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Influence of strength, endurance and concurrent training on the lipid profile and blood testosterone and cortisol response in young male wrestlers

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Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

Key words: *young male wrestlers, cardiovascular diseases, anabolic and catabolic hormones, lipid, concurrent training.*

Abstract

Background: *There is little information regarding the effects of concurrent training (endurance and resistance training) on the fat profile, blood testosterone and cortisol response. The aim of the study was to investigate the effect of eight weeks of concurrent training on the fat profile, blood testosterone and cortisol response in young male wrestlers.*

Material/Methods: *Twenty-four young male wrestlers voluntarily participated and were randomly assigned to three groups, namely: endurance training (ET, N=8), strength training (ST, N=8) and concurrent training (CT, N=8). The groups did their training programs three sessions per week.*

Results: *The findings of this study showed that high-density lipoprotein cholesterol (HDL-C) decreased by 33.54% in the strength group (P=0.02). Total Testosterone (TT) experienced a decrease by 30.68% in the endurance group (P= 0.02) and by 41.55% in the concurrent group (P=0.02). Cortisol (cor) increased by 55.73% in the endurance (P=0.00) and by 41.55% in the concurrent (P=0.02) group, respectively. Testosterone-to-Cholesterol ratio (TT:Cor) decreased by 125.80% by and 78.12% in the endurance (P=0.00) and concurrent (0.04) groups, respectively.*

Conclusions: *The results of this study showed that the decrease in HDL, an increasing trend in TT in the strength training group and also a decrease in TT and an improved lipids profile in the endurance and concurrent training groups can be a function of the training type.*

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Introduction

Cardiovascular diseases (CVD) are one of most prominent unpreventable factors all around the world which have caused death of over 3.5 million people in terms of developing communities. Evidence has shown the total cholesterol (TC) level, the low-density lipoprotein cholesterol (LDL-C) level and a high concentration of serum triglyceride (TG) to be associated with development of CVD [1]. Changes of reproductive steroids and glucocorticoids as the main determinant of distributing the fat tissue, considering the hypothalamic-pituitary-adrenal (HPA) axis in interactions and other factors in the fat tissue, like changes of steroid androgens [2], can create different responses to different physical training. Cardiovascular diseases (CVD) are one of the most important non-preventable factors in today's world [3]. The results of investigations have revealed that unfavorable changes in hormones like testosterone, a negative lipid profile and physical inactivity are in relation to the increase in the risk of cardiovascular diseases [4]. Thus, the results of some studies have shown that a high concentration of total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) and triglyceride (TG) can be influential in increasing the risk of cardiovascular diseases [5]. Also, there are results showing a high prevalence of CVD and high levels of plasma testosterone among men [6], while some other studies have determined that a decrease in the level of testosterone can be a fundamental factor for increasing the risk of cardiovascular diseases in men. In fact, the role of gender should be considered in the response to changes in the lipid profile, steroid hormones and cardiovascular diseases [1]. The results of studies on physical activity have shown that concurrent training (a combination of strength and endurance training) can improve the lipid profile. Similarly, endurance training alone can improve the lipid profile; however, contradictive results have been demonstrated for strength exercises [7]. In addition, strength training can increase testosterone and muscle hypertrophy [8] while endurance training, especially long-term aerobic training, is accompanied by a decrease in testosterone circulation in blood plasma [9]. Considering all this, researchers have demonstrated the negative effect of testosterone on the cardiovascular system by showing the increase in cardiovascular diseases and heart hypotrophy [10]. The present study's hypothesis is as follows: considering the fact that an increased concentration of endogen testosterone may result in an increased level of LDL and a decreased level of HDL and also the fact that strenuous exercise is considered as the main part of young wrestlers' training schedule, a combination of aerobic and strenuous training may boost the testosterone level regulating adverse changes in the lipid profile. Therefore, the present study aimed at finding the effect which concurrent aerobic and strenuous training may have on testosterone concentration and the lipid profile in young wrestlers.

