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ESTIMATION OF THE TOTAL TESTOSTERONE, SEX HORMONES BINDING GLOBULINE (SHBG), DEHYDROEPIANDROSTERONE SULPHATE (DHEA-S) AND CORISOL DURING TRAINING MEZOCYCLES IN BASKETBALL PLAYERS

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Abstract

Introduction: Interpretation of various reports on hormonal changes accompanying training cycle is difficult. Due to differences in training loads it is often impossible to compare obtained results. There is little data on changes of endocrine parameters in elite sportsmen undergoing long-term and high-intensity training.

Aim of the study: The aim of the present study was to investigate serum concentrations of gonadal and adrenal steroids in three consecutive training mezocycles. Hormones (total testosterone, DHEA-S, cortisol) were evaluated before the first mezocycle and after each of the following three mezocycles.

Methods: Twelve professional basketball players were recruited for the study. They were preparing for the play-off round of the national basketball championship.

Results: Overall, after three months of training: total testosterone decreased by 35%, DHEA-S by 39% and FAI by 19% when compared with baseline values.

In the mezocycle I the training load was increased. In comparison to the baseline, total testosterone decreased from 31-2 to 19.9 nmol·l^{-1}, DHEA-S from 264.5 to 214.5 nmol·l^{-1} and FAI from 110.0 to 57.6, while cortisole and SHBG did not change.

In the mezocycle II the exercise load was reduced. In comparison to the first mezocycle, concentrations of total testosterone increased from 19 to 29 nmol·l^{-1}, cortisol from 497.2 to 664.5 nmol·l^{-1} and FAI from 57 to 135, while DHEA-S and SHBG did not change.

In the mezocycle III the training load was increased anew. This time total testosterone decreased from 29 to 20 nmol·l^{-1}, DHEA-S from 220.1 to 160.5 nmol·l^{-1} and cortisol from 664.2 to 524.1 nmol·l^{-1} in comparison to the second mezocycle.

Conclusion: We conclude that professional training significantly affects endocrine status of elite athletes.

Key words: training, hormones, basketball players

Introduction

In competitive sports, especially in top class competitors, training loads are constantly increased. This situation is a serious challenge to the organism. An appropriate level of the training load should evoke positive adaptative changes and enhance the organism's efficiency. Conversely, excessive loads or applied for too long may inhibit processes of adaptation. They can reduce organism's efficiency and – similarly to metabolic disorders – have a negative impact on the training process. Endocrine changes that are induced by the physical stress may in turn positively or negatively influence the performance of athletes.

Changes of hormone levels during training cycles were studied by multiple authors (1-5). Unfortunately, results of most of them are ambiguous and rarely comparative (e.g. because of different loads applied in training programs).

Our aim was to compare changes of the serum concentrations of hormones: total testosterone, cortisol, DHEA-S and SHBG in three training cycles.

Materials and Methods

Twelve males, professional players of the Polish Basketball Extraleague, were enrolled for the study.

Their mean age was 26.1 ± 3.2 years, mean height was 198.3 ± 10.2 cm, and mean body weight was 98.2 ± 4.1 kg. They engaged in sports professionally for an average 12.5 ± 2.8 years. At the time of our investigation the studied subjects avoided drugs that could interfere with hormonal evaluation.

The concentrations of hormones were measured before the (0) and after each of the three successive training mezocycles (I, II, III). The three mezocycles constituted a preparatory period before the final, play-off round of the season. All subjects underwent the same, standardized training program.

All the details of training mezocycles reported by the coach are shown in table 1.

Each of the studied subjects was asked to avoid physical effort in the day of the laboratory measurements. Blood samples were taken from the elbow vein at 8 a.m. after 15 minutes of rest (and an overnight

Table 1. *Percent of wide-ranging work (W), directed work (U) and special work (S) and its intensity in particular training mezocycles during the preparatory period to the play-off games*

Training mezocycle	Information area			Energetic area				
					Moulding			
	W	U	S	Supporting	Aerobic	Mixed	Anaerobic -lactate	Anaerobic -alactate
				Intensity levels				
				1	2	3	4	5
Mezocycle I (25 days)	27%	42%	31%	19%	17%	34%	24%	6%
Mezocycle II (20 days)	23%	40%	37%	22%	21%	38%	14%	5%
Mezocycle III (20 days)	18%	36%	46%	16%	16%	36%	27%	5%

sleep). After centrifugation, sera were stored in the temperature -20°C. Total testosterone, dehydroepiandrosterone sulfate and cortisol concentrations were determined by the immunochemical method with the use of commercial kits (Auto-DELFIA, Finland). According to the producents' declarations, the sensitivity for the used diagnostic methods was: total testosterone <0.4 nmol·l^{-1}, DHEA-S < 2 μmol·l^{-1}, cortisol < 5.6 nmol·l^{-1}, SHBG < 0.04 nmol·l^{-1}.

