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Pre-competitive anxiety and autonomic responses in professional U-20 futsal players: effect of the competition phase and game location

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ABSTRACT

The study examined whether pre-competition anxiety and autonomic responses in elite futsal players change across the playoffs at away *vs* home venues. Heart rate variability, somatic and cognitive anxiety and self-confidence (by CSAI-2R questionnaire) were evaluated in fourteen male futsal players from a professional U-20 team, before competitive matches at the quarter-final, semi-final and final stages played at home and away venues. Two-way ANOVA for repeated measures was used, with factor one the game location and factor two the playoff stage, with significance set at $p<0.05$. Significant effects of the playoff stage were demonstrated in the Mean of HR (F=4.643; p=0.014) and SD2 index (F= 14.83; p=<0.001). No difference was found for somatic and cognitive anxiety and self-confidence between the two factors. The results suggest that play at the final stage of the playoff, regardless of the game location, may cause higher physiological stress, demonstrated by elevated HR and decrease of SD2 index.

Keywords: anxiety, cardiac autonomic, athletes, futsal, competition

1. Introduction

Competition can be considered a stressful situation, increasing anxiety-state, triggering physiological and emotional changes in athletes' responses, leading to changes in their performance [1,2]. Regarding the autonomous nervous system (ANS), an increase in sympathetic and a decrease in parasympathetic activation is observed when faced with a new stressors [3]. In the sport settings, measurement and evaluation of the ANS via heart rate variability is sensitive to describe the changes in the *sympathovagal* balance in stressful situations, such as the pre-competition [4-6]. The competitive environment includes several contextual factors that may increase the perceived stress and lead to different behavior in athletes.

In team sport, contextual factors, such as the stage of competition, standard of opponent, and game location could conceivably influence players' pre-competitive anxiety. Previous studies demonstrated the effect of these contextual factors on pre-competitive anxiety and physiological responses such as salivary hormone concentrations [7,8] and autonomic responses [4] are equivocal. Yet, it is unclear how athletes respond to these contextual factors, all together, in the field settings. In sports such as Futsal, the playoff structure consists of playing home and away in each classification stage (e.g., quarterfinal, semi-final, and final). Therefore, it might be expected that players' physiological and psychological responses may be different depending on game location and the perceived importance of the competition stage. Moreover, players in the transition from youth-professional to first-team have reported that they put more pressure on themselves to perform well and experience anxiety about moving to senior sport [9].

Therefore, we aimed to examine the effect of two contextual factors on pre-competition anxiety and cardiac autonomic response in Futsal youth-professional players. Consequently, this study aimed to examine pre-competition anxiety and autonomic responses during the

playoff quarter-final, semi-final, and final stages in games played away vs. home venue in a professional U-20 futsal team. It was postulated that playing in different contexts during the playoffs would promote different psychological and physiological responses in futsal athletes. We hypothesized that players would demonstrate higher scores of cognitive and somatic anxiety, lower self-confidence, together with changes in HRV suggestive of increased sympathetic tone (or vagal activity) when playing away (*versus* home) and in the final stage (*versus* quarter and semi-final).

2.Material and methods

2.1. Participants

Fourteen professional male futsal players belonging to the same team volunteered to participate in the study. However, data from nine players who completed data collection from all games wre analyzed (mean ± sd: age, 19±0.68 years; height, 176.9±5.4 cm; body mass, 73.07± 5.87 kg). The team was participating in the Under-20 State Futsal Championship in São Paulo, Brazil, and was ranked 1st in the State Championship during the period investigated. Players were not taking prescribed medications or any special dietary supplement and did not report any cardiovascular disease. All procedures were conducted with the approval of the Ethics Committee of the local University (n° 544.410/2014), and informed consent was obtained from each participant before study commencement.

2.2 Experimental design

Players were assessed in six games during the playoff stages (quarter-final, semi-final and final), with each stage being played at home and away. The games occurred between 19:00 and 20:00h. Measurements were recorded approximately 35min prior to each game (before the warm-up procedures). The first measurement was the cardiac autonomic response, assessed by

the recording of heart rate variability (HRV) for 10 min, followed by the completion of the state-anxiety questionnaire (CSAI-2R). Data collection was performed inside the locker room in both home and away games. Players were instructed to refrain from caffeine and alcohol in the previous 24h.

2.3. Autonomic response

The autonomic response was measured via resting heart rate variability (HRV). Beat-to-beat heart rate was recorded for 10min, using a portable heart rate monitor (Polar Team^2 Pro, Kempele, Finland) with an electrode belt firmly held around the thorax. The players remained in a seated position inside the locker room (21-22°C) and were instructed to stay quiet, without speaking, breathing spontaneously, with eyes open. After collection, the data was downloaded onto a computer using recognized software (Polar®Pro Trainer, Kempele, Finland) and exported as a text file for analysis using Kubios 2.0 software (Biosignal Analysis and Medical Imaging Group, Finland). Data analysis was performed as previously described [10]. The 10 min sampling time was chosen from standardized protocols for HRV data collection under resting conditions [11], and the final 5min were selected to be analyzed due to the most reliable method demonstrated in this sample [12].

Each HRV index measures different features of ANS activity, with common methods used to evaluate HRV at rest being time domain and spectral analyses. Complementary, non-linear indices were also calculated. Time-domain indices included mean heart rate (Mean HR), absolute square root of the mean of the sum of the squares of differences between adjacent RR interval (RMSSD) and natural logarithm transformed (lnRMSSD). For the frequency domain analysis, firstly, a Smooth Prior function was applied to the entire signal in order to remove the slow trend components. Afterward, the signal was re-sampled at 4Hz using cubic splines, and the Fast Fourier Transform (FFT) method was used to perform the spectral decomposition of

the signal. The bands within low (LF: 0.04-0.15Hz) and high (HF: 0.15-0.4 Hz) frequencies, and natural logarithm transformed (ln) of these indices, were calculated. The ratio between lnLF and lnHF was also reported. Finally, regarding the non-linear analysis, the SD1 (instantaneous beat-to-beat variability) and SD2 (long-term beat-to-beat variability) indices were calculated from the Poincaré plot. These indexes have been used before in team-sport athletes to assess the effect of competition stressor [4-6], especially the RMSSD and SD1 indexes due to the relation with parasympathetic modulation [13].

2.4. Anxiety state

The Revised Competitive State Anxiety Inventory-2 (CSAI-2R) [14] was administered pre-competition to estimate the athletes' cognitive and somatic anxiety, as well as self-confidence levels. The CSAI-2R consists of 17 items scored on a 4-point Likert Scale (from 1 = not at all to 4 = very much so). A higher score related to cognitive and somatic anxiety indicates a higher level of anxiety, and an elevated score on the self-confidence subscale corresponds to a higher level of 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 [15].

2.5 Statistical analysis

To analyze the effect of venue and playoffs factors, the two-way ANOVA for repeated measures was used. Factor one was the game location (home *versus* away) and factor two was the playoff stage (quarters, semi and finals). The assumptions of normality and heterogeneity of the variances were tested by Shapiro Wilk and Levene’s tests, respectively. If the main effects or interaction effects were significant, Bonferroni post hoc tests were performed for multiple comparisons of different conditions. All Levene’s values were higher than 0.05. The

143 normality of the data was verified for each combination of the two factors as suggested
144 elsewhere [16], and significant deviations were observed for some indices of HRV and the
145 anxiety parameters. Considering the ANOVA is a robust test for violation of normality [17,18],
146 it was opted to use the test in the comparison of the two factors. The significance level was set
147 at $p<0.05$. Data were analyzed using JAMOVI statistical software package.
148
149 **3. Results**
150 Table 1 shows the outcomes of pre-competition HRV indices and anxiety state during
151 the playoff stage, whilst playing home and away, describing also the interaction of the two
152 factors (stage * venue). Significant effects of the playoff stage were demonstrated by the Mean
153 of HR ($F=4.643$; $p=0.014$) and SD2 index ($F= 14.83$; $p=<0.001$). Based on these findings,
154 Figure 1 shows the effect of the playoff stages only on these variables, in which playing at the
155 final stage was a higher stressful condition compared to the quarter-final stage. No difference
156 was found between the game location for any the HRV indices. Somatic and cognitive anxiety
157 and self-confidence differed neither by the playoff stage nor the game location.

Table 1. Pre-competition HRV and anxiety considering the game location and playoff stage (n=9).

	Quarter-Finals		Semi-Finals		Finals		*P*-value venue	*P*-value payoff stage	*P*-value interaction
Variable	Home	Away	Home	Away	Home	Away			
Mean HR	70.3 ± 6.95	65.8 ±9.26	72.2 ± 6.75	80.3 ± 9.79	74.6 ± 10.3	74.7 ± 7.76	0.603	0.014*	0.095
RMSSD	46.2 ± 17.7	61.6 ± 26.5	47.6 ± 27.0	38.1 ± 19.7	40.9 ± 20.2	48.9 ±22.6	0.452	0.305	0.246
lnRMSSD	3.77 ± 0.39	3.48 ± 0.85	3.74 ± 0.50	3.31 ± 0.91	3.60 ± 0.70	3.79 ± 0.50	0.335	0.760	0.359
lnLF	7.57 ± 0.82	7.23 ± 0.62	7.34 ± 0.76	7.23 ± 0.87	7.25 ± 0.88	7.30 ± 0.58	0.529	0.852	0.743
lnHF	6.35 ± 0.869	6.77 ± 0.87	6.14 ± 1.01	6.02 ± 0.970	5.96 ± 1.08	6.36 ± 1.03	0.396	0.295	0.645
lnLF/HF	1.20 ± 0.13	1.08 ± 0.14	1.20 ± 0.17	1.21 ± 0.09	1.23 ± 0.09	1.17 ± 0.13	0.097	0.261	0.339
SD1	33.1 ± 12.6	44.1 ± 18.9	34.1 ± 19.2	27.3 ± 14.0	29.0 ± 14.3	34.6 ± 16.0	0.452	0.290	0.244
SD2	107 ± 34.4	135 ± 40.7	102 ± 35.4	95.5 ± 28.1	63.1 ± 20.4	67.2 ± 19.3	0.315	<0.001*	0.234
Anxiety-state									
Somatic	8.67 ± 2.74	9.33 ± 2.96	9.56 ± 3.43	9.78 ± 3.07	10.1 ± 3.76	10.8 ± 3.60	0.564	0.424	0.973
Cognitive	7.78 ± 2.22	7.89 ± 2.20	7.22 ± 2.22	7.56 ± 2.46	7.22 ± 2.22	7.33 ± 2.35	0.767	0.743	0.986
Self-confidence	18.4 ± 2.19	18.6 ± 1.67	18.9 ± 1.83	19.1 ± 1.69	19.3 ± 1.41	19.0 ± 1.73	1.000	0.505	0.883

*Significant difference in playoff stage ($p<0.05$).

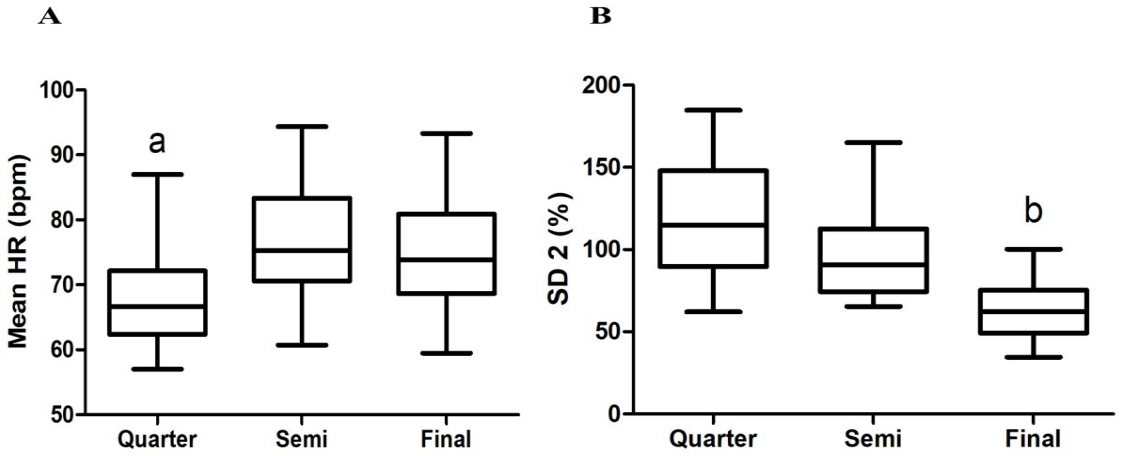

Figure 1. Descriptive outcomes of the mean of heart rate (A) and SD2 index (B) during the playoff stage (quarter-final, semi-final and final). [a] Significant difference from quarter-final compared to semi-final and final. [b] Significant difference from final to quarte-final and semi-final.

4. Discussion

The purpose of the present study was to examine the effect of game location and playoff stage on pre-competition cardiac autonomic responses and anxiety state in U-20 futsal players. It was hypothesized that players would demonstrate higher scores of cognitive and somatic anxiety, lower self-confidence, together with changes in HRV suggestive of increased sympathetic tone (or vagal activity) when playing away (*versus* home) and in the final stage (*versus* quarter and semi-final). The main findings of the present study partially corroborate the hypothesis formulated, indicating that playing the final stage was a challenging situation, compared to the quarter and semi-finals, showed by players' higher values of the Mean HR and a decrease in SD2 values. Nonetheless, the hypothesis about the game location, somatic and cognitive anxiety and self-confidence were refuted in the study. No difference among the playoff stages venue (home *versus* away) for pre-competition HRV and anxiety-state was verified. This result suggests that the players in the present study consider the final stage a stressful factor independent of the game location.

Considering the contextual factors included in the present study, the game location was chosen due to address the concept of territoriality and dominance, in which athletes seem to protect their territory against the opponent, demonstrating an increase in physiological arousal [19]. However, the futsal players exhibited contradictory responses, with no difference in HRV indices, it seems that players in the present study weigh the importance and demand of the playoff stage more than the game location. Most studies have reported differences in HRV indices in athletes' before competition compared to pre-training [4,5,20] but no comparison was found regarding playoff stage playing away versus at home. Recently, a study with female soccer players evaluated the pre-competitive HRV and anxiety responses according to the demanding level of the match and found that a highly-demanding game led to a decrease in RMSSD and SD1 indexes pre-competition. Also, the authors described an increase in cognitive anxiety when compared with a lowly-demanding match [5]. Our results demonstrated that besides the changes in Mean HR and SD2 indices regarding the playoff stage, the somatic and cognitive anxiety and self-confidence did not change. A variation in somatic anxiety was expected due to evidence of a positive correlation between pre-game HRV and somatic anxiety state [6]. A possible explanation may be due to the physiological arousal level and individual perception, in which, it is likely that individuals perceive physiological arousal (e.g., increases in cardiac autonomic responses) when it was under higher levels. Maybe the increases in Mean HR and decrease of SD2 index were not that higher for players who perceived the physiological arousal changes.

A pre-competition context seems to inhibit the parasympathetic activity, leading to higher physiological arousal, usually shown with a reduction in the RMSSD and the SD1 indices [4,5,13]. Interestingly, the results of the current study presented a change during the playoff stages by the Mean HR and SD2 index only. The SD1 is directly linked to parasympathetic activity, however, the SD2 still needs a clear physiological meaning. Some

reported that SD2 seems to be inversely proportional to sympathetic activity [21,22]. As described elsewhere, *if we take the inverse of SD2, we have a direct index for sympathetic activity… especially in a relationship to evaluate the sympathetic-parasympathetic balance* [23]. To improve the understanding of the SD2 index, Orellana et al [23] suggested a stress score (SS) based on the SD2 index (1000 x 1/SD2) for elite soccer players. The authors described the ratio SS: SD1 as a new index than can improve the physiological meaning of HRV by the Poincaré plot-analysis method.

One limitation of this study is the assessment of small sample size (n=9) from a selected sport-team. The outcomes from the present study are specific samples; therefore, the current results should be interpreted with caution. Besides the limitations, to our knowledge, this is the first study involving pre-competitive cardiac autonomic response and anxiety state analyzed in two different contexts: playoff stage and game location. Additionally, the assessment of HVR performed in the field setting increases the ecological validity and the major strength of this study.

As a practical application, coaches and physical trainers could monitor the players' HRV responses, especially through the playoff stage, in order to identify stressful levels before games. Interventions related to decreasing physiological arousal, such as biofeedback or neuromodulation, could be provided to manage the stress levels that the final stage of playoffs may be required.

In conclusion, the results indicated that the playoff stage, but not the game location, may be perceived as a stressful factor for professional U-20 futsal players. An increase in Mean HR and a decrease of SD2 index as shown by the players in the final stage of playoffs. These findings highlight the importance of monitoring cardiac autonomic status before the playoff games. The monitoring could be useful in identifying situations where interventions to manage pre-competition stress may be required.

Conflict of Competing Interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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