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The Effect of Combined Strength-Endurance Training on the Improvement of Cardiovascular Disease Risk Factors of Obese Middle-aged Men

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ABSTRACT

The present study attempts to investigate the effect of combined strength-endurance training program on the improvement of coronary disease risk factors in obese middle-aged men.Forty non-athlete healthy men with the age mean of 57/6±4/8 were selected from among the volunteers of this study. They were randomly divided to four groups of strength (n=10), endurance (n=10), combined strength-endurance (n=10) and control (n=10). To measure cardiovascular disease risk factors, blood samples were taken from the participants in two stages (before and after the training program) while they were fast. The training of the strength group included two sets of pyramidal strength training and the endurance group performed 30-min running with the intensity of 60-75% maximum heart rate. The training of the combined group included one set of pyramidal strength training and 15-min running with the intensity of 60-75% maximum heart rate for eight weeks (3 sessions per week). The research data were analyzed using a dependent t test for within-group evaluation and one-way Analysis of Variance (ANOVA) along with Toki post-hoc test for between-group evaluation(α<%5). The protocol included aerobic training with 60-75% maximum heart rate, three sessions per week for eight weeks. The control group continued their normal life during the period of study. The research findings showed that eight weeks of endurance, strength and combined training caused a significant increase in HDL-C concentration by 23%, 39% and 38%, respectively (P<%5). Also, eight weeks of endurance and combined training significantly decreased the LDL-C concentration by 18% and 18% and TC concentration by 6% and 7%, respectively (P<%5). Considering the research findings, combined strength-endurance training and endurance training are effective for improving heart coronary disease risk factors and middle-aged people can use these training programs in order to prevent from cardiovascular diseases.

Key words: Strength training, Endurance training, Combined training, Cardiovascular disease risk factors.

INTRODUCTION

Every year, a large number of people die because of cardiovascular diseases all over the world [1]. Studies have shown that today more than one in every two deaths in America is the result of cardiovascular diseases [3] and many cardiac deaths occur because of coronary heart diseases, that is, blocked heart blood vessels. Important risk factors of cardiovascular diseases include increased low density lipoprotein (LDL), total cholesterol (TC), triglyceride (TG) and decreased high density lipoprotein (HDL) [3-6]. Research has shown that 1% decrease at the level of cholesterol causes 2% to 3% decrease in the risk of coronary artery diseases. [6].

There are many personal and environmental factors which affect plasma lipids and lipoproteins. Age, gender, body fat level, cholesterol and carbohydrates in the diet, smoking and physical activity are some examples (5, 7). According to the conducted studies, physical activity is one of the methods which decreases plasma lipoproteins and lipids and maintains it at an acceptable level (8-10). However, most studies have only considered the effect of endurance activities and few researches have been done on the effect of endurance and combined strength-endurance training. For instance, Lippi (2006), Lynn (2006), Ignarro (2007), Stoedefalke (2007), Wong (2008), Dambarchi (2009), Martins (2010) and Narayani (2010) have stated that those people who do aerobic exercises with medium intensity have lower levels of TC, TG and LDL and higher levels of HDL compared with other people [5, 11-17].

On the other hand, in the studies which have investigated the effect of strength training on lipoproteins, contradictory results have been obtained. Harley and et al (18) reported the increase of HDL-C and decrease of LDL-C after 16 weeks of strength training while, in the studies conducted by Kevin et al. (2003) and Patrick et al. (2004), no difference was observed in HDL-C concentration [19, 20]. Therefore, considering the mentioned contradictory findings and using different endurance and strength training programs, the present research investigated the effect of combined strength-endurance training on the coronary heart disease risk factors. Moreover, the combined training was compared with the separately performed strength and endurance trainings.

MATERIALS AND METHODS

Participants

From among volunteers for participating in the present study, 40 inactive healthy men with the age mean of 57/6 ± 4/8 were selected. After participants got familiar with the research conditions, a consent letter and a questionnaire containing general characteristics and disease history were given to them. Then, the participants were randomly divided to four groups (10 people): training 1 (combined strength-endurance training), training 2 (resistance training), training 3 (endurance training) and control groups. The body composition and physical characteristics of the participants of the four groups are shown in Table 1.

