

Psychophysiological Effects of Competitive Stress on Swimming Coaches

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Abstract

Competitions may cause stress and anxiety to athletes and their coaches. The effect of psychological stress on salivary cortisol concentration was studied in eight coaches during a national swimming championship. Saliva samples were collected at four time points (fifteen days before and on three days during the championships) and analyzed for salivary cortisol. Additionally, the subjective ratings of perceived psychological arousal were measured on three days during the championships. No statistically significant changes were found in salivary cortisol concentration and cognitive anxiety during the championships. Conversely, a significant decline in somatic anxiety was observed from the beginning to the end of the championships. The temporal development of the anxiety experience supports the multidimensional anxiety theory. The findings are discussed in the specific context of swimming.

Index Terms: Cortisol, anxiety, competition, coaching, CSAI-2

Introduction

Competitive sport activities may cause stress to participants and their coaches. When a person attributes a great subjective importance to the result of an athletic event, stress increases (18). Hans Selye, the pioneer in the study of stress, defined it as a "non-specific response of the organism to any request made upon it" (27). Stress is a complex psychophysiological process, often causing marked emotional, cognitive and physiological changes (25). Anxiety is a psychological manifestation of stress (29).

Since the 1960s, an idea has started to develop that anxiety may be a multidimensional phenomenon with at least two dimensions: cognitive and somatic (5,17,19,23). Cognitive anxiety is the mental component of anxiety caused by negative expectation about success or negative self-evaluation. Worry, negative self-talk, and unpleasant visual imagery characterize cognitive anxiety (23). Empirical evidence has not provided

a stable pattern of cognitive anxiety influence on sport performance. A number of studies have reported a negative relationship between cognitive anxiety and performance (2,3), while there is also evidence supporting a positive relationship (32,33). Somatic anxiety, on the other hand, is the physiological or affective component of anxiety that is directly related to autonomic arousal. Somatic anxiety is reflected in such responses as rapid heart rate, shortness of breath, clammy hands, butterflies in the stomach, and tense muscles (21). A number of methodologies have been developed attempting to estimate the various aspects of anxiety in sport including self-report measures, biochemical and physiological indices. Research findings have indicated inconsistent patterns of response between psychological and physiological measures of anxiety (4,13,22). Thus, the use of multiple methods is necessary for a more complete estimation of anxiety (7,9,24).

In order to estimate competitive anxiety multidimensionally, a valid and reliable self-report tool was developed; namely, the Competitive State Anxiety Inventory-2 (CSAI-2) (3,19). This inventory evaluates the participants' self-reported cognitive anxiety (cognitive A-state), the perception of their physiological responses, or somatic anxiety (somatic A-state), and self-confidence. Self-confidence, as conceptualized by Martens and coworkers (21), refers to the positive thoughts and expectations from involvement with the task at hand. Research evidence with Greek athletes has supported the inventory's ability to assess cognitive and somatic anxiety effectively, while the self-confidence subscale has received criticism (31).

The most commonly used biochemical index of anxiety is the steroid hormone, hydrocortisone (cortisol), which is secreted by the adrenal cortex under the influence of the hypothalamo-pituitary-adrenal axis in response to a multitude of psychological stimuli (14). The concentration of cortisol in saliva has been shown to correlate well with its concentration in plasma (26). A number of studies reported increased salivary cortisol concentrations in athletes after exposure to acute stress, such as competition (1,6). Elite golfers experienced elevated cortisol during competition compared to practice (22). On the other hand, repeated daily stress events, such as public speaking for five days, resulted in consistently higher levels of salivary cortisol compared to baseline (15), while the mean excretion rate of cortisol on three working days was higher than baseline in long-distance coach drivers (28).

The psychological response of coaches to the acute stress of a competition has been evaluated in the past (16,20). However, there are no published studies specifically addressing the responses of coaches to repeated daily stress events. Moreover, although there is substantial research on the effect of competition importance on precompetitive anxiety (30,33), there has been limited use of physiological estimates of state anxiety (6). Therefore, the aim of the present study was to investigate the psychophysiological responses of swimming coaches experiencing 5 days of competitive stress and the relation of these responses to the perceived importance of competition.

Methodology

Participants

Eight apparently healthy male professional swimming coaches, aged 26–40 years (mean, 33.0), participated voluntarily in the study. They were on no medication and only one was a smoker. The coaches were recruited from among ten head coaches of swimming clubs in Thessaloniki, Greece. Coaches' experience with athletes competing at the national and international levels ranged from 5 to 14 years. They coached male and female age-group swimmers who had been

chosen to compete at the national swimming championships. Their teams ranked between the 3rd and 16th places at the particular championships. Informed consent was obtained from all subjects. The study was designed and carried out according to the guidelines of the University of Thessaloniki Ethics Committee and the Declaration of Helsinki.

