

Alteration of Immune Function and Muscular Power in College Student-Athletes and College Students

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ABSTRACT

The purpose of this study was to determine the stress-induced alterations in immune function in college student-athletes over the course of a competitive season and to determine the peak power levels associated with exercise. Twenty-eight subjects (14 soccer players and 14 controls) participated in the study. For nine weeks subjects gave saliva samples on the same day each week at the same time of day. The saliva was analyzed for cortisol and immunoglobulin A (IgA) concentrations. Both prior to the first saliva collection and after the final collection subjects were tested for peak power production and vertical jump height. An ANOVA procedure for repeated measures showed no changes in salivary concentrations of cortisol and IgA. The soccer players had a significantly higher vertical jump at both pre- and post-testing compared to the control subjects (10.8 and 15.3% respectively). They were also significantly more powerful (14.0 and 19.9%). Over the season the soccer players significantly increased their vertical jump height by 4.5% and increased peak power by 13.7%. There were no significant changes in the control subjects. It does not appear that there are significant changes in stress hormone responses or IgA during the course of a competitive soccer season.

INTRODUCTION

The combination of chronic intense exercise, the specific stressors associated with college life and seasonal participation in competitive sports may lead to a decrease in the immune system and thus predispose college students and college student-athletes to an increased risk of infections. Moderately intense exercise has been shown to enhance the body's natural defense mechanism against infections (Klentrou et al. 2002).

Immunoglobulin A (IgA) is the most predominant antibody contained in secretions of the mucosal immune system and is the major effector of host defense against pathogenic microorganisms (Novas et al. 2003). It interferes with viral attachment to epithelial surfaces, neutralizes viruses directly within the epithelial cells, and is involved in excretion of viral antigens through adjacent epithelium into the lumen (Reid et al. 2001). It is believed that intense exercise will lower the body's level of this immunoglobulin and put the body at increased risk of contracting infection, specifically upper respiratory tract infection (URTI). On the other hand, moderate exercise is believed to increase one's level of IgA, decreasing the risk of URTI (Klentrou et al. 2002). Sedentary individuals are believed to have the lowest level of IgA and be at the greatest risk of contracting an URTI (Klentrou et al. 2002). Nieman and Nehlsen-Cannarella (1991) have reported that mean IgA values in athletes have been shown to decrease post-exercise during the recovery phase up to four days before returning to baseline levels.

Cortisol is known to play a major role in metabolism and immune function (Jacks et al. 2002). It is considered catabolic because of its effects on protein and carbohydrate metabolism (Jacks et al. 2002). Mather et al. (1986) reported that cortisol levels in conditioned athletes return to near-normal levels one hour post exercise, while the non-conditioned athlete's level of cortisol remained elevated longer than the conditioned athletes. Kraemer et al. (2004) showed that there were no significant changes in plasma cortisol over the course of the soccer season. Assessment of the circulating concentrations of cortisol represents a possible means of monitoring the stress of training and competition, therefore providing a means of avoiding the performance decrements associated with the rigors of practice, conditioning and competition (Kraemer et al. 2004). However, there is no previous research investigating the changes in the immune and stress markers in competitive soccer players. Therefore, the purpose of this study was to investigate the stress-induced alterations in immune function and stress hormones in college students and college student-athletes.

METHODS

Subjects

Fourteen NCAA Division III female soccer players from the University of Wisconsin-La Crosse were subjects for this study (mean age 19.8 ± 1 years; mean body weight 65.9 ± 7.4 kg). All subjects voluntarily agreed to participate over the 9-week competitive season. The study was approved by the institutional review board prior to the start of the study. Written informed consent was received prior to the start of the study. Fourteen college females (22.5 ± 2.6 years; 62.2 ± 7.4 kg) also agreed to voluntarily participate in the control group for this study.

Subject Lifestyle

The subjects were given a training and performance questionnaire at the beginning of each week. The questionnaire comprised of questions about the subjects training pattern as well as any injuries or illness suffered. Subjects were asked to provide information about the exercise or training that they had done that week. This included matches, practice sessions and individual conditioning sessions. The subjects recorded the duration of each session and outlined what type of exercise they did.

Power Testing

Power and vertical jump height were measured using a Kistler Quattro Pro Force Plate (Kistler Instrumente AG, Winterthur, Switzerland). The subjects performed three trials of squat jumps and countermovement jumps to measure peak power and maximum jump height. The data was sampled at 500 Hz by a computer-based data acquisition and analysis program. The protocol that the subjects followed when executing a static jump (SJ) consisted of the subject standing erect on the force plate with their hands placed on their hips. The subject then lowered to a self-selected depth and maintained that position for 3 seconds in order to eliminate any stretch shorten cycle that may contribute to the following jump. Once signaled, the subject performed a maximal vertical jump. The protocol that was followed for the counter movement jump (CMJ) involved the subject standing erect on the force plate with their hands placed on their hips. Once signaled, the subject lowered to a self-selected height and instantaneously performed a maximal vertical jump. Coefficient of variations of 2.5% and 3.4% were obtained for peak power and jump height from repeated tests on a group of sixteen men and women in our laboratory, who were tested on two consecutive days.

Hormonal Analyses

Saliva samples were collected at the beginning of each testing session (without stimulation, by spitting directly into a plastic tube) and then stored at -80 °C until analysis. To avoid any confounding effects due to variations in circadian rhythm all samples collected at the same time of day. Salivary IgA concentrations were determined in duplicate by Enzyme Immunoassay using a Salimetrics Salivary Secretory IgA Indirect Enzyme Immunoassay kit (Salimetrics LLC, State College, PA). Intra-assay variance was 8.2% and the sensitivity of the assay was 2.5 $\mu\text{g/mL}$. The concentrations were expressed as the concentration of salivary IgA (S-IgA) and the secretion rate of S-IgA (calculated by multiplying absolute IgA concentration by saliva flow rate in ml/min).

Salivary cortisol concentrations were determined in duplicate by Enzyme Immunoassay using a Diagnostic Systems Laboratories Salivary Cortisol Enzyme Immunoassay Kit (DSL, Webster, Texas). Assay plates were read using an *Opsys* MRTM Microplate Reader (Dyex Technologies, Chantilly, USA). Intra-assay variance was 7.6% and the sensitivity of the assay was 0.011 $\mu\text{g/dL}$. Assay plates were read using an *Opsys* MRTM Microplate Reader (Dyex Technologies, Chantilly, USA).

Statistical Analyses

S-IgA concentration, cortisol concentration, saliva flow rate, S-IgA secretion rate and power performance were analyzed separately by analysis of variance (ANOVA) for repeated measures, using SPSS version 11.0 (SPSS Inc., Chicago, IL). A one-tailed t-test was used to determine the difference in means between the two groups. A level of significance of $p \leq 0.05$ was chosen prior to any statistical analysis.

RESULTS

Power Testing

The soccer players had a significantly higher vertical jump at both pre- and post-testing compared to the control subjects (10.8% and 15.3% respectively). The soccer players were also more significantly powerful (14.0% and 19.9%). Over the season the soccer players significantly increased their vertical jump height by 4.5% and increased peak power by 13.7%. There were no significant changes in the control subjects.

Salivary IgA

The analysis of S-IgA levels was reported in two forms: (A) Absolute concentration of S-IgA (ug/mL) or (B) S-IgA secretion rate or the total amount of S-IgA in the saliva per unit time. The repeated measures of ANOVA showed no changes in salivary concentrations of IgA. There was a significant difference at baseline between soccer and control S-IgA levels (Figure 1). The weekly variations of S-IgA levels over the 9-week competitive season for the soccer players in contrast to that of the controls are shown in Figure 1.

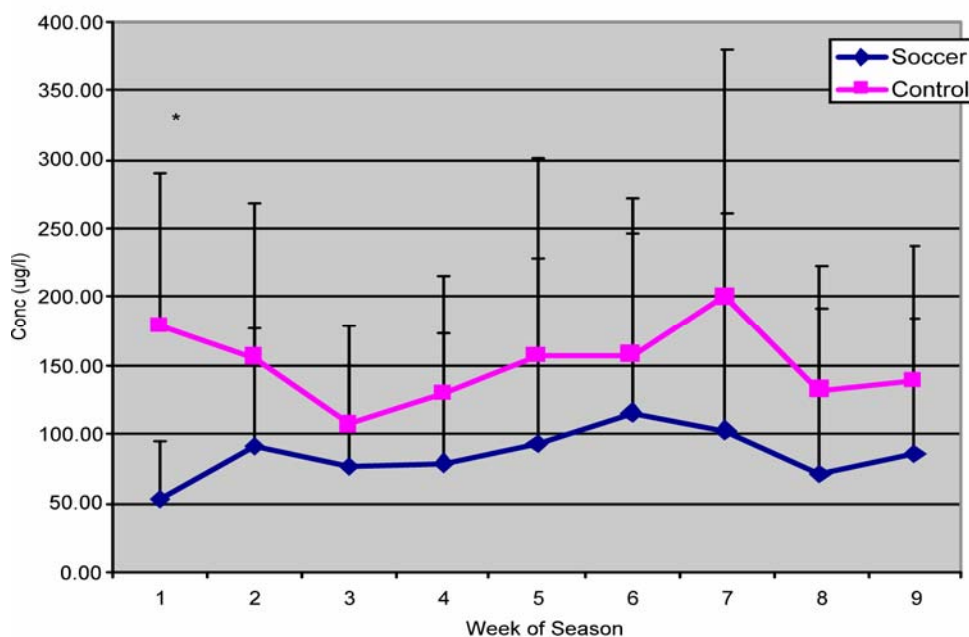


Figure 1. Weekly variation of S-IgA levels over 9-week competitive season for soccer players to that of controls.

Cortisol

The ANOVA procedure for repeated measures showed no changes in salivary concentrations of cortisol. The pattern of variation in cortisol concentrations of soccer players and college students during the course of the study are shown in Figure 2. There was a significant difference at baseline between soccer and control cortisol levels. The patterns slightly increased and decreased as the season progressed for the soccer players. But there was no significant difference over the course of the 9-week competitive training season.

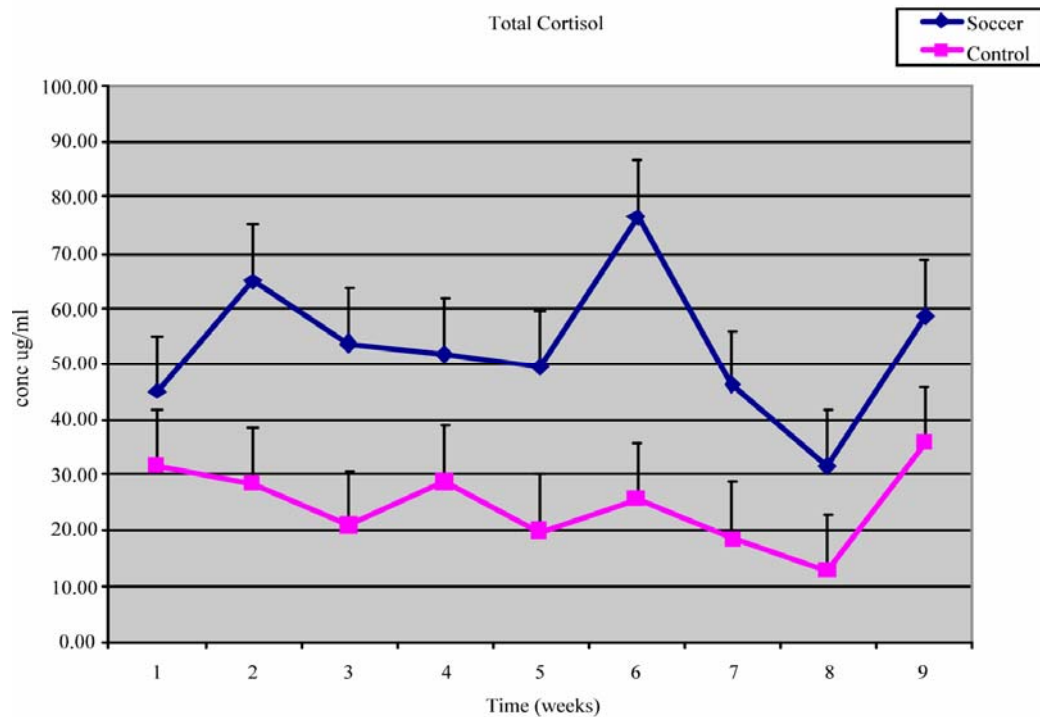


Figure 2. Pattern of variation in cortisol concentrations of soccer players and college students during 9-week competitive soccer season.

DISCUSSION

The purpose of this study was to compare the stress-induced alterations in S-IgA and cortisol concentrations in women college students who were athletes (soccer players) and women college students who were not involved in competitive athletics. Athletes suffer from a variety of injuries and illnesses throughout a competitive season, impacting the performance of a team and the success of a coach. Research has been conducted on the S-IgA levels in elite athletes (Klentrou et al. 2002, Mackinnon, 1997, Nieman, Nehlsen-Cannarella, 1991, Nieman et al. 1989, Novas et al. 2003) but there is limited research on IgA levels in athletes and non-athletic college students. The major finding of this study was that there was no significant difference in S-IgA and cortisol concentrations in soccer players and college students throughout the course of a 9-week competitive season. The peak power output and the vertical jump height of the soccer players was increased by the end of the season. The results of the hormonal analyses are consistent with the findings of Nieman et al. (1989), who reported that there were no differences in the levels of immunoglobulins of athletes and sedentary controls.

From this study it can be inferred that the stressors associated with college life affect both athletes and non-athletes in the college sector to the same degree. Whether stress is due to intense exercise or to the stressors associated with an intense college schedule, this study has shown that there is no difference in how the immune system is affected and no one group is more at-risk for URTIs. However, it can also be seen from this study that a predetermined conditioning program is a more effective means to increase power production and jump height.

This study confirmed results of other studies that have been conducted on the effect of intense exercise (athletes) and effect that it has on the immune system (Nieman et al. 1989). There are some limitations that warrant explanation as to why the results of the S-IgA and cortisol levels were insignificant between the two groups. The first aspect that must be examined is the intensity of Division III soccer practice sessions throughout the course of the 9-week season. It can be expected that the intensity level of practice and games increase as the standard of play is increased. The non-significant difference between the means of the control and soccer group may be due to the fact that soccer practice may not be as intense as needed for there to be a significance in levels of S-IgA and cortisol between athletes and non-athletes as has previously been reported (Mackinnon 1997, Mathur et al. 1986, Novas et al. 2003).

Another area that needs to be examined is the amount of exercise that the control subjects participated in. There was not a determined protocol for the control subjects that only allowed them to participate in a certain type and amount of activity. Due to this fact, the intensity of exercise of the control group had the ability to be as high as that of the soccer group. It must also be noted that peak power production and vertical jump height was only measured at the beginning and the end of the 9-week study due to the fact that academic schedules and soccer practice interfered with the ability to allow for time to test these variables. For this reason results could not be obtained as to when power production and jump height increased the most from week to week in the soccer group. During the course of a competitive season collegiate soccer players are exposed to a number of physical and psychological stresses from practice, conditioning, and competition. The ability of the players to recover following such activities can ultimately affect the quality of the performance for ensuing physical activity.

This study showed that there were no significant stress-induced alterations in the S-IgA and cortisol concentrations in women college students who are athletes (soccer players) and college students who are not athletes. There was no significant difference in S-IgA and cortisol concentrations in soccer players and college students through out the course of a 9-week competitive season. The peak power output and the vertical jump of the soccer players was increased by the end of the season and was significantly higher than the control subjects.

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