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PERCEIVED STRESS AND SALIVARY CORTISOL IN COLLEGIATE TRACK AND FIELD ATHLETES. A PILOT STUDY

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ABSTRACT

Purpose. The purpose of this pilot study was to examine changes in stress, recovery and salivary cortisol in track and field athletes over an eight month period. **Method**. Stress and recovery were measured using Recovery-Stress Questionnaire for Athletes (RESTQ-52). Surveys and saliva for measurement of cortisol were collected weekly. In season and off season values were compared using t-tests ($p<0.05$). **Results**. One hundred and one saliva samples and 90 RESTQ-52 surveys were collected from eight athletes. Those who completed at least 50% of the surveys and saliva collections (4 athletes) were included in the final analysis. Salivary cortisol levels were not significantly different in the in season vs. off season (6.1±0.7 and 5.0±0.9 nmol/L, $p=0.3$). For stress scales, only fatigue was significantly different in the in season compared to the off season (1.2±0.2 and 2.2±0.2). For the recovery scales, success was significantly lower in the in season vs. off season (2.8±0.2 and 3.5±0.2), whereas physical recovery was significantly higher in the in season compared to the off season (4.1±0.2 and 3.4±0.3). **Conclusion**. The results of this pilot study suggest that stress and recovery values measured using the RESTQ-52 and salivary cortisol values may be variable within and between student athletes, with few significant differences between in season and off season periods. Additional studies are needed with a larger sample and a variety of athletes. These studies will help to determine effective ways to monitor perceived and physiological stress in athletes.

Keywords: student athletes, stress and recovery, cortisol

INTRODUCTION

Understanding the body's psychological and physiological responses to intense exercise training is important in optimizing athletic performance. Previous research has shown that short-term increases in exercise intensity and volume can lead to significant increases in psychological stress levels (3,7,8,15). Jurimae et al. (7,8) and Bouget et al. (3) observed significant increases in perceived stress, as well as significant decreases in recovery, measured using the Recovery Stress Questionnaire for

Athletes, after a period of heavy training. In addition to increased psychological stress with increases in exercise intensity and volume, investigators observed changes in hormones indicative of increased physiological stress and reduced physical recovery, including elevated cortisol levels or a decreased testosterone/cortisol ratio (3,8). The increase in stress hormones, particularly cortisol, may also negatively affect immune system function, which may have additional negative effects on physical performance and recovery (16). A significant decrease in athletic performance, reflected by an increase in the time to complete a 2000 m rowing test, has also been observed following an increase in training volume (7,8). These results emphasize the importance of monitoring exercise training to optimize the improvements in performance and the ability of the body to recover from the physical and psychological stress of training.

Additional studies have examined markers of physiological and psychological stress during an extended training period and competition period. Di Fronzo et al. (5) examined markers of stress and recovery in the preseason, after a 21-day training period, and during the play-offs in amateur Italian basketball players. Using the Recovery Stress Questionnaire for Athletes (RESTQ), the authors observed higher values for emotional stress during the competition phase compared to the preseason phase. Elloumi et al. (6) also examined psychological markers of stress in rugby players during the season, including competition at the international level. Relative tiredness and competitive anxiety, examined using the French Society for Sports Medicine (FSSM) and the Sport Competition Anxiety Test questionnaires respectively, increased over the competitive season, with competitive anxiety scores dependent on the importance of the competition. Other investigators examined physiological markers of stress, including salivary and blood levels of cortisol and testosterone, during periods of training and competition. These investigators observed decreases in the testosterone/cortisol ratio after periods of training and competition, suggesting a decrease in the anabolic state and incomplete recovery as well as reduced performance (1,2,6,14). In contrast, Nunes et al. (12) examined the influence of a 50-day, resistance training program on salivary cortisol and testosterone levels. The important feature of this study is that the training program was periodized, with the training load variation to optimize training adaptations. The researchers observed significant increases in the salivary testosterone/cortisol ratio, along with a significantly positive association with changes in muscle strength. The results of this study suggest the importance of training periodization to optimize enhancement in performance. Mazon et al. (11) also examined the effects of training periodization in volleyball players, noting significant reductions in cortisol, along with increased testosterone and the testosterone/cortisol ratio, suggesting beneficial adaptations to training and recovery. These investigations emphasize the importance of monitoring physical and psychological stress and recovery of individual athletes.

