

The Effects of Intensive Training on Selected Sex Hormones in Young Wrestlers

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ABSTRACT Adolescence is a crucial period for growth and sports training during this period, besides its positive effects, may have negative effects on growth. The aim of the present study was to evaluate the effect of an 8-month intensive training on selected hormones in young male wrestlers. Forty-five subjects (13.94±0.57) volunteered as the training group (TG) and a control group (CG) of 35 non-athlete subjects (13.93±0.51) was assigned. TG attended to an 8-month wrestling training program for 5 days a week 90 minutes per day. CG did not receive any exercise sessions. Homogeneity of data was tested by using Kolmogorov-Smirnov test ($p>.05$) and independent samples t-test was used to analyse the significance of the differences between pre and post-tests. Change in luteinising hormone levels was significant ($p<.01$) but no significant difference was observed in the other hormone levels ($p>.05$) or BMI ($p>.05$). In conclusion, long-term intensive training caused alterations in LH hormone responses in young wrestlers.

INTRODUCTION

Alike other combat sports, wrestling is a sport whose success greatly depends on well-developed motor performance and skills. For an efficient preparation of a wrestling competition, the athletes usually have 12-20 weeks of physical training session and in this period all the performance components must be developed (Passelergue and Lac 2012). It has been speculated that the physiological stress is associated with competitive wrestling, along with nutrient and fluid restriction to slow the somatic growth of young wrestlers (Roemmich and Sinning 1997) and it is also known that applying rapid weight loss methods had deleterious effects on the immune systems of wrestlers (Ghaemi et al. 2014). Physical performance highly contributes to wrestling performance and studies indicate that a very wide range of training regimens can have favourable responses in performance both in young and older adults (Galvao and Taaffe 2005). Adolescence is a crucial period for linear growth, and sports training during this time may have positive or negative effects on some physiological processes as growth (Bertelloni et al. 2006). Exercise is known to have positive effects in human metabolism (Bassuk and Manson 2003) but when its intensity, duration and type are considered, physical activity is a demanding job for the human body (Eslami et al. 2010). Physical exercise causes some stress on the human systems, particularly on the endocrine system. Significant changes in hormonal levels may be observed if an intensive training is applied (Hackney et al. 2011). Exercise stimulates the immune cells in adults in a natural way but the responses to exercise during teenage period are less known (Nemet et al. 2004). Although, there are many unanswered questions about the health risks and benefits of intensive training during childhood and adolescence (Willows et al. 1993), it is believed that the world-class athletic performance success can be achieved only if the intensive exercise is started well before puberty (Maffulli and Helms 1988). The effects of intensive training in young athletes should be well examined. In spite of the literature, few data is available concerning the effects of intensive training on sex hormones in young male wrestler.

Preparing scientific-based training programs for young athletes, is an important issue. Because the adolescents are different than adults, both physiologically and physically, appropri-

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ate training programs should be prepared according to their hormonal differences and needs. To do so, the hormonal status of the adolescents should be clearly elucidated.

The aim of this study was to investigate the changes in selected sex hormones of young wrestlers who were exposed to an eight-month intensive training program.

MATERIAL AND METHODS

Eighty subjects were selected and assigned into one of two groups as training (n=45) or control (n=35) groups. The training group (TG) attended to a wrestling training program for eight months, for 5 days a week- 90 mins per day. The control group (CG) was composed of 35 sedentary healthy young males and received no planned exercise sessions.

The study was approved by the local ethics committee of Zonguldak Karaelmas University, Faculty of Medicine. All the subjects and their legal guardians were informed about the method and the aim of the study. It was declared that the subjects had the option to leave the study at any time, without having any responsibility. The subjects provided oral assent to participate in the study. Written consent was provided by the guardians of the subjects who were not of sound mind.

The TG was trained for eight months. Both the TG and CG subjects were tested spontaneously at the beginning and the end of the eight-month training period. Age, height, weight and BMI values were obtained as the anthropometric data. The subjects were weighed on bare feet, in t-shirts and tights, in kilograms by using a scale with a 1/10 kg sensitivity. Heights of the subjects were measured on bare feet in centimetres using a ruler with a 1/10 cm sensitivity. Each subject's body mass index (BMI) was calculated by using the Quetelet formula [weight (kg)/height $(m)^2$].

The following basal hormonal parameters were also evaluated: Testosterone (RIA kit Testo; Sorin Biomedica, Saluggia, Italy), follicle stimulating hormone, luteinizing hormone, cortisol (RIA kit Cortisol, DPC; Diagnostic Products, Los Angeles, Calif., USA) and insulin like growth factor-1 (IGF-1). All data were collected at the Medical Faculty laboratory at Karaelmas University, Zonguldak. Blood samples were withdrawn into heparinized tubes from a cubital vein after overnight fasting and immediately stored in ice. Plasma was separated from cells by centrifugation at 3000 rpm for 10 min and the plasma samples were stored at -80 °C, until analyses were done. Analyses of serum testosterone (T), follicle stimulating hormone (FSH), luteinizing hormone (LH), cortisol (C), and insulin-like growth factor-1 (IGF-1) were determined by an automated chemistry analyser (Spectrophotometric enzymatic method, Roche Integra 800) using commercial kits.

Subjects

Eighty healthy subjects in good health, with no known history of endocrine dysfunction participated in this study voluntarily. The training program which was applied to the training group (n=45) was held at the Wrestling Training Center, located in Corum, Turkey. The control group (n=35) received no planned exercise session.

Training Program

An intensive training program was applied to the training group for 90 minutes/day for 6 days a week. The subjects were trained for 8 months. The subjects participated in domestic competitions as competitors during this period. The typical daily training program covered the following schedule: 5 minutes of preparation (explanatory info about the training session was given and questions answered, if any) followed by about 25 minutes of warm up and stretching. In the main part of the training, the subjects were exposed to a series of exercises according to the monthly schedule that had an intensity of about 60 percent for 45 minutes. 15 minutes of cooling period was applied at the end of each training session.

Statistical Analysis

Statistical analysis was performed by using SPSS 18.0 software (SPSS Inc., Chicago, IL, USA). Homogeneity of data was tested by Kolmogorov-Smirnov and differences between groups were analysed by using independent samples t-test. All applicable data were introduced as mean±SD. Descriptive statistics were also given. The statistical significance level was set at $p<.05$ for all tests.

RESULTS

Descriptive statistics of the subjects were given in Table 1. The TG subjects (n=45) were aged between 13.20 and 14.80 years and the average ages of TG and CG were 13.94±0.57 and 13.93±0.51, respectively. Height averages of the groups were 151.13±9.56 for the TG and 150.65±8.89 for the CG. BMI values of the subjects were calculated as 19.81±2.49 and 18.82±2.61 for TG and CG, respectively. The training group's average weight was 45.75±9.82, whereas the average height of the control group was 43.12±9.16.

Normal distribution of the data was tested by using Kolmogorov-Smirnov test and the results were given in Table 2. LH, FSH, IGF-1, T, C and BMI values in both TG and CG groups were distributed normally (p>.05).

Table 2: Normality test results (K-S)

	*One-Sample Kolmogorov-Smirnov Test**					
	LH	*FSH*	*IGF-1*	*T*	*C*	*BMI*
Training	.369	.261	.513	.460	.956	.966
Control	.994	.680	.719	.949	.967	.779

* *All variables are normally distributed (p>.05)*

The pre and post-test mean±SD values of the test data were computed as follows- pre- and post-test LH levels of TG were 1.45±0.98 and 2.36±1.59, respectively. CG values for LH were 1.64±0.95 and 1.67±0.83. There was an increase in LH values of TG but a slight increase in CG's LH values. There was a significant difference in the mean differences of LH values between training and control groups; t (65.886) =3.035, p=.003 (Table 3).

FSH values of TG were 2.40±1.53 and 2.70±1.54 whereas CG's values were 3.12±1.73 and 3.14±1.63. There was no significant difference between FSH values of both groups; t(78)=0.859, p=.393.

Pre and post-test IGF-1 values of TG were 45.26±23.85 and 45.00±21.20, whereas, CG's values were 51.55±24.59 and 51.29±27.55. No significant difference was found between IGF-1 values of the training and control groups; t(78)=0.000, p=.999.

Mean differences in testosterone and cortisol data, of both training and control group, were not significantly different, either. Testosterone values of the training group was 7.36±6.85 while the control group showed the values as 12.30±6.71 and 13.46±6.28 at pre and post-test, respectively; t(78)=1.345, p=.183. Cortisol values

Table 1: Descriptive statistics

Group	*Variables*	*M*	*SD*	*Min*	*Max*
Training (N=45)	Age (years)	13.94	0.57	13.20	14.80
	Height (cm)	151.13	9.56	136.60	167.60
	Weight (kg)	45.75	9.82	26.20	66.10
	BMI (kg/m2)	19.81	2.49	14.04	24.86
Control (N=35)	Age (years)	13.93	0.51	13.20	14.80
	Height (cm)	150.65	8.89	135.90	166.70
	Weight (kg)	43.12	9.16	27.99	58.61
	BMI (kg/m2)	18.82	2.61	15.00	24.10

