The effect of 8 weeks of increasing resistance training and a non-training period on left ventricular end-diastolic volume (LVEDV) in sedentary women.

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Abstract

The aim of the current research was the effect of 8 weeks of increasing resistance training and a period of non-training after that on the left ventricular LVEVD index of sedentary women. In this semi-experimental research that was conducted in a field-laboratory manner, 32 sedentary women who were able to regularly participate in the exercise protocol were selected by simple random sampling and randomly divided into 2 groups: 1- Resistance exercise group (16 people), 2- control group (16 people). In the present study, before the implementation of the training program, all the anthropometric characteristics, body composition and structural and functional indicators of the left ventricle of the subjects were measured and recorded in three stages under the same conditions. Variable left ventricular end-diastolic volume (LVEDV), by a cardiologist with echocardiography using M-Mode, Spectral Doppler, Color Doppler (2-D) methods and in a special echocardiography room in 3 stages (before exercise, after the end of 8 weeks The resistance training program was measured after 4 weeks of non-training after training. It was also measured before echocardiography. All training programs including 3 training days per week and every day for 90 minutes were implemented in the sports hall of Azad University, Yazd branch. This program was implemented for 8 weeks from low to high intensity, taking into account the principle of overload and increasing the intensity of training. Finally, the results showed that eight weeks of increasing resistance training was significant on the left ventricular end-diastolic volume (LVEDV) of sedentary women, and it reduced the positive effects of increasing resistance training on the left ventricular end-diastolic volume.

Key words: increasing resistance training, no training, end-diastolic volume, left ventricle (LVEDV), sedentary women

Introduction

Physical fitness and engaging in physical activities throughout life leads to cardiovascular fitness, reducing the risk of various diseases such as arteriosclerosis, blood pressure, osteoporosis, obesity, and achieving personal and social health. (Babaei et al., 2023) Regular physical activity is one of the most important factors of health and well-being. With regular and long-term exercise, the heart undergoes changes. Such changes are called the phenomenon of adaptation of the heart in response to exercise or physiological changes. Many researches have shown that the structural and functional changes of the left ventricle are greater than other parts of the heart during sports activities (Ghane 2014, et al). Lack of training after training can also reduce the dimensions resulting from training and return the changes made to the pre-training state. Resistance training refers to strength training or weight training, which in response to this type of training, adaptability is created in both types of skeletal and cardiac muscles, strength training increases the production of contractile proteins and muscle hypertrophy, especially in fast tension fibers, which may parallel to the decrease in the volume density of mitochondria. (Barauna et al., 2007).

Also, strength training increases muscle strength, increases lean mass and decreases body fat percentage. This form of exercise is associated with a severe and acute increase in systolic blood pressure or afterload, which may be a strong stimulus for increasing left ventricular thickness and mass (Gholami, 2018). The increase in the thickness of the wall due to the pressure overload created in resistance training is basically due to the increase in the cross-sectional area of the muscle cells, as long as the strength training is performed, the pressure inside the chest increases. Due to the Valsalva phenomenon, venous blood return drops significantly and as a result, heart rate and average arterial blood pressure increase (Behjati Ardakani et al, 2016).

In athletes who participate in intense isometric, strength, or static training (anaerobic, strength, and power), inward hypertrophy of the left ventricle occurs. It does not, in some studies it has been stated that resistance exercises increase the thickness of the interventricular wall, the posterior wall of the left ventricle, and the left ventricular mass index (Malakian Fini et al, 2021).

Levinger et al. (2005), have shown that long-term and short-term resistance exercises cannot have an effect on cardiac parameters such as thickness, interventricular wall, left ventricular posterior wall thickness, systolic function and shortening fraction.

Although the effect of resistance exercises on the morphology of skeletal muscles is known, the effect of these exercises on cardiovascular adaptations is contradictory (Johnson et al., 2001). However, on the one hand, few studies have investigated the effects of resistance training on the structure of the left ventricle of human samples, and on the other hand, the effects of non-training after resistance training on the structure and function of the heart muscle tissue have not been well studied and clarified. Therefore, other researches are needed to investigate the independent effects of resistance training and non-training after it on the structural characteristics of the heart, especially the left ventricle. Therefore, the present study aims to answer the question that, is 8 weeks of increasing resistance training and a non-training period after that effective on the left ventricular end-diastolic volume (LVEDV) of sedentary women?

