

**Research Paper****The Effect of a Resistance Training Course on Blood Pressure and Nitric Oxide Levels in Elderly Women**Alireza Behjati Ardakani<sup>1</sup>, \*Ahmad Qassemian<sup>2</sup>, Maryam Koushki<sup>2</sup>, Elham Shakour<sup>2</sup>, Ahmad Mehrez<sup>2</sup>

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**ABSTRACT****Objectives** Endothelial function is an important factor in the assessment of atherosclerosis, lipid deposition in the inner walls of the arteries, high blood pressure, and heart failure. Vascular endothelial cells play an important role in regulating vascular activities by producing substances such as nitric oxide to stimulate vessels.**Methods & Materials** The current study was attempted to find out the effect of resistance training on old women's plasma nitric oxide levels and blood pressure. Twenty-four postmenopausal women (age:  $67.37 \pm 6.02$ , BMI =  $26.87 \pm 4.16$ , and WHR =  $0.92 \pm 0.4$  mean  $\pm$  SD) were selected objectively and divided into control (n=12) and experimental (n=12) groups randomly. Experimental group performed resistance training for eight weeks, three sessions per week with 40-65% intensity. Study variables were measured and recorded before and after training program. Paired and independent sample t tests were used for data analysis. The significance level was lower than 0.05.**Results** The results revealed that resistance training had a significant effect on nitric oxide levels ( $P=0.01$ ) and blood pressure ( $P=0.006$ ,  $P=0.002$ ) in old women.**Conclusion** A period of resistance training with present study characteristics can reduce both systolic and diastolic hypotension and increase plasma nitric oxide levels, and therefore is recommended for prevention of cardiovascular diseases, atherosclerosis, and hypertension in old women.**Key words:**

Nitric oxide, Blood pressure, Older women, Resistance exercise

**Extended Abstract****1. Objective****O**

ne of the common diseases after menopause is atherosclerosis [1]. Vascular endothelial cells play an important role in regulating vascular activity by pro-

ducing vasoactive substances such as nitric oxide [2]. Nitric oxide acts as a vasodilator that can lower blood pressure with this mechanism [3, 4]. Old blood vessels produce lesser amount of endothelial nitric oxide [5]. Furthermore, strong correlation reported between the reduction of nitric oxide bioavailability and the outbreak of cardiovascular diseases in postmenopausal women [6, 7]. However, regular physical exercises, es-

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pecially resistance exercises may reduce or delay the impairment of the endothelial function in the elderly people and causes the endothelial function to return in people with atherosclerosis [8, 9]. Therefore, due to limited research on the effect of physical activity on elderly people and the all the above-mentioned materials, current study was undertaken with the aim to investigate the effect of a resistance training course on the concentration of nitric oxide in elderly women.

## 2. Methods and Materials

This research was quasi-experimental and was performed as a 2-group research project with pre-test and post-test. 24 elderly women were selected purposefully as the research sample. They did not have any history of participation in resistance training and were not afflicted with heart disease or specific illnesses. After filling out the consent form by the subjects, they were randomly divided into two groups: resistance training group and control group ( $n=12$ ). First, the questionnaire of general health, physical activity level, and the medical history was completed by the subjects. To assess their initial situation, we measured their height, weight, BMI, daily systolic and diastolic blood pressure, and resting heart rate. Experimental group participated in course comprising eight weeks of resistance training, three sessions a week with 40-65% intensity and at most one repetition [10-12].

Blood pressure was measured 48 hours before and after resistance training and 5 cc blood sample was taken from each subject to measure the concentration of nitric oxide. Blood sampling was done at 8 a.m. and after 12 hours of fasting. Blood samples were taken, and immediately sent to the lab before starting the resistance training program. Blood plasma was separated with centrifuge and frozen at  $-70^{\circ}\text{C}$ . After taking post-test blood samples and separation of blood plasma, samples were sent to the medical diagnostic laboratory at once for analysis. In the lab, concentration of nitric oxide was measured using the GLASY ELISA kit, USA, with a precision of  $0.1 \mu\text{mol/L}$ . Correlated t-test was used to review intragroup variations and independent t-test was used for inter-group differences. The level of significance was less than 0.05. This research was approved by the Ethics Committee of the Physical Education Department of Shahrekord University.