Material and methods

Participants

Twenty-eight young male wrestlers with the age range of 19 to 22 years (their mean, SD, height, weight, age and BMI are given in Table 1) voluntarily participated in this study. After providing written consent, they were randomly assigned to three groups: endurance training (ET), N=9; strength training (ST), N=8; and concurrent training (CT), N=8). The participants were selected from the same cultural and economic background and their nutrition was normal. The training was conducted in the months of May-June, especially when the weather is hot. A written consent was received from the ethical committee for blood tests; this was based on the ethical standards explained by Harris [11]. The criteria for choosing the participants were their full cardiovascular and pulmonary health, having no diseases or hormonal disorder for at least two months before the test. In addition, they were asked not to use any drugs and stimulants like caffeine or alcohol before starting the training. The initial criteria of health evaluation were applied through the questionnaire designed by the researchers. The health condition of the heart, the gland and the lungs function of all the participants were examined by a physician during the pre-test. The subjects in this study were all casual wrestlers – practicing for six-eight months and treating wrestling just as a kind of physical activity rather than taking a serious professional approach toward it; after adding the training program, frequency of the wrestling training sessions have been decreased to two sessions.

Tab. 1: General specifications of the participants

Wariables	Concurrent training (n=8)	Strength training (n=8)	Endurance training (n=8)
Age (year old)	21±1.06	20.50±1.19	20.50±1.19
Height (cm)	1.73±0.64	1.73±0.31	1.71±0.62
Weight (kg)	69.02±6.38	67.90±5.03	61±6.77
Body mass index (kg/cm^2)	23.07±1.87	22.60±1.25	22.10±1.30

Research Design

The present research was implemented by doing strength, endurance and concurrent training. This study was conducted for over eight weeks and all subjects took three sessions each week. The participants were examined prior to training, after the fourth week and at the end of the eighth week. Therefore, all the blood tests were conducted three times during the study; the first session (the control period) was done to determine the stability, consistency and reliability. The test for each person was conducted at the same time of the day. The sum of the weight of the people was measured and calculated with no clothes and shoes on using the standard processes and digital measurement criteria. Their height (without shoes) was calculated in millimeters (mm) and using a stadiometer with standard rating (Karada Scan, HBF362).

Strength training

All the participants of the strength group practiced for two sessions after the beginning of the training period. All the participants exercised all the six movements as a warm-up before starting the main training session. Specialized exercises were conducted in a set with 25 repetitions of a very low load on the lower and the upper body parts [12]. The strength training program included bench press, toe raise, shoulder press, squat, lateral pull down and leg curl with 90 to 120 seconds' rest between each exercise. In the first week, the strength training was done in two sets, 10 repetitions and 55% 1RM; all these six movements gradually reached three sets, 6 repetitions and 85% 1RM at the end of the eight week [13]. During the fourth week, the level of training was decreased in order to improve the performance and prevent excessive injury. In the next stage, the maximum strength test was conducted in order to determine 1RM. The training program of the second four-week period was designed according to the obtained 1RM. In each set, the volume of repetition and implementation were fixed.

Endurance training

The endurance training group participated in an advanced running program using the treadmill which lasted for 16 minutes at 65% of the maximum heart (HR max) during the first week. The maximum heart rate was determined using the following formula: HR max (HR max = 220 – age). Every two weeks, the intensity of the training was increased by 5% and its time duration was increased by two minutes in each session so that the intensity and duration of training reached 80% HR max and 30 min at the end of the eighth week [13]. The equipment used in this training was "T 9700 HRT Vision Fitness".

Concurrent training

All the participants in the concurrent group conducted a combination of all the training programs of the strength and endurance groups. During the training period, each subject performed the same evaluation protocol including anthropometric, field, and laboratory tests. The subjects did not perform any intense physical activity during 24 to 48 hours preceding each test. The strength training was done before the endurance training between which there was a 15-20 minutes' resting period. This training method was approved by Leperes et al. [14], because doing aerobic training before strength training induces an increase in fatigue. Hence the subjects should do the strength training before endurance training because of less fatigue.

Blood collection method

The blood samples were collected between 8 and 8:30 a.m. (in three steps of the pre-test, the end of the fourth week, the end of the eighth week). This was conducted using the following criteria: after eight hours of sleeping, 12 to 14 hours of fasting and two days of resting. After doing the training in each session, the time of blood taking was determined because of the circadian rhythm of hormones [15]. 5 cc of blood sample was collected from each participant and then centrifuged for 10 minutes (at 2500 rpm). The obtained serum was frozen at the temperature of – 20oC for analysis. The measurement variables included VLDL-C, LDL-C, HDL-C, TC, TG, testosterone and cortisol. In order to measure TT in the unit of ng/ml with 0.038 pg/ml sensitivity and Cor in the unit of micg/dl and 0.025 mg/dl sensitivity, the Monobind Inc.n kit was used by the ELISA method. The Colorimetric Diagnostic kit (thermo, Arlington, TX) was used to measure TC and TG, and HDL-C was measured using the modified heparin – MNCL1 – dextran sulfate method in mg/dl units. To obtain the ratio of TT:Cor, the units were turned to nmol/l.

