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Physiological and Psychological Responses to Stress in Elite Swimmers

Josie M. Jedick
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The purpose of this study was to analyze the effects of different amounts of outside stress on a group of 13 male and 12 female swimmers from Arizona State University who were involved in the same amount of exercise stress. It was hypothesized that high levels of outside stress in addition to the imposed training stress should correlate with more negative mood and with more health problems. It was also expected that the combination of these effects would contribute to a decline in performance. Several questionnaires were utilized to evaluate the defined variables of life event stress (Life Events Survey for Collegiate Athletes), daily stress/hassles (Hassles and Uplifts Scale), mood (Profile of Mood States), and health (Environmental Symptoms Questionnaire). The data supported the hypothesis that high levels of outside stress (determined by the LESCA and the Hassles and Uplifts Scale) were predictive of more negative mood (testing times 1, 2, 3 and 4) and poorer health (testing times 1, 2, and 4 for the LESCA and times 1, 3, and 4 for the Hassles and Uplifts Scale) in the collegiate swimmers. However, the data did not support the hypothesis that there would be a link between external stress and performance. Implications for this study are that athletes should be monitored for outside stress to avoid overtraining and burnout.

Collegiate athletes are constantly faced with large amounts of stress and pressure to perform well, both in their sport and also in the classroom. They are also forced to deal with large time demands, leaving little time for leisure (Silva, 1990). Training regimens of elite swimmers at the college level emphasize high frequency and long duration exercise bouts, which result in a high total training volume (Taylor, Rogers, & Driver, 1997). Due to these high training loads, swimmers are often used in studies related to excessive training. Adaptations to this type of rigorous training can be positive if the situation is ideal, or negative when an imbalance occurs between excessive training demands and a lack of individual coping capacity (Silva, 1990).

It has been proposed that optimal athletic performance is achieved when the body experiences a maximal adaptation response to extremely high exercise loads (Rushall, 1990). However, when this highly intense and precisely accurate state is maintained over time, a majority of the body's resources must be utilized to cope with the excessive training loads. This mechanism consequently lowers the body's resistance to other stresses, thus making elite athletes extremely susceptible to negative responses to external stress (Rushall, 1990; Goss, 1994). Negative adaptations to imposed exercise stress can be caused by too much training, insufficient work and rest patterns, conflict, boredom, and inefficient coping mechanisms (Silva, 1990). Athletes are repeatedly faced with many types of stress which may originate from within or outside of
the sporting environment (Rushall, 1990). Exercise stress refers to the individual’s response to the act of physical exertion while outside stress reflects an individual’s response to situational factors encountered elsewhere.

The effects of exercise stress have been extensively studied, and several researchers have identified relationships between increases in training volume and intensity with outcome variables such as poor mood, decreased immune system efficiency, and other hormonal changes (Booth, 1993; Kirwan et al, 1988; Rushall, 1990; Silva, 1990). Outside psychological stressors caused by major life events or daily hassles have also been correlated with these same variables (DeLongis, Folkman, & Lazarus, 1988; Fawkner, McMurray, & Summers, 1999; Nieman, 1997). Daily hassles differ from major life events in that daily hassles reflect individual interpretations of the unique conditions, interpersonal experiences, and social contexts of daily living (Chamberlain & Zika, 1990) while major life events represent life as a whole. Fawkner, McMurray, and Summers (1999) have proposed that minor life events in the form of daily hassles must be included in a thorough stress analysis and measured on a consistent basis since fluctuations are likely to occur.

Both types of stress have been correlated with changes in mood and mental health. DeLongis, Folkman, and Lazarus (1988) found that an increase in daily hassles was associated with a decrease in mood. Stress caused by both major life events and daily hassles has been found to independently predict mental health (Chamberlain & Zika, 1990). Elite athletes may be subject to greater psychological stress than the average population since many of the hormones and chemicals that are released during exercise are also released during periods of emotional stress (Booth, 1993). It has been proposed by Selye (1950) that an individual’s tolerance for stress is finite, implying that the effects of exercise stress and outside stress are additive. For this reason, it is important to understand the unique stress response of athletes who frequently encounter both exercise and outside stress.

Recent research has proposed that moderate exercise is beneficial for the immune system, but that the intense training endured by elite athletes may actually suppress the immune system and increase susceptibility to infections (Fitzgerald, 1991). High levels of life stress and daily hassles have been linked with increased incidence of injury and vulnerability to illnesses (Clow & Hucklebridge, 2001; Petrie, 1992). It has also been found that participation in heavy exercise during the incubation phase of an illness serves to increase the duration and severity of symptoms (Fitzgerald, 1991). The finding of immune suppression in elite athletes has been attributed to the elevation of stress hormones which are released both during and following sessions of heavy exercise (Nieman, 1997). Since psychoneural factors are modulators of immune function in many situations, there is a complex interaction between the nervous system and the immune system (Booth, 1993). This interaction is responsible for the established relationship between stress variables and depressed immune responsiveness.