Collegiate-level sports typically involve high-level training that can place additional physiological stress demands on the body when compared to recreational workouts. Combined with academic stress, collegiate student-athletes can be at high risk for impaired athletic and academic performance. The purpose of this study is to examine changes in perceived stress and physiological markers of stress in collegiate track and field athletes over the course of the academic year. We hypothesized that perceived stress levels and salivary cortisol levels would increase during periods of intensive training and competition and that salivary cortisol levels would be related to perceived stress and recovery levels. The information from this pilot study will help to identify how physical and psychological stress are affected during the academic year and what factors might affect athletic performance in collegiate student athletes.

METHODS

Participants

Approval for the study was obtained from the University Institutional Review Board. Information was initially sent to the coach of the track and field team via e-mail, explaining the purpose and importance of the study. With the coach's approval, investigators met with the team before practice to describe the study and the necessary time commitment. Team members interested in participating talked to investigators in person at the time of the meeting or contacted investigators via e-mail. Those athletes who were currently injured and not able to compete were excluded from participating in the study. Those interested in participating in the study signed the consent form. Demographic information was then collected from the participants, which included age, sex, length of time participated in the sport and specific events, usual semester course load, academic major, as well as any additional work hours outside of school. A total of eight subjects (three males and five females) agreed to participate in the study.

Measurements of stress and recovery

Perceived stress and recovery were measured weekly from September 2009 to April 2010, using the Recovery-Stress Questionnaire for Athletes Sport Survey (RESTQ-52, 4,10). Participants received a reminder e-mail to complete the questionnaire each week, directing them to the online survey on the Zoomerang website.

The RESTQ-52 survey evaluates psychological and physical well-being specific to athletes (4,10). Nineteen different scales are represented in the survey by two or more questions in the survey. The present research analyzed scales specific to stress and those specific to recovery (12 different scales), but did not include analysis of sport specific scales for stress or recovery (seven additional scales). The RESTQ-52 scales and survey questions used to calculate these values are described in detail in the RESTQ User Manual (10).

Seven RESTQ-52 scales evaluate different aspects of stress and its consequences (general stress, emotional stress, social stress, conflicts and pressure, fatigue, lack of energy, and physical complaints). General stress relates to nonspecific stress responses. Two survey questions are used to measure general stress ("I felt down" and "I was fed up with everything"). The emotional stress scale includes evaluation of anxiety and irritation. Two survey questions are used to measure emotional stress ("I was in a bad mood" and "I was annoyed"). Social stress considers fights or arguments or being irritated with others. Two survey questions are used to measure social stress ("I was annoyed by others" and "I was upset"). The conflicts and pressure scale evaluates unresolved conflicts, unpleasant activities or tasks, and not meeting set goals. Two survey questions are used to measure the conflicts and pressure scale ("I worried about unresolved problems" and I felt under pressure"). The fatigue scale evaluates disturbances during important work or training. Two survey questions are used to measure the fatigue scale ("I was dead tired after work" and "I was overtired"). The lack of energy scale measures the ability to

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concentrate on important tasks. Two survey questions are used to measure the lack of energy scale ("I had difficulties concentrating" and "I put off making decisions"). The physical complaints scale evaluates the presence of any physical complaints. Two survey questions are used to measure the physical complaints ("I had a headache" and "I felt uncomfortable"). Additional details on the stress scales are described in the RESTQ User Manual (10).