Statistical method

In this research, SPSS (Version 16) software was used. The research design included three tests: a) within-case (three sessions of measurement), b) between-case (three strength, endurance and concurrent groups) and c) the mixed factorial test (within-case analysis of variance with repeated measures). To compare the scores of the variables in the three groups of the pre-test, the mid-test and the post-test and to normalize the data, the intergroup analysis of variance and Kolmogorov-Smirnov test were used, respectively. The statistical method of dependent t was used in order to compare muscular fitness progress in the pre-test to post-test. Furthermore, one-way statistical method was utilized in order to compare the differences in within groups progress. In the test, the minimum level of significance was considered as $p<0.05$.

Results

There was no significant difference in the weights ($F2=0.25$; $P=0.77$) and the body mass index ($F2=0.14$; $P=0.86$) among the participant groups before and after the eight weeks' training ($P > 0.05$) (Table 2). The findings of this research showed no significant differences for the serum cholesterol in the three measurement steps ($F2=0.28$; $P=0.81$). Also, serum LDL-C did not show any significant difference in the three measurement steps ($F2=0.72$; $P=0.49$). HDL-C had a significant difference in the three measurement sessions ($F2=3.85$; $P=0.03$). Coefficient η showed that 68% of variability of the HDL-C variable was caused by the eight-week training of the participants in the strength group ($F2=6.20$; $P=0.03$). This difference between the two steps of the mid-test and the post-test showed a 33.544% decrease ($P= 0.02$). Serum TG did not show a significant difference in the three measurement sessions ($F2=0.02$ and $P=0.98$). Similarly, serum VLDL had no significant difference ($F2=0.98$; $P=0.39$). The TC:HDL-C ratio of serum was not significantly different ($F2=3.46$; $P=0.05$) and the n-coefficient showed that the 0.27 variability of the TC:HDL-C ratio was caused by the eight weeks of training, which showed a 6.96% increase in the strength group (Table 3). Serum TT was significantly different in the three measurement steps ($F2=13.85$; $P=0.00$). The increasing trend of TT was observed in the strength group, which was statistically insignificant ($F2=1.6$; $P=0.89$). The average of serum TT in the three measurement steps of the endurance group was significantly different ($F2=6.54$; $P=0.03$). Coefficient η showed that 0.69 variability of serum TT was caused by eight weeks of endurance training, which was significant in the pre-test and the post-test and decreased by 30.68% ($P= 0.02$). Coefficient η showed that 0.79 variability of serum TT in the concurrent group was caused by eight weeks of concurrent training ($F2=0.83$; $P=0.20$), the significance of which decreased by 41.55% in the pre-test and the post-test ($P=0.02$). The average of serum cor was significantly different in three measurement steps ($F2=19.79$; $P=0.00$) and coefficient η showed that 97% variability of cortisol increase in the endurance group was caused by the eight weeks of endurance training ($F2=99.19$; $P=0.00$). This variability was significantly different between the mid-test and the post-test and showed 55.738% increase ($P=0.00$). 64% of cortisol variability in the concurrent group was due to eight weeks of concurrent training

(F2=5.78; P=0.04), which was significantly different between the mid-test and the post-test, which showed 48.586% increase (P=0.02).

There was a significant difference between the three measurement steps as far as the average of TT:Cor ratio was concerned (F2=16.20; P=0.00). The coefficient η showed that 87% variability in the endurance group was caused by eight weeks of endurance training (F2=19.644; P=0.00) which was between the mid-test and post-test and showed a 125.80% decrease (P=0.00). Noticeable variability was observed in the concurrent group equaling to 63% which was not statistically significant (F2=5.04; P=0.05). This difference was significant between the mid-test and the post-test and showed 78.125% increase (P=0.04). No significant difference was observed between the variables in the three training groups (p > 0.05) (Table 4). The strength training group showed a significant increase in all movements; the endurance group showed significant reductions in bench press, lateral pull-down, and shoulder press; the concurrent group showed significant differences in all the movements except squat (p<0.05). Significant differences were detected in comparison of the muscular fitness progress among three groups in bench press (F2 =93.29; P=0.00), lateral pull-down (F2=06.56; P=0.00), and shoulder press (F2=06.51; P=0.00), (Table 5).

