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The Effect of Eight Weeks of Concurrent Training on Total Plasma Protein Levels and Muscle Strength of Elderly Men

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Abstract

Introduction: In old age, people develop muscle atrophy due to motor constraints. As a result, these factors have a significant impact on the quality of life and health of the elderly. The purpose of the present study was to investigate the effect of eight weeks of concurrent training on total protein plasma levels and muscle strength in elderly men.

Methods: In this study, 16 elderly men (mean age ± SD: 63.25 ± 3.87 years; weight: 80.25 ±13.69 and BMI: 27.04 ±4.19 kg / m^2) were randomly divided into two groups of eight, including: (1) concurrent training, and (2) control. The training protocol consisted of eight weeks of resistance and endurance combinations, three sessions per week, taking into account the overload principle. The control group continued its routine life without any regular activity. Blood samples were taken to measure blood variables in fasting conditions before and after the training protocol. Measurement of one-repetition maximum (1RM)was done in two stages of pretest and post-test. To analyze the results, statistical procedures of dependent and independent samples t-test were used at significance level of $P \leq 0.05$.

Results: Based on the results, eight weeks of training increased total protein plasma levels ($P=0.002$) and 1RM in leg extension and dumbbell shoulder press ($P=0.0001$), but this was not the case in the control group.

Conclusion: It seems that concurrent training improves total protein plasma levels and maximal strength, which consequently results in muscle mass and muscle strength in elderly people.

Keywords: Elderly, Concurrent Training, Total Protein Plasma, Strength

Introduction

The aging population is considered to be a real challenge for all countries. People are considered to be aged when they are 60 or older (1).The prevalence of problems and illnesses associated with elderly people is a major social, economic, and health problem, and it is expected that the world's population will increase by 3 times by 2050 (2), and in Iran, the present eight percent population of the elderly will reach 22 percent. One of the aging problems is sarcopenia, which is referred to as the loss of muscle mass, which occurs naturally with increasing age (2).After 50, muscle mass decreases by 1-2% every year, and also at this age (50) muscle strength decreases by 12-15% every 10 years (3). Muscle strength is a vital component in maintaining physical activity in the elderly. Therefore, motor constraints in the elderly leads to the loss of strength, power and muscle mass, and low muscle mass is associated with weakness, which severely impairs the performance of these individuals. 4). Plasma proteins are the protein in the blood plasma. It means total protein, albumin and globulins in the blood and other proteins that are in the plasma.Total protein plasma is considered as a biochemical index for measuring the total amount of protein in the plasma which decreases in elderly age (5).Albumin (over 60%) is the most abundant protein in the plasma which is produced only by the liver. Loss of muscle mass in the elderly is associated with lower levels of albumin. A low level of albumin contributes to aggravate acute pathology (6). Reducing musculoskeletal mass is 30% higher in people with low albumin concentrations, thus lower albumin concentration in the elderly may be a risk factor for sarcopenia (decreased muscle strength and muscle mass).The results show that low serum albumin, even in the normal range, is independently associated with weak muscle strength, and loss of mass and muscle strength in older women and men (7, 8). Elderly people voluntarily reduce their physical activity, which decreases muscle strength and functional capacity. However, it has been shown that concurrent training improves strength and power as well as hypertrophy and simultaneously increases aerobic capacity (9). Considering the concurrent training capacityto set up adjustment in the skeletal muscle to cope with disorders such as sarcopenia, type 2 diabetes, obesity, muscle strength and mass degradation affecting the functional capacity and metabolic health of the elderly, it seems it will be an attractive training strategy to prevent and cope with numerous illnesses (10). In their research, Wilson et al. (2012) showed that concurrent training improves muscle strength and quality (10). Also, Ferrari *et al.* (2016) reported that different concurrent training periods (resistance-aerobics) led to increased muscle strength and muscle quality in elderly men (11). A study by Bomgatner *et al.* (1996) has shown that physical activity can improve the level of albumin in blood, which increases muscle mass and strength (9). Cadore *et al.* (2010) by examining the effects of strength and endurance concurrent training on neuromuscular and hormonal parameters in older men found that there was a significant increase in strength and maximum muscle activity (12). Accordingly, considering that muscle mass in older people is less than younger (13), low muscle mass in the elderly as an effective factor causes loss of muscular strength and instability in balancing and postural control and ultimately accelerates the process of sarcopenia (14). On the other hand, research has proven that physical activity has had a positive effect on reducing the process of sarcopenia and increasing muscle strength following the measurement of maximum strength. Also, physical activity can improve the level of blood albumin, which will increase muscle mass and strength (15). In recent years, in the field of sports science, research on the effects of sport interventions on muscle strength in elderly people has been conducted and their results are contradictory. Considering the importance of muscle strength in improving the quality of life and the health of the elderly, the present study attempts to investigate the effect of concurrent training on improvement symptoms in muscle quality factors so that appropriate advice is offered to take potential steps in increasing the quality level of life ofelderly people.

