

## Game location effect on pre-competition cortisol concentration and anxiety state: A case study in a futsal team

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### Abstract

The main aim of this study was to investigate the game location effect on pre-competition salivary cortisol and state anxiety in professional futsal players. Fourteen male players from a U-20 futsal team were evaluated during four competitive matches played away ( $n=2$ ) and home ( $n=2$ ) venues. Saliva samples were collected in order to analyse the salivary cortisol concentrations (sal-C) by the ELISA assay and state anxiety was evaluated using the CSAI-2R questionnaire. All the data collection took place before the pre-match warm-up. Medium and clear increase on sal-C ( $ES= 0.67$ ;  $CL= 0.20$ ;  $1.14$ ) was observed from home to away venues. Trivial and unclear differences between away and home venues were observed in cognitive anxiety ( $ES= 0.12$ ;  $CL= -0.34$ ;  $0.57$ ); somatic anxiety ( $ES= 0.06$ ;  $CL= -0.40$ ;  $0.51$ ) and self-confidence ( $ES= 0.06$ ;  $CL= -0.40$ ;  $0.51$ ). In conclusion, the data suggested that game location affects hormonal responses; increases in sal-C suggest that playing away represents a more challenging situation in futsal athletes compared to their home venue.

**Keywords:** Salivary cortisol; Competitive Anxiety; Territoriality; Sport

In team sports competition such as basketball, rugby, football (Pollard and Armatas, 2017; Jones, 2018), ice hockey and baseball, a factor that should be considered is the “home advantage” phenomenon (Nevill and Holder, 1999; Dosseville, Edoh and Molinaro, 2016). The home advantage can be interpreted as the advantage of a sport team competing at their home venue, winning over 50% of the games playing in their domains (Courneya and Carron, 1992). It has been proposed that some game location factors may underlie the home advantage phenomenon such as crowd, travel, familiarity with the competition facility and rules (Courneya and Carron, 1992; Dosseville, Edoh and Molinaro, 2016).

The perceived advantage of playing at home may be associated with the concept of territoriality and dominance, representing a perception of proprietary rights over a physical space (Terry, Walrond and Carron, 1998; Furley, Schweizer and Memmert, 2018). Territoriality behaviour is well evident in many animal species, in which an animal or group advert or defend their area from occupation by others (Wilson, 1975). In the context of competitive sports, sometimes athletes show a similar territorial behaviour to animals, characterized by increasing on steroid hormones (Neave and Wolfson, 2003; Arruda et al., 2014) and

aggressive behaviour (Kerr and Van Schaik, 1995; Gronek, Wielinski and Gronek, 2015).

Indeed, some steroid hormones, such as the cortisol, have been associated with competition environment (Crewther, Heke and Keogh, 2011; Fernandez-Fernandez et al., 2015; Arruda, Aoki, Paludo e Moreira, 2017). The cortisol is considered a hormone marker of the activation of hypothalamic pituitary adrenal axis (HPA) (Hiller-Sturmhöfel and Bartke, 1998). In sports settings, increases in HPA axis activity has been linked with major psychological or physiological stress, leading to high cortisol concentration (Crewther, Heke and Keogh, 2011; Casto and Edwards, 2016). Increment in cortisol concentration has been found previous to official games compared to simulated games or training sessions (Crewther, Heke and Keogh, 2011; Fernandez-Fernandez et al., 2015; Arruda, Aoki, Paludo e Moreira, 2017); and preceding games played at home compared to away venue (Carré, Muir, Belanger and Putnam, 2006).

In addition, the psychological responses such as state of anxiety also have demonstrated to be sensible to game location. Increases in cognitive and somatic anxiety also have been found previously official games compared to training session (Arruda, Aoki, Paludo e Moreira, 2017);

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during competition (Filaire, Alix, Ferrand and Verger, 2001); and during the final competition compared to semi-final (Arruda, Aoki, Drago and Moreira, 2018). Regarding the game location, studies have reported higher pre-match cognitive and somatic anxiety in athletes when playing in their opponent's venue (Carré, Muir, Belanger and Putnam, 2006). Otherwise, higher self-confidence state was found pre-match playing in home venue compared to away venue (Terry, Walrond and Carron, 1998; Carré, Muir, Belanger and Putnam, 2006). Despite the results aforementioned, some studies do not found any effect of game location or found opposite results on pre-competition hormonal and psychological responses in some team sports (Bray, Jones and Owen, 2002; Arruda et al., 2014; Cunniffe, Morgan, Baker, Cardinale and Davies, 2015; Arruda et al. 2016).