Tab. 2. Body mass index (mean ± SD)

Variables	Endurance training		Strength training		Concurrent training		p
	pre-test	post-test	pre-test	post-test	pre-test	post-test	
Weight	68.40±6.77	64.3±6.57	67.90±5.03	67.50±5.51	69.02±6.38	67.26±6.49	0.15
BMI	23.07±1.30	21.78±2.05	22.60±1.25	22.46±1.36	23.07±1.87	22.56±2.81	0.18

BMI – Body Mass Index, significant difference (p ≤ 0.05)

Tab. 3. Mean ± SD of the lipid profile

Variable	Endurance group			Strength group			Concurrent group			p in 3 stages
	pre-test	mid-test	post-test	pre-test	mid-test	post-test	pre-test	mid-test	post-test	
TC mg/dl	126.75±1.3	129.75±2.3	126±2.2	127.25±2.2	132.88±1.4	125.38±2.0	130±2.6	122.62±2.0	122.88±2.2	0.81
LDL-C mg/dl	66.37±1.7	57.75±2.9	62.62±2.6	67±2.0	67±1.9	67.50±2.3	72.12±14.2	62±1.4	62.50±2.3	0.49
HDL-C mg/dl	41.15±1.1	54.62±7.5	46.87±1.8	43±8.5	52.75±1.1	39.50±1.6	41.50±9.3	43.37±9.4	42.37±8.7	0.03††
VLDL-C mg/dl	18.87±4.2	16.25±0.6	16.25±0.4	17.25±1.8	16.50±0.7	17.62±1.1	16.37±0.5	17.25±2.1	17.87±2.9	0.39
TG mg/dl	94.25±2.1	82.50±2.8	81.12±1.2	87±9.5	82.75±2.9	88±5.4	82.12±2.3	89.37±1.5	90.87±1.3	0.98
TC:HDL-C ratio mg/dl	3.21±0.7	2.40±0.5	2.89±0.9	3.13±1.1	2.60±0.5	3.35±0.8	3.20±0.4	2.88±0.4	3.01±0.8	0.05
HDl-C: LDL-C ratio mg/dl	1.71±0.5	.078±0.5	1.50±0.8	1.71±1.0	1.33±0.4	1.86±0.8	.78±0.4	1.46±0.4	1.57±0.7	0.06

❋Significance level of serum TC, TG, HDL-C, LDL-C, VLDL-C, TC:HDL (p ≤ 0.05).
†† Significant difference of serum HDL-C in the strength group (P=0.025).
TC – total cholesterol; LDL-C – low-density lipoprotein cholesterol; HDL-C – high-density lipoprotein cholesterol; VLDL-C – very low density lipoprotein cholesterol; TG – triglycerides.

Tab. 4. Mean ± SD of the hormones

Variable	Endurance group			Strength group			Concurrent group			p in 3 stages
	pre-test	mid-test	post-test	pre-test	mid-test	post-test	pre-test	mid-test	post-test	
TT Nmol/l	20.15±23	22.60±4.4	12.42±4.1	18.80±4.1	20.45±8 7	19.05±2.9	18.53±2.1	18.54±4.5	13.09±3.1	00.0 ††
COR Nmol/l	490.8±2.6	320.3±3.2	498.8±8.2	490.8±2.6	364.38±9.1	441.5±1.2	464.43±2.3	326.76±4.7	485.52±1.0	00.0 ‡‡‡
TT:Cor Nmol/l	0.05±0.0	0.07±0.0	0.03±0.0	0.04±0.0	0.05±0.0	0.04±0.0	0.04±0.0	0.05±0.0	0.03±0.0	00.0 †‡ †

* Significance level of serum total testosterone, Cortisol, Total Testosterone: Cortisol (p<0.05)

□Significance of total testosterone (TT) in the endurance group

†† Significance of total testosterone (TT) in the concurrent group

‡‡ Significance of cortisol (Cor) in the endurance group

‡ Significance of cortisol (Cor in the concurrent group

† Significance of testosterone-to-cortisol ratio (TT:Cor) in the endurance group

‡† Significance of testosterone-to-cortisol ratio (TT:Cor) in the concurrent group

