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THE EFFECT OF COMBINED RESISTANCE AND ENDURANCE TRAINING ON SOME PHYSICAL FITNESS FACTORS IN YOUNG MEN

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ABSTRACT

The aim of this study was to investigate the effect of an eight-week combined resistance and endurance training program on the body composition (total body water percentage, fat free body mass and body fat percentage) and aerobic power of young men. Fifty young men students with the age mean of 21.18±2.1, height mean of 176.34±4.1 and weight mean of 70.1±5.4 were randomly divided to five combined endurance- resistance (n=10), combined resistance-endurance (n=10), resistance (n=10), endurance (n=10) and control (n=10) groups. In three sessions (week 0, week 4 and week 8), their aerobic power and body composition were measured in order to obtain their maximum oxygen consumption, total body water percentage, fat free body mass and body fat percentage. Then, the training groups performed their training programs for eight weeks, three sessions per week. The training program of the resistance group included circular resistance. The endurance group performed running with 70-80% maximum heart rate for 20-26 min. The program of the combined endurance-resistance group was composed of doing endurance training first and resistance training next and that of the combined resistance-endurance group included performing resistance training first and endurance training next. The control group did not participate in any training program during the research period. The research data were analyzed using Analysis of Variance (ANOVA) with repeated measures along with dependent t test considering the Bonferroni's P correction for within group evaluation and one way Analysis of Variance (ANOVA) along with Tukey's post hoc test for between group evaluation (α <0/05). The results showed that eight weeks of endurance training, combined endurance-resistance training and combined resistance-endurance training significantly increased the maximum oxygen consumption (P<0.05). Also, total body water percentage significantly increased after eight weeks of resistance, endurance, combined endurance-resistance and combined resistance-endurance training (P< 0.05). Fat free body mass increased in the combined endurance-resistance, combined resistance-endurance and resistance groups; however, this increase was only significant in the resistance group. Body fat percentage had significant decrease in the four experimental groups but this decrease was more evident in the combined endurance-resistance and combined resistance-endurance groups compared with the resistance and endurance groups (P<0.05).Considering the research findings, people can perform combined resistance-endurance training in order to highly decrease their body fat percentage. In sum, it can

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be concluded that doing combined resistance-endurance training is more helpful for decreasing fat and controlling weight and this kind of combined training can be recommended to people.

Keywords: Combined resistance-endurance training, Aerobic power, Total body water percentage, Body fat percentage, Fat free body mass.

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1. INTRODUCTION

One of the topics which are considered today by researchers and experts is the issue of obesity and weight control. Obesity is a syndrome which is determined by the increase in the amount of fat tissues and is considered a negative factor for health and longevity (LeMura, 2000). The results of studies on obesity and its relationship with different diseases along with issues like beauty and appearance have caused the public to increasingly welcome weight control programs (Brochu, 2000; Maghsoud Peeri *et al*., 2011). Some references have mentioned that resistance and endurance tainting programs create changes in body composition; as a result, body fat percentage decreases in both of these activities and fat free body mass increases in the resistance training. On the other hand, fat free body mass have not shown great changes as a result of endurance activities (Pratley, 1994; Bell, 2000; Hakkinen, 2003; Shawn Glowacki *et al*., 2004; Izquierdo, 2005; Hendrickson, 2010). Various pieces of research evidence have shown that aerobic activities (endurance) are one of the reliable ways for decreasing weight and body fat percentage. Therefore, it is not surprising that many scholars in the field of sports sciences consider aerobic training an appropriate physical activity for controlling weight and body composition (Brochu, 2000; Akbarpour Beni *et al*., 2011; Masomeh Kamyabnia, 2011). Nevertheless, a number of research evidence has also stated the effect of resistance training on decreasing body fat percentage (Pratley, 1994; LeMura, 2000). Thus, it seems that considerable studies have been conducted on the positive effect of endurance and resistance training on body composition and weight control (Pratley, 1994; Bell, 2000; LeMura, 2000; Hakkinen, 2003; Shawn Glowacki *et al*., 2004; Izquierdo, 2005; Hendrickson, 2010). More recent studies have demonstrated that people can perform both these training activities in order to acquire adjustments related to resistance and endurance training. Moreover, doing a combination of strength and endurance training is more beneficial for those people who want to lose weight and change their body composition (Dolezal and Potteiger, 1998; Hendrickson, 2010; Akbarpour Beni *et al*., 2011). McCarthy (1995) investigated the effect of concurrent strength-endurance training on the changes of body peak oxygen consumption and body composition in non-athletic adult males. The results obtained from the study showed that fat free body mass increased by 3% and 5% in the strength and concurrent groups, respectively, while endurance group showed no changes (McCarthy, 1995). Wallace *et al*. (1997), Dolezal and Potteiger (1998), Pratley (1994) and Takeno *et al*. (2001) studied the effect of combining strength and endurance training on the basal metabolism level and body composition change in active adult males and females and compared the results with those of the strength and

