EFFECT OF A 6-WEEK WRESTLING AND WRESTLING –TECHNIQUE BASED CIRCUIT EXERCISE ON PLASMA LIPOPROTEIN PROFILES AND HORMONE LEVELS IN WELL-TRAINED WRESTLERS

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ABSTRACT
The effect of 6 weeks of wrestling and wrestling–technique based circuit exercise on the plasma lipoprotein profile and selected hormonal changes was examined in 20 well-trained senior wrestlers. Subjects were randomly divided into two groups, an experimental group participated in 6 weeks of wrestling and wrestling–technique based circuit exercise (WTBCE) and the control group that remained sedentary. Blood samples were taken 48 hours before and after the first and last session of exercise training, respectively. Growth hormone (GH), insulin-like growth factor (IGF-1), testosterone, cortisol, insulin, cholesterol, HDL, LDL, triglycerides (TG), fasting blood sugar (FBS), plasma volume (PV), body weight, body mass index (BMI), body fat, maximum power, fatigue index and VO_2max were measured. In the experimental group, significant decreases were observed in fasting FBS, IGF-1, GH, insulin, cortisol, PV, body weight, BMI, and body fat. Significant increases were observed in testosterone, maximum power, fatigue index and VO_2max. No significant changes in cholesterol, HDL, LDL and TG, were seen in the experimental group. However, when the data was adjusted for the mean decrease of plasma volume in the exercise group, it was shown that cholesterol and HDL decreased significantly ($p<0.05$). There were no significant changes observed in the control group. We concluded that the significant decreases, especially in GH and IGF-1 can affect senior wrestlers' growth during the in-season training.
KEY WORDS: Circuit training, lipoprotein, IGF-1, growth hormone, insulin, cortisol, testosterone.

INTRODUCTION

Wrestling is a very vigorous physical activity and sport. It requires tremendous physical, as well as, significant psychological and emotional preparation. Both anaerobic (i.e. power, speed, strength, anaerobic capacity, lactate tolerance, and anaerobic endurance) and aerobic characteristics are very important for a wrestler's success (1, 2, 3, 4, 5). Wrestling is categorized as a power-anaerobic based sport on the basis of its nature of practice, competition times (3×2min with 30s rest between), and reliance on phosphagen and lactic acid systems for energy provision. Observation of the intensity of wrestling reveals that the anaerobic component is of vital concern. Indeed, the blood lactate concentration in wrestlers has been recently used as indicator of anaerobic power and capacity in successful wrestlers (4, 6). With this in mind, in wrestling, lactic acid training is the main part of the in-season training program. Although the three metabolic systems contribute to energy production in a wrestling practice and match, it is estimated that 90% of the energy used in wrestling comes from phosphagen and lactic acid metabolism, while the remaining 10% can be obtained through aerobic mechanisms (7,8,9). From the perspective of the coach and athletes the emphasis of training will be on the development of maximal strength, speed and power, and less on aerobic power and capacity.

A training program that emphasizes strength, power, speed ability, resistance, explosive, and interval sprint can result in undesirable health and fitness consequences for the participants in power-anaerobic based sports. This is in contrast to the general agreement about the beneficial effects of aerobic based sports and activities on lipid and lipoprotein profiles, The lack of benefits from chronic and acute power-anaerobic based exercise/sports on lipid and lipoprotein metabolism has been shown (10,11,12,13,14,15,16,17,18), including some research that reports a lower HDL-C in power-anaerobic athletes (19,20,21,22). In this regard, Eliakim et al (21) reported that when Olympic athletes were studied on the basis of their HDL-C levels, only one of the power athletes had a high HDL-C (75mg/dl) level and 24 of the other athletes had moderate to low HDL-C (35-45mg/dl) concentrations. They also pointed out that hypercholesterolemia and low levels of HDL-C were more pronounced in power sports (i.e., weight lifting, boxing, wrestling and judo) and anaerobic sports (i.e., tennis, sprints, and jumps, gymnastics, ice skating). The under nutrition of adolescent wrestlers has led several investigators to suggest that weight-loss practices of wrestlers may lead to temporary growth suppression (45, 46). Previous studies of pubescent

wrestlers have shown that some markers of somatic growth indicate decreased incremental growth during the season and increased incremental (catch-up) growth postseason (47, 48). Others have shown that during the sport season, collegiate (post pubertal) wrestlers have reductions in growth-related hormone concentrations (49, 45, 50).