Methods

The statistical population in this semi-experimental and applied study was elderly men of Isfahan city. After the general call with a special recall form in the city of Isfahan, 16 elderly men with a mean age of 63.25 ± 3.87 (years), weight of 80.25±13.69 (Kg) and body mass index (BMI) of 27.4±04.19 kg / m^2 were selected as volunteers and divided into two groups of concurrent training and control, with eight subjects in each group. All subjects were examined in terms of general health and had no physical problems.It is worth noting that by asking individuals and studying their medical records, the subjects were shown not to have used anti-oxidant supplements in the former six months and had not performed regular physical exercises in the past year. Written consent was taken from all participants before starting to do anything. The training protocol including aerobic and resistance training was carried out simultaneously. The program lasted for eight weeks and three sessions per week, and moved from simple trainings to difficult and low to high intensity; also, the principle of overload and increased exercise intensity was taken into account in the protocol.All training sessions started with 15 minutes of warming up and stretching. Resistance training program designed for the subjects included:Barbell BenchPresses-Medium Grip, Wide-Grip LatPulldown, Dumbbell Shoulder Press,Wide-GripStanding Barbell Curl, Triceps Pushdown, Leg Extensions, Lying Leg Curls, and Standing CalfRaises. Resistance training program was proceeded in two rounds with 16-18 repetitionsand 40% of one-repetition maximum (1RM) at the beginning of the course, turned into three rounds with 8-10 repetitions and 75% of 1RM and ended with 2-minute rest at the end of the training period (13). The subjectsب aerobic training included the use of stationary bicycling. The aerobic training program involves working on a stationary bicycling with an intensity of 60% of maximum heart rate (MHR) for 16 minutes in the first week, which reaches 88% of MHR for 30 minutes in the eighth week (16).The trainings were arranged in such a way that resistance trainings were performed, followedby aerobic trainings with 2-minute intervals.All training sessions were performed between 8:00-10:00 pm, under the supervision of an exercise physiologist. It is worth noting that before starting the training program, the maximum strength or 1RM was taken from the elderly at a separate meeting. In the present study, the Brzycki formula was used to determine 1RM:

$$1RM = \frac{\text{(kg) displaced}}{1.0278 - (0.0278 \times \text{Repeat number})}$$

All of the above movements were performed according to training intensity control. In each session, the intensity was controlled and measured by determining the heart rate of the subjects before starting the activity, during the performance, and after the trainings by the researcher, using the polar heart rate monitor. The trainings were also arranged so that in the first place the resistance trainings were conducted and then with an interval of two minutes, aerobic trainings were performed (Table 1). In this study, the Borg Scale was used to control the intensity of training, because this scale is one of the most important and widely used scales for determining the intensity of training, and is used in situations such as the elderly, ill or medicine-taking individuals. Another instrument to control intensity in aerobic trainings is employing resting heart rate and Karvonen formula.This formula was used to determine the amount of subjectsب training heart rate to reach the appropriate percentage of training intensity. Measurements of weight, height, body fat percentage, and body mass index were performed. All subjects followed the same type of diet in both groups.This nutritional control was performed with NUT4 nutritional software, which was completely accurate. Blood samples were taken to determine the total plasma protein level in two steps, one day before the first pre-test session and 48 hours after the last training session, at the eighth week, and after 12 hours of fasting between 7:00-8:00 in the morning;blood samples were taken from the brachial vein. Besides, Pars test kit was used and the auto-analyzer device was employed to calculate total protein level. Also, 1RM in the dumbbell shoulder press and leg extension in two stages of pretest and post-test was taken and the control group also went on routine activities. The ethical aspects of this study were approved by the Committee on Organizational Ethics of Tabriz University of Medical Sciences with the code IR.TBZMED.REC.1396.1136. SPSS software version 23 was used for statistical analysis. Initially, the normal distribution of data was examined using K-S test. In the next step, to determine the change in the factors measured in the post-test compared to the pre-test, dependent sample t-test in each group was employed separately. Also, independent sample t-test was used to compare both groups in the measured variables. Significance level in all tests was considered at $P \leq 0.05$.