Table 1: The participants' general characteristics (mean± standard deviation)

Groups / Variable	Combined strength-endurance training N=10	Strength training N=10	Endurance training N=10	Control N=10	F	P
Age (year)	86.8±5	57.3±4.5	57.7±4.4	56.5±5.1	6.347	0.831
Weight (kg)	89.25±5.3	90.7±6.47	92.03±7.19	91±5.34	5.748	0.749
Height (cm)	172.29±4.93	174.31±4.81	175.14±5.1	173±6.2	5.283	0.791
VO_{2max} (ml.kg/min)	35.83±2.3	36.64±1.6	36.84±1.8	37.19±1.9	3.568	0.657
BMI	30.07±2.41	29.87±2.74	30.01±2.45	30.4±2.69	2.34	0.622
Body fat %	25.74±2.85	25.27±2.49	26.36±2.04	24±3.24	3.56	0.674

Physiological Measurements

To measure height and weight, a digital scale and a tape were used. Body mass index was calculated by placing the numbers related to height and weight in the equation (squared height in meter/ weight in kilogram) and body fat percentage was computed by measuring subcutaneous fat in three areas of chest, abdomen and thigh and placing it in Jackson and Pollock Equation (Williams, 2002) (21).

The Training Program

First, the maximum heart rate was measured for each person using the following formula: 208-(0.7 × age) (22).

In this research, the training programs were performed for 8 weeks, 3 sessions per week and 45 minutes per session for the training groups. Each training session included warming-up for 10 minutes, doing specialized exercises of each group for 30 minutes and stretching as a cool-down for 5 minutes. The specialized program of the training group 1 was the combined strength-endurance training program; the strength training of this group included chest press, underarm stretch, leg press and leg squat which was according to the one-set pyramidal method for each movement with 70% to 95% one maximal repetition between 2 and 6 repetitions in each time and 30 min. resting between each two times. The endurance training included running with 60% maximum heart rate in the first two weeks and increase of training intensity to 75% maximum heart rate in week 8 and to duration 15 min. To control heart intensity, a belt and rate meter were used. The specialized program of the second training group included performing strength program similar to group 1. The only difference was that their strength training was performed according to the pyramidal method in two sets. The specialized program of the third group included doing endurance exercises similar to group 1. The only difference was that their endurance training was performed for 30 min. The control group did not participate in any training program after the initial test and, at the end of the program, all four groups took the final test.

Blood Sampling

To investigate biochemical variables, in the first stage, the participants were asked not to do any sport activities up to two days before the test and keep their diets. Then, at 8 a.m., 5 ml blood was sampled from the participants of the experimental group after 12 hours of fasting which was taken from their left-hand antecubital vein while sitting. After this stage, the training groups performed their specialized training programs for 8 weeks. Then, after 48 hours from the last training session and 12 hours of fasting, the second stage of blood sampling was done on the participants of the control and experimental groups for the second time which was similar to the one in the first stage.

Biochemical Measurements

To measure total cholesterol, triglyceride and HDL-c and LDL-c, a Technicon RA 1000 auto analyzer system and EnzyChrom™ Kits from the Hayward, CA, USA with the sensitivity of less than 1 mg/dL were applied.

Also, the receiving diet during the research was controlled using the 24-h food recall questionnaire, standardized by the Nutrition Group, Tehran University of Medical Sciences (in week 0, week 8).

The Statistical Method

To identify the data naturalness and parallelism, Kolmogorove-Smirnov test was used and in order to examine the within-group differences, a dependant t test was applied. Moreover, one-way Analysis of Variance (ANOVA) was used to investigate between-group differences. If statistically significant differences were found, Tukey's post hoc test was used for determining the location of between-group differences. The statistical calculations were conducted using SPSS software, version 15, and the significance level of tests was considered to be $\alpha<0.05$.