Tab. 5. Mean ± SD of the maximum muscular strength

Variable	Endurance group				Strength group				Concurrent group			
	pre-test	post-test	mean diff	p	pre-test	post-test	mean diff	p	pre-test	post-test	mean diff	p
Bench press ‡†	70.15±17.07	67.92±15.71	-2.23	0.03	66.11±8.50	70.30±8.14	4.19	0.00	62.23±7.45	64.85±7.28	2.62	0.00
Leg curl	104.74±42.41	115.09±19.23	10.35	0.51	117.93±21.62	122.62±20.59	4.69	0.00	113.46±18.35	116.62±18.62	3.16	0.00
Lateral pull down	73.75±14.03	70.53±14.47	-3.22	0.00	73.04±12.03	78.11±11.84	5.07	0.00	65.82±5.35	69.23±5.93	3.41	0.00
Squat	85.70±32.65	96.20±14.68	10.5	0.46	90.99±15.38	95.77±15.18	4.78	0.00	97.22±12.73	98.03±15.46	0.81	0.73
Shoulder press ‡†	62.06±15.22	59.17±15.78	-2.82	0.00	58.62±8.21	62.81±8.55	4.19	0.00	56.47±8.47	60.49±7.71	4.02	0.00
Toe raise	220.73±22.76	203.14±42.98	-17.59	0.23	225.49±21.60	228.31±21.47	2.82	0.03	212.45±22.45	215.02±22.03	2.57	0.00

‡ Significant between strength and endurance training groups (P=0.00)

† Significant between endurance and concurrent training groups (P=0.00)

Discussion

In the present study, the effect of eight weeks of strength, endurance and concurrent training on the lipid profile and the concentration of testosterone and cortisol were investigated.

Lipid profiles

Exercises have noticeable effects on the size of lipoprotein particles in peripheral fat oxidation through the hepatic mechanism, especially high hepatic lipase activity (HL) which is related to the high ratio of small HDL to large HDL [16]. It has been shown that aerobic training can decrease the hepatic lipase activity. A decrease in the level of HL during six months of activity leads to an increase in the concentration of large HDL2; there were no significant changes in the case of HDL3 levels [17]. Although any weight reduction could explain the change in HDL and might also offer insights into the change in testosterone and cortisol, there was no significant weight loss among wrestlers. The TC:HDL-C ratio is used as a method for investigating cardiovascular diseases in middle-aged men [18]. Stampfer et al. [18] demonstrated that a negligible decrease (one unit) in the TC:HDL-C ratio was accompanied by a 53% decrease in the participants' risk of CHD (*coronary heart disease*). In this regard, there was a noticeable increase equal to 6.96% in the TC:HDL-C ratio in the strength group. However, the results of the effects of strength training on the lipid profile have shown that this type of training does not improve the lipid profile in a similar way to endurance training [19]. The results of this study on measuring the lipid profile showed 33.54% decrease in HDL-C in the strength group. Ghahramanloo et al. [7] and Mirghani et al. [20] demonstrated that the combination of strength and endurance training had a positive effect on the lipid profile, which was in line with the results of this study. The current investigation depicted the increasing trend of serum HDL-C during three measurement steps within eight weeks of training in the concurrent group. Studies conducted on young men have shown an increase in the central arterial compliances as a result of doing strength training [21]. The correct proportion of strength and endurance training for improving the central arterial compliance is unknown; however, in order to increase arterial compliance, the volume of endurance training relative to strength training should be higher [22]. Studies have demonstrated that rowing exercises, which include a combination of strength and endurance training, are associated with high arterial compliance [23]; these changes can be generalized to wrestling exercises.