There is no research to date that has studied the hormonal, lipid and lipoprotein response of wrestlers to the stimulus of a wrestling technique-based circuit exercise. The purpose of this study was to examine, the effect of a 6 week wrestling–technique based circuit exercise (WTBCE) on plasma hormone and lipoprotein levels in well-trained wrestlers.

METHODS

Written consent was obtained from the 20 well trained wrestlers who volunteered to participate in the present study. Wrestlers were randomly assigned to two groups, a wrestling and wrestling–technique based circuit exercise (WTBCE) (n=10) or a control group (n=10). The wrestlers were experienced in national and international wrestling competitions. All subjects were asked to complete a medical examination and a medical questionnaire to ensure that they were not taking any medication, were free of cardiac, respiratory, renal, metabolic diseases, and were not using steroids. Also, all the subjects were completely familiarized with all steps of the experimental procedures.

Exercise Testing Procedures: Before the main trial, participants were familiarized with the exercise procedures. The subjects completed a practice session to insure that each participant was able to complete the entire exercise session and also to confirm that the program was producing fatigue at the end of the session. This was confirmed by visual and verbal feedback from the participants. In the first group, subjects participated in a 6 week program, each week containing 8 sessions of training in 4 days (A.M and P.M) and each session contained wrestling exercise (table 1) and WTBCE. WTBCE consisted of wrestling skills/technique circuit and is shown in figure 1. 4 sets of 3 non-stop trips through the circuit exercise (8 stations of wrestling skills set 5m apart, with one-repetition for each technique at their maximum speed). A 2 minute rest was given between the 4 sets. Subjects were given a 5 min rest between the two separate exercise protocols. The entire session lasted for 65 minutes.

Table 1. Protocol of wrestling exercise in the experimental group

2 min exercise	30 sec rest	2 min exercise	30 sec rest	2 min exercise
2 min rest				
3 min exercise		30 sec rest	3 min exercise	

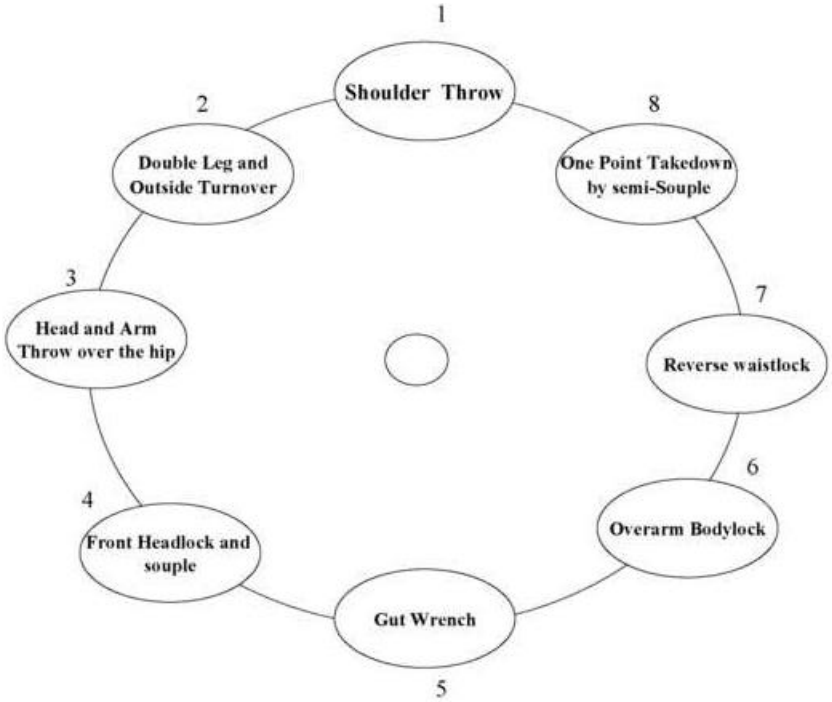

Figure 1: Experimental working plan of WTBCE

The control group remained sedentary. Before and after the 6 weeks of training, the anaerobic and aerobic power of subjects was predicted from RAST (running based anaerobic sprint test) and the Rockport test respectively.