The coefficients of interserial variation were: 5.5% for total testosterone, 4.4% for DHEA-S, 3.8% for SHBG and 6.8% for cortisol. The coefficients of intraserial variations were: 3.5% for testosterone 5.8% for DHEA-S, 7.9% for SHBG-, and 4.1% for cortisol.

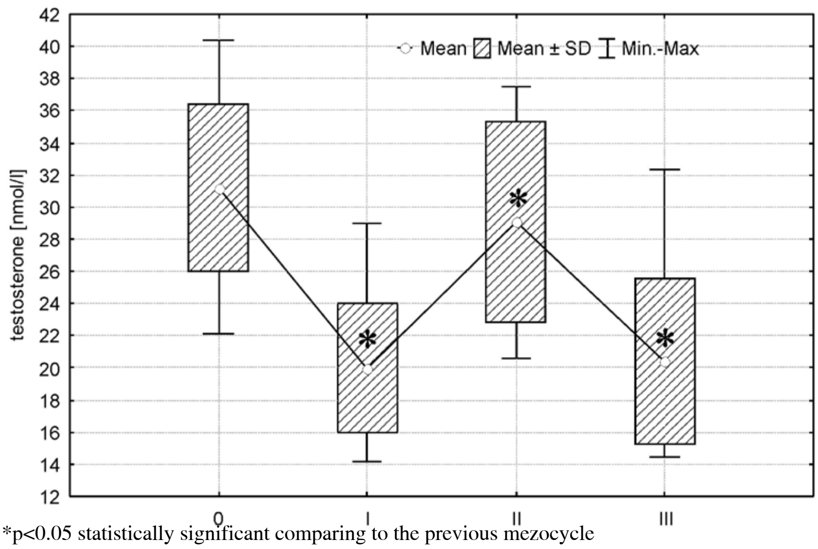
The free testosterone index (FAI) was calculated as total testosterone concentration (nmol·l^{-1})/SHBG (nmol·l^{-1}) x 100.

The influence of physical effort on the concentration of each of the investigated hormones was estimated by the analysis of variance between groups (ANOVA). Differences of means and their significance in the analysis of variance were tested by post hoc Newman – Keul test. Statistical importance of the differences between the means was established at $p<0.05$. All calculations were made with the use of STATISTICA software (version 6.0, Stat.Soft).

Results

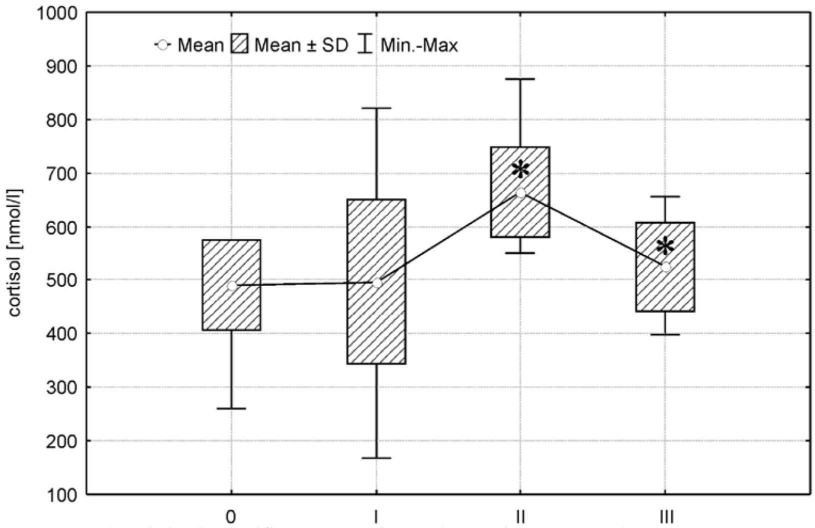
The obtained results were shown as means and standard deviations in the Fig 1-5.

After the mezocycle I total testosterone, DHEA-S and FAI statistically significantly decreased. There were no changes of cortisol or SHBG in comparison to the baseline.