Testosterone/Cortisol ratio

Research has determined that there may be a relationship between testosterone expression and CAD development [24]. Moreover, other studies have indicated that other sexual steroids have the same effect of testosterone expansion [25]. Considering the gathered information from the patients who use testosterone supplements, it is believed that testosterone supplements have incompatible effects on the profile of lipoproteins and increase the risk of cardiovascular diseases [26]. In another group, studies have shown that low testosterone concentration is related to the coronary artery diseases, and disorders in its circulation levels may create atherosclerosis conditions [27]. These pieces of evidence show that testosterone is noticeably related to the decrease in cardiovascular diseases and death rates. However, some studies have also shown that a high concentration of physiological testosterone is accompanied by a decrease in HDL-C [28]. The MMAS study noted a strong, positive relationship between HDL and testosterone in men with CVD [29]. However, treatment with testosterone does not seem to increase HDL. Some studies have observed that supraphysiologic doses of testosterone will lower HDL [30]. High-density lipoprotein (HDL) cholesterol levels were also found to decrease in patients that were on oral testosterone therapy [31]; in line with these findings, the present research showed a noticeable HDL-C decrease and an increasing trend of testosterone in the strength group. As a result, strength training can effectively decrease serum HDL-C. Hero et al. showed that a higher testosterone level in pubertal boys corresponded with declined adiponectin in the same treatment [32]. Since adiponectin secretion is lower in obese children and adolescents than in their lean peers of corresponding age and pubertal stage [33], this may be explained by the differential changes in body composition; the decrease in relative FM may have protected the pubertal boys from a more profound testosterone-induced decline in adiponectin concentration. Hyperandrogenism could predispose obese adolescent boys to hypoadiponectinemia [32], which is connected with insulin resistance [34], low HDL-C [33], non-alcoholic hepatic steatosis [35], and recently, with signs of early atherosclerosis [36]. In a completely contradictive study, Rosano et al. [4] showed a noticeable relationship between the levels of plasma testosterone and the prevalence of coronary atherosclerosis. It is noted that a decrease in the testosterone level can be an important factor for cardiovascular diseases in men [37]. Ghahramanloo et al. showed that concurrent training had a positive effect on the condition of blood fat and can lead to a decrease in cardiovascular diseases [7], which is in line with the findings of the present study. Testosterone is a strong stimulant for producing protein [38], which has an anti-catabolic property in the muscle skeleton [39]. Also, an increase of cortisol is in relation with metabolism and stress factors of carbohydrate which leads to the protein analysis [17]. Thus, measuring hormone concentration in this research was accompanied by the 30.68% and 41.55% decrease of testosterone in the endurance group and the concurrent group, which showed a decrease in the anabolic situation. Additionally, 48.58% and 55.73% increase in the cortisol of blood serum in the concurrent group and the endurance group showed an increase in the catabolism situation; the cortisol increase in the concurrent group can be caused by the increasing characteristic of cortisol in the endurance group. On the other hand, 125.8% decrease in the TT:Cor ratio in the endurance group indicated a severe increase of the catabolism situation compared with the anabolism one, while Cador et al. demonstrated the improvement of the TT:Cor ratio and the increased catabolism was not shown [15]. However, performing wrestling exercises (2 sessions per week) while doing the training protocol along with the beginning of the training in the hot summer can have a relationship with the severe increase of cortisol. Studies have shown that variations in physiological indicators can be influenced by participants' age, gender, initial exercise condition and the training protocol [40]. Anabolic hormone variations like T and catabolic hormones like Cor may play an important role in concurrent training, in fact, when such an effect is along with the fundamental cortisol increase [41]. Therefore, the participants experienced a fundamental decrease in the anabolic condition and a severe increase in the catabolic condition in the endurance and the concurrent groups. Alternatively, the presence of changes, particularly an increase in cortisol and a decrease in testosterone, may indicate overtraining. The results of previous studies have shown that endurance athletes have less testosterone concentration compared with inactive and old ones [8], which is in line with the findings of this research. On the other hand, Cador et al. showed that no increase was found in the free testosterone level in the endurance group, which can be related to the training period and a constant increase in the volume and intensity [11]. In fact, variations of the blood variables, by themselves, can be caused by twice as high volume of training in the concurrent group compared with the strength and the endurance groups.

Conclusion

Consequently, the data of the present study showed a noticeable increase in the TC: HDL-C ratio and HDL-C decrease, and an increasing trend in concentration of testosterone in the strength training group indicates that probably an increase in testosterone as a result of strength training leads to a negative effect on the lipid profile, especially in individuals taking long-term strength training exercise. Moreover, these results show that the combination of endurance and strength training can decrease testosterone and useful operation of lipid in the blood serum considering the duration, intensity and period of training. Considering the physical and physiological needs and the participants' health, it seems that concurrent training was more useful than the other two individual types of training for developing physical factors and cardiovascular operation. In fact, if the volume of combination training (strength and endurance) can be equalized with the individual strength and endurance training in terms of calorie consumption (energy expenditure), the effect rate can be better evaluated in the results obtained from concurrent training. This point indicates a need for more studies in this regard.

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