analysis method

In this semi-experimental-applied research that was conducted in a laboratory-field method with a pre-test-post-test design with repeated measurements and with a control group. There were less active women in the city (150 people) in 1400. Based on the criteria for entering the research (they have no cardiovascular, metabolic, respiratory, high blood pressure or any injury or problem, and they have not participated in regular sports activities within 6 months before the start of the research, and they do not take any special drugs and supplements, and they are sedentary.) 96 people were selected. Then, from this number, 32 eligible women were randomly selected as a research sample from the statistical population and were randomly assigned to the 16-person group, the experimental group, and the control group. The selected people were already fully aware of the conditions of the research and participated in the research with full satisfaction and interest. The people selected in the groups remained in the research process until the end of the exercises.

total body weight (weighing scale) Diameter (flexible tape measure, marker and 10 A4 sheets) BMI (calculated by equation), WHR (waist to hip circumference) IRM of the chest press (calculated by the equation) Leg press IRM (calculated by the equation).

The age of the subjects was recorded in the table according to the self-report of the subjects. The subject's weight and height were measured and recorded by a Seca medical scale (Ecozonare brand. Made in America. Model 1220) equipped with a measuring device (Seca, Made in Japan. Model 2012) without shoes and socks with minimal clothing in kilograms. For this purpose, after 8 hours of fasting, the subject was placed on a scale equipped with a height gauge on a flat surface, standing and placing his hands freely on the sides, while his head and face were in a balanced position looking forward, without moving his weight. They used to divide the soles of the two feet. The number recorded on the scale with an accuracy of 0.1 kg was recorded as the person's weight in the table. Also, the height of the subjects was measured at the same time as their weight was measured using a vertical measuring rod that was placed on the scale with an accuracy of 0.1 cm.

Determining a Maximum Repetition (IRM): After the echo and before the main program, a familiarization session and working with weights was held considering that the subjects were beginners. In the following, the subjects, after training on the correct execution of the movements, went to the prepared gym at 5:00 PM to determine the maximum number of repetitions in the desired movements. Maximum one maximum repetition in the desired movements (leg press, chest press with barbell, seated rowing, stomach with bent knees, front leg, lifting on toes, back of thigh, shoulder press, barbell pull to chin, open front and barbell) with It was estimated using Berzisky's equation (1993). To calculate the maximum power ( ) was met. Choose and execute the move until the end.

Variable left ventricular end-diastolic volume (LVEDV), by a cardiologist with an echocardiography machine capable of echocardiography using M-Mode, Spectral Doppler, Color Doppler (2-D) methods and in a special echocardiography room in 3 stages (before exercise, It was measured after the end of 8 weeks of resistance training program, after 4 weeks of non-training (after training). Resting heart rate was measured by counting pulses for 60 seconds. Before echocardiography, height and weight variables were measured with a laboratory scale equipped with a height meter. All training programs including 3 training days per week and every day for 90 minutes were implemented in the sports hall of Azad University, Yazd branch. This program was implemented for 8 weeks from simple to difficult exercises and from low intensity to high intensity taking into account the principle of overload and increasing the intensity of training.

Incremental resistance training program

The increasing resistance training program is designed based on the principles of resistance training science and its adaptations on fat tissue and muscle mass. After getting to know the principles of correct execution of the desired movements, the training protocol was implemented for 8 weeks.

