



Influence of competition playing venue on the hormonal responses, state anxiety and perception of effort in elite basketball athletes



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HIGHLIGHTS

- Playing at home was accompanied by elevated pre-game free testosterone concentration.
- The basketball games played at home were also won.
- Free testosterone and cortisol concentrations were similarly elevated (%) across the games.
- No differences in state anxiety and perception of effort were identified between the playing venues.
- Hormones were significantly related to somatic and cognitive anxiety.

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ABSTRACT

This study examined the influence of competition playing venue on the hormonal responses, state anxiety and perception of effort in elite basketball players. Eighteen males from two basketball teams were monitored during two competitive matches that were played against each other on a home and away basis. Salivary testosterone (T) and cortisol (C) concentrations were measured before and after each match. The Competitive State Anxiety Inventory-2 (CSAI-2) test was also administered prior to each match and session ratings of perceived exertion (RPE) were taken post-game. Playing at home was accompanied by elevated pre-match T concentration, as compared to playing away ($p < 0.05$). The matches played at home were also won. Salivary T and C concentrations were similarly elevated across the matches (percent changes from pre to post) played either at home or away. No significant differences in state anxiety and perception of effort were identified between the playing venues. Pre-match T and C concentrations and the percent changes in these hormones were significantly related to somatic anxiety, especially when playing at home ($p < 0.05$). In conclusion, the competition playing venue appeared to influence athlete salivary hormonal responses prior to elite basketball matches. These hormonal responses were associated with player's anxiety state, which might contribute to performance and the eventual match outcomes.

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1. Introduction

The home advantage is a well documented phenomenon in sports competition such as baseball, football, ice hockey, rugby, and basketball [1,2]. The concept of territoriality and its association with dominance, aggressiveness and status emerges as one possible candidate to explain

the perceived advantage of a sports team competing at their home venue [3,4]. Territoriality is prevalent within many animal species displaying agonistic behaviors, for example, animals attack with greater vigor when are trying to defend their home territory [5]. Commensurate with these findings, there are reports of increased aggression or arousal state playing at home in the sports of ice hockey [6] and rugby union [7].

Agonistic behavior is defined by any social behavior related to fighting; however it has broader meaning than just aggressive behavior because it is comprised of threats, aggression and submission [8]. This social behavior is thought to be reciprocally related to endogenous T [4] and T has been linked to athletes' attitude in a sport competition

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[9,10]. Indeed, pre-game increases in T concentration have been reported in sports teams playing in their own home stadium, versus an opponent's venue [11,12]. Likewise, winning in human competition is often associated with elevated T level, relative to losing [9,13–15]. These findings confirm a link between T and the concepts of dominance, territory and aggression. However, to our knowledge, no previous investigations have assessed the playing venue effect in the sport of basketball and compared teams of similar rankings or abilities.

Cortisol (C), another steroid hormone, also responds to the competition environment. Marked increments in C level (>100%) have been verified prior to real weightlifting events versus simulated events [16, 17] and during official Jiu–Jitsu matches, as opposed to simulated games [18]. These findings are important considering the possible link between athlete C concentration, state anxiety and subsequent physical performance in sport [19,20]. The behavioral responses of T in threatening situations, which can be linked to elite sports competition, might also be suppressed by the C effects on the hypothalamic–pituitary–axis (and T secretion) and the androgen receptors themselves [21]. Thus, it would be useful to investigate both the T and C responses to team sports competition when examining the home and away effect in sport.

Studies on athletes have demonstrated higher state anxiety in a competition facility than in their own training facility [22–24]. In other studies, positive relationships were demonstrated between cognitive and somatic anxiety and C concentration in male judoists during competition [19] and C responses were also used to verify changes in state anxiety associated with performance in tennis players [20]. Therefore, it is reasonable to suggest that elite performance during competition could be mediated by interactions between the emotional, hormonal and behavioral responses. Up to now, no research has taken a psychophysiological approach, using anxiety scores along with hormonal responses, to assess playing venue effect in elite basketball players.

In this study, two basketball teams were monitored during two competitive matches that were played against each other on a home and away basis. In accordance with the challenge hypothesis and territoriality phenomenon [25], higher free T concentration was expected when playing at home (versus away venue). It also was hypothesized that the winners of these matches would show greater match increment in salivary T and C concentrations compared with the losers. Based on previous assumptions [26,27], it was further hypothesized that player anxiety levels would correlate to salivary T and C concentrations.

2. Materials and methods

2.1. Subjects

Twenty four elite male basketball players volunteered for this study (mean \pm SD: age, 17.8 ± 0.4 years; height, 190 ± 10 cm; body mass, 87 ± 8.5 kg). They played for two under-19 teams competing in the State Basketball Championship, São Paulo, Brazil. The teams were ranked first and second in the State championship during the monitoring period. From the initial 24 players recruited, only data from 18 players were retained for analysis based on their participation in the two investigated matches. On a weekly basis, each player trained twice a day (90–120 min per session), five days a week and they played in one official match. The training sessions consisted of basketball drills, tactics, sprints, intermittent running exercises and specific conditioning work, as well as weight training and plyometrics. Participants provided informed consent before the study commenced and all procedures received local ethics committee approval.

2.2. Experimental approach to the problem

Two matches involving the same two basketball teams were investigated using measures of salivary hormone concentrations, anxiety levels and perceived effort. The two matches were completed during

the regular competitive season (8 weeks apart) and both were played between 2000 and 2200 h. The first match was performed at the facility of the team denoted as Team “B”, which was ranked second at the start of this study. Team “A” was ranked first prior to the first match. The second match was performed at the playing facility of Team A. The team rankings remained the same during the second match played.

2.3. Procedures

Subjects arrived at the playing venue approximately 90 min before the matches started. Both matches were preceded by a 30-minute warm-up comprising of light aerobic exercise, basketball and team drills, and stretching of the major muscle groups. A saliva sample was taken by passive drool before the warm-up procedures. No food was taken 1.5 h before the first saliva sample to reduce the effect of food intake on salivary hormone concentrations [28]. During the basketball matches, participants were encouraged to drink water during the quarterly breaks to maintain hydration levels. Salivary flow rate was also determined, as a possible indicator of hydration status [29]. No weight management strategies were implemented, and no differences in body mass or saliva flow rate from pre-game to post-game were observed for players in either teams, suggesting that the athletes were able to maintain an appropriate hydration status during the assessed games. The two matches were played at a similar time of the day (between 2000 and 2200 h), which helped to control for diurnal variation in hormones and performance. Each player maintained their normal training schedule in the week leading up to each match, which remained relatively stable in terms of training mode, frequency and volume across the competition season.

2.4. Hormonal assessments

Subjects provided a saliva sample before the pre-match warm-up (PRE) with a post-match (POST) sample collected within 15 min of the completion of each match. The samples were collected in a pre-weighed sterile 15-mL centrifuge tube over a five minute period and stored at -80°C until assay. The tubes were re-weighed before analysis, so that saliva volume could be estimated. Saliva density was assumed to be $1.00\text{ g}\cdot\text{mL}^{-1}$. Salivary flow rate was determined by dividing the volume of saliva collected by the duration of the sampling period. After thawing and centrifugation (10,000 g for 10 min at 4°C), the samples were tested for C and T concentrations using enzyme-linked immunosorbent assays (ELISA, Salimetrics™ expanded range kit) and the manufacturer's recommendations. The average intra-assay coefficient of variation for the C and T assays were 3.7% and 3.2%, respectively. The minimum detection limit for the T assay was 21 pmol/L and 0.33 nmol/L for the C assay.

2.5. Psychometric assessments

The Competitive State Anxiety Inventory-2 (CSAI-2) test was implemented with the aim to estimate the players' cognitive and somatic anxiety, as well as self-confidence levels. The CSAI-2 consists of 27 items, with 9 items for each the subscale, named cognitive anxiety, somatic anxiety and self-confidence [27]. Each item scored, regardless the subscale, is rated on a 4-point Likert-type scale. Thus, a score from 9 to 36 for each subscale can be obtained. The CSAI-2 was filled out before the warm-up, in the dressing room, immediately before the saliva sample collection. The Cronbach's alpha coefficients of internal consistency of 0.89 for cognitive anxiety, and 0.92 for somatic anxiety and self-confidence, were reported earlier [20]. Session-RPE score [30] was assessed after the matches, in order to quantify internal training load. Briefly, each player rated the match intensity using the CR-10 sliding scale, where 1 = nothing at all and 10 = very, very hard. To assess the match intensity, after 30 min of the end of the match, the athletes were asked a simple question: “How was your workout?” and a chart

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