Materials and procedures

For cortisol determination, subjects provided four saliva samples, i.e., one fifteen days before competition (pre-stress baseline), one on the first day, one on the third day and one on the fifth (final) day of the national swimming championships. To this effect, participants were asked to chew a plain cotton swab (Sarstedt, Nümbrecht, Germany) for one minute. Subjects consumed no coffee and did not smoke for six hours before sampling. The swab was then placed in a special centrifuge tube (salivette) holding the swab in a suspended insert well above the bottom. The tubes were frozen at -20°C to precipitate mucins. To control for diurnal variation in cortisol concentration, all samples were taken at the same time of the day, i.e., shortly before 6 p.m., which was the time that the events started during the championships.

Immediately following each of the three saliva samplings during the championships and minutes before the start of the events, multidimensional state anxiety was assessed using the Greek version of CSAI-2 (31). The inventory consisted of two factors, i.e., somatic anxiety and cognitive anxiety, with nine items for each factor. Then, just before the start of the events, the perceived importance of the particular day's events was rated on a four-point Likert-type scale ranging from 1 (not at all) to 4 (very much so).

For cortisol determination the specimens were thawed completely and centrifuged at $1500 \times g$ for fifteen minutes to produce approximately 1 mL of clear saliva. Cortisol was assayed by using an enzyme immunoassay kit from Salimetrics (State College, PA).

Statistical analysis

Descriptive statistics (minimum, maximum, mean and standard deviation) of the variables are reported. Comparisons with respect to cortisol concentration, Likert-type scale and subcomponents of CSAI-2 were carried out through one-way Friedman ANOVA. Correlations between variables were examined by Pearson's correlation analysis. The level of statistical significance was set at $\alpha = 0.05$. Data were analyzed with SPSS 10.

Results

The descriptive statistics of the variables tested in the study are shown in Table 1. Mean salivary cortisol of the coaches ranged from 0.21 $\mu\text{g/dL}$ at pre-stress baseline to 0.33 $\mu\text{g/dL}$ at the end of the championships (Figure 1). Most of the 32

Table 1. Descriptive statistics of the study variables.

	Minimum	Maximum	Mean	Std. deviation
Pre-stress baseline cortisol ($\mu\text{g/dL}$)	.12	.29	.21	.06
Cortisol (day 1) ($\mu\text{g/dL}$)	.15	.63	.25	.16
Cortisol (day 3) ($\mu\text{g/dL}$)	.16	.53	.28	.14
Cortisol (day 5) ($\mu\text{g/dL}$)	.15	.81	.34	.22
Cognitive anxiety (day 1)	12	17	15.38	1.77
Cognitive anxiety (day 3)	12	18	15.88	1.89
Cognitive anxiety (day 5)	9	20	16.13	4.05
Somatic anxiety (day 1)	13	22	16.88	3.31
Somatic anxiety (day 3)	13	19	14.75	2.05
Somatic anxiety (day 5)	12	17	13.25	1.83
Competition importance (day 1)	2	3	2.75	.46
Competition importance (day 3)	2	4	3.00	.53
Competition importance (day 5)	1	4	3.13	.99

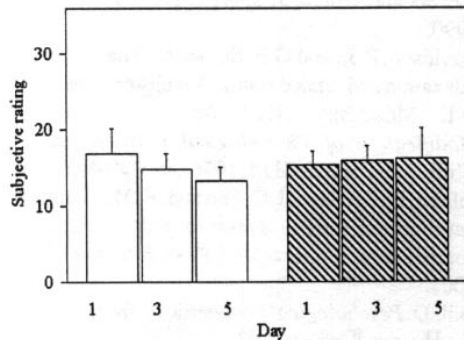


Figure 1. Subcomponents of CSAI-2 during days 1, 3 and 5 of the swimming championships: somatic anxiety (open bars), and cognitive anxiety (striped bars).

individual values were within the normal range for the general population ($0.02\text{--}0.36 \mu\text{g/dL}$; ref. 14). Five values obtained during the championships were above this range. No statistically significant changes were found ($h^2 = 0.16$). Likewise, the perceived importance of the events that took place during the first, third, and fifth day of the championships showed a trend (Figure 2), but the results were not significant ($h^2 =$

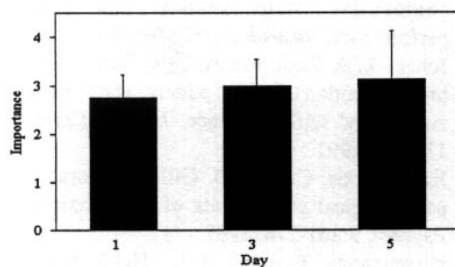


Figure 2. Perceived importance (Likert-type scale) of the events during days 1, 3 and 5 of the swimming championships.