Table 2-3: Increasing resistance training protocol

meetings	First session	second session	third session
The first week	rounds x ۱۲ repetitions ۲ ۵۰٪)RM (۱	rounds x ۱۲ repetitions ۲ ۵۰٪)RM (۱	rounds x ۱۲ repetitions ۲ ۵۰٪)RM (۱
second week	rounds x ۱۲ repetitions ۲ ۵۵٪)RM (۱	rounds x ۱۲ repetitions ۳ ۵۵٪)RM (۱	rounds x ۱۲ repetitions ۳ ۵۵٪)RM (۱
The third week	3 rounds x ۱۲ repetitions ۶۰٪)RM (۱	rounds x ۱۲ repetitions ۳ ۶۰٪)RM (۱	rounds x ۱۲ repetitions ۳ ۶۰٪)RM (۱
forth week	rounds x ۱۲ repetitions ۲ ۶۵٪)RM (۱	rounds x ۱۲ repetitions ۲ ۶۵٪)RM (۱	rounds x ۱۲ repetitions ۳ ۶۵٪)RM (۱
The fifth week	rounds x ۱۰ repetitions ۳ ۷۰٪)RM (۱	rounds x ۱۰ repetitions ۳ ۷۰٪)RM (۱	rounds x ۱۰ repetitions ۳ ۷۰٪)RM (۱
The sixth week	rounds x ۱۰ repetitions ۳ ۷۵٪)RM (۱	rounds x ۱۰ repetitions ۳ ۷۵٪)RM (۱	rounds x ۱۰ repetitions ۳ ۷۵٪)RM (۱
The seventh week	rounds x ۱۰ repetitions ۳ ۸۰٪)RM (۱	rounds x ۱۰ repetitions ۳ ۸۰٪)RM (۱	rounds x ۱۰ repetitions ۳ ۸۰٪)RM (۱
The eighth week	rounds x ۱۰ repetitions ۳ ۸۵٪)RM (۱	rounds x ۱۰ repetitions ۳ ۸۵٪)RM (۱	rounds x ۱۰ repetitions ۳ ۸۵٪)RM (۱
ninth week	lack of practice	lack of practice	lack of practice
tenth week	lack of practice	lack of practice	lack of practice
The eleventh week	lack of practice	lack of practice	lack of practice
The twelfth week	lack of practice	lack of practice	lack of practice

Between the stations, 1-2 minutes of passive rest (doing soft movements such as walking, bending and opening the arms and legs) was performed, but between each round, 3-4 minutes of active rest (brisk walking, soft and light jogging) were performed. was taken

Table 3-3: Weight movements used in each training session

Movements performed from the first to the eighth training session	Muscles involved in movement
chest press	anterior , triceps ,pectoralis major, pectoralis minor deltoid, anterior deltoid, anterior subclavian, anterior deltoid
Sit-ups	Flexors of the cervical vertebrae, sternum, pectoralis major, rectus abdominis, rectus femoris, rectus femoris, shoulder

Armpit stretch	**,(superior) triceps ,pectoralis major, parallelogram posterior deltoid, teres major, brachialis, pectoralis minor, extensor long**
trunk extension	**Interspinous, multiceps, dorsal half, cervical interspinous, rotators**
squat	**Large buttock, half membrane, half and three, double femur, straight femur, inner wide, middle wide, outer wide, twin, sole**
back of thigh	**Half membrane, half and three, double thigh, twin**
Back of arm with barbell	**٣ ,Long palm, anterior ulna, anterior inferior ulnar elbows, deep flexor of the fingers, superficial flexor of the fingers, long flexor of the thumb**
leg press	**Internal width, middle width, straight thigh, outer ,width, large pelvis biceps femoris, hemichord and membranous**

All data were expressed as (mean ± standard deviation). First, the Shaypro-Wilk statistical test was used to determine the normality of the distribution and the Levine test was used to check the equality of variances. In the next step, independent T-tests, analysis of variance with repeated measurements were used to test the research hypotheses. The significance level for all calculations was considered P > 0.05 and all calculations were done with SPSS 22.

Results

Some of the subjects' general indicators were measured in three stages (pre-test, post-test and non-practice) and the results are shown in Table (1-4). Table 1-4: Average and standard deviation of the subjects' general indicators

Indicators / **Groups**	**Age (Year)**	**height (centimeter)**
	M ±SD	M ±SD
) experimentaln (١۶=	45/37 ±5/46	160/56 ±5/40
) controln (١۶ =	44/75 ±4/61	161/75 ±4/10

Table 1-4 shows the characteristics of the general indicators of the subjects of each group in the form of average and standard deviation. Table 3-4: The mean and standard deviation of the LVEDV index shows the muscle function of the groups

Table 4-4: Mean and standard deviation of the LVEDV index of the subjects

Indicators / **Groups**	LVEDV (cc)

		M ±SD
Experimental ۱)n (۱۶ =	**before**	**70/43 ±12/50**
	So	**76/31 ±11/03**
	lack of practice	**72/25 ±12/19**
	Percentage changes from before to after	**-34.8%**
	Percentage of changes from post to no training	**32.5%**
Control)n (۱۶ =	**before**	**75/87 ±7/71**
	So	**74/62 ±9/11**
	lack of practice	**26/9 ±18/74**
	Percentage changes from before to after	**1/64%**
	Percentage of changes from post to no training	**0.58%**

Table 4-4 shows the characteristics of the left ventricular LVEDV index of subjects in each group in three stages (pre-test, post-test and non-exercise) in the form of mean, standard deviation and percentage of changes. Shapiro-Wilk-Welvin test to check the normality of data and homogeneity of variance In the second part of this chapter, the measured dependent variables have been tested using inferential statistics. At first, the normality of the data and the homogeneity of the variances were checked and confirmed using the Shapiro-Wilk and Levin tests, respectively, and then parametric tests were used to compare the means and test the hypotheses.