Five scales represent recovery, including success, social recovery, physical recovery, general well-being, and sleep quality. The success scale is related to doing well and achieving goals. Two survey questions are used to measure success ("I was successful in what I did" and "I made important decisions"). Social recovery evaluates the presence of positive social interaction. Two survey questions are used to measure social recovery ("I laughed" and "I had a good time with my friends"). Physical recovery examines the ability to relax after completing a task or training. Two survey questions are used to measure physical recovery ("I felt physically relaxed" and "I felt as if I could get everything done"). The general well-being scale evaluates general positive feelings and mood. Two survey questions are used to measure general well-being ("I was in good spirits" and "I was in a good mood"). Finally, the sleep quality scale represents ability to fall asleep and to remain asleep without interruptions. Two survey questions are used to measure sleep quality ("I had a satisfying sleep" and I slept restlessly"). Additional details on the recovery scales are described in the RESTQ User Manual (10).

Likert-type scales are used in the RESTQ-52, with values ranging from 0 ("never") to 6 ("always"), indicating how often the athlete participated in various activities during the previous three days and nights. All of the questions pertaining to a single scale, such as "general stress", are averaged, with mean scores ranging from 0 to 6. High scores for the stress scales suggest elevated stress levels, whereas high scores on the recovery scales suggest more than adequate recovery. Standardized stress and recovery scores were also calculated, using the average score for all of the "stress-related" (general stress, emotional stress, social stress, conflicts and pressure, fatigue, lack of energy, and physical complaints) or "recovery-related" scales (success, social recovery, physical recovery, general well-being, and sleep quality) (13).

Saliva collection and cortisol analysis

Weekly saliva samples were collected before practice on one predetermined day of the week. Every effort was made to keep the time (3:00 pm) and day of collection consistent throughout the duration of the study. Participants were instructed to abstain from eating, drinking, and chewing gum for 60 minutes prior to sample collection, to not drink alcohol 24 hours prior to saliva sampling, and to not brush their teeth within two hours of collection. Prior to collection of saliva, each participant answered a few questions including what time he/she woke up that morning, when he/she last ate, and any stressful events in the last 24 hours. Participants were also asked to "grade" the intensity of their workouts for the last 3 to 5 days, using a scale of 1 to 10, with 10 being the highest intensity.

The participant then placed a small sponge under his/her tongue for approximately 3-5 minutes in order for the sponge to absorb the saliva. The sponge was then placed in a collection tube that was on ice. The tubes were transported on ice back to the laboratory and centrifuged at 3000 rpm. Saliva aliquots were frozen at -20^{o}C until analysis. Salivary cortisol was measured by immunoassay (Salimetrics Inc., State College, PA). Intra- and Inter-assay coefficients of variation were less than 5%.

Statistical Analyses

Data was analyzed using a standard statistical software package (SPSS for Windows, IBM Corporation, Somers, NY). Descriptive statistics were calculated for all data, including means, medians, and standard deviations for individual participants and for all participants together. T-tests were used to determine differences between off-season and in-season values. Correlations were used to determine any significant relationship between RESTQ-52 scales and salivary cortisol levels. Statistical significance was set at p <0.05.

RESULTS

From September 2009 to April 2010, a total of 101 saliva samples and 90 RESTQ-52 surveys were collected and analyzed. Completion rates for the weekly saliva sample collections and RESTQ-52 surveys ranged from 27% to 92% and 42% to 100%, respectively. Athletes who completed at least 50% of the surveys and saliva collections (1 male and 3 female, 20±1 years old) were included in the final analysis, which included 69 saliva samples and 71 RESTQ-52 surveys. The four athletes who met the inclusion criteria were full-time undergraduate students, taking at least 12 credits each semester. Two of the athletes also worked 14-20 hours per week in addition to training and classes. The four athletes competed in the following events: 400 m and 400 m hurdles (Subject 1), 3 km and cross country (Subject 2), discus (Subject 3), and 100 and 200 m (Subject 4). Subject 2 competed in cross country, indoor track, and outdoor track, thus the data best represented all in season values due to overlapping competitive seasons and training. Subject 2's results were similar to the other athletes.

