases significantly, and is replaced at the visceral regions. Furthermore, in these patients, muscle and bone mass and intracellular water is lower due to an increase in fat mass (Oshakbayev *et al.*, 2011).

Also the basal metabolic rate decreases with an increase in body fat (Oshakbayev *et al.*, 2011). On the other hand, It has been shown that exercise (especially resistance training) increases the basal metabolic rate and muscle mass (Evans, 2001; Campbell *et al.*, 1994; Treuth *et al.*, 1995).

Although in this study the basic metabolic rate, insulin resistance and changes in liver tissue were not examined, it is possible that a decrease in the body fat percentage of the experimental groups and the subsequent reduction in hepatic enzymes are due to an increase in muscle mass, the basal metabolic rate, improvement of insulin resistance and a reduction in liver fat.

Conclusion

The results of this study showed that despite no reduction in body weight and BMI, resistance training can be helpful to improve liver function and body fat percentage**.** In addition, the light intensity resistance training (30% 1-RM) with high repetitions can be effective in achieving better gains.

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