endurance training programs conducted separately. The obtained results indicated that concurrent training can significantly increase basal metabolism and decrease body fat relative to the obtained amounts in the before-training period (Pratley, 1994; Wallace *et al*., 1997; Dolezal and Potteiger, 1998; Takeno *et al*., 2001). In addition, Maiorana *et al*. (2002) and Akbarpour Beni *et al*. (2011) reported the significant decrease of subcutaneous fat, body fat percentage and waist-to-hip ratio after performing eight weeks of combined resistance and endurance training (Maiorana *et al*., 2002; Akbarpour Beni *et al*., 2011). Some scholars like Poehlman (2000) and LeMura (2000) stated lack of change in body composition after performing 10 and 16 weeks of combined resistance and endurance training in healthy women (LeMura, 2000; Poehlman, 2000). Therefore, considering different effects of training type in different age groups and genders and in people with different fitness, it is essential to notice important points like changes created in body composition during the training period and consider the order of performing endurance and resistance training. Since it is very important for people, especially non-athletes, to obtain appropriate body composition, it is imperative to determine the effect of different endurance, resistance and combined endurance and resistance training on the aerobic power and body composition which include body fat percentage, fat free body mass and total body water percentage in order to record and compare the changes of these factors as a result of doing different training. Consequently, an appropriate training program can be recommended to people for obtaining optimum body composition.

2. MATERIALS AND METHODS

2.1. Subjects

After the physical activity readiness questionnaire was filled in by 450 non-athlete male students in University of Qom, 412 people were determined as the available population of the research. Then, 50 students with the age mean of 21.18±2.1 years were selected as the research sample using simple random sampling method. They were divided to five 10-people groups of combined endurance-resistance (Group 1), combined resistance-endurance (Group 2), resistance (Group 3), endurance (Group 4) and control (Group 5). Body composition and aerobic power tests were taken in three sessions in week 0, week 4 and week 8. Table 1 shows body characteristics and body composition of the participants of the five groups.

To measure aerobic power, 20-m shuttle run test was used and maximum oxygen consumption (VO_{2max}) was measured by putting the figures related to distance and time in Eq. 1. Body composition (body fat percentage, fat free body mass and total body water) was calculated using the bio electric impedance analysis (Model 400, England) and by connecting system electrodes to the participants' right wrists and ankles.

Eq. 1: $VO_{2max}(ml.kg/min) = 24.4+6\,(distance_{(m)}) / time_{(s)}$

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

Groups / Variable	Combined endurance - resistance training N=10	Combined resistance-endurance training N=10	Resistance training N=10	Endurance training N=10	Control N=10	F	P
Age (year)	20.5±2.1	21.6±1.8	20.2±2.4	22.1±1.9	21.5±2.3	7.154	0.911
Weight (kg)	68.9±4.8	70.4±6.2	69.8±5.12	71.1±5.7	70.3±5.2	6.326	0.769
Height (cm)	178.4±3.2	173.3±4.4	175.4±3.42	180.1±4.3	174.5±5.2	6.435	0.824
VO_{2max} (ml.kg/min)	38.94±3.1	39.15±2.7	38.74±2.6	40.11±2.4	38.23±2.7	5.147	0.792
BMI	21.64±2.37	23.44±2.58	22.69±3.02	21.92±2.71	23.08±3.12	4.51	0.841
Body fat %	12.49±1.2	12.77±1.8	13.58±2	13.65±1.6	13.07±2.1	4.75	0.723

2.2. Training Program

First, maximum heart rate was measured for each person using the following formula (Akbarpour Beni *et al*., 2011):

$MHR=208-(0.7\times age)$.