RESULTS

The results obtained from the present research showed that 8 weeks of endurance and combined strength-endurance training increased VO_{2max} (p=0.0001). Also, 8 weeks of endurance and combined strength-endurance and strength training decreased body fat percentage (p=0.001) and body mass index (p=0.001) compared with the control group. The level of plasma LDL-c in endurance and combined strength-endurance training groups significantly decreased after 8 weeks of training compared with the pre-test stage (before doing exercises) {the LDL-c of the endurance training group (P=0.003) and combined strength- endurance group (P=0.004)} while the amount of plasma LDL-c in the control and strength groups did not show a significant within-group difference (P=0.43).

Table 2: Mean and standard deviation changes of cardiovascular risk factors in control and training groups in different test stages

Variable	*Groups*	Pre test (week 0)	post test (week 8)	
Vo2max (ml.kg/min)	Combined strength-endurance training group	**35.83±2.3**	**39.9±1.8**	†‡*
	Strength training group	**36.64±1.6**	**40.53±2.6**	
	Endurance training group	**36.84±1.8**	**36.03±1.7**	†‡*
	Control group	**37.19±1.9**	**36.54±1.9**	
Body Fat %	Combined strength-endurance training group	**25.74±2.85**	**21.78±1.5**	‡*
	Strength training group	**25.27±2.49**	**20.25±1.7**	‡*
	Endurance training group	**26.36±2.04**	**25.99±2.2**	‡*
	Control group	**24±3.24**	**25.54±1.9**	
Total clolestrol (mmol/L)	Combined strength-endurance training group	**4.95±0.4**	**4.56±0.52**	†‡*
	Strength training group	**4.67±0.31**	**4.47±0.68**	
	Endurance training group	**4.88±0.29**	**4.78±0.42**	†‡*
	Control group	**4.75±0.25**	**4.49±0.62**	
HDL-C (mmol/L)	Combined strength-endurance training group	**1.13±0.63**	**1.45±0.56**	‡*
	Strength training group	**1.18±0.68**	**1.51±0.58**	‡*
	Endurance training group	**1.21±0.53**	**1.24±0.51**	‡*
	Control group	**1.15±0.54**	**1.20±0.49**	
LDL-c (mmol/L)	Combined strength-endurance training group	**2.96±0.62**	**2.64±0.58**	†‡*
	Strength training group	**2.87±0.56**	**2.38±0.62**	
	Endurance training group	**2.81±0.50**	**2.77±0.53**	†‡*
	Control group	**2.79±0.54**	**2.81±0.48**	
Triglyceride (mmol/L)	Combined strength-endurance training group	**1.47±0.51**	**1.36±0.59**	
	Strength training group	**1.35±0.67**	**1.31±0.61**	
	Endurance training group	**1.39±0.59**	**1.33±0.46**	
	Control group	**1.31±0.64**	**1.35±0.55**	

** Denote significant with pre test phase (p<0/05)*

† Denote significant with strength group (p<0/05)

‡ Denote significant with control group (p<0/05)

And the results of the one-way analysis of variance along with Tukey's post hoc test showed a significant difference in the amount of plasma LDL-c after 8 weeks between endurance, combined strength-endurance groups with strength and control groups (P=0.003).

Moreover, after 8 weeks of training, the level of plasma HDL-c in the endurance, strength and combined strength-endurance training groups showed a significant increase compared with the pre test stage (before training) {the HDL-c of the endurance group (P=0.002), the combined strength-endurance group (P=0.003) and the strength group (P=0.003)} while the amount of HDL-c did not show a significant within-group difference (p=0.28). After 8 weeks, the results of the one-way analysis of variance along with Tukey's post hoc test showed a significant difference in the amount of plasma HDL-c between the control group and endurance group (P=0.001), combined endurance-strength group (p=0.002) and strength group (p=0.003).

The total cholesterol of the endurance and combined strength-endurance training groups significantly decreased after 8 weeks of training compared with the pre test stage (before training) {TC of the endurance group (P=0.02) and combined strength- endurance group (P=0.03} while the amount of plasma TC of the strength and control groups did not show a significant within-group difference (P=0.26).