0.15). A significant decline in somatic anxiety was observed from the beginning to the end of the championships ($p = 0.017$, $h^2 = 0.61$; Figure 3) but no significant changes were

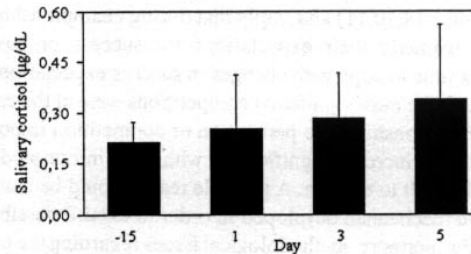


Figure 3. Salivary cortisol concentration of the coaches before and during the national swimming championships.

found in cognitive anxiety ($h^2 = 0.13$). Finally, correlation analysis revealed only one significant correlation, i.e., between cortisol and somatic anxiety on the third day of the championships ($r = 0.84$, $p < 0.001$).

Discussion

The performance and rank of swimmers, as well as the ranking of the team are the main concerns of swimming coaches in a national championship. The aim of the present study was to examine psychophysiological manifestations of stress in swimming coaches during such a championship. The findings from the present study indicate that there were no significant changes in salivary cortisol levels, cognitive anxiety and perceived importance of the competition. As far as cortisol is concerned, research in soccer coaches has shown that cortisol concentration increased as a result of competition and normalized after one hour (16). Similarly, Kirschbaum and coworkers (15) reported that, although salivary cortisol levels were significantly elevated on each of 5 days of exposure to the same daily psychological stressor (public speaking), the mean response decreased from day 1 to day 2 and did not change during the remaining days. This is similar to the findings that drivers of motor coaches had higher salivary cortisol concentrations on all three working days in comparison to baseline and a trend towards accumulation of cortisol from the first day to the third working day (28).

The contradiction between the present study and the studies of Kugler and coworkers (16), as well as Kirschbaum and coworkers (15), could be explained by the different degree of threat experienced by the swimming coaches. At the national championships of swimming, the competitions that would determine the rank of the athlete and the team were scheduled for the final two days. This might have provided swimming coaches with sufficient time to cope with the experience of anxiety and have a cortisol response not significantly different from the response to a routine training day.

As far as the dimensions of state anxiety are concerned, the findings of the present study revealed that somatic anxiety peaked at the beginning of a championship and decreases subsequently, whereas cognitive anxiety remained relatively

stable in a way similar to temporal patterning prior to a single competition. These findings are similar to those reported in the literature (8,10,11) and imply that during championships coaches maintain their expectations for success or have sufficient time to cope with changes in success expectations.

Although the most significant competitions were at the end of the championships, the perception of competition importance did not increase significantly with time in our study. This is difficult to explain. A possible reason could be that a defensive mechanism developed in order to excuse possible failure. Furthermore, methodological issues regarding the use of a single item to estimate perceived importance may have led to these results.

Correlation analysis revealed that the importance of competition was not related to the variables of state anxiety or cortisol. These findings are in contrast to those of Jones and coworkers (12), who reported that importance of competition is a significant predictor of cognitive anxiety. Furthermore, the present study did not reveal significant correlations between cortisol concentration and the state anxiety variables (with one exception, i.e. between cortisol and somatic anxiety on the third day). These findings are similar to those reported in the literature (4,13), indicating that physiological and psychological measures of anxiety are not necessarily related.

A limitation of the present study was the small sample size—which has been primarily dictated by the small number of available head coaches in the particular environment—and the resulting low power of the analysis (approximately 0.1). This might have been the reason why some of the visible trends have not produced significant differences or correlation. It is therefore possible that a larger sample size would have yielded different results. Within this limitation, our results imply that repeated daily stress events may not influence the majority of psychophysiological measures of anxiety in swimming coaches.

Applications

The present study revealed important directions regarding future research with swimming coaches. For example, it would be interesting to examine the effect of athletes' success and failure on the construction of a coach's expectations and anxiety. Furthermore, the study of anxiety levels during training periods would be very interesting. Training periods may be extremely stressful for coaches as well as athletes, since coaches experience daily concerns regarding the load and intensity of the training program, the adaptations of the athlete and a number of peripheral issues that affect the athlete's training and subsequent performance, such as physiotherapy, nutrition, medical examinations etc. The study of possible variations in psychophysiological measures of anxiety with training period may prove useful in improving coaching efficiency and hence increase performance of the athlete.

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