In this research, the training programs were performed for the training groups for eight weeks, three sessions per week and 55 min per session. Each training program included 15 min warm-up, specialized training of each group for 30 min and 10 min of stretching activities as cool-down. The specialized program of the resistance group included (leg press with a system, chest press, bending knee with system, front arms with barbell, front leg with system, back arm with wire, seated leg, side wiring, anterior foot motion, sit-up and waist fillet activities) according to the circular method which was done with 10-12 repetition during 2 sets with 70-75 one-repetition maximum in the first four weeks and with 6-8 repetition during 4 sets with 75-80 one-repetition maximum in the second four weeks. The training program of the endurance group included running which was done with 70-75 maximum heart rate for 20 min in the first four weeks and with 75-80 maximum heart rate for 26 min in the second four weeks. The combined endurance-resistance group performed endurance training with the same intensity of the one in the endurance group for 10 min and 13 min in the first four weeks and second four weeks, respectively, and conducted circular resistance training similar to the activities of the resistance group with the same intensity for 1 set in the first four weeks and for 2 sets in the second four weeks. The training program of the combined resistance-endurance group was similar to that of the combined endurance-resistance group; the only difference was that this group performed resistance training first and endurance training next. The control group did not participate in any training program and only took part in three sessions of test (pre-test, mid-test and post-test).

2.3. Statistical Method

To determine naturalness and homogeneity of the data, Kolmogorov Smirnov test was used and repeated measures Analysis of Variance (ANOVA) was applied for within group differences, considering Greenhouse Gyzer (GG) correction. In case of significance and considering the Bonferroni's P correction, dependent t test was used for determining between group location of

difference. Moreover, one way Analysis of Variance (ANOVA) was applied for examining between group differences and, in case of statistical significance, Tukey's post hoc test was used to determine the between group locations of difference. The statistical procedure of the research was conducted in SPSS software (Version 15) and significance level of $\alpha < 0.05$was considered.

3. RESULTS

The obtained results showed that maximum oxygen consumption after four weeks of training in endurance (P= 0.026), combined endurance-resistance (P= 0.034) and combined resistance-endurance (P= 0.039) groups had significant increase compared with the pre-test stage (before doing exercises). Its significant increase was observed after eight weeks of training in endurance (P= 0.0001), combined endurance-resistance (P= 0.001) and combined resistance-endurance (P= 0.001) groups compared with the pre-test stage (before doing exercises) whereas no significant within group differences were observed in the VO_{2max} in the resistance (P= 0.14) and control (p= 0.31) groups.

Table-2. Changes of mean and standard deviation of aerobic power and body composition in training and control groups at different experimental stages

Variable	Groups	Pre test (week 0)	Mid test(week 4)	post test (week 8)
Vo2max (ml.kg/min)	Cocurrent endurance - resistance group	38.94±3.1	39.64±2.8 *	41.22±3.4 +†*
	Cocurrent resistance-endurance group	39.15±2.7	40.76±3.2 *	42.37±2.6 +† *
	Resistance training group	38.74±2.6	38.81±2.8	39.1±2.9
	Endurance training group	40.11±2.4	42.82±3.3 *	45.63±2.5 + †*
	Control group	38.23±2.3	38.46±2.6	38.79±2.8
Total body water %	Cocurrent endurance - resistance group	64.08±2.9	65.64±2.5 *	66.65±2.4 +*
	Cocurrent resistance-endurance group	65.22±3.1	66.62±3.2 *	67.16±3.5 + *
	Resistance training group	63.5±3.6	64.76±3.4 *	65.43±3.7 +*
	Endurance training group	64.1±2.5	65.47±3.1 *	66.21±3.0 +*
	Control group	64.57±2.8	63.92±2.4	64.85±2.9
Fat free body *(kg)*	Cocurrent endurance - resistance group	58.69±3.7	60.76±3.8	61.53±3.9 +‡*
	Cocurrent resistance-endurance group	55.93±4.1	57.97±4.3	59.87±4.2 + ‡*
	Resistance training group	59.37±3.2	61.7±3.1	63.7±2.9 +‡*
	Endurance training group	55.87±3.2	58.2±3.4	58.44±3.1
	Control group	56.9±2.1	56±2.4	57.12±2.2
Body fat %	Cocurrent endurance - resistance group	12.49±1.2	11.14±1.1	10.04±1.1 +*
	Cocurrent resistance-endurance group	12.77±1.8	11.3±1.7	10.16±1.3 +*
	Resistance training group	13.58±2	11.75±1.8	11.04±1.7 +*
	Endurance training group	13.65±1.6	11.72±1.7	10.6±1.8 +*
	Control group	13.07±2.1	12.97±2.3	13.32±2.2

