Physiology & Behavior 177 (2017) 291–296

Contents lists available at ScienceDirect

Physiology & Behavior

journal homepage: www.elsevier.com/locate/physbeh

Salivary steroid response and competitive anxiety in elite basketball players: Effect of opponent level

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ARTICLE INFO

Keywords:
Saliva
Cortisol
Testosterone
Team-sports
Training monitoring

ABSTRACT

This study examined the effect of playing matches against different opponent teams (hard match; HM, medium match; MM, and easy match; EM) on pre-match testosterone concentration (T), pre-to-post match cortisol (C) concentration, and pre-competitive anxiety (CSAI-2 questionnaire) in 20 elite male basketball players. One training session (TS) was also assessed (control condition). Saliva steroids were determined by ELISA. The pre-T concentration was significantly lower for the TS (163 ± 54 pmol L^{-1}), compared to the three official matches (EM: 208 ± 82 pmol L^{-1}, MM: 213 ± 57 pmol L^{-1}, and HM: 218 ± 37 pmol L^{-1}) ($p < 0.05$). A significant change in C from pre-to-post was observed for all conditions (TS [5.8 ± 3.7 vs 14.4 ± 9.4 ηmol L^{-1}], EM [10.1 ± 4.9 vs 17.3 ± 10.2 ηmol L^{-1}], MM [13.0 ± 7.4 vs 21.5 ± 8.3 ηmol L^{-1}], and HM [18.9 ± 5.8 vs 31.4 ± 5.3 ηmol L^{-1}] ($p < 0.05$). A higher PRE-C was observed for the HM, compared to TS and EM ($p < 0.05$) and a higher POST-C concentration for the HM was detected, compared to the TS, EM, and MM ($p < 0.05$). A lower anxiety level was observed for the EM (somatic: 15.0 ± 3.7; cognitive: 15.8 ± 4.5 arbitrary units [AU]) compared, to the MM (somatic: 16.4 ± 3.5; cognitive: 17.7 ± 4.0 AU) and HM (somatic: 15.8 ± 3.9; cognitive: 18.3 ± 3.9 AU) ($p < 0.05$) and a higher self-confidence was observed for the TS (28.9 ± 5.1 AU), compared to the HM (26.7 ± 3.0 AU) ($p < 0.05$). These results suggest that playing against a high-level opponent may cause a higher psychobiological stress, likely because opponent level may be perceived as threating to the social status in a given hierarchy.

1. Introduction

Dominance and status-seeking behavior is reportedly influenced by testosterone concentration (T), a steroid hormone that is regulated by the hypothalamic-pituitary-gonadal (HPG) axis [1]. Elevated T level is positively related to aggressive and dominant behaviors in a variety of animal species, especially when social status is threatened [2,3].

Some human studies have also indicated that T is associated with dominance under conditions of status threat or challenge [3,4]. For instance, Archer [3] reported that T is an index of dominance during competitive interaction. Interestingly, some studies with humans have indicated that a higher T is linked to dominance when conditions are associated with status threat or challenges [4–7]. Nevertheless, weak or null results regarding T and dominance index have also been described [8–10].

In general, evidence suggests, however, that a higher T is related to social dominance, and that the role of testosterone in human social behavior might be associated with the search for and maintenance of social status [11]. An elevated T concentration is thought to prepare individuals to gain or defend their status in competitive or socially-threatening interactions. Previous studies have used sports competitions to model status dynamics [12,13,14] and the results of these studies were consistent with the prediction of the biosocial model of status (BMS), which hypothesizes that winning a competition should cause a rise in T, compared to losing (competition effect). Nevertheless, other studies did not replicate the predicted winner-loser effect [15,16].

These conflicting results in the sports setting may indicate that psychological and contextual factors might also affect T responses, besides competition outcome [17]. Nevertheless, with regard to pre-T concentration; since elevated T might play a role in preparing individuals to gain or defend their status, the uncertainty of players regarding their clear dominance over the opponent might affect T concentration prior to the match and needs to be considered. It may be hypothesized that when players are facing a perceived high-level opponent, this contextual factor might cause a rise in T, due to feelings of the uncertainty of success in maintaining a given social status, therefore causing doubts about status hierarchy.

Another steroid hormone that has been associated with instable and

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http://dx.doi.org/10.1016/j.physbeh.2017.05.017
Received 14 December 2016; Received in revised form 6 May 2017; Accepted 16 May 2017
Available online 17 May 2017

uncontrollable social status is cortisol (C) [18]. Dickerson and Kemeny [18] conducted a meta-analysis review that included laboratory studies of acute psychological stressors. The authors were interested in examining which conditions were capable of affecting C responses. Results of this study revealed that those tasks containing both instable (uncontrollable) and social-evaluative elements were associated with a higher C response and with longer times to recovery. Nevertheless, it is worth highlighting that C is also known to rise in response to distinct physical and psychological stressors, and competitive situations (i.e sports competition) and exercise per se (physical stress), may represent a potent physiological stressor [19], where augmentations in C increase cardiovascular activity, glucose level and anti-inflammatory responses [20].