## 3. Result

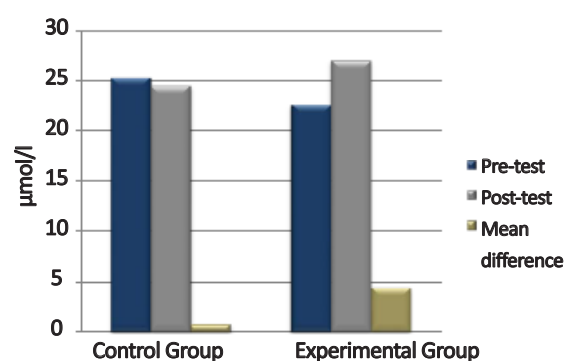
This study was conducted with a sample of 24 postmenopausal women [mean age of  $67.37 \pm 6.02$ , Body

Mass Index (BMI) of  $26.87 \pm 4.16$ , and Weight-Hip Ratio (WHR) of  $0.92 \pm 0.4$  who were selected purposefully and divided randomly into experimental and control groups. There was a significant no significant difference between the two groups in terms of the general characteristics of the subjects and the mean variables of the research before intervention. However, it should be noted that average weight and average WHR of experimental group decreased after intervention and those differences were significant at the level of  $P \leq 0.05$ .

Based on the findings, it has been determined that mean Nitric Oxide (NO) levels in the experimental group in the pretest and posttest setting were 22.58 and 27.00, respectively, and the difference between them was significant in this group ( $P=0.008$ ). In the control group, there was no significant difference between the means of NO in pre-test and post-test scores, which were 25.50 and 24.50, respectively ( $P>0.05$ ). Independent t-test results showed that there was a significant difference between the means of NO in the post-test in both groups ( $P=0.01$ ). In other words, intervention of independent variable (resistance training) had significant effect on the increase in NO levels in the experimental group. Therefore, it can be said that eight weeks of resistance training significantly increases NO levels in elderly women (Figure 1).

Our study also confirmed that systolic ( $P=0.006$ ) and diastolic blood ( $P=0.002$ ) pressure decreased significantly in the experimental group after the intervention, and based on t-test results on the average blood pressure in pre- and post-test. However, the mean difference between these two pressures was not significant in the control group in pre- and post-test ( $P>0.05$ ).

In examining the relationship between variables, correlation ( $r$ ) of nitric oxide concentration variable



**Figure 1.** Comparison of mean NO levels in control and experimental groups before and after intervention

and systolic blood pressure equaled to 0.582 and the relationship was significant at the level of  $P=0.014$ . Therefore, it can be concluded that there is a direct relationship between increasing plasma nitric oxide concentration and the decreasing systolic blood pressure. On the contrary, correlation of nitric oxide concentration with diastolic blood pressure found to be 0.257, which was not significant at the level of  $P\leq 0.05$ . In summary, the results of this study have shown that a course on resistance training has a significant effect on the increase in plasma nitric oxide levels and the decrease in the systolic and diastolic blood pressure in elderly women.

#### 4. Conclusion

Our study established that a course of eight weeks on resistance training with 40-65% intensity and at most one repetition has a significant effect on the increase in plasma concentration of nitric oxide in elderly women and this is an important indicator to prevent cardiovascular disease, especially atherosclerosis and hypertension. Moreover, this training course caused a significant decrease in systolic and diastolic blood pressure in elderly women. Decreased blood pressure can be due to the reduction in catecholamines production, because of the training and the subsequently reduced environmental resistance. In addition, sports activities can lower blood pressure by increasing the number of capillaries in active skeletal muscle, reducing vascular resistance due to the diffusion, reducing blood flow resistance, improving nervous system regulation of blood vessels, and decreasing heart rate during rest and activity [13]. Considering the results of our study as well as other benefits of physical activity, resistance exercise can be recommended to the elderly and those who suffer from conditions like hypertension.

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#### Conflict of Interest

The authors declared no conflicts of interest.