* Denote significant with pre test phase (p<0/05)
† Denote significant with resistance group (p<0/05)
‡ Denote significant with endurance group (p<0/05)
+ Denote significant with control group (p<0/05)

Moreover, after eight weeks, the results of the one way Analysis of Variance along with Tukey's post hoc test demonstrated significant difference in the amount of VO_{2max} between endurance, combined endurance-resistance and combined resistance-endurance groups, on the one hand, and resistance and control groups, on the other ($P<0.05$).

Body fat percentage significantly decreased after eight weeks of training in the endurance ($P= 0.002$), combined endurance-resistance ($P= 0.001$), combined resistance-endurance ($P= 0.001$) and resistance ($P= 0.003$) groups compared with the pre-test stage (before doing exercises) while body fat percentage of the control group did not change. Moreover, this factor decreased in the combined endurance-resistance, combined resistance-endurance, resistance and endurance groups compared with the control group and the amount of this decrease in the combined endurance-resistance and combined resistance-endurance groups was more than that of the resistance and endurance groups. Fat free body mass in resistance ($P= 0.001$), combined endurance-resistance ($P= 0.003$) and combined resistance –endurance ($P= 0.003$) groups significantly increased compared with the pre-test stage (before doing exercises). At the same time, fat free body mass of the endurance ($P= 0.094$) and control ($P= 0.15$) groups did not show a within group significant difference. The results of the one way Analysis of Variance along with the Tukey's post hoc test demonstrated significant increase of the fat free body mass after eight weeks of training in combined endurance-resistance, resistance-endurance and resistance groups compared with the control and endurance groups; the amount of this increase in the resistance group was more than that in other groups. After four weeks, total body water percentage in the endurance ($P= 0.004$), combined endurance-resistance ($P= 0.003$), combined resistance-endurance ($P= 0.003$) and resistance ($P= 0.004$) groups significantly increased compared with the pre-test stage (before doing exercises). Also, this factor significantly increased in the endurance ($P= 0.001$), combined endurance-resistance ($P= 0.0001$), combined resistance-endurance ($P= 0.0001$) and resistance ($P= 0.0001$) groups compared with the pre-test stage (before doing exercises) while total water percentage of the control group ($P= 0.22$) did not show within group significant differences. Furthermore, one way Analysis of Variance along with Tukey's post hoc test indicated significant difference between experimental groups and control group after eight weeks of training as far as total body water percentage was concerned ($P< 0.05$).

4. DISCUSSION

The results of the study showed that there was significant difference between the groups in the total body water percentage after four and eight weeks of training. In the combined endurance-resistance, combined resistance-endurance, resistance and endurance groups, total body water percentage increased after four and eight weeks of training compared with the control group, which was in correspondence with the findings of Takeno *et al.* (2001). Therefore, doing physical activities can generally lead to the increase in the total body water, which may be due to the decrease of body fat since there is a negative relationship between body fat and body water. Also, it is because of the increase in the mechanism performance of renin angiotensin, aldosterone and anti-diuretic hormone while doing exercises that an increase in plasma volume

and extracellular fluid happens (Takeshima *et al*., 2004; Masomeh Kamyabnia, 2011). Significant difference was observed between the groups in the fat free mass after four and eight weeks of training. In the combined endurance-resistance, combined resistance-endurance and resistance groups, fat free mass significantly increased compared with the control and endurance groups after four and eight weeks of training, which was not significant during the first four weeks of training compared with the control and endurance groups; however, complete performance of training program in the second four weeks significantly increased fat free body mass, which was probably because of muscular hypertrophy in the combined endurance-resistance, combined resistance-endurance and resistance groups as a result of doing training programs during the second four weeks. That was because performing resistance training first led to neural adjustment and increased resistance; then, muscular hypertrophy happened which increased resistance. The increase in fat free body mass in these three groups during the second four weeks may be due to muscular hypertrophy. No significant changes were observed in the control and endurance groups, as far as fat free body mass was concerned. Therefore, all the training programs of combined resistance-endurance, combined endurance-resistance and resistance increased fat free body mass during the eight weeks and these findings were in line with those obtained by McCarthy (1995), Zabiholah Tarasi *et al.* (2011) and Akbarpour Beni *et al.* (2011) (McCarthy, 1995; Akbarpour Beni *et al*., 2011; Zabiholah Tarasi *et al*., 2011); however, they were not in parallel with those found by Poehlman (2000) and LeMura (2000) which reported lack of change in fat free body mass, probably because of differences in gender, readiness level and training program types of different investigations (LeMura, 2000; Poehlman, 2000). There was significant difference in the body fat percentage after four and eight weeks of training between the groups. In the combined endurance-resistance, combined resistance-endurance, resistance and endurance groups, body fat percentage decreased significantly compared with the control group after four and eight weeks of training. Therefore, performing these training programs for four weeks significantly decreased body fat percentage, which was probably because of the increase in the muscle mass percentage and consuming more energy. This led to the drop in body fat percentage after performing training programs. In addition, significant difference was observed between endurance and resistance groups after eight weeks of training as far as body fat percentage was concerned; this difference was not observed between the two groups in the first four weeks of training so that endurance training for eight weeks significantly decreased body fat percentage compared with the resistance group and, in the control group, no change was observed in the body fat percentage. Furthermore, after eight weeks of training, the level of body fat percentage in the combined endurance-resistance and combined resistance-endurance groups had more decrease relative to the endurance group, which was not statistically significant. Probably, if the duration of training program was more than eight weeks, this decrease could have been significant. Although the training programs of the groups were considered the same in terms of intensity and duration in this study, possibly the participants of the combined groups consumed more energy than the ones in the endurance or resistance groups because no energy measurement was conducted in this study. Decrease of body fat percentage in the training groups in this study was in line with the results of McCarthy (1995), Wallace *et al.* (1997), Zabiholah Tarasi *et al.* (2011) and Akbarpour Beni *et al.* (2011) (McCarthy, 1995; Akbarpour Beni *et al*., 2011; Zabiholah Tarasi *et al*., 2011). In contrast, they were not in correspondence with the findings of Poehlman (2000) and LeMura (2000) who reported lack of change in

body fat percentage; this may be because of differences in their gender and training program (LeMura, 2000; Poehlman, 2000).

In brief, considering the findings of this study, it can be stated that eight weeks of combined endurance-resistance and combined resistance-endurance training increased total body water percentage just like the resistance and endurance programs which were done separately. Fat free body mass and fat body percentage increased and decreased as a result of doing combined training, respectively. Similar to the decrease of body fat percentage in this study, some other investigations have reported decrease of body fat percentage after combined training, which was more than the one in the endurance and resistance training.

5. CONCLUSION

In sum, it can be stated that performing combined resistance-endurance training is more helpful than endurance or resistance training for reducing body fat percentage of non-athlete people. Also, there was no significant difference between combined resistance-endurance and combined endurance-resistance groups as far as total body water, fat free mass and body fat percentage were concerned. Therefore, the order of performing these exercises does not make any difference.

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REFERENCES

Akbarpour Beni, M., A. Mohsen and S. Hamid, 2011. The effect of combined strength-endurance training on the improvement of cardiovascular disease risk factors of obese middle-aged men. J Annals of Biological Research, 2(6): 123-129.

Bell, G.J., 2000. Effect of concurrent strength and endurance training on skeletal muscle properties and hormone concentrations in humans. Eur J Appl Physiol, 81(5): 418-427. Available from http://www.ncbi.nlm.nih.gov/pubmed/10751104.

Brochu, M., 2000. Modest effects of exercise training alone on coronary risk factors and body composition in coronary patients. J Cardiopulm Rehabil, 20(3): 180-188. Available from http://www.ncbi.nlm.nih.gov/pubmed/10860200.

Dolezal, B.A. and J.A. Potteiger, 1998. Concurrent resistance and endurance training influence basal metabolic rate in nondieting individuals. J Appl Physiol, 85(2): 695-700. Available from http://www.ncbi.nlm.nih.gov/pubmed/9688748.