Biochemical analyses: Blood samples (following an overnight fast) were obtained from the antecubital vein of the subjects 48 h before and after of first and last exercise sessions, respectively. Plasma and serum was separated by centrifugation within 15 minutes of collection and divided into three aliquots. The aliquots were frozen and stored at between -20°C and -80ºC for subsequent analyses. The samples were analyzed for glucose, triglyceride (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), GH, cortisol, insulin, IGF-1 and free testosterone. We used a radioimmunoassay kit (KAVOSHYAR, Iran) for the measurement of hormonal changes, with the following specifications: testosterone sensitivity 0.1 nmol/L, inter assay coefficient of variation percent (CV%) =3.8% and intra assay CV%=4.8; insulin sensitivity = 0.5 µIU/ml, inter assay CV%=4.3, intra assay CV% =3.4; cortisol sensitivity = 2 standard deviations from zero, inter assay CV=6.5% intra assay: CV=2.6%; IGF-1 sensitivity 3ng /ml, inter assay CV=7.8%, intra assay CV=2.6%; and GH sensitivity 0.1 µIU/ml, inter assay CV=1.5%, intra assay CV=14% (Wallac Gama counter device). Serum glucose was determined by enzymatic (glucose oxidase) colorimetric method (Pars Azmoun Co, Tehran, Iran). The assay sensitivity was 1 mg/dL and the intra assay CV was 1.2%. Serum HDL-C was determined by the direct immune-method (HDL-C Immuno FS, Pars Azmoun, Tehran, Iran), the intra-assay CV% was 1.2 and the sensitivity of the method was 0.03 mmol/L. Cholesterol was determined by enzymatic (cholesterol oxidase) colorimetric method (Pars Azmoun Co, Tehran, Iran). Serum total triglyceride (TG) was determined by enzymatic (GPO, glycerol-3-phosphate oxidase) colorimetric method (Pars Azmoun, Tehran, Iran), the intra-assay CV and sensitivity of the method were 2.2% and 1 mg/dL, respectively. Serum total cholesterol (TC) was determined by enzymatic (CHOD-PAP, cholesterol oxidase-amino antipyrine) colorimetric method (Pars Azmoun, Tehran, Iran), the intra-assay CV and sensitivity of the method were 1.9% and 0.08 mmol/L. Changes in plasma volume were calculated by using the Dill-Costill (33) and Aguiló (34) method based on hemoglobin and hematocrit estimation. Before and after 6 weeks training, body weight was measured with a digital weight scale (Babilyss, PRC), body fat predicted from 5 skin fold method with a Lafayette caliper (Lafayette Instrument Co.)

Statistics: The data were analyzed using an SPSS package (version 10.1). Paired sample T tests were used to compare pre and post tests, and a one-way ANOVA for the comparison of different values of tests between groups. Statistical significances was accepted at $p<0.05$. Significant effects were also followed by the appropriate planned comparisons.

RESULTS

The descriptive characteristics of the subjects are listed in table 2.

Table 2: characteristics of subjects of experimental and control group

	mean				
	age	height	weight	BF%	BMI
Exercise group	18.5±2.5	170.5±7.5	71.2±23.4	16.25±8.25	24.8±6.81
Control group	18 ± 1	170.5±7.5	62.6±19.4	15.9±7	23.275±4.125

Table 3 lists the mean values of the study's dependant variables. There were no significant changes observed in the variables in the control group. In the exercise group there were no significant changes in cholesterol, HDL, LDL and TG. However, when the data was adjusted for the mean decrease of plasma volume in the group (fig. 2), it was shown that cholesterol and HDL in the exercise group decreased significantly ($p<0.05$).

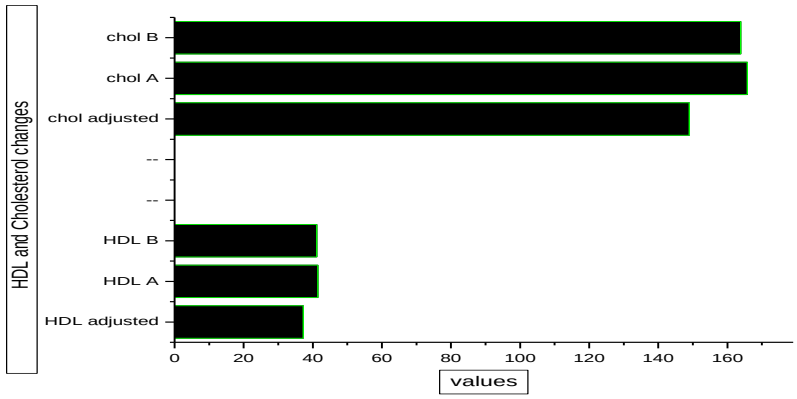

Figure 2: *HDL and cholesterol changes, before exercise (HDL B, CHOL B), after exercise (HDL A, CHOL A) and adjusted.*