Table 5-4: Shapiro-Wilk test results regarding the normality of data distribution

) controln =16 (		**) experimentaln =16 (**		**group**	**Variable**
p-value	Df	p-value	dF	**Time**	
0/264	**16**	**0/742**	**16**	**before**	**LVEDV**
0.055	**16**	**0/588**	**16**	**So**	
0.058	**16**	**0/451**	**16**	**lack of practice**	

The results of Table 5-4 show that the data distribution of the measured variables is normal because the probability of error or the significant number (P-value) is greater than the error level of 0.05. Levine's test to check homogeneity of variance

Table 6-4: The results of Levine's test about the equality of variances

p-value	df2	df1	F	**Time**	**Variable**
0.062	**30**	**1**	**3/754**	**before**	**LVEDV**
0/443	**30**	**1**	**0/603**	**So**	
0/183	**30**	**1**	**1/854**	**lack of practice**	

The results of Table 4-7 regarding the comparison of the averages of the dependent variables in the pre-test stage of the two groups show that there is no significant difference in the measured variables between the two groups, because the significance level (P-value) is higher than 0.05. This shows the lack of significance of the homogeneity of the groups in the pre-test stage, and based on this, parametric statistical tests can be used to test the hypotheses.

LVEDV	**between groups**	**236/531**	**١**	**236/531**	**2/193**	**0/149**
	Intergroup	**3235/688**	**٣٠**	**107/856**		
	Total	**3472/219**	**٣١**			

theories Eight weeks of increasing resistance training has no significant effect on left ventricular end-diastolic volume (LVEDV) in sedentary women. A non-training period after eight weeks of increasing resistance training has no significant effect on left ventricular end-diastolic volume (LVEDV) in sedentary women.

Table 8-4: Results of 1-way analysis of variance with repeated measures on values (LVEDV)

Sources of changes Time group variable			SS	df	MS	F	P	**Size Effect**
LVEDV	**Practice**	**Pre-post test**	**276/125**	**١**	**276/125**	**26/572**	*** 0.000**	**0/639**
		- Post-test the end of non-practice	**132/031**	**١**	**132/031**	**12/905**	*** 0.003**	**0/462**
	Control	**Pre-post test**	**12/500**	**١**	**12/500**	**5/597**	*** 0.032**	**0/272**
		- Post-test the end of non-practice	**1/531**	**١**	**1/531**	**11/667**	*** 0.004**	**0/438**

* Significant difference at P>0.05 level

The results of Table 8-4 show that according to the significance level of a = 0.05, there is a significant difference between the LVEDV values from the pre-test to the post-test and from the post-test to the end of the no-exercise period separately between the experimental and control groups (0.5 0 < P). Therefore, the end-diastolic volume increased significantly from the pre-test to the post-test and decreased significantly from the post-test to the end of the non-training period.

Table 9-4: One-way analysis of variance test results with repeated measurements on the values from the pre-test to the end of the non-training period (3 measurement stages)

Sources of changes group variable		SS	df	MS	F	P	**Effect size**
LVEDV	**Practice**	**289/625**	**2**	**144/813**	**17/305**	*** 0.0001**	**0/536**
	Control	**24/542**	**2**	**12/271**	**7/344**	*** 0.003**	**0/329**

The results of Table 9-4 show that according to the significance level of a = 0.05, there is a significant difference between the LVEDV values from the pre-test to the end of the non-training period (three measurement stages) by groups (>0.05). p). Therefore, Bonferroni's post hoc test was used to show the location of these introverted group differences, the results of which are shown in Table 10-4.