Results

First, Kolmogorov-Smirnov test (K-S) confirmed the normal distribution of data (P≥0.05). With the normalization of the distribution of data, parametric tests can be used to analyze the data. Table 2 shows the individual characteristics of the subjects. The results of independent t-test are shown in Table 3 in which the total plasma protein levels and 1RMof shoulder press and leg extension are illustrated separately in each group. It reveals that the training group shows a significant increase in total plasma protein (P=0.002), 1RM of shoulder press (P = 0.0001) and 1RM of leg extension (P = 0.0001) after eight weeks of concurrent training.On the other hand, the control group completed this study without any changes in total plasma protein (P =0 .747), 1RMof shoulder press (P = 0.450) and 1RM of leg extension (P = 0.197). Independent samples t-test shows the difference between the groups (training and control) in total plasma protein levels (p = 0.003) and 1RM of shoulder press-leg extension (p = 0.001). These results indicate a significant increase in total plasma protein levels and 1RM in the training group compared to the control group. It should be noted that in addition to the comparison of the pre-test in both groups and also the post-test in the two groups, the slope of the changes (post-test minus pre-test) was also compared between the two groups. Changes in total plasma protein levels and 1RM are indicated in Figure 1.

Table 1. Concurrent trainings intensity and duration

Resistance Trainings (weight)				Aerobic Trainings (Stationary Bicycling)				
Week	Number of sessions per week	Set	Repeat	Intensity of RM	Aerobic Exercise Duration	VO_{2max}	MHR	Ratings of Perceived Exertion (RPE)
1	3	2	18-16	40%	16 Minutes	45%	60%	11
2	3	2	18-16	45%	16 Minutes	50%	66%	11
3	3	2	14-12	50%	20 Minutes	55%	70%	13
4	3	2	14-12	55%	20 Minutes	60%	74%	13
5	3	3	12-10	60%	25 Minutes	65%	77%	15
6	3	3	12-10	65%	25 Minutes	70%	81%	15
7	3	3	10-8	70%	30 Minutes	75%	85%	11
8	3	3	10-8	75%	30 Minutes	80%	88%	17

Table 2. Physical and physiological characteristics of the subjects and their changes in the groups

Variable	Group	Number	Mean and standard deviation
Age (Year)	Training	8	61.2±87.69
	Control	8	64.4±62.53
Height (Centimeters)	Training	8	176.3±37.29
	Control	8	171.5±50.29
Weight (Kilograms)	Training	8	87.10±75.38
	Control	8	79.17±75.12
Body mass index (kg / m^2)	Training	8	25.1±07.07
	Control	8	27.1±06.90

Table 3. Results of dependent samples t- test for total plasma protein levels (g / dl) and 1RM

Statistic Variable	Group	Sampling Time	Number	Mean and standard deviation	t	df	P
Total plasma protein (g/dl)	Training	Pre-test	8	6.0±83.26	4.906	7	.002
		Post-test	8	701.0±53.45			
	Control	Pre-test	8	7.0±27.33	-0.346	7	.747
		Post-test	8	7.0±30.28			
1RM of theDumbbell Shoulder Press	Training	Pre-test	8	20.6±00.21	-21.16	7	.0001
		Post-test	8	28.6±00.84			
	Control	Pre-test	8	44.9±12.53	-0.800	7	.450
		Post-test	8	45.7±25.06			
1RM of the Leg Extension	Training	Pre-test	8	46.8±75.89	-35.85	7	.0001
		Post-test	8	54.9±87.01			
	Control	Pre-test	8	43.10±62.29	1.426	7	.197
		Post-test	8	43.10±0.25.02			

*** Level of significance is considered at P≤0.05**

Table 4. Results of independent samples t- test on total plasma protein levels and 1RM

Variable	Sampling Time	Levene's test		Independent Samples t-test		
		F	Sig.	t	df	Sig.(2-tailed)
Total Plasma Protein	Pre-test	0.011	0.917	-2.924	14	0.011
	Post-test	3.536	0.081	1.177	14	0.259
	Slope changes	0.328	0.576	3.656	14	0.003
Variable	Sampling time	**Levene's test**		**Independent Samples t-test**		
		F	**Sig.**	**t**	**df**	**Sig.(2-tailed)**
1RM of the Shoulder Press	Pre-test	1.583	0.229	-5.988	14	0.0001
	Post-test	0.001	1.000	-4.959	14	0.0001
	Slope changes	8.714	0.011	4.719	14	0.0001
Variable	Sampling time	**Levene'stest**		**Independent Samples t-test**		
		F	**Sig.**	**t**	**df**	**Sig.(2-tailed)**
1RMof the Leg Extension	Pre-test	0.019	0.893	0.650	14	0.526
	Post-test	0.008	0.930	2.536	14	0.024
	Slope changes	0.001	1.000	24.48	14	0.0001

* Level of significanceis considered at P≤0.05.

