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Hormone and Adipokine Alterations across 11 Weeks of Training in Division 1 Collegiate Throwers: An Exploratory Study

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Introduction

Conceptually, it is important to understand the underlying physiological mechanisms of any training program model. This understanding aids the coach/sport scientist in making better choices in manipulating variables in formulating the training model. These underlying mechanisms can be associated with training variable manipulation and fatigue management aspects as well as the overall health of the athlete. Hormone and cytokine concentrations can be linked to alterations resulting from the manipulation of training variables and to subsequent alterations in performance (Haff et al., 2008; Ishigaki et al., 2005; Jurimae et al., 2010; Stone et al., 2007). For example, alterations in the testosterone: cortisol ratio (T:C) has been associated with alterations in training volume as well as physiological aspects such as lean body mass (LBM), fat content and strength/power performance (Haff et al., 2008; Häkkinen, 1989; Stone et al., 2007). Although cytokine production is part of the adaptive process, markedly increased/excessive cytokine production has been related poor fatigue management and over training (Angeli et al., 2004; Jurimae et al., 2010; Smith, 2000).
The present study followed NCAA division 1 (D-1) collegiate throwers over a period of an 11 week fall semester preparation-phase block form of periodized training. Volume and intensity alterations and their effects on physiological variables (e.g. neuromuscular, hormonal, cytokine) are a key component in understanding the effects of a training process. Alterations in these physiological variables were tracked over time. A better understanding of physiological adaptations to a training program assists a throws coach in constructing a more optimal periodization plan.

Methods

Subjects

Nine (9) Division 1 collegiate throwers and 4 control subjects participated in this study. The ability level of the throwers (6 male and 3 female) ranged from conference champions and potential NCAA Division I regional qualifiers to conference non-scorers. Throwing performance (taken from NCAA sanctioned meets) ranged from 10.98m to 16.9m in the shot put and 12.03m to 18.6m in the weight throw. The control subjects (3 males and 1 female) were sedentary individuals and were instructed to not change their dietary habits and to remain sedentary throughout the study. Prior to the initiation of the study, the throwers had just completed a 4 wk period of moderately high volume resistance, conditioning and throwing period.

Experimental Design

The present investigation was a time series study, analyzing physiological and performance changes over 11 weeks of training in 9 D-1 collegiate throwers. It was a collaborative effort between the sport coach (track and field), the event coach (throws), the strength and conditioning staff, and sport scientists at East Tennessee State University (ETSU). Daily training outcomes were recorded and "monitored" while the throwers executed a periodized throws and resistance training program that was structured and sequenced with the objective of enhancing various strength characteristics to potentially optimize performance for the indoor conference championships and produce a foundation for training for the outdoor season. A series of three testing periods were implemented periodically throughout the study (weeks 1, 7, and 11) to measure hormonal alterations, and cytokine concentrations. The control group took part in pre and post (T1 and T3) measurements 11 weeks apart.

Serum Collection Procedures

Blood was collected from an antecubital vein into clot activator blood collection tubes. After standard preparation serum samples were analyzed in one data set at the end of the study. Testosterone (T), Cortisol (C), adiponectin, leptin, and resistin were measure by ELISA; intra-assay CV's were < 4.1 %.
used successfully with collegiate throwers (Stone et al., 2003).

Training Protocol

The development of the training program was a collaborative effort and involved input from the strength and conditioning coach, as well as the throws coach, multiple scientific sources served as its foundation (Bompa & Haff, 2009; Garcia-Pallares et al., 2009; Harris et al., 2000; Plisk & Stone, 2003; Stone et al., 2007).

The resistance training program was sequenced with a series of three 3-4 week blocks (summated micro cycles) of training. The beginning of the preparatory phase focused on a short period of higher volume and less technical work with an emphasis on strength endurance, while the end of the preparatory phase there was a shift towards a focus on strength and a small increase in technical work. Block 1 consisted of a strength-endurance emphasis while during block 2 and block 3 the emphasis shifted towards strength. Exercises were chosen in concert with the set/repetition scheme in an attempt to achieve the goals and objectives of each block. Alterations in relative intensities were incorporated into the weekly training structure to produce heavy and light days. Similar programs have been used successfully with collegiate throwers (Stone et al., 2003).

Figure 2. The Set and Repetition Scheme

B1	Strength-Endurance
Week 1	3x10
Week 2	3x5 (1x10)
Week 3	3x5 (1x10)
B2	**Strength Phase 1**
Week 4	5x5
Week 5	3x5 (1x5)
Week 6	3x3 (1x5)
Week 7	3x3 (1x5)
B3	**Strength Phase 2**
Week 8	3x10
Week 9	3x5 (1x5)
Week 10	3x3 (1x5)
Week 11	3x2 (1x5)