Hakkinen, K., 2003. Neuromuscular adaptations during concurrent strength and endurance training versus strength training. Eur J Appl Physiol, 89(1): 42-52.

Hendrickson, N.R., 2010. Combined resistance and endurance training improves physical capacity and performance on tactical occupational tasks. Eur J Appl Physiol, 109(6): 1197-1208. Available from http://www.ncbi.nlm.nih.gov/pubmed/20383644. DOI 10.1007/s00421-010-1462-2.

Izquierdo, M., 2005. Effects of combined resistance and cardiovascular training on strength, power, muscle cross-sectional area, and endurance markers in middle-aged men. Eur J Appl Physiol, 94(1-2): 70-75. Available from http://www.ncbi.nlm.nih.gov/pubmed/15616847. DOI 10.1007/s00421-004-1280-5.

LeMura, L.M., 2000. Lipid and lipoprotein profiles, cardiovascular fitness, body composition, and diet during and after resistance, aerobic and combination training in young women. Eur J Appl Physiol, 82(5-6): 451-458. Available from http://www.ncbi.nlm.nih.gov/pubmed/10985600.

Maghsoud Peeri, M.A.A., A. Mohsen and E. Mansor, 2011. The effect of aerobic training on the immune system of aging men. J Annals of Biological Research, 2(5): 299-304.

Maiorana, A., G. O'Driscoll, C. Goodman, R. Taylor and D. Green, 2002. Combined aerobic and resistance exercise improves glycemic control and fitness in type 2 diabetes. Diabetes Res Clin Pract, 56(2): 115-123. Available from http://www.ncbi.nlm.nih.gov/pubmed/11891019. DOI S0168822701003680.

Masomeh Kamyabnia, M.J.B.M.K., 2011. Comparison of physical fitness level among normal weight and obese female university students. J Annals of Biological Research, 2(3): 126-133.

McCarthy, A., 1995. Compatibility of adaptive responsive with combining strength and endurance training. Med. Sic. Sport Exercise, 27(3): 429-436.

Poehlman, E.T., 2000. Effects of resistance training and endurance training on insulin sensitivity in nonobese, young women: A controlled randomized trial. J Clin Endocrinol Metab, 85(7): 2463-2468. Available from http://www.ncbi.nlm.nih.gov/pubmed/10902794.

Pratley, R., 1994. Strength training increases resting metabolic rate and norepinephrine levels in healthy 50- to 65-yr-old men. J Appl Physiol, 76(1): 133-137. Available from http://www.ncbi.nlm.nih.gov/pubmed/8175496.

Shawn Glowacki, P., S.E.M. Ann Maurer, B. Wooyeul, S. John Green and S.F. Crouse, 2004. Effects of resistance, endurance, and concurrent exercise on training outcomes in men. Medicine & Science in Sports & Exercise, 36(12): 2119-2127.

Takeno, Y., Y.I. Kamijo and H. Nose, 2001. Thermoregulatory and aerobic changes after endurance training in a hypobaric hypoxic and warm environment. J Appl Physiol, 91(4): 1520-1528. Available from http://www.ncbi.nlm.nih.gov/pubmed/11568132.

Takeshima, N., M.E. Rogers, M.M. Islam, T. Yamauchi, E. Watanabe and A. Okada, 2004. Effect of concurrent aerobic and resistance circuit exercise training on fitness in older adults. Eur J Appl Physiol, 93(1-2): 173-182. Available from http://www.ncbi.nlm.nih.gov/pubmed/15293053. DOI DOI 10.1007/s00421-004-1193-3.

Wallace, M.B., B.D. Mills and C.L. Browning, 1997. Effects of cross-training on markers of insulin resistance/hyperinsulinemia. Med Sci Sports Exerc, 29(9): 1170-1175. Available from http://www.ncbi.nlm.nih.gov/pubmed/9309627.

Zabiholah Tarasi, Y.B., H. Fatemeh and M. Maryam, 2011. The effect of the sequence of concurrent strength and endurance training on aerobic capacity, anaerobic capacity and maximum strength of male adolescents. Australian Journal of Basic and Applied Sciences, 5(10): 1195-1201.