Measurements of psychological stress and salivary cortisol were evaluated for differences between in season and off season. Salivary cortisol levels varied greatly within and between subjects and were not different in the off-season compared to the in-season (Table 1).

The fatigue scale value was significantly lower in the in season compared to the off season (1.2±0.2 compared to 2.2±0.2, Figure 1). There were no other significant differences between in season and off season values for the stress-related scales: general, emotional, and social stress, conflicts and pressure, lack of energy, and physical complaints (all p>0.05). In addition, the standardized stress score was not significantly different during the in season compared to the off season (Table 1). Measures of stress were not significantly related to salivary cortisol levels or workout intensity.

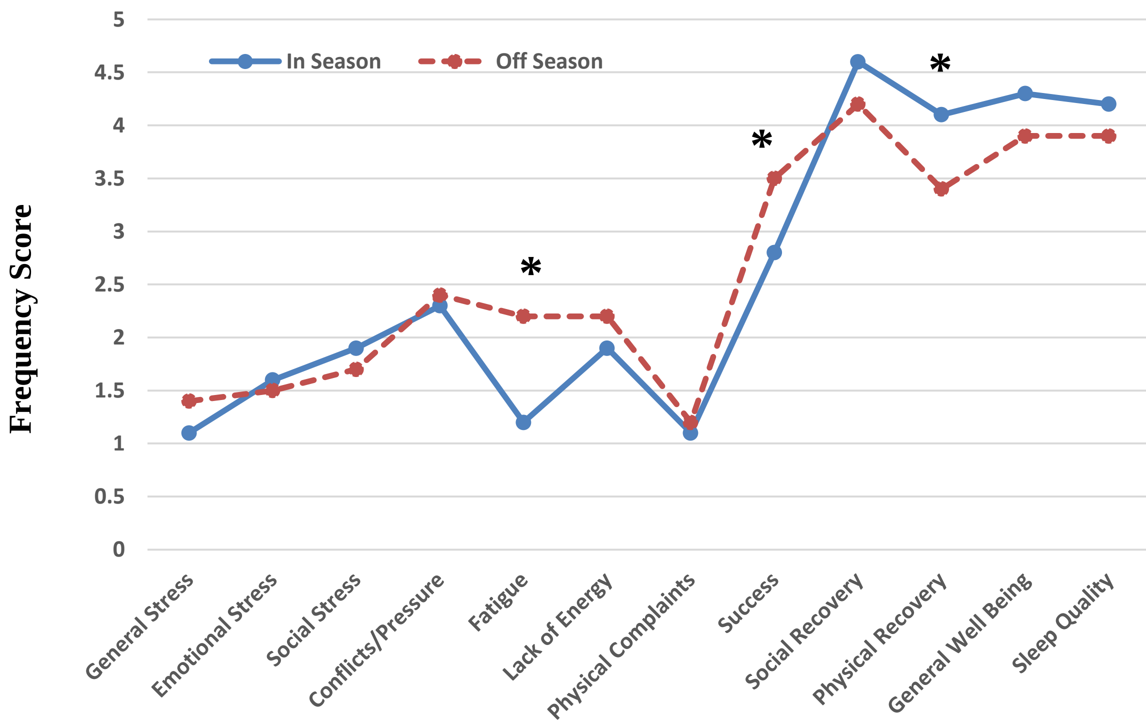
Recovery-related scales were also evaluated for differences between in season and off season. The success scale was significantly lower in the in season compared to the off season (2.8±0.2 compared to 3.4±0.2), whereas the physical recovery scale was significantly higher in the in season compared to the off season (4.1±0.2 compared to 3.4±0.3, Figure 1). There were no significant differences between in season and off season values for social recovery, general wellbeing, and sleep quality. In addition, the standardized recovery score was not significantly different during the in season compared to the off season (Table 1). Measures of recovery were not significantly related to salivary cortisol levels or work intensity.