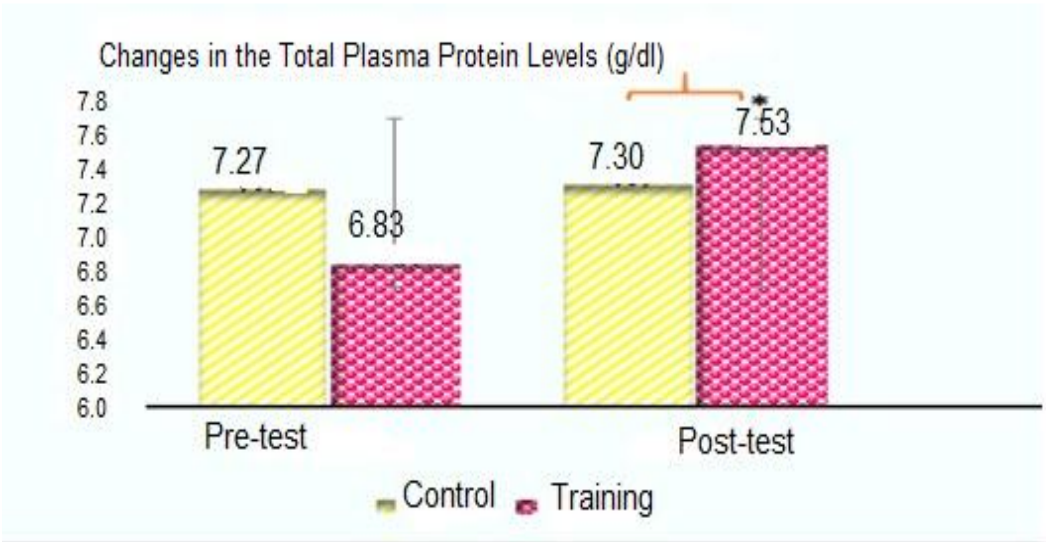

Figure 1. Changes in total plasma protein levels in the post-test compared to the pre-test
* Indicates a significant change in total plasma protein levels in the post-test compared to the pre-test.
# Indicates a significant difference in protein scores between training and control groups.

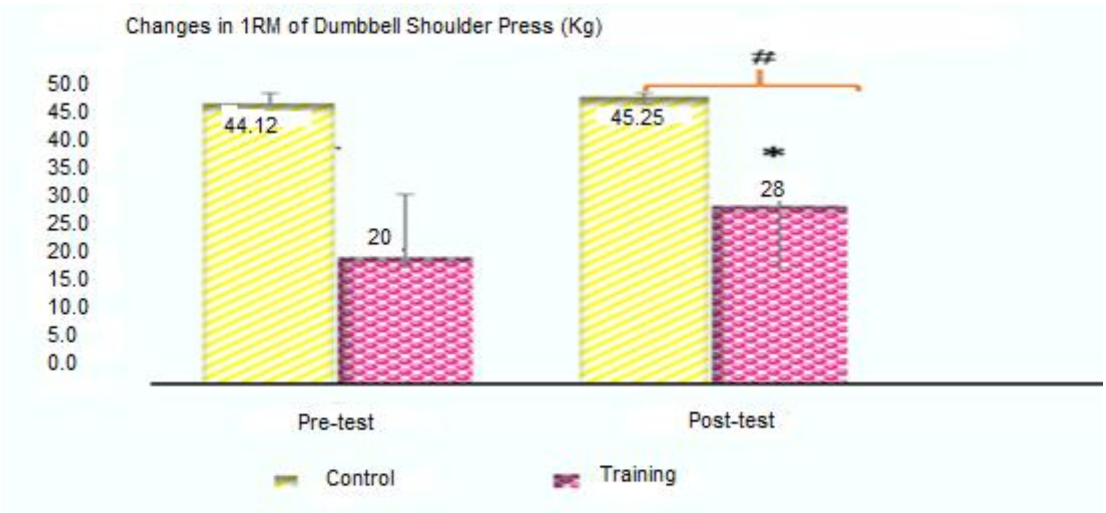

Figure 2. Changes in 1RM of shoulder press in the post-test compared to the pretest
* Indicates a significant change in the mean of 1RM in the post-test compared to the pre-test.
# Indicates a significant difference between the RM scores in the two training and control groups.