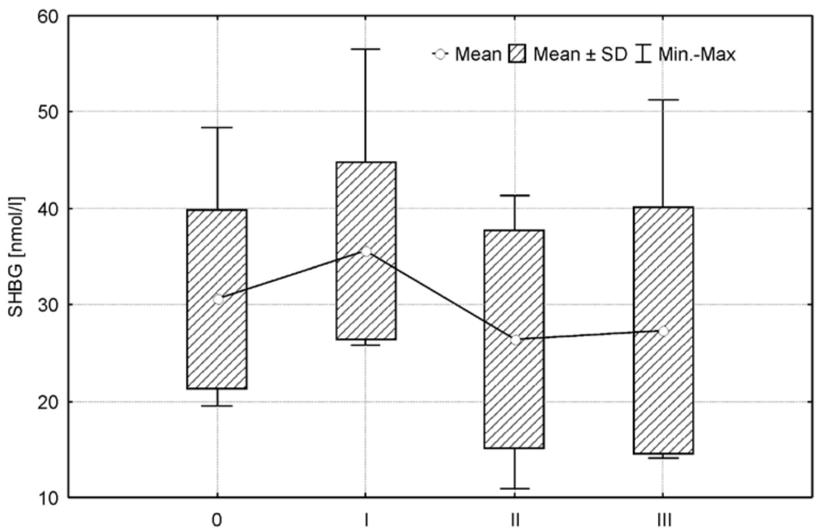
*p<0.05 statistically significant comparing to the previous mezocycle

Fig. 1. *The testosterone concentration after the training mezocycles*



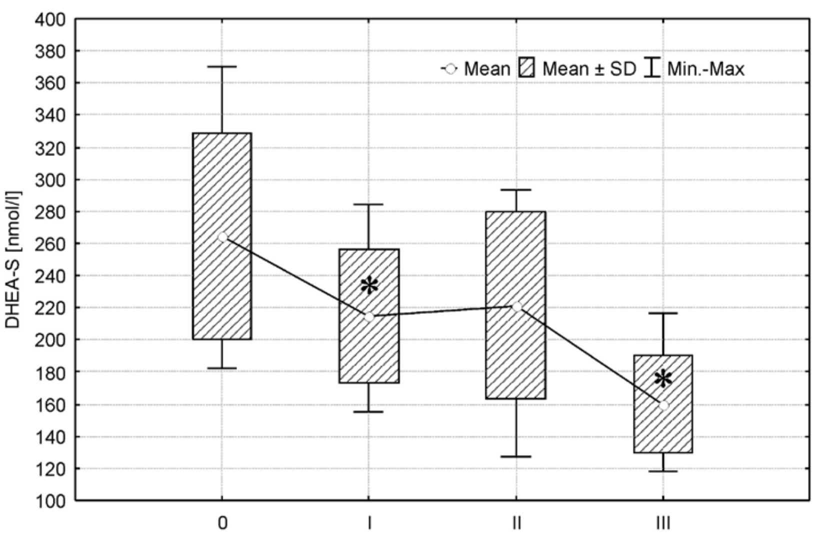
*p<0.05 statistically significant comparing to the previous mezocycle

Fig. 2. *The cortisol concentration after the training mezocycles*



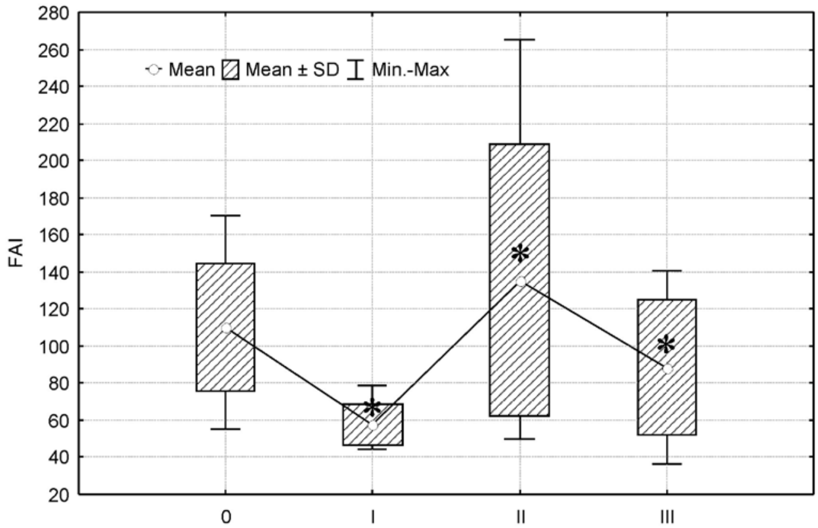
*p<0.05 statistically significant comparing to the previous mezocycle