Therefore, the present study was undertaken to examine the effect of game location on pre-competition salivary cortisol (sal-C) and state anxiety (cognitive anxiety, somatic anxiety and self-confidence) in a futsal team, during the quarterfinals and the semi-finals played in the home and away venues. Based on the findings aforementioned and following the territoriality concept, it was hypothesized that a higher sal-C concentration, higher cognitive and

somatic anxiety state and higher self-confidence would be observed when playing at home compared to away venue.

## Method

### Experimental design

Four official games were analysed. The games were played during the quarterfinals and semi-finals at home ( $n = 2$ ) and away ( $n = 2$ ) venues. The games were played between 19:00 and 20:00 h. Approximately 35 min prior to each game (before the warm-up procedures) saliva sample were collected; and somatic anxiety, cognitive anxiety and self-confidence were assessed by the Revised Competitive State Anxiety Inventory-2 (CSAI-2R). The data collection was performed with players inside the locker room. The players were instructed to refrain from caffeine and alcohol in the previous 24 h (Martin and Pangborn, 1971). Food and intake was not strictly monitored, but players were instructed to avoid eating at least 1 h before the games, to reduce the effect of food intake on salivary hormones (Papacosta and Nassis, 2011) (Fig. 1).

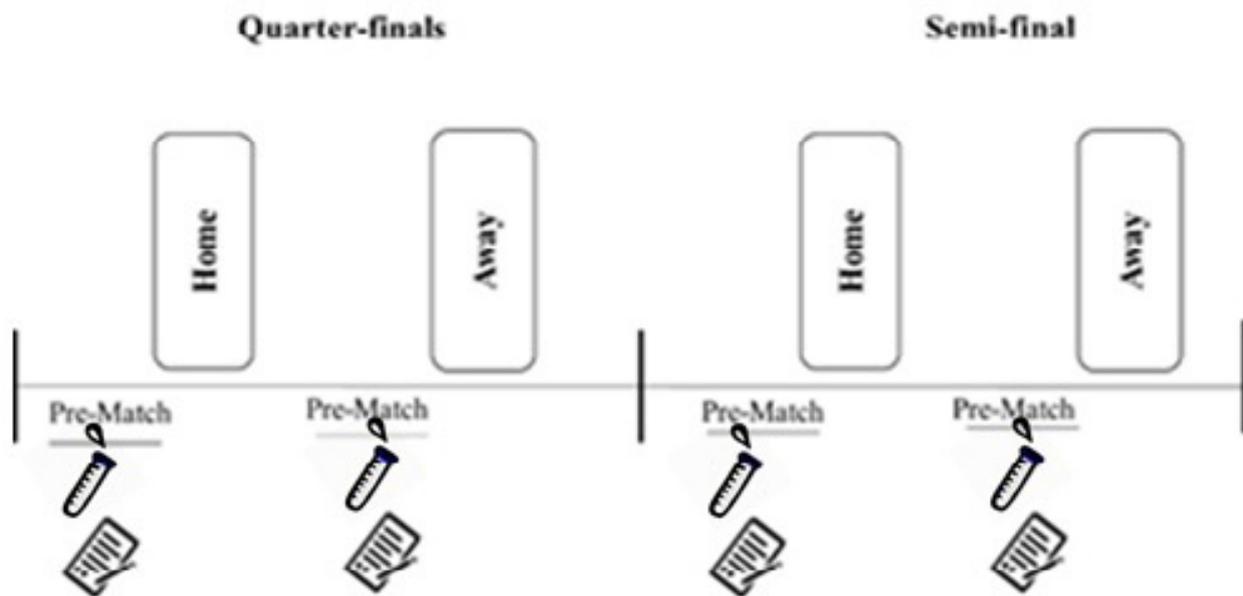


Figure 1. Schematic diagram of experimental procedures.

### Participants

Fourteen male futsal players from the Under 20 belonging to the same team, volunteered to participate in this study (age:  $18 \pm 2$  years; height:  $1.77 \pm 0.5$  m; body mass:  $71.6 \pm 7$  kg; experience:  $10.4 \pm 1.8$  years). The team was participating in the Under-20 State Futsal Championship in São Paulo, Brazil, and was ranked 1<sup>st</sup> in the State Championship

during the period investigated. All players involved in the study were selected to play in each match assessed. The procedures were conducted with approval of the Ethics Committee of the local University (n° 544.410/2014), and the informed consent was obtained from each participant, prior to the study commencement.

## Measures

**Salivary hormone assessment.** Saliva samples were collected before the pre-game warm-up with participants seated, with their head tilted slightly forward. Unstimulated samples were provided by passive drool collected in a sterile 15-ml centrifuge tube over 8-min period and stored at  $-80^{\circ}\text{C}$  until assay. After thawing and centrifugation, samples were tested for cortisol concentration using enzyme-linked immunosorbent assays (ELISA) in accordance to previously procedures (Paludo et al., 2017; Moreira et al., 2018). All samples were tested within a single assay plate. The average intra-assay coefficient of variation was 8.5% and had a detection limit of 0.12ng/ml.

**Anxiety and self-confidence assessment.** The Revised Competitive State Anxiety Inventory-2 (CSAI-2R) (Cox, Martens and Russell, 2003) was administered pre-game, before saliva collection, to estimate the athletes' cognitive and somatic anxiety, as well as self-confidence levels. The CSAI-2R consist of 17 items scored on a 4-point Likert Scale (from 1 = *not at all* to 4 = *very much so*), derived by asking each player "how do you feel right now – at this moment?". Cognitive anxiety was assessed from 5 items (intensity range: 5-20), somatic anxiety from 7 items (intensity range: 7-28) and self-confidence from 5 items (intensity range: 5-20). A higher score related to cognitive and somatic anxiety indicates a higher level of anxiety. An elevated score on the self-confidence subscale correspond to a higher level of self-confidence. The players answered questions, such as "I am concerned about this competition (cognitive anxiety)", "My body feels tense" (somatic anxiety), and "I am feeling self-confident" (self-confidence).

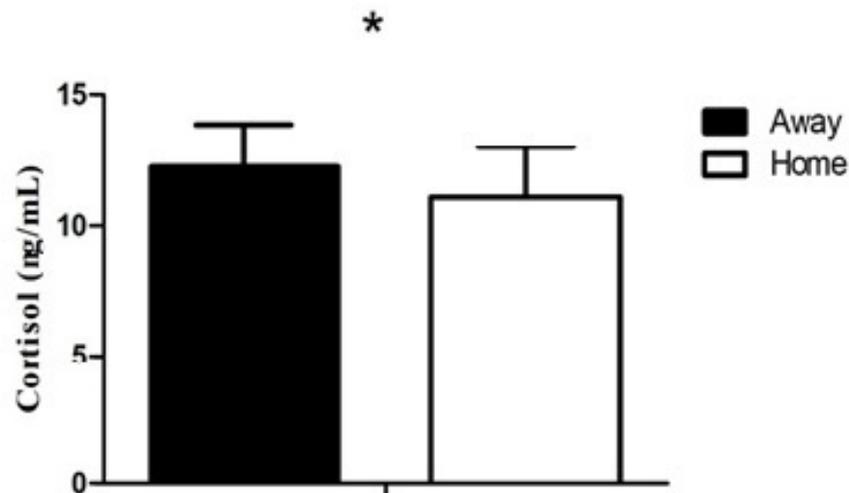
The Cronbach's alpha coefficients of internal consistency were 0.84 for cognitive anxiety and self-confidence, and 0.88 for somatic anxiety reported previously in Brazilian athletes (Fernandes, Nunes, Raposo, Fernandes and Brustad, 2013). All the players were familiarized with the questionnaire, which was used by the coaching staff during a regular season as part of the team's stress monitoring.

## Statistical analysis

Game location effect was analysed by a magnitude-based inferential statistical approach, based on previous recommendations (Winter, Abt and Nevil, 2014). Effect sizes (ES) were performed to determine the meaningfulness of the difference, presented 90% Confidence Limits (CL) (Batterham and Hopkins, 2006). ES with values of  $< 0.2$ ;  $0.2$  to  $< 0.5$ ;  $0.5$  to  $< 0.8$ ; and  $> 0.8$  were considered trivial, small, medium and large differences, respectively (Cohen, 1998). Also, was assumed when CL does not cross the "0", a clear difference would be presented, however when CL crossing the "0" were classified as representing unclear differences. Data were analysed using Microsoft Excel (Microsoft™; USA).

## Results

Salivary cortisol concentration pre-competition away and home are presented in Figure 2 (mean  $\pm$  SD). A medium and clear difference was observed for sal-C (by the ES calculation and classification). An increase was found from home to away venues (ES= 0.67, CL= 0.20; 1.14).



**Figure 2.** Salivary cortisol concentrations (mean  $\pm$  SD) pre-match away and home venue.  
\* Clear difference between away and home.

Figure 3 shows values for cognitive anxiety (A), somatic anxiety (B) and self-confidence (C) (mean  $\pm$  SD). Trivial and unclear differences were observed between home and

away venue for cognitive anxiety (ES= 0.12, CL= -0.34; 0.57); somatic anxiety (ES= 0.06; CL= -0.40, 0.51) and self-confidence (ES= 0.06; CL= -0.40, 0.51).

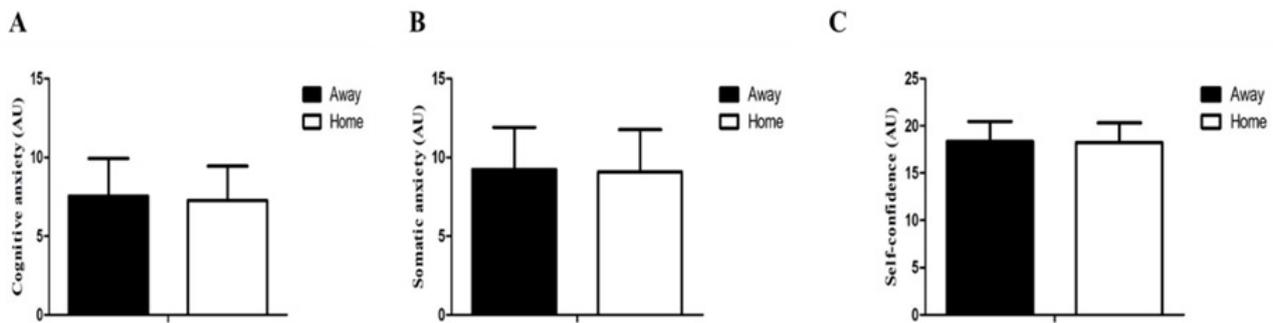


Figure 3. Cognitive (A) and somatic anxiety (B) and self-confidence (C) pre-match away and home venue.

Table 1 shows the results of the assessed matches.

**Table 1.**  
Matches results and competition venue in the quarterfinal and semi-final.

Quarter Final		Semi-final	
Competition venue	Result	Competition venue	Result
Away	4-3 (won)	Away	6-3 (won)
Home	9-2 (won)	Home	6-1 (won)

## Discussion

The main purpose of the present study was to examine the effect of game location on pre-competition sal-C concentration and state anxiety in a futsal team playing at home and away venues, considering the home advantage phenomenon and the territoriality hypothesis. The main results of this study were: a) playing in the away venue increased clearly the sal-C concentration compared to playing in the home venue; and b) trivial and unclear differences between home and away conditions were observed for cognitive anxiety, somatic anxiety and self-confidence measures.

Opposite to the concept of territoriality, the athletes in the present study seems to perceived playing away more stressful and threatening than playing at home venue, demonstrated by a moderate and clear effect of game location on sal-C concentration. Previous studies have demonstrated high sal-C concentration in athletes pre-game when playing in their home location compared to away, supporting the territoriality concept (Carré, Muir, Belanger and Putnam, 2006). However, in accordance with the present result, previous study evaluated the psychophysiological responses pre-match away and home in of Rugby union athletes, and the players demonstrated a higher sal-C concentration pre-match playing away (vs home) (Cunniffe, Morgan, Baker, Cardinale and Davies, 2015). The authors speculated some factors that could be

attributed to this result, such as that athletes may perceive playing away from home as more threatening than playing in familiar surroundings at home venue, considering that de cortisol modulates several physiological mechanisms and behavioural responses to threatening circumstances (Erickson, Drevets and Schulkin, 2003); as well as the possible stress-related to the team travel to away venues on pre-match cortisol concentration.

The present study is in line with the hypothesis suggested by Cunniffe and collaborators (2015). Indeed, playing on opponent's venue may be more threatening considering the crowd density factor. It has been proposed that crowd density may play an important role in the home advantage (Agnew and Carron, 1994; Boudreaux, Sanders and Walia, 2017) and this crowd density is likely to increase the sal-C responses in the athletes playing away. Moreover, some studies have reported that teams traveling to their opponent's venue are more likely to lose the games compared to home games (Pace and Carron, 1992; ); however, no traveling effect was found elsewhere (Du Preez and Lambert, 2007). In the current study, the away games included approximately 1-hour and 2-hour trips by bus in the quarterfinal and the semi-final respectively to the opponent's venue. Given the focus of the study was the pre-competition hormonal and anxiety state, the crowd and traveling factors were not evaluated, however they require further investigation.

Despite the change in sal-C concentration, no effect for the game location was observed in the state anxiety. Trivial and unclear differences were observed in pre-match cognitive anxiety, somatic anxiety and self-confidence. Although the changes in sal-C between the conditions, the somatic anxiety, that refers the physical component of anxiety, did not change. A change in somatic anxiety was expected due to evidence of a positive correlation of pre-match cortisol concentration and somatic anxiety state (Doan, Newton, Kraemer, Kwon and Scheet, 2007; Filaire, Alix, Ferrand and Verger, 2009). Furthermore, it was expected to find increases in self-confidence in home venue as found previously (Carré, Muir, Belanger and Putnam, 2006), which was not evidenced in the current study.

In accordance with the results of the present study, Arruda et al. (2014) have also presented no difference in cognitive and somatic anxiety and self-confidence in basketball athletes pre-game played at home and away venues. Moreover, previous studies have not found a relationship between cortisol and somatic and cognitive anxiety either (Carré, Muir, Belanger and Putnam, 2006; Cunniffe, Morgan, Baker, Cardinale and Davies, 2015). A possible explanation may be due to the physiological arousal level and individual perception. As speculated from previous studies, it is likely that individuals perceive a physiological arousal (e.g. increases in cardiac autonomic responses and/or hormones release) when it was under higher levels. Analysing the influence of somatic anxiety in performance, Hardy (1996) hypothesized that only under high level of somatic anxiety that athletes perceived their physiological symptoms. Additionally, Carré and collaborators (2006) highlight the idea that athletes who showed high level of pre-game sal-C may have subjectively reported lower somatic anxiety because their short-term stress-response occurred prior to the data collection.

It is also worth to highlight that although the futsal players presented a clear increase on sal-C concentration pre-game when playing in their opponent venue, this behaviour may not necessarily lead to a “home advantage” per se. The present Futsal team won all games (table 1), the two games away as well as the two games at home venue. However, it is important to understand the player’s behaviour pre-game considering the game location. It was possible to observe that even presenting increases in sal-C concentration pre-game in the away venue, it seems that the athletes of the present study dealt efficiently with the local situations so that it did not impact the team’s performance during the away games; or the moderate effect of game location on sal-C was not enough to impair the match results playing away.

The present study has some methodological limitations that should be described. Firstly, the number of the games analysed (2 games home and 2 games away) may have not been enough to observe the effect of the game location

on state anxiety responses. Secondly, the present study did not evaluate the effect of pre-competition hormonal and state anxiety responses upon the team performance at home and away venues. Despite the fact that the team have won all games, maybe the technical efficiency or the player’s involvement could have been different between game location conditions. Thirdly, the selection of one sport team and two specific periods (quarterfinal and semi-finals) limited the present finding to the specific sample; therefore, the current results should be interpreted with caution in other sport teams as well as other periods of competitions. Finally, player’s perception regarding the match (e.g. difficulty, importance, opponent level) was not evaluated, maybe these information could be support the players responses about their anxiety state. Besides the limitations, the present study is aiding to better understand the complex relationship between psychobiological impacts on game location, especially in futsal modality, in which still have a lack of information (Arruda et al., 2016).

## Conclusion

The present data indicate that the game location affect the pre-game hormonal response but not the anxiety state. Playing in the opponent’s locations seems to cause a higher neuroendocrine stress on futsal athletes compared to their home venue, demonstrated by high sal-C concentrations away compared to home venue. Additionally, the pre-game effect on sal-C do not impact negatively the game results, not supporting the home-advantage phenomenon, suggesting a possible athletes’ strategy to deal with challenging situation in away venue.

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## Efecto del lugar de juego sobre las concentraciones de cortisol y el estado de ansiedad precompetitivo: un estudio de caso en un equipo de fútbol sala

### Resumen

El objetivo de este estudio fue investigar el efecto del lugar de juego sobre el cortisol y el estado de ansiedad precompetitivo en los atletas profesionales de futsal. Catorce atletas de un equipo de futsal masculino Sub-20 fueron evaluados durante cuatro juegos competitivos jugados afuera (n = 2) y en adentro (n = 2). Las muestras de saliva se recolectaron para el análisis de concentración de cortisol (sal-C) mediante análisis ELISA y el estado de ansiedad se evaluó mediante el cuestionario CSAI-2R. Todos los datos fueron recopilados antes de que el juego se calentara. Se observó un aumento claro y medio de la sal-C (ES= 0,67; CL = 0,20; 1,14) afuera en comparación con adentro. Se observaron diferencias triviales y poco claras entre jugar afuera y adentro por la ansiedad cognitiva (ES= 0,12, CL= -0,34; 0,57); somático (ES= 0,06; CL= -0,40; 0,51) y confianza en sí mismo (ES= 0,06; CL= -0,40; 0,51). En conclusión, los datos sugieren que el lugar de juego afecta la respuesta hormonal; un aumento en sal-C sugiere que los juegos fuera representan una situación más desafiante para los atletas de futsal en comparación con los juegos adentro.

**Palabras clave:** cortisol salival; ansiedad competitiva; territorialidad; deporte

## Efeito do local de jogo nas concentrações de cortisol e estado de ansiedade pré-competitiva: um estudo de caso em uma equipe de futsal

### Resumo

O objetivo desse estudo foi investigar o efeito do local de jogo no cortisol e estado de ansiedade pré-competitiva em atletas profissionais de futsal. Quatorze atletas de uma equipe Sub-20 de futsal masculino foram avaliados durante quatro jogos competitivos jogados fora (n=2) e dentro de casa (n=2). Amostras de saliva foram coletadas para análise da concentração de cortisol (sal-C) pela análise de ELISA e o estado de ansiedade foi avaliada pelo questionário CSAI-2R. Todos os dados foram coletados antes do aquecimento do jogo. Um aumento médio e claro na sal-C (ES= 0,67; CL= 0,20; 1,14) foi observado em casa comparado fora de casa. Diferença trivial e pouco clara entre fora e dentro de casa foram observados pela ansiedade cognitiva (ES= 0,12, CL= -0,34; 0,57); somática (ES= 0,06; CL= -0,40; 0,51) e autoconfiança (ES= 0,06; CL= -0,40; 0,51). Em conclusão, os dados sugerem que o local de jogo afeta a resposta hormonal; um aumento no sal-C sugere-te que jogos fora de casa representam uma situação mais desafiadora nos atletas de futsal comparado aos jogos em casa.

**Palavras-chave:** cortisol salivar; ansiedade competitiva; territorialidade; esporte

### References

- Agnew, G.A., and Carron, A.V. (1994). Crowd effects and the home advantage. *International Journal of Sport Psychology*, 25(1), 53-62. doi: 10.1123/jsep.14.1.13.
- Arruda, A. F., Aoki, M. S., Freitas, C. G., Drago, G., Oliveira, R., Crewther, B. T., and Moreira, A. (2014). Influence of competition playing venue on the hormonal responses, state anxiety and perception of effort in elite basketball athletes. *Physiology & Behavior*, 130, 1-5. doi: 10.1016/j.physbeh.2014.03.007.
- Arruda, A. F., Aoki, M. S., Miloski, B., Freitas, C. G., Moura, N. R., and Moreira, A. (2016). Playing match venue does not affect resting salivary steroids in elite Futsal players. *Physiology & Behavior*, 155, 77-82. doi:10.1016/j.physbeh.2015.12.005.
- Arruda, A. F., Aoki, M. S., Paludo, A.C., and Moreira, A. (2017). Salivary steroid response and competitive anxiety in elite basketball players: Effect of opponent level. *Physiology & Behavior*, 177, 291-296. doi: 10.1016/j.physbeh.2017.05.017.
- Arruda, A. F. S., Aoki, M. S., Drago, G., and Moreira, A. (2018). Salivary testosterone concentration, anxiety, perceived performance and ratings of perceived exertion in basketball players during semi-final and final matches. *Physiology & Behavior*. doi: 10.1016/j.physbeh.2018.10.008.
- Batterham, A.M., and Hopkins, W.G. (2006). Making meaningful inferences about magnitudes. *International Journal of Sports Physiology & Performance*, 1 (1), 50-57.
- Boudreaux, C. J., Sanders, S. D., and Walia, B. (2017). A natural experiment to determine the crowd effect upon home court advantage. *Journal of Sports Economics*, 18(7), 737-749. doi: 10.1177/1527002515595842.
- Bray, S. R., Jones, M. V., and Owen, S. (2002). The Influence of Competition Location on Athletes' Psychological States. *Journal of Sport Behavior*, 25(3). doi: 10.1016/S1440-2440(98)80006-6.
- Carré, J., Muir, C., Belanger, J., and Putnam, S. K. (2006). Pre-competition hormonal and psychological levels of elite hockey players: relationship to the 'home advantage'. *Physiology & Behavior*, 89(3), 392-398. doi: 10.1016/j.physbeh.2006.07.011.
- Casto, K.V., and Edwards, D.A. (2016). Testosterone, cortisol and human competition. *Hormones and Behavior*, 82, 21-37.
- Cohen, J. (1998). *Statistical Power Analysis for the Behavioural Sciences*, Lawrence Erlbaum (2<sup>ed</sup>), Hillsdale, NJ.
- Courneya, K., and Carron, A. (1992). The home advantage in sport competitions: a literature review. *Journal of Sport & Exercise Psychology*, 14, 13-27. doi: 10.1123/jsep.14.1.13.
- Cox, R.H., Martens, M.P., and Russell, W.D. (2003). Measuring anxiety in athletics: The revised competitive state anxiety inventory-2. *Journal of Sport & Exercise Psychology*, 25(4), 519-533. doi: 10.1123/jsep.25.4.519.
- Crewther, B.T., Heke, T., and Keogh, J.W.L. (2011). The effects of training volume and competition on the salivary cortisol concentrations of Olympic weightlifters. *Journal of Strength & Conditioning Research*, 25(1), 10-5. doi: 10.0.5.239/JSC.0b013e3181fb47f5.
- Cunniffe, B., Morgan, K. A., Baker, J. S., Cardinale, M., and Davies, B. (2015). Home versus away competition: Effect on psychophysiological variables in elite rugby union. *International Journal of Sports Physiology and Performance*, 10(6), 687-694. doi: 10.1123/ijsp.2014-0370.
- Doan, B.K., Newton, R.U., Kraemer, W.J., Kwon, Y.H., and Scheet, T.P. (2007). Salivary cortisol, testosterone, and T/C ratio responses during a 36-hole golf competition. *International Journal of Sports Medicine*, 28(6), 470-9. doi: http://10.0.4.31/s-2006-924557.
- Dosseville, F., Edoh, K.P., and Molinaro, C. (2016). Sports official in home advantage phenomenon: A new framework. *International Journal of Sport and Exercise Psychology*, 14(3), 250-254. doi: 10.1080/1612197X.2015.1023422.
- Du Preez, M., and Lambert, M. I. (2007). Travel fatigue and home ground advantage in South African Super 12 rugby teams. *South African Journal of Sports Medicine*, 19(1), 20-22.

- Erickson, K., Drevets, W., and Schulkin, J. (2003). Glucocorticoid regulation of diverse cognitive functions in normal and pathological emotional states. *Neuroscience & Biobehavioral Reviews*, 27(3), 233-246. doi: 10.1016/s0149-7634(03)00033-2.
- Fernandes, M.G., Nunes, A.S., Raposo, J.V., Fernandes, H.M., and Brustad, R. (2013). The CSAI-2: An examination of the instrument's factorial validity and reliability of the intensity, direction and frequency dimensions with Brazilian athletes. *Journal of Applied Sport Psychology*, 25(4), 377-391. doi: 10.1080/10413200.2012.744780.
- Fernández-Fernández, J., Boullosa, D. A., Sanz-Rivas, D., Abreu, L., Filaire, E., and Mendez-Villanueva, A. (2015). Psychophysiological stress responses during training and competition in young female competitive tennis players. *International Journal of Sports Medicine*, 36(1), 22-28. doi: 10.1055/s-0034-1384544.
- Filaire, E., Alix, D., Ferrand, C., and Verger, M. (2009). Psychophysiological stress in tennis players during the first single match of a tournament. *Psychoneuroendocrinology*, 34(1), 150-7. doi: http://10.0.3.248/j.psychneuen.2008.08.022.
- Filaire, E., Sagnol, M., Ferrand, C., Maso, F., Lac, G. (2001). Psychophysiological stress in judo athletes during competitions. *Journal of Sports Medicine & Physical Fitness*, 41(2), 263-268.
- Furley, P., Schweizer, G., and Memmert, D. (2018). Thin slices of athletes' nonverbal behaviour give away game location: Testing the territoriality hypothesis of the home game advantage. *Evolutionary Psychology*, 16(2), 1-12. doi: 10.1177/1474704918776456.
- Gronek, P., Wielinski, D., and Gronek, J. (2015). Genetic and non-genetic determinants of aggression in combat sports. *Open Life Sciences*, 10(1), 7-18. doi: 10.1515/biol-2015-0002.
- Hardy, L. (1996). Testing the predictions of the cusp catastrophe model of anxiety and performance. *The Sport Psychologist*, 10(2), 140-156. doi: 10.1123/tsp.10.2.140.
- Hiller-Sturmhöfel, S., and Bartke, A. (1998). The Endocrine System: an overview. *Alcohol Health Res. World*, 22(3), 153-164.
- Jones, M.B. Differences in home advantage between sports (2018). *Psychology of Sport and Exercise*, 34, 61-69. doi: 10.1016/j.psychsport.2017.07.012.
- Kerr, J.H., and Van Schaik, P. (1995). Effects of game venue and outcome on psychological mood states in rugby. *Personality & Individual Differences*, 19(3), 407-10. doi: 10.1016/0191-8869(95)00044-7.
- Martin, S. and Pangborn, R.M. (1971). Human parotid secretion in response to ethyl alcohol. *Journal of Dental Research*, 50(2), 485-490. doi: 10.1177/00220345710500026201.
- Moreira, A., Aoki, M. S., Franchini, E., da Silva Machado, D. G., Paludo, A. C., and Okano, A. H. (2018). Mental fatigue impairs technical performance and alters neuroendocrine and autonomic responses in elite young basketball players. *Physiology & Behavior*, 196, 112-118. doi: 10.1016/j.physbeh.2018.08.015.
- Nevill, A., and Holder, R.L. (1999). Home advantage in sport: an overview of studies on the advantage of playing at home. *Sports Medicine*, 28(4), 221-36. doi: 10.2165/00007256-199928040-00001.
- Neave, N., and Wolfson, S. (2003). Testosterone, territoriality, and the 'home advantage'. *Physiology & Behavior*, 78(2), 269-275. doi: 10.1016/S0031-9384(02)00969-1
- Pace, A., and Carron, A.V. (1992). Travel and the home advantage. *Canadian Journal of Sport Sciences*, 17(1), 60-4.
- Paludo, A. C., Cook, C. J., Owen, J. A., Woodman, T., Owen, S., and Crewther, B. T. (2017). Psycho-physiological responses of mountain bike riders during anaerobic and aerobic testing. *Journal of Science and Cycling*, 6(1), 18-25.
- Papacosta, E., and Nassis, G.P. (2011). Saliva as a tool for monitoring steroid, peptide and immune markers in sport and exercise science. *Journal of Science & Medicine in Sport*, 14(5), 424-434. doi: 10.1016/j.jsams.2011.03.004.
- Pollard, R., and Armatas, V. (2017). Factors affecting home advantage in football World Cup qualification. *International Journal of Performance Analysis in Sport*, 17(1-2), 121-135. doi:10.1080/24748668.2017.1304031.
- Terry, P. C., Walrond, N., and Carron, A. V. (1998). The influence of game location on athletes' psychological states. *Journal of Science and Medicine in Sport*, 1(1), 29-37. doi: 10.1016/S1440-2440(98)80006-6.
- Wilson, E. O. (1975). *Sociobiology: The new synthesis*. Cambridge, MA: Harvard University Press.
- Winter, E.M., Abt, G.A., and Nevill, A.M. (2014). Metrics of meaningfulness as opposed to sleights of significance. *Journal of Sports Science*, 32(10), 901-902. doi: 10.1080/02640414.2014.895118.