Figure 3. Changes in 1RM of leg extension in the post-test to the pre-test
* Indicates a significant change in the mean of 1RM in the post-test compared to the pre-test.
# Indicates a significant difference between the 1RM scores in the two training and control groups.

Discussion

The results of this study indicate that concurrent training improves total plasma protein levels and 1RM, and these results can be a significant factor affecting the quality of life of the elderly. Therefore, this research can confirm that performing concurrent trainings, in the long run, by affecting important health factors improves total protein and 1RM in elderly people, which can lead to strengthening the muscle mass and strength of these people. In line with this study, Sheffield Moore *et al.* (2005), recently showed that moderate intensity aerobic training increased short-term plasma and muscle protein synthesis in young and old men (25).Also, consistent with our research, Izquierdo *et al.* (2005) reported that eight weeks of concurrent training increased 1RM among middle-aged people (27). Moreover, Hakkinen (2003) in his research maintained that concurrent training could increase 1RM (28). Inconsistent with the present study, Gholamali *et al.* (2016), examined the intensity of acute (endurance and resistance) combined training, and showed that total plasma protein did not significantly change in different intensity activities immediately after exercise and 24 hours after exercise compared to before exercising (26).In this vein, it was inconsistent with our results, in that their exercises were acute and short-term, and that the subjectsب body did not have enough time to adapt to the process of protein synthesis. Studies have shown that the ability of musculoskeletal regeneration to elderly people is largely lost, as the number of satellite cells, the amount of protein renewal, as well as the ability to multiply them are weakened. Thus, by decreasing protein synthesis, the skeletal muscle of the elderly is increasingly atrophic (17).Also, by reducing the amount of total plasma protein, especially albumin, a phenomenon called sarcopenia occurs in elderly people. Because people with low albumin concentrations are more likely to reduce skeletal muscle mass, hence low albumin concentrations in the elderly may be a risk factor for the development of sarcopenia (8). Increasing evidence in the elderly nursing home suggests that muscle mass weakness is associated with fragility and severely impaired function (4) and this is important because skeletal muscle is the most abundant tissue in the human body (consisting of 40% of body weight and 30% of base energy consumption).Skeletal muscles also play a central role in body transmissions and play an important role in daily living activities and maintaining posture and balance (18). Many studies show that from the second to the eighth decades of life, muscle mass is reduced by 18% in men and by 27% in women (19). Resistance and endurance exercises represent different sports styles, which produce a definite response in muscle environments that minimize cellular stress during exercise attacks (20). The findings also show that concurrent training can enhance the performance of both short-term (under 15 minutes) and long term exercises (over 30 minutes), mainly through improvements in the economy as well as muscle and nervous activity (21). Studies have shown that the adaptations that result from the concurrent training of skeletal muscle are due to the accumulation of acute signaling responses and the expression of genes after repetitive exercises as well as the accumulation of specific proteins over time, which consequently, change the muscle's phenotype. Since, as the age increases, the muscle volume decreases and the concurrent trainings cause muscle hypertrophy in the elderly. Researchers have shown that concurrent trainings lead to increased power (10). Also, research by Ferrari et al. (2016) examined the effects of different concurrent training periods (strength and aerobics) on muscle strength and quality of practicing elderly men;finally, it was reported that these trainings led to increased strength and muscle quality (12). Another study has shown that increased synthesis of albumin after intense exercise increases the content and maintenance of albumin (22, 23). Also, a recent studyhas examined the effect of altitude and exercise on the rate of synthesis of albumin and fibrinogen; in both cases the synthesis increased and the exercise was the main stimulus (24).

Conclusion

Considering the results obtained in this study, concurrent training in elderly people is recommended for hypertrophy and muscle strength, as it is beneficial; it has low side effects; has no problem, and has a multifaceted role in improving the health of the elderly. It is worth noting that elderly people, in order to prevent sarcopenia and its consequences, participate in the concurrent training programs, to take advantage of both the benefits of resistance training and endurance training, so that they can spend their lives with health and strength. Overall, based on the findings of this study, it seems that performing eight weeks of concurrent training (a combination of resistance and endurance training) in healthy elderly people is useful and profitable to develop total protein level, most of which consists of albumin and improve 1RM.

Ethical issues

Not applicable.

Authors' contributions

All authors equally contributed to the writing and revision of this paper.

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