The role of the competition environment in the C response in athletes of various sports has been demonstrated. For example, Moreira et al. [21,22] reported a higher increase in salivary C concentration from pre-to-post official matches, compared to simulated matches, in professional and elite youth basketball players. Crewther et al. [23] and Passelergue et al. [24] showed a greater increase in C level (> 100%) prior to real weightlifting events versus simulated events. Moreover, Arruda et al. [25] in a study with elite basketball players reported that playing at home induced a greater C post-match response (vs. playing away) despite no significant differences in the perception of effort between the playing venues.

Taken together, these results suggest that a sports competition is a typical model of an uncontrollable and social-evaluative task, and that the pressure of participating in official matches (vs training or simulated matches), associated with the playing venue, may be considered as additional stress factors (contextual factor) to the well-known physiological role of C during exercise. In addition, as many aspects of status can be physically or psychologically stressful, including competing for status or maintaining high status [26], the concerns regarding the maintenance of social status when playing official matches may also be elevated. This situation might lead to a higher level of stress on the players resulting in a higher C response.

The use of salivary hormonal profile (eg. T and C), together with the level of anxiety, may provide a sensitive index of competitive stress, as shown by the relationships observed between somatic and cognitive anxiety and hormonal measurements (C and T) [27]. Filaire et al. [28], for instance, showed that interregional judo competitions elicited a high level of anxiety and a lower self-confidence, along with an increase in salivary C level. Additionally, Pappacosta et al. [29] also demonstrated a high level of cognitive anxiety, associated with an elevated salivary C concentration in judo athletes during competition. The authors reported that a higher level of cognitive anxiety, along with a higher C concentration, was observed in the winners when compared to losers, suggesting that this result could indicate better psychophysiological arousal for promoting winning performance. Conversely, some studies have found no relationship between anxiety level and C or T responses before competition [30,31]. However, to date, no previous studies have investigated pre-competitive anxiety, when athletes played against opponents of different levels. Playing against a high-level opponent may be perceived as a greater social-related status provocation or hierarchy threatening, which could in turn lead to elevated hormonal responses.

Thus, the aim of this study was to examine the effect of playing matches against different opponent teams on pre-match salivary testosterone (T) concentration, pre-competitive anxiety, and pre- and post-match C concentration. It was hypothesized that greater pre-match salivary T concentration and pre-match salivary C concentration would be observed for official matches (versus training session), and when playing against a more difficult opponent team (hard match vs easy match), which would be perceived as more challenging by the players for gaining, or maintaining, social status. In addition, it was also hypothesized that a higher anxiety level and a lower self-confidence would be observed playing against a higher-level opponent team, and that this behavior would be accompanied by a higher post-match salivary C concentration.

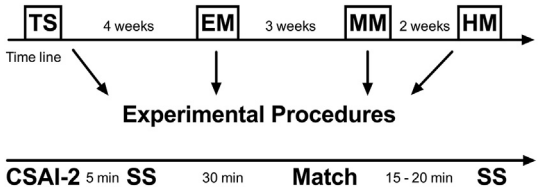

Fig. 1. Experimental design. TS = Training session ("control condition"); EM = Easy match; MM = Medium match; HM = Hard match. CSAI-2 = Competitive State Anxiety Inventory-2. SS = saliva sampling.

2. Material and methods

2.1. Experimental methodology

Three official matches involving the same team playing at the home venue were analyzed. One training session (TS) was also assessed as the "control condition". TS and matches were performed during the regular competitive season. All training and official matches were performed between 1900 and 2100 h. Players were required to complete the Competitive State Anxiety Inventory-2 (CSAI-2) to estimate players' cognitive and somatic anxiety, as well as self-confidence level, before the warm-up and saliva collection. After having filled out the CSAI-2, players provided saliva samples (before the warm-up procedures). Saliva collection after TS and official matches occurred within 15–20 min (Fig. 1). During the TS, players performed a 90-min training session composed of warm-up exercises, technical and tactical exercises (~50 min), followed by a simulated match which lasted approximately 40 min, divided into 4 quarters of 10 min separated by approximately 1 min of rest. Coach and staff members were encouraged by the researchers to be extremely demanding on the players. Each official match assessed was played against a different team. The three opponent teams were chosen according to a ranking established at the beginning of the season by the coaches and their staff and monitored by training staff and researchers over the investigated period to track possible changes in ranking. Therefore, the level of the opponent was determined due to the estimated "difficulty" of the match, and was classified as follows; hard match (HM – opponent team ranked between 1st and 3rd place); medium match (MM - ranked between 4th and 6th place); and easy match (EM - ranked between 7th and 10th place). The sequence of matches was that of increasing difficulty as the competition progressed (Fig. 1).

2.2. Subjects

Twelve elite male basketball players, belonging to the same team volunteered for this study (mean ± SD: age, 18.6 ± 0.5 y; height, 192 ± 7 cm; body mass, 88.9 ± 14.5 kg). The team was participating in the under-19 State Basketball Championship, São Paulo, Brazil. The team was ranked 1st in the State Championship during the period investigated. Habitually, the players performed two training sessions per day (90–120 min per session), 5 days a week and participated in one official match every week. Training sessions consisted of basketball drills, tactics, sprints, intermittent running exercises and specific conditioning work, as well as weight training and plyometrics. All the players were familiarized with sampling and survey procedures. Participants provided written informed consent before the study commenced. The study was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans, and all procedures received University Ethics Committee approval.