significant decreases in fasting blood sugar (FBS), IGF-1, GH, insulin, cortisol and plasma volume (PV), body weight, BMI (p<0.05), and body fat (P<0.001). Significant increases were observed in testosterone, maximum power, fatigue index and VO_2max (P<0.001).

Table 3. Values for Study Variables

	Control Group		Exercise Group	
	Mean before exercise period	Mean after exercise period	Mean before exercise period	Mean after exercise period
Insulin (µIU/ml)	6.13	6.27	9.44	6.58
GH (µIU/ml)	4.75	4.62	4.97	3.12 *
IGF-I (ng /ml)	228.88	226.11	266.11	260.00
Testosterone (nmol/L)	4.48	6.83	5.20	7.35 *
Cortisol (nmol/L)	518.88	431.44	501.11	235.11 **
HDL (mg/dL)	35.50	36.00	41.11	41.44
LDL (mg/dL)	89.75	90.12	95.88	103.22
TG (mg/dL)	88.25	92.12	134.11	106.11
Cholesterol (mg/dL)	142.75	144.50	163.88	165.77
Fasting blood sugar (mg/dL)	85.25	79.00	87.00	78.66 *
Plasma volume (%)	55.42	52.97	55.88	50.15 **
Fatigue index (watts)	8.38	8.57	7.66	10.29 **
Maximum power (watts)	614.98	614.39	601.83	688.88 **
VO_2 max (ml/kg/min)	67.73	68.63	67.19	70.02 *
Body weight(kg)	62.56	62.37	68.44	67.25 *
Body fat (%)	14.28	14.33	12.77	9.53 **
BMI (kg/m2)	21.61	21.54	23.63	23.23 *

* (p<0.05) ** (p <0.001)

DISCUSSION

The main findings of this research were significant decreases in fasting blood sugar (FBS), IGF-1, GH, insulin, cortisol and plasma volume (PV); and significant increases in testosterone and maximum power, fatigue index and VO_2max in the experimental group. An insignificant change in PV after an intermittent and resistance exercise has been reported by previous studies (35,36), but in our study there was a significant decrease, The decrease in GH concentration in the present study may have been caused by a increased negative hypothalamic feedback by IGF-1 or an increase in GHBP concentration. The growth effects of GH are enhanced by GH secretion, which would need to increase to account for the reduced GHBP concentration and ensure continuation of normal growth (57). Roemmich reported a preseason to late season significant elevations for morning serum concentrations of growth hormone, that is opposite with our findings. In present study, decrease in GH concentration, can affect the normal growth in senior wrestlers (48). It has been shown that small weight loss in normal weight individuals reduces the serum insulin concentration and increases growth hormone (GH) secretion patterns (58, 59, 63).

Insulin levels may play an inhibitory role in GH secretion. Insulin is known to inhibit GH translation in the rat pituitary (60), therefore a reasonable supposition is that any decrease in plasma insulin levels in the experimental group is probably not responsible for the decrease in plasma GH concentration in these subjects.

A direct correlation between IGF-1 and GH has been previously demonstrated in normal subjects (61). GH secretion and dietary intake are both important modulators of the IGF-1 concentration. A reduced protein intake decreases IGF-1, and a subsequent refeeding abruptly increases IGF-1 (62). Therefore one of the possible reasons for a decrease in IGF1 concentration along with decrease in GH levels can be due to an inadequate diet during the training weeks. One of the possible reasons for decrease in IGF-1 concentration could be the increase in plasma insulin-like growth factor-binding protein 3 (IGFBP3), because most circulating IGF-1 is bound to IGFBP3 (51), which inhibits IGF-1 action, because IGF/IGFBP3 complexes do not bind to IGF-1 receptors (52). Furthermore, IGFBP3 inhibits IGF-1 action when present in an excess molar ratio (53).

Albumin and sex hormone-binding globulin (SHBG) are plasma proteins that limit the amount of biologically active free T (54). Horswill et al reported that, serum albumin concentrations of adolescent wrestlers do not change over a sport season (55), although the wrestlers' SHBG concentrations increased (56). Increase in serum testosterone in the experimental group can be due to an increase in hormone production or a decrease in hormone clearance.

A 13% increase in plasma HDL-C level after a single maximal treadmill exercise test on lasting 12-14min was observed in wrestlers by Sgouraki (40). In another study by Sgouraki (41), with the same exercise test, wrestling and control groups showed significant increases in HDL-C levels compared to resting values (13% and 14.4% respectively), but in our study there was a significant decrease in HDL levels (when values was adjusted for the mean decrease of plasma volume). Discrepancies between our results with those previously reported could also be explained by general factors such as duration, intensity or energy expenditure per session, resting period, mode of exercise (11,12,17,18), and diet (43,44).

PRACTICAL IMPLICATIONS/ADVICE FOR ATHLETES AND COACHES

The present data indicate that wrestling and wrestling-technique based circuit resistance (WTBCE) can generate the same metabolic changes as other circuit-resistance exercise models. In summary we can conclude that significant decreases, especially in GH and IGF-1 can affect the wrestlers' growth during in-season training. This can be due to the high intensity of the training exercise, and the possible of an inadequate dietary intake of both total calories and protein intake. Attention must be given to appropriate rest and recovery, along with monitoring dietary practices during intense training.

The findings with serum HDL-C seems to indicate that reverse cholesterol transport (RCT) processes may be temporarily decreased in power athletes. The significant decrease in HDL and plasma volume in experimental group shows that for the control of heart disease risk factors in senior wrestlers, endurance training must be added to the wrestlers' preparation programs for continued long-term health.

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LES EFFETS DE 6 SEMAINES DE LUTTE - LA TECHNICITE DE LA LUTTE ELABOREE A PARTIR D' UN CIRCUIT D'EXERCICES INFORMANT SUR DES PROFILS LIPOPROTEINIQUES PLASMATIQUES ET DES NIVEAUX D'HORMONES CHEZ DES LUTTEURS BIEN ENTRAINES

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RÉSUMÉ
L'effet de 6 semaines de lutte et la technicité de la lutte se basant sur un circuit d'exercices avançant des profils lipoprotéïniques plasmatiques et certains changements hormonaux ont été examinés chez 20 lutteurs très bien entraînés. Les sujets ont été répartis au hasard en deux groupes, le groupe expérimental a participé à 6 semaines de lutte et à un Circuit d'Exercices sur la Technicité de la Lutte (CETL) tandis que le groupe témoin est resté sédentaire. Des échantillons de sang ont été prélevés 48 heures avant et après le premier et le dernier entraînement physique, respectivement. L'Hormone de Croissance (HC), Facteur de Croissance analogue à l'Insuline (FCI-1), la testostérone, le cortisol, l'insuline, de cholestérol, HDL, LDL, triglycérides (TG), glycémie à jeun (GAJ), le volume plasmatique (VP), le poids corporel, l'indice de masse corporelle (IMC), le corps gras, la puissance maximale, l'indice de la fatigue et la VO2max ont été mesurés. Des diminutions significatives dans le jeûne FBS, l'FCI-1, HC, insuline, le cortisol, VP, le poids corporel, l'IMC et la masse grasse corporelle, augmentation significative a été observée de la testostérone, la puissance maximale, l'indice de la fatigue et la VO2max. Pas de changement significatif du taux de cholestérol, HDL, LDL et de TG, ont été observés dans le groupe expérimental. Dans le groupe contrôlé, toutes les variables n'ont pas sensiblement changé. Nous avons conclu que des diminutions significatives, en particulier dans GH et d'IGF-1 peuvent affecter la croissance des lutteurs seniors lors de la formation en cours de saison. Il semble que ce type d'exercices peut être considéré comme un stimulant pour les réactions métaboliques.
MOTS-CLÉS: entraînement en circuit, des lipoprotéines, l'IGF-1, l'hormone de croissance, l'insuline, le cortisol, testostérone.