Figure 1. Exercises

Block 1	Block 2	Block 3
Monday	**Monday**	**Monday**
AM Squats Press **PM** Bench Press Front Raise (dumbbells)	**AM** Squats Push Press **PM** Incline Press 45^{0} Front Raise (dumbbells)	**AM** Squats Push Jerk **PM** Incline Press 10^{0} Front Raise (dumbbells)
Wednesday	**Wednesday**	**Wednesday**
AM Light Power Snatch CGSS CG Mid-thigh pulls **PM** Light Power Snatch CGSS (50% of AM) CG pulls from the Knee CGSLDL	**AM** Light Power Snatch CGSS CG Mid-thigh pulls **PM** Light Power Snatch CGSS (50% of AM) Cleans 1 set at 70-75% CGSLDL	**AM** Light Power Snatch CGSS CG Mid-thigh pulls **PM** Light Power Snatch CGSS (50% of AM) Cleans 1 set at 75-80% CGSLDL
Friday	**Friday**	**Friday**
AM Squats Push Jerk **PM** Incline Press 10^{0} Front Raise (dumbbells)	**AM** Squats Push Jerk **PM** Incline Press 10^{0} Front Raise (dumbbells)	**AM** Squats Push Jerk **PM** Incline Press 10^{0} Front Raise (dumbbells)
Saturday	**Saturday**	**Saturday**
Light Power Snatch Ball Throws Pull Ups	Light Power Snatch Ball Throws	Light Power Snatch Ball Throws

Statistical Analysis

Differences between male and females were determined using partially adjusted t-tests. Due to the Exploratory nature of the observation and the relatively small number of subjects differences over time were determined using effect sizes and %Δ. A small control group was measure over the same time period (pre-post).

Results

Control group did not show a meaningful alteration over time. Group means, standard deviations, and statistical differences for the throwers hormone concentrations are presented in Table 1. Based on moderate effect sizes and %Δ, Cortisol, T:C, and adiponectin showed trends suggesting that training may have had an effect on resting concentrations. Interestingly both cortisol and adiponectin showed consistent alterations; cortisol concentrations decreased over all 3 testing sessions, while adiponectin demonstrated increases over all 3 testing sessions. This suggests an inverse relationship between cortisol and adiponectin. In support of this contention; there was an r = -0.57 correlation for the % gain from T1 – T3 between these two hormones

Males had statistically greater T, lower C concentrations and larger T:C ratios compared to females. No other differences between males and females were noted. Indeed in most cases the directions of the alterations across time were quite similar, thus males and females were analyzed as one group. Additionally, the throwers as a group showed several statistically significant alterations (repeated measures ANOVA) over time for performance variables (e.g. increased strength, RFD) not shown in this data set.

Table 1. Hormone and Adipokine Data

Variable	Testing 1*	Testing 2*	Testing 3*	η^2	%Δ
T	14.6±10.3	18.9±15.7	14.9±11.1	0.24	0.2
C	673±197	612±265	586±235	0.39	-12.9
T/C ratio	0.025±0.018	0.039±0.036	0.032±0.029	0.23	28
Adipo	6573±3539	7181±5175	7842±4501	0.29	19.3
Leptin	19877±10739	17902±16363	20851±12180	0.066	4.9
Res	30.7±12.3	37.9±16.6	25.4±14.4	0.48	-17.3

Discussion

Potential trends in the data may be associated with important alterations in physiology and performance. Only three potential trends (Cortisol, T:C and adiponectin) noted in the data are discussed.

In the present study, based on the consistency of change across time, a moderate effect size, and %Δ, cortisol appears to have steadily decreased from T1 to T3. This trend indicates that "*stress*" may have decreased over time. The decreases appear to have followed alterations in volume load as T2 and T3 corresponded to periods in which the volume load had been decreased which should reduce training stress; the alterations in resting C support this contention.

Training induced alterations in the T:C may affect body composition as well as strength-power performance. Furthermore it has been suggested that only very small alterations in the T:C ratio are necessary to effect performance alterations and preparedness for sport (Haff et al., 2008; Häkkinen et al., 1989; Stone, & Sands, 2007). Before the present study was initiated the throwers had just completed a moderate - high volume of training lasting several weeks, this may explain the relatively low T:C ratio noted at T1. Furthermore, the T/C ratio was markedly higher at weeks 7 and 11 when training volume load was reduced. These trends agree with previous findings among well-trained strength athletes (Haff et al., 2008; Häkkinen et al., 1989).
Resting adiponectin concentrations are generally inversely related to these inflammatory conditions; however, paradoxically adiponectin appears to be positively correlated with non-obesity related inflammatory conditions (Fantuzzi, 2008). This indicates that adiponectin is regulated in the opposite direction in typical versus obesity-associated inflammatory conditions and therefore may exert differential effects (Fantuzzi, 2008). These findings also suggest that all inflammation is not the same or at least is produced as a result of different mechanisms. Furthermore, considering the relationship of adiponectin to joint synovium inflammation it may be possible that training induced increases in adiponectin concentrations could be associated with more typical inflammation responses to training.

One potential trend was noted (Figure 1.1), based on consistency, effect size and %Δ, there was an increase in the throwers adiponectin levels This is a potentially advantageous trend since adiponectin is generally associated with reductions in obesity related inflammation (Bouassida et al., 2010), on the other hand it could be related to training increased joint inflammation a more negative outcome of training. Adiponectin has been shown to have an inverse relationship with resting cortisol concentrations (Fallo et al., 2004; Yang et al., 2004). Interestingly, in the present study the decrease in cortisol was accompanied by a steady increase in adiponectin.

Based on the hormonal and adipokine data, it appears that the training program produce some positive effects. These effects indicate a reasonable degree of fatigue management in that C decreased (Figure 1.2) and the T:C ratio was increased as volume load decreased. Assuming that increases in adiponectin is a positive outcome of a sound training protocol, the present observation indicates that adiponectin increased in concert with decreases in cortisol and increases in the T:C. ratio. Considering effects of these hormones and cytokines; these alterations over time indicate a lesser degree of obesity related inflammation and a higher degree of "fitness" and preparedness (Mujika, 2009).

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