Table 3: Pre- and post-test descriptives

		Training (N=45)				*Control (N=35)*			
		M	*SD*	*Min*	*Max*	*M*	*SD*	*Min*	*Max*
LH	Pre	1.45	.98	.10	3.90	1.64	.95	.20	3.20
	Post	2.36	1.59	.10	6.20	1.67	.83	.10	3.10
FSH	Pre	2.40	1.53	.20	6.60	3.12	1.73	.20	5.80
	Post	2.70	1.54	.20	7.10	3.14	1.63	.20	6.00
IGF-1	Pre	45.26	23.85	8.35	95.81	51.55	24.59	10.60	94.70
	Post	45.00	21.20	10.71	89.70	51.29	27.55	9.80	92.20
T	Pre	7.36	6.85	.10	24.01	12.30	6.71	.63	22.99
	Post	10.87	8.78	.10	31.25	13.46	6.28	.35	22.90
C	Pre	406.86	135.74	104.84	717.34	416.31	190.09	119.40	711.30
	Post	379.27	120.72	146.23	692.51	411.48	208.57	114.80	707.50
BMI	Pre	19.81	2.49	14.04	24.86	21.06	2.46	16.19	26.87
	Post	18.82	2.61	15.00	24.10	20.63	3.29	15.69	26.64

of the training group were as 406.86±135.74 at pre-test and 379.27±120.72 at the post-test while control group had 416.31±190.09 and 411.48± 208.57, respectively. Mean differences in cortisol values were not significantly different; t(78)= -0.463, p=.645.

BMI values were not different at post-test when compared to the pre-test values. Although there were decrements in both TG and CG, the difference between the mean differences was not enough to be statistically significant, t(78)= -0.832, p=.408. The mean values of TG were 19.81±2.49 and 18.82±2.61 at pre and post-test, respectively. CG had 21.06±2.46 and 20.63±3.29 values.

DISCUSSION

The present study aimed to examine the relationship between intensive exercise in adolescents and responses of the sex hormones. It is known that intensive training may have negative effects on growth, especially when the adolescents were exposed to prolonged exercise sessions. The results of this study indicate that there is a relationship between intensive training and some sex hormones in adolescent athletes. Luteinizing hormone (LH), follicle stimulating hormone (FSH), insulin-like growth hormone-1 (IGF-1), testosterone (T), and cortisol (C) were examined in this study and a significant difference was found between pre and post-tests in LH but not in FSH, T, C levels of the subjects (Table 4).

There are studies showing that wrestling training caused weight loss in training period (Strauss et al. 1985; Gibbs et al. 2009) but in the current study, the subjects gained weight and their height was also increased. The increase in weight, resulted in this study, was thought to be due to the natural growth pattern of the adolescent athletes. The subjects' heights were also increased and the reason for this was assumed to be the same as previous.

When the hormonal changes were examined, it was seen that there were statistically significant changes in FSH (p<.05) and LH (p<.01). Although the athletes' IGF-1 and C levels were increased at post-tests, the increase was not enough to be statistically significant. As an anabolic hormone, IGF-1 is critical to skeletal muscle growth. It was recently reported that muscle isoforms of IGF-1 may play a substantial role in tissue remodelling via up-regulation by mechanical signalling (Kraemer and Ratamess 2005).

Daly et al. (1998) examined the training-related responses of testosterone, IGF-1, and cortisol in 16 male gymnasts (10.5±.9 years) over a 10-month period. When the results were compared to control subjects (n=17; 9.6±1.2 years), they found that testosterone, cortisol, and IGF-1 did not differ at any time of the training period. They concluded that the results suggested that either the athletes were not exposed to such an intense training program or that the athletes were well adapted to training. The findings in the present study are similar to the results of study conducted by Daly et al. (1998).

Although exercise is known to stimulate IGF-1 (Pilz-Burnstein et al. 2010), in the present study no statistically significant difference was observed between pre and post-test results of the subjects. The absence of significance was thought to be due to the intensity of the training program which might have not been enough to stimulate IGF-1 secretion well.