Table 10-4: The results of Ben Ferrarouni's post hoc test on these LVEDV values

Sources of changes group variable		SS	df	MS	F	P	Effect size
LVEDV	**Practice**	**289/625**	**2**	**144/813**	**17/305**	*** 0.0001**	**0/536**
	Control	**24/542**	**2**	**12/271**	**7/344**	*** 0.003**	**0/329**

* Significant difference at P>0.05 level

The results of Table 10-4 show that in the training group, the LVEDV values of the pre-test with the post-test and the post-test with the non-training period have a significant difference ($p < 0.05$). It was also observed in the control group that the pre-test and post-test LVEDV values have a significant difference with the non-training period ($p < 0.05$). In order to investigate the difference between groups regarding the LVEDV values between the two experimental and control groups, the independent t-test was used with the difference of the pre- and post-test averages (Gain Score) in the groups, and the results are presented in Table 11-4.

Table 11-4: Independent t-test results to show the difference in LVEDV average among groups

Sources of changes			**the difference**	**T**	**Df**	**P**	**MD**
Variable	**Time**	**group**	M ±SD				
LVEDV	**_ -pre After the test**	**Practice**	**-5/87 ±4/55**	**-5/672**	**30**	*** 0.0001**	**-7/125**
		Control	**1/25 ±2/11**				
	Post-test lack of - practice	**Practice**	**4/06 ±4/52**	**3/185**	**30**	*** 0.003**	**3/625**
		Control	**0/44 ±0/51**				

Significant difference at the level of P>0.05

Based on the comparison of LVEDV values between the two groups, the results of Table 11-4 indicate that there is a significant difference between the LVEDV values between the experimental and control groups based on the difference between the pre-test and the post-test ($p < 0.05$). In addition, the results of Table 11-4 show that there is a significant difference between the LVEDV values between the experimental and control groups based on the post-test difference from the non-training period ($p < 0.05$). Based on the interpretations of the inferential tests stated about the first hypothesis, the null hypothesis that there is no significant effect of eight weeks of increasing resistance training on the left ventricular end-diastolic volume LVEDV of sedentary women is rejected, and the hypothesis of the research states that the effect of eight weeks of increasing resistance training on the end-diastolic volume of the ventricle The left LVEDV of sedentary women was significant. Therefore, eight weeks of increasing resistance training causes a significant increase in the end-diastolic volume of the left ventricular LVEDV of sedentary women. On the other hand, based on the interpretations of the inferential tests stated about the second hypothesis, the null hypothesis that there is no significant effect of 4 weeks of non-training after eight weeks of increasing resistance training on the left ventricular end-diastolic volume LVEDV of sedentary women is rejected and the research hypothesis states that the effect of eight weeks of resistance training Increasing on the left ventricular end-diastolic volume LVEDV of sedentary women has been significant. Therefore, 4 weeks of non-training can reduce the positive effects of increasing resistance training on left ventricular end-diastolic volume.

Discussion

(LVEDV) of sedentary women was rejected and the hypothesis of the research states that the effect of eight weeks of increasing resistance training on left ventricular end-diastolic volume (LVEDV) of sedentary women was significant. Therefore, 4 weeks of non-training can reduce the positive effects of increasing resistance training on left ventricular end-diastolic volume. The results of this part of the research were consistent with the research of Haji Ghasemi et al. (1390) and Giadaa (1998), Baptista et al. (1420). The researcher's interpretation of this hypothesis was that the increase in the variable values of the end-diastolic volume in the experimental group is due to the resistance training method, considering that resistance training is one of the factors affecting cardiac variables (Cullinen, 1998). An increase in end-diastolic volume, which is a sign of volume overload on the heart, as occurs in athletes (Fleck, 2008). Most of the studies conducted in the field of short-term resistance exercises and studies conducted on highly trained men have shown that resistance exercises have an effect on the absolute value of the internal dimensions of the left ventricle, which are considered as an indicator of the size of the heart cavity. 1998, Fleck). This overload is a function of venous return, ventricular volume and heart rate reduction (Robergs, 1999). Considering the beneficial effect of 8 weeks of increasing resistance training on left ventricular indicators (LVEDV, LVESV, SV, EF%, AO) in sedentary women, it is suggested to use this type of training in training centers for this statistical population, and since 4 weeks without An exercise after 8 weeks of exercise has adverse effects on the established adaptations. It is recommended that sedentary women continue their exercise programs in a regular and principled manner. Although in this research the researcher tried to control the research conditions as much as possible, but this research has faced limitations which are: 1. Lack of control over the subjects' mental states and motivation. 2. The impossibility of controlling the subjects' hidden diseases. 3. Lack of information about nutrition compliance by the subjects. 4. Not knowing the maximum effort used by the subjects

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