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THE CORTICOTROPIN AND ENDORPHINS RESPONSES PRE AND POST COMPETITION

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Abstract

Many investigations have reported an important increase in ACTH and END plasma concentration in response to predominantly aerobic exercises. Although several studies have attempted to determine the response of these hormones in competitive situations. Considering all above mentioned, the aims of this study were to determine the corticotrophin (ACTH) and endorphin (END) responses to a single bout of competitive swimming exercise, and to examine the relationship between them. Conclusion of this study: single bout of competitive swimming induces a psychological and physiological stress which stimulates practically the same pattern of response for ACTH and END.

1. Introduction

Corticotropin (ACTH) and endorphins (END) are secreted from the major anterior pituitary gland in response to psychological or somatic stress (Carrasco, 2002). Therefore, it is not surprising that ACTH and END plasma levels rise in response to exercise. In fact, many investigations have reported an important increase in ACTH and END plasma concentration in response to predominantly aerobic exercises (Odagiri, Shimomitsu, Iwane & Katsamura, 1996; Estorch et al., 1998) as well as exercises of anaerobic nature (Laurent et al., 2000). Moreover, the exercise-induced psychological stress can also potentiate the ACTH and END response. In this sense, pre-competitive anxiety experienced by athletes under competition environments appears as a key factor in the hypothalamic-pituitary-adrenal (HPA) axis activation, and thus can provoke increases in ACTH and END plasma concentrations.

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Although several studies have attempted to determine the response of these hormones in competitive situations (Oltras, Mora & Vives, 1987; Scavo Barletta, Vagiri & Letizia, 1991), little data exist on the magnitude of the ACTH and END responses when athletes carry out a maximal, short term, and highly demanding competitive exercise.

Considering all above mentioned, the aims of this study were to determine the corticotrophin (ACTH) and endorphin (END) responses to a single bout of competitive swimming exercise, and to examine the relationship between them.

2. Material and methods

Thirteen national level male swimmers, all of whom were specialists in swimming distances of 100 and 200 m with an experience of at least 6 years in systematic training (experimental group) and ten healthy male students (age-matched control group) took part in this study (table 1). Informed written consent was obtained from all participants, and the project was approved by local Ethical Committee.

Table 1. *Main subjects' characteristics*

n=13	Age (yr)	Height (cm)	Weight (kg)	BMI (kg/m2)	Body fat (%)
	18.6±0.8	174.9±1.8	65.11±2.14	21.28±0.66	10.75±1.00

Values are expressed as mean ±SEM

The swimmers underwent three experimental trials. In the first trial, the swimmers were tested in basal conditions (subjects were asked to abstain from strenuous physical activity for at least 24 h and to fast for 8 h before testing). Upon arrival to the laboratory anthropometrical and body composition parameters: height, weight, body mass index (BMI), and body fat percentage (bioelectric impedance, OMRON BF300 analyzer) were registered, and a blood sample (10 ml) was obtained from the antecubital vein. Subsequently, all subjects completed the State - Trait Anxiety Inventory (STAI) (Spielberger, Gorsuch & Lushene, 1970). One week later, at approximately the same time of day (between 8:30 and 10:00 am), in the same resting and fasting conditions of the first trial, the swimmers participated in an official swimming competition. Before competition, and after 10 min of rest in the swimming pool, a blood sample (10 ml) was obtained from swimmers, and they completed the STAI questionnaire (state version). This was followed by a standard warm-up (20 min easy swimming). Immediately after the warm-up period, the swimmers competed in their respective 100 m freestyle heats. Time to complete this distance was the mean of that registered by two official timekeepers. Immediately after each heat (1-2 min post-exercise) the swimmers were subjected to another blood extraction (10 ml), and completing the STAI questionnaire (state version). The environment conditions registered in the competition were the following: 27.5º C for water temperature, 29.4º C for air temperature and 58% for relative air humidity (similar to first trial conditions).

Each blood sample was divided in two aliquots of 5 ml (EDTA K2 tubes with 50 µl of aprotinin: SIGMA A6279). One of the aliquots was destined to haematological analysis (Coulter JT3 analyzer), and plasma was obtained from the remaining aliquot. END and ACTH concentrations were assessed in plasma samples (RIA, END: Nichols; intra-assay variation: 4.1%; inter-assay variation: 7.7%. ACTH: intra-assay variation: 2.3%; inter-assay variation: 4.6%). Also, haemogram (haemoglobin concentration and haematocrit value) was performed to calculate the possible changes in plasma volume (PV) that could alter the results of the biochemical analysis (Dill & Costill, 1974).

Statistical Analysis

Data are expressed as mean ± standard error of the mean (SEM). Non-parametric methods were used. Friedman test was used to compare the experimental trials. Furthermore, linear regression analysis was performed, and Pearson correlation coefficient was calculated to determine the relationship between variables. In all cases, statistical significance was established at an alpha level of 0.05.

3. Results and discussions

Changes in END plasma concentration can be observed in diagram 1. A significant increase in plasma END levels was observed in pre-competition assessment (51.8±3.2 vs. 36.3±2.9 pg/ml in basal conditions; $p \leq 0.05$). However, no differences were observed in ACTH plasma levels when basal and pre-competition measures were compared (diagram 2; 10.1±0.9 vs. 10.9±1.2 pg/ml, respectively).

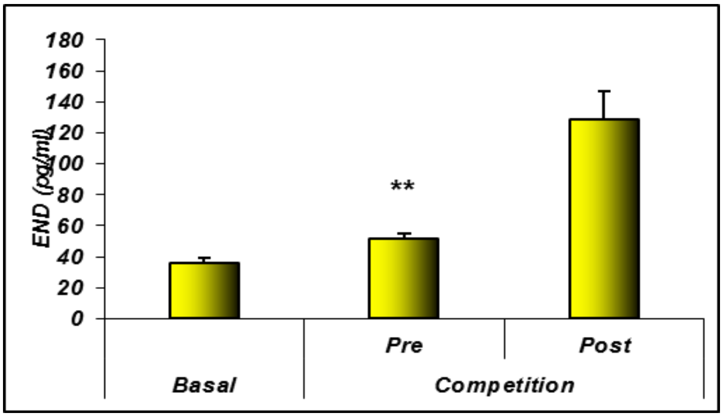

Figure 1. *END plasma levels at the three assessments points*
**Differences regarding basal levels;*
+differences regarding pre-competitive condition

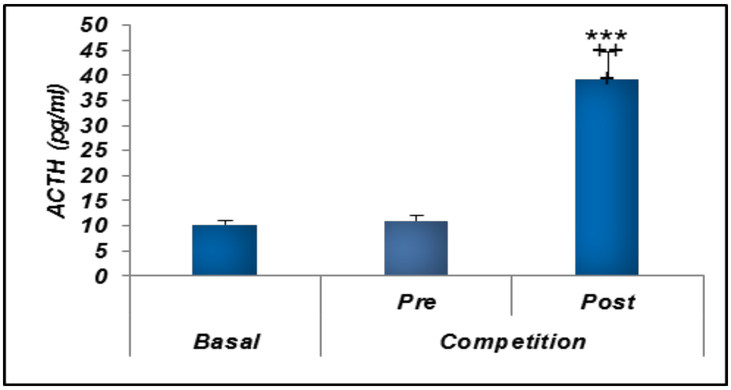

Figure 2. *ACTH plasma levels at the three assessments points*
**Differences regarding basal levels;*
+differences regarding pre-competitive condition

Regarding STAI scores, the pre-competition values resulted significantly higher than the basal ones (24.5±3.1 vs. 18.5±2.8, respectively; $p \leq 0.05$) (diagram 3).

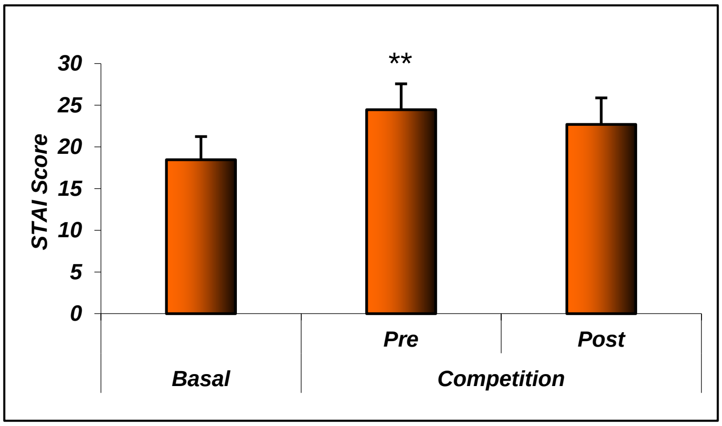

Figure 3. *State-anxiety levels at the three assessment points*
**Differences regarding basal levels*

Time to complete the swimming race (100 m freestyle) was 61.47±1.98 s. Despite the effort was short, a decrease in PV was observed in post-competition situation. In any case, the individual percent change was used in order to correct END and ACTH plasma levels at this point.

The stress induced by competitive effort produced a huge increase of END plasma levels, reaching values of 128.6±18.1 pg/ml. These data were significantly higher than those found both in basal and pre-competition conditions ($p \leq 0.001$; diagram 1). Similarly, ACTH plasma levels increased significantly just after competition (diagram 2), finding values of 39.4±5.2 pg/ml; $p \leq 0.001$). On the other hand, and taking as reference the pre-competitive results, a slight decrease in STAI scores was found (22.7±3.2) showing no statistical differences between the two assessment points.

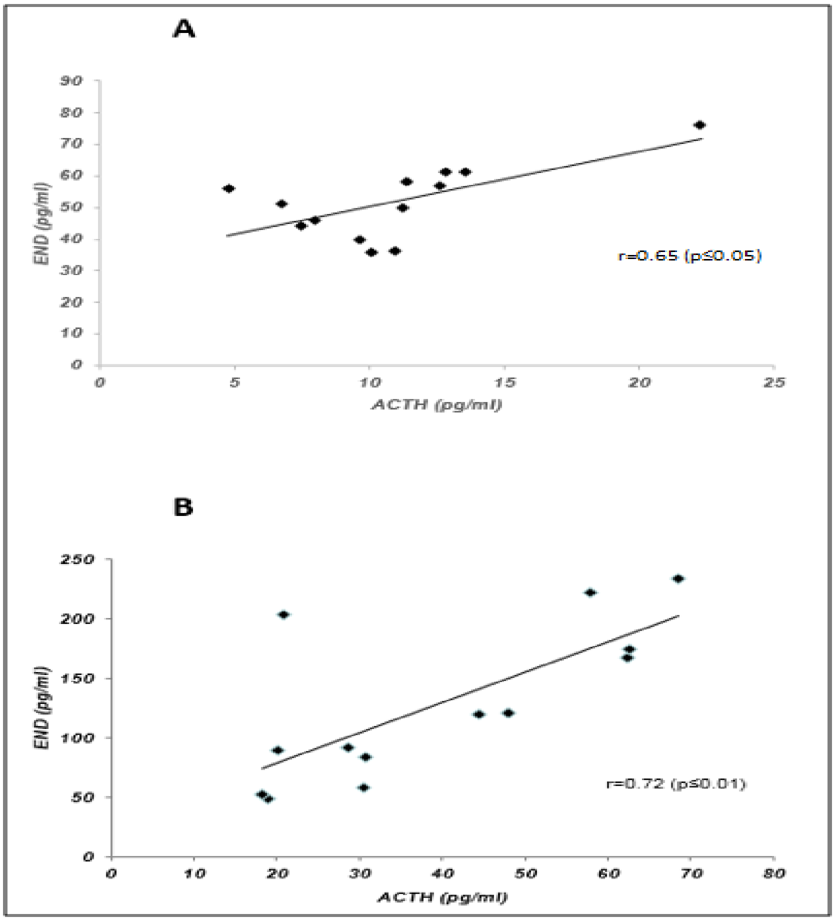

Figure 4. *Correlation analysis between END and ACTH plasma levels at pre-competition (A), and post-competition (B) assessment points.*

Correlation analysis only detected two significant relationships between END and ACTH plasma levels. One of them in pre-competition situation ($r=0.65$; $p\leq0.05$) and the other one in post-competition condition ($r=0.72$; $p\leq0.01$) (diagram 4). Finally, no statistical relationship was found between STAI scores and hormonal response.

Discusions

The novelty of this study was to investigate the relationship between END and ACTH responses to a single bout of competitive swimming. To date, previous studies have focused on these responses after mid- or long-duration efforts (sustained mainly by aerobic metabolism). Moreover, we evaluated the reactivity of HPA axis of swimmers exposed to one of the most remarkable stressful experience for them: a real swimming competition.

As we expected, END and ACTH released from the anterior pituitary gland to the bloodstream in response to competitive effort (psychological and somatic stress) although only END responses were observed to pre-competitive condition (psychological stress associated with pre-competitive anxiety). A mean increase of approximately 40% over the basal levels can define the END reactivity to this type of exercise stress. Similar results were obtained by Gonzalez de Juan (1990) and Scavo et al. (1991) when different athletes were evaluated in pre-competitive conditions. Despite the significant increases in anxiety levels at this assessment point, no correlations was found between END plasma levels and state-anxiety scores.

On the other hand, ACTH plasma levels obtained in pre-competition situation were similar to those measures in basal conditions. This lack of ACTH reactivity is opposed to the findings of Scavo et al. (1991) who registered elevated ATCH concentrations in a group of runners 1 h prior to take part in an official marathon race. However, in the same study, these authors noted that ACTH concentrations remained at basal levels when their athletes were preparing to participate in a less-compromising half–marathon running competition. In our investigation, the competitive compromise was high since it was the main competition of the season for the great majority of swimmers; nonetheless, we didn't observe any change in ACTH response. Also, and in spite of significant rise in pre-competitive anxiety levels, there was no correlation between STAI scores and ACTH plasma concentrations.

Just after finishing the competitive effort, significant increases in plasma END levels were measured such that post-competition values were up to 350% higher than basal levels and 240% higher than those found in the pre-competition assessment point. This latter percent change could to indicate the extent to which the physical stress accounts for the END response. These findings are similar, in part, to those obtained in previous investigations where the END response to high-intensity, and short-term anaerobic exercise was evaluated (Schulz, Harbach, Katz & Geiger, 2000). Although it seems clear that strenuous exercise can stimulate the release of END, in a recent study, Choi et al. (2013) didn't find plasma END increases after an official kumdo competition. Regarding anxiety levels, and taking into account the pre-competition results, we observed a slight decrease in STAI scores that didn't also show any significant correlation with post-competition END levels.

Unlike pre-competitive anxiety, physiological stress itself was a stimulus for the ACTH response since their levels experimented a remarkable increase (up to 380%) compared to the pre-competitive ones. These results are in consonance with those reported by Schwartz and Kinderman (1990) and Bosco et al. (1996), although the increases reported here were higher than those found by the latest authors. In this line, Weib, Pollert, Stehle and Weicker (1988) found increases in plasma ACTH after all-out 150 m breaststroke swim and 10 min of moderate intensity swimming. In any case, ACTH levels reported were lower than those found in the present study.

As previously happened between END and STAI scores, there was no statistical correlation when post-competitive ACTH and state anxiety levels were matched, results that are agree with those informed by Deuster et al. (1998).

Regarding to correlation analyses, and considering that END and ACTH share the same precursor (proopiomelanocortin), it would be logical to think that these hormones are present in equal quantities in the bloodstream. However, unlike studies as performed by Estorch et al. (1998), we did not found a well-defined relationship between basal levels of END and ACTH. Nevertheless, relevant correlations were found between END and ACTH levels in both pre- and post-competition conditions. Curiously, and taken into account that ACTH concentration remained broadly unchanged in pre-competition situation, a significant relationship with END levels was established at that assessment time. To our knowledge, the relationships between END and ACTH responses to psychological stress had not been well defined so these results are novel and at the same time fit well with our current understanding of psychological stress-induced HPA axis reactivity. On the other hand, a remarkable relationship was found between these hormones in post-competition situation. These results are consistent with previous studies in which END and ACTH were measured just at the end of different efforts (Fellmann et al., 1992; Odagiri et al., 1996; Heitkamp, Huber & Scheib., 1996; Estorch et al., 1998).

4. Conclusions

It can be concluded that single bout of competitive swimming induces a psychological and physiological stress which stimulates practically the same pattern of response for ACTH and END.

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