Nieman (1994) has proposed that the relationship between exercise and infection forms a "J" shaped curve such that sedentary individuals are at average risk for infection, moderate exercisers are at below-average risk, and high intensity exercisers are at above-average risk. Further, athletes are exposed to immune system deficiencies and increased risk of infection due to high psychological training demands and increased exposure to pathogens caused by deep breathing associated with exercise (Clow & Hucklebridge, 2001). External stress and exercise stress produce very similar adaptive responses in the immune system and a parallel relationship exists between stress and exercise. Specifically, a short bout of exercise produces effects similar to an acute psychological stressor, while endurance training results in effects comparable to chronic psychological stress (Clow & Hucklebridge, 2001). Nieman (1997) suggests that immune function can be maintained by keeping life stresses to a minimum.

Due to high stress levels leading to several significant implications, it is important that we look at possible additive effects of exercise stress and outside stress in elite athletes. The prolonged psychological stress associated with training and competition makes athletes extremely vulnerable to negative stress responses (Clow & Hucklebridge, 2001). The need for sport-specific research that involves a repeated measures design and includes both major and minor life
events as indicators of stress has been suggested by Fawkner, McMurray, and Summers (1999). Past research has assumed that all athletes experience comparable levels of external stress and has only examined the different levels of exercise stress imposed on these athletes. The purpose of this study was to analyze the effects of different amounts of outside stress on athletes who were involved in the same amount of exercise stress.

In this experiment, male and female swimmers from a Division I nationally ranked team were consistently monitored for outside stress, mood, health, and performance. Since all of the athletes were partaking in a constant training load over an eight-week period, external stress was isolated as the independent variable while exercise stress serves as a control between participants. The external stress variable was determined through an analysis of life events and daily hassles to provide a complete stress profile. It was expected that external stressors, which would be considered trivial for the general population, might become significant in athletes who were already encountering high levels of exercise stress on a daily basis. The addition of external stressors might interfere with an athlete's optimal exercise-stress adaptation potential (Rushall, 1990). Specifically, it was hypothesized that high levels of outside stress (defined as life stress and daily hassles) in addition to the imposed training stress would correlate with more negative moods and with more health problems. It was also expected that the combination of these effects would contribute to a decline in performance.

Method
Participants
A total of 28 varsity swimmers from Arizona State University volunteered to participate in this study. There were 16 males and 12 females with an average age of 20.48 years (SD=0.83). The average amount of competitive swimming experience for the participants was 12.12 years (SD=3.70). Each participant was paid $50 for his/her time.

Materials
All participants completed a demographic questionnaire which included age, gender, and years involved in swimming. Several questionnaires were utilized to evaluate the defined variables of life event stress, daily stress/ hassles, mood, health, and performance (see Appendix for all questionnaires).

The Life Events Survey for Collegiate Athletes (LESCA; Petrie, 1992) was used to determine life stress experienced in the past year. This survey was designed for collegiate athletes to provide a valid athlete-specific measure of life stress. Participants were instructed to rate each possible life event on the questionnaire as having either a positive or a negative effect on them. They were also asked to rate the degree of this effect on a scale of 1 (somewhat positive or negative effect) to 4 (extremely positive or negative effect). The sum of each category was then taken, creating a score for positive experiences and a score for negative experiences. The sum of the positive events was then subtracted from the sum for the negative events so that the final life stress rating was interpreted such that a more positive score indicated a higher experience of negative life stress (i.e., more life stress).

The Hassles and Uplifts Scale (DeLongis, Folkman & Lazarus, 1988) was used to monitor daily stress encountered during a two week period. Each item was scored with either a positive number for uplifts or a negative number for hassles. The positive scores were then added to create a total uplifts score, while the sum of the absolute values of the negative scores created a total hassles score. The uplifts score was then subtracted from the hassles score at each timepoint, such that a more positive number represented more hassles (i.e., more daily stress).

The Profile of Mood States (POMS) was used to evaluate mood. The POMS has been widely used to study the effects of training with athletes (Goss, 1994). An overall mood score was calculated by adding together all of the scores in the fatigue, anger confusion, depression, and tension categories. Variables in the vigor and the friendliness categories were scored in reverse. A higher score on the POMS indicated a worse mood.

The revised Environmental Symptoms Questionnaire (ESQ) was used to reflect symptoms related to sickness (Sampson & Kobrick, 1980). Scoring on the ESQ was calculated by adding together each of the symptom levels, such that a higher score indicated worse health problems.

The Daily Hassles scale, POMS and ESQ were administered every two weeks to evaluate overall mood and health as it related to the previous two-week training period. Swim meet
performance was evaluated objectively by comparing each participant's time to his/her personal best time in his/her best event.

Procedure

This study took place over the summer training season from May to July of 2002. Participants were assessed every two weeks over an eight-week period with testing dates on May 28, June 12, June 26, and July 10 (see Table 1). All questionnaires were administered before the afternoon workout at approximately 1:30 in the afternoon. The LESCA was given only once at the first session while the Hassles and Uplifts Scale, POMS, and ESQ were administered at each session. Performance ratings were taken from one of two possible meets: Phoenix Swim Club (PSC) Invitational on June 24, 2002 or Santa Clara International (SCI) invitational on June 30, 2002. Each athlete chose his/her best event to analyze for the performance data.

Statistical Analysis

The data scores were tabulated by hand and then inserted into an SPSS computer program for analysis. For the effect of life events stress on mood, a regression analysis was utilized at each of the four time points with life stress score as the independent variable and POMS score as the dependent variable. For the effect of life events stress on health, a regression analysis was utilized at each of the four time points with life stress score as the independent variable and ESQ score as the dependent variable. For the effect of daily hassles on mood, a regression analysis was utilized at each of the four time points with daily hassles score as the independent variable and POMS score as the dependent variable. For the effect of daily hassles on health, a regression analysis was utilized at each of the four time points with daily hassles score as the independent variable and ESQ score as the dependent variable. For the effect of daily hassles on performance, a regression analysis was used to determine if daily hassles at time 3, mood at time 3, or perceived health at time 3 were predictive of performance. Time 3 was used to analyze the performance data since this testing period was closer in time to the two swim meets.

Complete data were available for 25 of the original volunteers, so data analyses were conducted using these 25 participants (13 male and 12 female).

Results

The life stress score (obtained from the Life Events Survey for Collegiate Athletes) was a significant predictor of mood at time 1, $F(1,23)=17.65, p<.05$, time 2, $F(l,23)=5.92, p<.05$, time 3, $F(1,23)=6.64, p<.05$ and time 4, $F(l,23)=13.71, p<.05$. At all testing times, the regression coefficient indicated that participants reporting more life stress also experienced more negative moods (see Figure 1).

The life stress score was also a significant predictor of perceived health (obtained from the Environmental Symptoms Questionnaire) at time 1, $F(1,23)=8.43, p<.05$, time 2, $P(1,23)=5.06, p<.05$, and time 4, $F(1,23)=4.51, p<.05$. Examination of the regression coefficient indicated that people reporting more life stress also experienced more health problems (see Figure 2). However, a significant relationship was not found at testing time 3, $F(1,23)=3.61, p>.05$.

The daily hassles score (obtained from the Hassles and Uplifts Scale) was a significant predictor of mood (obtained from the Profile of Mood States) at time 1, $F(1,23)=9.54, p<.05$, time 2, $F(l,23)=7.50, p<.05$, time 3, $F(l,23)=33.6, p<.05$, and time 4, $F(1,23)=9.57, p<.05$. At all testing times, the regression coefficient indicated that participants reporting more daily hassles also experienced more negative moods (see Figure 3).

The daily hassles score was a significant predictor of perceived health at time 1, $E(l,23)=8.99, p<.05$, time 3, $F(1,23)=10.40, p<.05$, and at time 4, $F(1,23)=7.29, p<.05$. Examination of the regression coefficient indicated that people reporting more daily hassles also reported more health problems (see Figure 4). However, a significant relationship was not found at testing time 2, $F(l,23)=1.67, p>.05$.

The daily hassles score at time 3 was not a significant predictor of performance, $F(1,23)=.055, p>.05$. The mood score at time 3 was not a significant predictor of performance, $F(1,23)=1.02, p>.05$. The perceived health score at time 3 was also not a significant predictor of performance, $F(1,23)=1.13, p>.05$.

Conclusion

The data supported the hypothesis that high levels of outside stress (determined by the LESCA and the Hassles and Uplifts Scale) were predictive of more negative mood (testing times
1, 2, 3 and 4) and poorer health (testing times 1, 2, and 4 for the LESCA and testing times 1, 3, and 4 for the Hassles and Uplifts Scale) in the collegiate swimmers. However, the data did not support the hypothesis that there would be a link between external stress and performance.

The failure of outside stress to predict performance may be due to the fact that the performance measure was not standardized since the individual athletes each competed in different events at different meets. The fact that this study took place in a natural setting means that the external validity of the study is high, but this limited our ability to use a common measure of performance for all athletes. It would have been impossible to coordinate an accurate and externally valid performance rating between all of the subjects. However, it can be speculated that long-term negative mood and poor health as a result of outside stress could potentially negatively affect performance and subsequent research should examine this hypothesis.

The implications of the results on mood and health found in this experiment are substantial and should be considered by all serious athletes and coaches. The topic of overtraining and burnout has been widely examined in the literature. Silva (1990) has proposed that negative training stress responses exist along a continuum from staleness to overtraining to burnout. In a study of collegiate athletes representing both genders and ten intercollegiate sports, Silva (1990) found that athletes experienced staleness an average of 2.5 times during their collegiate careers. These athletes also perceived stress as being the major factor responsible for experiencing staleness. The data from the present study contribute to these findings by identifying outside stressors as possible factors contributing to the overall stress equation.

Fawkner et al. (1999) have suggested that it may be beneficial to regularly monitor both life stress and daily hassles in athletes. When a substantial increase in hassles is identified, appropriate help should be implemented so that the athlete can successfully cope with the stress and avoid the potential for injury or staleness. Fitzgerald et al. (1991) have also proposed that athletes would probably benefit from stress reduction programs to help deal with daily hassles. Results from the present study have also indicated that both major life events and daily hassles should be identified as additional stressors that are additive towards exercise stress and training should be adapted accordingly. Ultimately, the possibility of overtraining can be managed by monitoring outside stress as well as exercise stress. It is very important for the athletes and coaches to have a realistic understanding of the types of stressors that are being encountered outside of the sporting arena.

This study could have been improved in several ways. First, it would have been beneficial to have several groups to compare the effects of daily hassles on mood and health. For example, it would be interesting to see the effects on collegiate athletes in different sports. As discussed earlier, a more sensitive measure of performance would have been ideal. Another

Table 1. Timeline of testing dates and swim meets.

<table>
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<td>Test #4</td>
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variable that could have enhanced the results would have been to include a hormonal measurement, such as cortisol levels in the blood. This would provide a stronger link between the physiological and psychological aspects of stress. It may also be helpful to track athletes for a longer period of time than two months.

Future research could also incorporate several individual factors that may moderate perceptions of stress. Personality factors such as hardiness, self-esteem, and optimism could change the way that an individual copes with stress. Goss et al. (1994) studied a group of collegiate swimmers and found that as hardiness increased, overall mood disturbances decreased. Specifically, the hardy swimmers were found to be less tense, depressed, angry, fatigued and confused, and more vigorous than the nonhardy swimmers. These results propose that the personality construct of hardiness may be an important factor in identifying athletes who are at high risk for mood disturbances while overtraining. However, similar to the present study, Goss et al. (1994) did not find a direct link between mood disturbances and performance.

Other possible factors that may influence coping ability under stress are self-esteem and social support. DeLongis et al. (1988) explored these relationships in a study of non-athletes using the Hassles and Uplifts Scale. These researchers found that participants with low self-esteem and social support were more susceptible to the relationship between increased stress and decreased mood and mental health. Petrie (1992) also found that social support moderated the stress-injury relationship in collegiate gymnasts, and Clow and Hucklebridge (2001) identified optimism, hardiness, and self-esteem as personality factors associated with decreased injury.

Stress is a complicated phenomenon that is multifaceted and can be analyzed on several dimensions. The data from this experiment supported the hypothesis that high levels of outside stress were correlated with a decline in mood and health among collegiate swimmers. This is an important finding because it agrees with much of the past exercise stress literature while also adding the dimension of outside stress. The results also demonstrated that life stress and daily hassles independently contribute to an analysis of outside stress. In the context of collegiate sports, athletes are placed under a lot of stress due to athletics and academics. A thorough understanding of the way stress affects athletic performance is essential to the attainment of optimal performance and well-being.

References


Figure 1. Effect of life stress on mood at test time #1.

![Graph showing the relationship between life stress and mood](image1)

- RSA = 0.4342
- Rsq = 0.4342

Life Stress (high positive = more stress)

Figure 2. Effect of life stress on health at test time #1.

![Graph showing the relationship between life stress and health](image2)

- RSA = 0.2682
- Rsq = 0.2682

Life Stress (high positive = more stress)
Figure 3. Effect of daily hassles on mood at test time #1.

![Graph showing the effect of daily hassles on mood.](image)

**Hassles Time 1 (high positive = stressful)**

R² = 0.2932

Figure 4. Effect of daily hassles on health at test time #1.

![Graph showing the effect of daily hassles on health.](image)

**Hassles Time 1 (high positive = stressful)**

R² = 0.2810
Figure 4. Average statistics for all variables.

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