LH is secreted from the anterior pituitary gland into the systemic circulation and its primary target tissue is the Leydig cells within the testes, from which testosterone is released (Nindl et al. 2001). FSH regulates the development,

Table 4: Independent samples t-test comparison table

	t-test for equality of means					*95% confidence interval of the difference*	
	t	*df*	*p*	M_D	SE_D	*Lower*	*Upper*
LH	3.035	65.886	.003	.882	.291	.302	1.462
FSH	.859	78	.393	.292	.340	-.385	.970
IGF-1	.000	78	1.000	.000	5.985	-11.915	11.916
T	1.345	78	.183	2.362	1.756	-1.134	5.858
C	-.463	78	.645	-22.758	49.177	-120.663	75.147
BMI	-.832	78	.408	-.564	.677	-1.912	.785

* M_D: Mean differences; SE_D: Standard error of difference

growth, pubertal maturation and reproductive processes of the body. FSH and LH work together to get the testes to begin producing testosterone. Similarly, Slowinska-Lisowska and Majda (2002) examined the hormonal effects of 400-meter run in six well-trained athletes and found that the two gonadotropins, LH and FSH, were increased but testosterone was decreased significantly in 24 hours following the training. In their study, Vasankari et al. (1993) found that trained cross-country skiers had higher basal FSH concentration when compared to the untrained subjects. In the present study, it was found that intensive training caused significant increase in LH levels of the young wrestlers but no significant change was observed between FSH levels.

T is an important male hormone and it plays role in growth and development. T is also important for the desired adaptations to training; in fact, T is considered the major promoter of muscle growth and subsequent increase in muscle strength in response to resistance training in men (Vingren et al. 2010). T is one of the most studied hormones in the literature in relation to exercise. The influence of training in young boys was studied by many researchers and it is a general acceptance that this type of training can increase muscle strength safely. In a study with 9 experimental and 10 control group subjects, Tsolakis et al. (2005) showed that resistance training increased T level in young (11.78±.84 years) boys who followed a 2-month strength training program for 3 times per week. In the current study, T levels of the TG were not changed significantly ($p>.05$). The reason for this was thought that the training intensity was not high enough to make a change in the T levels of the athletes.

Fifteen elite-junior wrestlers were trained in a sports training school for 15 weeks and the changes in cortisol and testosterone were examined at the end of the training period. It was found that the wrestlers gained a weight of about 1.5 kg without a change in PBF. Cortisol levels of the subjects were increased but no change in testosterone levels was observed (Passelergue and Lac 2012).

The effects of exercise on hormones were examined in numerous papers and there were some supporting results as well as opposing ones. The training intensity, training duration, adaptation levels of the athletes to training, load/rest ratio and nutritional differences may affect the results of the studies.

In one of the contradictory researches, which were conducted by Kraemer et al. (1998), it was found that an 8-week resistance training period resulted high testosterone levels in men. Similarly, Wheeler et al. (1992) reported reduced serum testosterone levels in wrestlers during the training season. Strauss et al. (1985) showed that maintaining low levels of fat during training period and caloric and fluid restriction before wrestling competition were associated with chronic suppression of serum testosterone and elevation of serum cortisol levels. The neuromuscular fatigue caused by exhaustive training led to an increase in cortisol but a decrease in testosterone and the subjects' (n=12 men, n=10 women; aged 21-45 years) testosterone level was still low at 48 h following the training (Taipale and Hakkinen 2013).

Eight endurance-trained athletes were exposed to either 40, 80 or 120 minutes of treadmill exercise and all of the subjects' testosterone levels increased in the first 60 minutes following the exercise session, then gradually decreased in the next 3 hours. The subjects' cortisol levels in the 40-minute group were higher than the other groups. It took a lot more time for testosterone and cortisol to rise when the intensity of the exercise was low (Tremblay et al. 2005).

Testosterone concentrations might be inhibited by exhaustive trainings, which were supposed to promote the secretion of testosterone. To find a way to eliminate this phenomenon, Kilic et al. (2006) investigated the effects of oral zinc supplementation on testosterone levels of elite athletes and concluded that 3 mg/kg/day supplementation suppressed the inhibition of testosterone concentrations caused by the exhausting exercise sessions.

It was previously shown that the training caused both acute and chronic alterations in secretion of numerous hormones, although there were many controversies in the literature about the responses of individual hormones (Howlett 1987). As it is well-known, the effects of a training depends on the training load, as well as on the athlete's ability to tolerate it (Pilz-Burstein et al. 2010).

CONCLUSION

There is no specific outcome provided scientifically. In some researches the hormone levels were increased, while decreases were observed in some other similar researches. There are no certain hormonal responses to exercise. This uncertainty seems likely to relate to the complex and variable nature of the exercise stimulus which remains poorly understood and therefore difficult to measure and control or to compare between studies. While physical training during growth may induce a catabolic state, further research is needed to determine the biological significance of this finding, particularly with regard to growth and maturation. In conclusion, in the current study, long-term intensive training had changed the hormonal responses of the young wrestlers in LH, but to make a decision of how long-term intensive training affects the hormonal responses in young athletes, further research is needed.

RECOMMENDATIONS

Nutritional status, load/rest ratio and the subjects' adaptation levels to exercise are critical points that should be taken into consideration in the future researches.

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