Table 1. Cortisol and RESTQ-52 values for each athlete and in season and off season averages.

	In Season	Off Season
Cortisol (nmol·L^{-1})	6.1±0.7 (n=35)	5.0±0.9 (n=34)
Workout Score	4.7±0.4	5.6±0.4
Standardized Stress Score	2.0±0.1 (n=41)	2.1±0.1 (n=30)
Standardized Recovery Score	3.4±0.1	3.2±0.2

Data presented as means±SEM. Values in parentheses are number of values included in the mean.

Figure 1. Mean subscale scores of the RESTQ-52 during in season and off season.



DISCUSSION

The purpose of this study was to examine changes in perceived stress, recovery, and physiological markers of stress in collegiate track and field athletes over the course of the academic year. The results for salivary cortisol and perceived stress and recovery were variable, with some values significantly higher in the off season compared to the in season (fatigue, success), while other values significantly higher in the in season compared to the off season (physical recovery). Values of perceived stress and recovery were not related to salivary cortisol levels, as originally hypothesized. Additional studies are needed with a larger sample size to determine changes in psychological and physiological markers of stress in collegiate athletes, and how changes in stress may affect athletic performance.

The results of this pilot study suggest that stress scores may increase, while recovery scores may decrease during periods of intensive training. These results are similar to what others have observed in elite athletes during short periods involving an increase in physical training (3,5,7,8,9). The results of the present study suggest that collegiate athletes may be under more psychological and physical stress during the off season, when they are training at higher levels than during the in season. This emphasizes the importance of monitoring physical and psychological stress during training, and that the RESTQ may be an effective tool for coaches and trainers to monitor stress and recovery during the season. In contrast, cortisol may not always accurately reflect changes in psychological stress and physical recovery.

In contrast to past research, salivary cortisol levels were not significantly higher after periods of intensive training, as in the off season compared to the competitive season. Significant variability in salivary cortisol was observed within and between subjects, with no significant differences between in season and off-season. The reasons for these results may be due the small number of study participants, making it difficult to find significant associations, as well as a number of other factors, including the periodization and intensity of the training. Nunes et al. (12) and Mazon et al. (11) noted significant increases in the testosterone/cortisol ratio in athletes using a periodized training program, suggesting appropriate training stress and time for recovery. It is possible that an appropriately periodized training program may not result in significant increases in perceived or physiological markers of stress, as observed during intense training. The workouts established for the athletes in the present study may have been well periodized, designed specifically with variations in intensity and duration to accommodate for increases in physical and psychological stress levels. The periodization of training may help to ensure that athletic performance is not negatively affected and accommodations are made for increases in psychological and physical stressors.

The present study is one of the first studies to examine perceived and physiological markers of stress over the academic year in collegiate athletes. There are limitations to the study, most importantly, the small number of study participants. The small number of participants (four) who met the criteria for inclusion and the variety of track and field events most likely affected the results. More participants from a variety of sports would add strength and generalizability of the results. In addition, investigators in the present study did not examine a number of factors that may also affect stress in collegiate athletes, including individual strategies for coping with stress, academic stress and achievement, as well as objective measures of training intensity. Additional research should examine how coping strategies, academic achievement, training intensity, and recovery strategies affect the athlete’s performance and ability to adapt to the stress of physical training.

CONCLUSION AND PRACTICAL APPLICATIONS

The present study examined changes in stress, recovery and salivary cortisol levels in collegiate track and field athletes over an eight month period. Monitoring stress and recovery during periods of rest, training, and competition is important to consider as part of an effective year-long training program for collegiate athletes. Coaches and trainers need to know how the physical and psychological stresses of training and competition affect performance in sport. Additional studies are needed, with larger sample size and a wider variety of athletes. These studies will help to determine effective ways to monitor stress and how stress affects the risk of injury and performance in athletics in collegiate athletes.

Conflict of Interest

No conflict of interest was declared for this study.

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