As far as triglyceride was concerned, the results of the dependent t test did not show a significant within-group difference in any of the training and control groups. Although its amount in the endurance and combined strength- endurance groups decreased after 8 weeks of training, this decrease was not significant (P>0.05). Moreover, the results of the one-way analysis of variance did not show a significant between-group difference between control and training groups (P>0.05).

DISCUSSION

The results of the present research showed that 8 weeks of endurance and combined strength-endurance training led to VO_{2max} increase ; also, 8 weeks of endurance, strength and combined strength- endurance training decreased body fat percentage and body mass index (13-15).

Also, the level of plasma LDL-c and total cholesterol of the endurance and combined strength-endurance groups significantly decreased after 8 weeks of training compared with the pre test stage (before the training program) while the levels of plasma LDL-c and total cholesterol of the control and strength groups did not show a significant within-group difference. The levels of plasma HDL-c of the endurance, combined strength- endurance and strength groups showed a significant increase after 8 weeks of training compared with the pre test stage (before the training program) while the amount of HDL-c in the control group did not show a significant within-group difference. The obtained results were in line with the findings of Lippi (2006), Lynn (2006), Ignarro (2007), stoedefalke (2007), Wong (2008), Dambarchi (2009), Martins (2010) and Narayani (2010) [5, 11-17]. With regard to triglyceride, the results obtained from this research did not show a significant within-group difference in the amount of serum triglyceride of the groups.

The results of the present study showed that the amount of LDL-c in the endurance and combined strength- endurance groups decreased (P=0.03) and the amount of HDL-c of the endurance, strength and combined strength- endurance groups increased (p=0.002). In the control groups, the levels of LDL-c and HDL-c did not change. This was possibly because of the increase in the enzyme activity of Lipo Protein lipase (LPL) followed by aerobic exercises which

caused the catabolism of triglyceride-rich lipoproteins and the decreased activity of Cholestrile ester transfer protein (CETP) while doing the activity which caused a decrease in the conversion of HDL-c to LDL-c. Furthermore, another enzyme (in addition to LPL) which may have increased HDL-c was Lesithin Cholestrole asyl transferase (LCAT). This enzyme converts free cholesterols to cholesterol esters (23). HDL_3 small particle is ester fed after being absorbed by LCAT and it converts to HDL_2 and leads to cholesterol reverse transfer by increasing the size (14, 23, 24). As a result, LCAT enzyme prevents the LDL oxidation by increasing its activity after performing physical exercises (24).

Also, a common concept regarding the pathophysiological mechanisms related to arthrosclerosis is the production of cytokines along with inflammation in response to the oxidized LDL stimulus and macrophages along with arthrosclerosis plaques (25, 26). The cytokines along with inflammation which are produced during this process include IL-1B, IL-6 (Interlukine-6) and TNF-α (Tomor Necrosis Factor-α). Laboratory studies have shown that different combinations of cytokines stimulate the production of CRP and Leukocytosis (27). Research has shown that regular sport activities decrease the oxidized LDL and levels of serum IL-6 and CRP (25, 26). There are different findings with regard to the effect of sports on the amount of total cholesterol and triglyceride; some have reported its decrease and some others have reported its lack of change in response to sports exercises. These contradictory results are probably due to the differences in age, gender and training program of the participants (28, 8-10). The present research showed no change at the level of serum triglyceride in response to 8 weeks of endurance, strength and combined strength- endurance training. Therefore, this study showed a negative correlation between physical fitness and cardiovascular diseases in a way that sport exercises can decrease LDL-c and total cholesterol and increase HDL-c. Thus, the increase of cholesterol and LDL-c and decrease of HDL-c due to obesity can be related to arthrosclerosis (5, 8, 12, 14-16, 29).

In sum, considering the findings of this research, it was determined that prolonged, regular endurance and combined strength- endurance training can significantly decrease LDL-c and increase HDL-c as predictive indicators of cardiovascular incidents. Therefore, it is recommended that the obese elderly perform endurance and combined strength- endurance training in order to reduce the risk of cardiovascular attacks to the minimum.

CONCLUSION

In sum, it can be stated that doing endurance and combined strength- endurance training can improve the cardiovascular disease risk factors and probably decrease the risk of future cardiovascular attacks in obese elderly men.

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