Fig. 3. *The sex hormones binding globuline (SHBG) concentration after the training mezocycles*



*p<0.05 statistically significant comparing to the previous mezocycle

Fig. 4. *The dehydroepiandrosterone sulphate (DHEA-S) concentration after the training mezocycles*



*p<0.05 statistically significant comparing to the previous mezocycle

Fig. 5. *The free testosterone index (FAI) level after the training mezocycles*

After the mezocycle II, in which the 10% increase in the aerobic efforts and 10% decrease in anaerobic-lactate efforts were observed, total testosterone, cortisol and FAI statistically significantly increased. There were no differences of DHEA-S and SHBG in comparison to the mezocycle I.

After the mezocycle III, where the aerobic efforts were reduced by 11% and anaerobic-lactate efforts increased by 13%, total testosterone, cortisol and DHEA-S decreased in comparison to the mezocycle II.

The training program of the three-months-long preparatory period was associated with a significant decrease in total testosterone (35%), DHEA-S (39%) and FAI (19%) when compared with baseline values.

Discussion

The influence of long-lasting training cycles on the concentrations of hormones was evaluated in numerous studies (2, 5). They were performed also by our group (8, 9). Researches in subject of influence of the training loads applied during the training mezocycles on the endocrine system of basketball competitors were reported as short conference abstracts (8, 9). Generally, obtained results were at least inconsistent if not contradictory.

Researches in subject of influence of the training loads applied during the training mezocycles on the endocrine system of basketball competitors were reported only as short conference abstracts (6, 7).

In our study we found a significant decrease in total testosterone and FAI after the period of an intensive training program. It's worth to notice, that both parameters (TT and FAI) were positively correlated. It is obvious that FAI may determine the level of free, but not protein-bound and biologically active testosterone (10).

The mechanisms underlying the testosterone reduction during the physical exercise have not been explained yet. Some authors suggest that the level of testosterone decreases because of an inhibitory impact of exercise on the release of GnRH (gonadotropin releasing hormone). In this way the ability of the testicles to produce androgens is diminished (11). Some reports indicate that intensive, long-lasting physical effort may reduce the number of LH receptors (like in hypogonadotropic hypogonadism) (11-13). Yet, other authors claimed that during training cycles testicular steroidogenesis could be reduced because of unknown reasons and mechanisms (14).

Our results suggest that total testosterone and FAI could be used for monitoring organism's ability to take up physical effort. Similarly to our observation, decreased levels in total testosterone in basketball players during training cycles were reported also by other authors (6, 7).

In subjects studied by us there were no statistically significant differences of SHBG levels among three training mezocycles. It may suggest that changes of total testosterone depend solely on the free fraction of the hormone. Similar suggestions were previously articulated (15, 16). The level of cortisol seems to increase during the training cycle (1, 5, 8, 17). However in several studies there was no change (2, 18) or even a reduction of the level of cortisol in response to an increased training load (9).

In our study increasing the training load in the mezocycle III resulted in a decreased cortisol level. There may exist a relationship between an adaptation to the physical effort and the direction of cortisol level changes. It has been suggested that an increase in the level of cortisol during the training cycle indicates an appropriate adaptive process, while a decrease in cortisol means a reduction of suprarenal reserves (sometimes even a complete exhaustion of adaptive abilities of the organism) (19).

Changes of the level of DHEA during the mezocycles followed the pattern of total testosteron. Both parameters were positively correlated. In response to an increased intensity of the training load a reduction of DHEA-S level was noticed. It has been suggested that DHEA-S could be a better parameter of the exercise stress than the level of cortisol. DHEA has been demonstrated as a useful marker of applied training loads, especially in men (20).

Our results suggest that endocrine status of elite athletes is influenced by changing loads of training programs. Evaluations of testosterone, DHEA-S, cortisol and FAI may be of use in monitoring organism's response to the program applied.

While concentrations of hormones decrease, a reduction of the training load should be considered. In our study this rationale was concordant with observations of athletes' physical performance made by the coach.

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Author's contribution
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection