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Revista Brasileira de Futsal e Futebol

ASSOCIATION BETWEEN DEHYDRATION INDICATORS AND AUTONOMIC MODULATION OF PROFESSIONAL MALE FUTSAL ATHLETES

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ABSTRACT

Dehydration is a common phenomenon in futsal that occurs when fluid loss is greater than ingestion and is influenced by several factors such as playing time. This condition, depending on the percentage of body mass loss, compromises the thermoregulation mechanism as it influences the other regulation systems of the organism. Thus, the objective of this research was to associate dehydration indicators, heart rate variability and playing time of professional male Futsal athletes. The sample consisted of 13 male professional athletes with a mean age of 23.93 ± 2.99 years and BMI of 23.75 ± 2.13 kg/m². Body mass, body water and HRV were evaluated 1 h and 30 minutes pre-game and up to 20 minutes post-game. Student's t test for independent samples was used in pre and post comparisons and Person correlation to verify the association between dehydration indicators and HRV assuming $p<0.05$ for all treatments. There was a significant difference ($p<0.05$) for all pre and post HRV parameters. No significant correlation was found between dehydration indicators and HRV parameters. There was a weak and moderate positive correlation between ΔpNN50 x playing time and ΔrMSSD x playing time, both being significant ($p<0.05$). The athletes presented percentage values below 1% about the loss of body mass and sympathetic hyperactivity in the post-game condition. However, no relationship was found between the presented dehydration level and the HRV parameters.

Key words: Dehydration. Autonomic nervous system. Heart rate variability. Athletes. Team sports.

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RESUMO

Associação entre indicadores de desidratação e modulação autonômica de atletas profissionais masculinos de futsal

A desidratação é um fenômeno comum no futsal, ocorre quando a perda de líquidos é maior que a ingestão e é influenciada por diversos fatores como o tempo de jogo. Essa condição, dependendo do percentual de perda de massa corporal, compromete o mecanismo de termorregulação, pois influencia os demais sistemas de regulação do organismo. Assim, o objetivo desta pesquisa foi associar indicadores de desidratação, variabilidade da frequência cardíaca (VFC) com o tempo de jogo de atletas profissionais de Futsal masculino. A amostra foi composta por 13 atletas profissionais do sexo masculino, com idade média de 23,93 ± 2,99 anos e IMC de 23,75 ± 2,13 kg/m². Massa corporal, água corporal e VFC foram avaliadas no pré-jogo (1 hora e 30 minutos antes) e até 20 minutos no pós jogo. Nas comparações pré e pós foi utilizado o teste t de Student para amostras independentes e a correlação de Person para verificar a associação entre os indicadores de desidratação e a VFC, assumindo $p<0,05$ para todos os tratamentos. Houve diferença significativa ($p<0,05$) para todos os parâmetros de VFC pré e pós. Nenhuma correlação significativa foi encontrada entre os indicadores de desidratação e os parâmetros de VFC. Houve correlação positiva fraca e moderada entre ΔpNN50 x tempo de jogo e ΔrMSSD x tempo de jogo, sendo ambas significativas ($p < 0,05$). Os atletas apresentaram valores percentuais abaixo de 1% sobre a perda de massa corporal e hiperatividade simpática na condição pós-jogo. Porém, não foi encontrada relação entre o nível de desidratação apresentado e os parâmetros da VFC.

Palavras-chave: Desidratação. Sistema nervoso autónomo. Variabilidade do batimento cardíaco. Atletas. Esportes coletivos.

INTRODUCTION

Futsal is a competitive sport usually played in indoor courts that has increasingly sought professional space. This professionalization, in turn, entails the interest of applying methods that can maximize player performance (García Jiménez, Yuste Lucas, García Pellicer, 2010).

Given the high physical demand in Futsal, it is noteworthy the large sweat production during the competition which is influenced by the time of exposure to the game, ambient temperature, relative humidity and types of clothing (Sepeda, Mendes, Loureiro, 2016).

In this sense, besides the reduction of water levels, there is the loss of electrolytes, increased plasma viscosity and changes in the thermoregulation system (García-Jiménez and collaborators, 2011).

Besides, the dehydration process increases myocardial work due to reduced cardiac output, increased blood pressure, reduced oxygen consumption capacity, compromising aerobic function, mood, and sensorimotor reactions, for example. end leading to early fatigue and in extreme cases death (Carvalho, Mara, 2010; Coelho and collaborators, 2012; Early and collaborators, 2018; Jiménez and collaborators, 2015; Mazzoccante and collaborators, 2016). From this understanding, García-Jiménez and collaborators (2011) claim that losses above 2% of body mass from sweating affect physical and mental performance.

Due to its intermittent characteristic, Futsal presents moments of high intensity, whose heart rate behavior modulates around 85% of the maximum heart rate (HR), for approximately 83.2% of the playing time (Barbero-Alvarez and collaborators, 2008; Oliveira and collaborators, 2012).

Thus, it is common to estimate and to monitor training loads by methods such as HR monitoring and HR-based training pulse. Recently, due to its noninvasive applicability and is considered a gold standard tool in the evaluation of cardiovascular autonomic neuropathy (Benichou and collaborators, 2018; Ewing and collaborators, 1985), heart rate variability (HRV) has been highlighted for showing efficiency when analyzing the autonomic function of Futsal players (Nakamura and collaborators, 2016).

HRV is the oscillations that occur at consecutive intervals between each heartbeat (Vanderlei and collaborators). This method evaluates the condition of the autonomic nervous system (ANS) and its regulation on the heart, whose system is divided into two antagonistic pathways, the sympathetic and parasympathetic pathways (Hernando and collaborators, 2018).

The sympathetic pathway acts on the myocardium, increasing the heartbeat during moments of activity, while the parasympathetic pathway seeks to reduce it at rest or low intensity (Esco and collaborators, 2010).

Considering that sympatho-vagal modulation is influenced by body water levels (Vanderlei and collaborators, 2009) and these, in turn, are related to time on exertion and are regulated by the thermoregulation mechanism (Sepeda, Mendes, Loureiro, 2016), it is believed that there is a relationship between dehydration indicators and heart rate variability values. Several studies in the literature sought to investigate the levels of dehydration, water replacement and performance of male futsal players (Ferreira and collaborators, 2012; García-Jiménez and collaborators, 2015, 2011; García Jiménez, Yuste Lucas, García Pellicer, 2010; Gomes and collaborators, 2014; Sepeda; Mendes; Loureiro, 2016; Trentin, Confortin, Sá, 2016; Webber and collaborators, 2009), however, there is the absence of investigations that clarify the possible association between them. physiological markers in official matches.

Thus, the objective of this research was to associate the dehydration indicators, heart rate variability and playing time of professional male Futsal athletes.

MATERIALS AND METHODS

Participants

The minimum sample calculation was obtained using the G*Power software (Heinrich-Heine-University Düsseldorf, version 3.1.9.2, Düsseldorf, Germany) considering the power of $\beta = 0.80$, a significance level of significance of $p \leq 0.05$ and effect size of $d = 0.80$, requiring a minimum sample of $n = 17$. In this sense, 13 professional male Futsal athletes who were active in the Gold Series championship in the state of Paraná were selected. Thus, to obtain a statistically significant sample, three games were evaluated resulting in a sample of n = 30 with sample loss of six samples according to the exclusion criteria resulting in n = 24.

Thus, the following research was included: a) athletes in the professional category affiliated to the Paranaense Indoor Football Federation (FPFS) present and participating in the target competitions; b) athletes with experience of at least one FPFS competition; c) athletes who confirmed the absence of any cardiovascular impairment and/or chronic diseases; d) availability to participate in the study by signing the free and informed consent form.

The following were excluded from the research: a) athletes who, during the research, requested to withdraw their free and informed consent; b) athletes who only performed the pre-game or post-game test only.

Table 1 presents the anthropometric characteristics and sports history of the research participants. In the first game, the environmental conditions presented a temperature of 17ºC and a relative humidity of 94% (n = 9). In the second game, the ambient temperature was 17ºC and relative humidity 65% (n = 9). Finally, in the third game, the ambient temperature was 17ºC and the relative humidity 60% (n = 6). All games evaluated were played at home and started at 18h. The evaluations took place in July and August, including the winter season. This study was approved by the Ethics and Research Committee of the UniDomBosco University Center under number 2,743,680.

Table 1 - Anthropometric characteristics and sports history of participants (n = 13).

Variável	Média ± DP
Age (years)	23.93 ± 2.99
Age at onset in the sport (years)	12.31 ± 4.79
Length of employment in the professional category (years)	5.35 ± 3.59
Total height (cm)	173.72 ± 6.81
Body mass index (kg/m^2)	23.75 ± 2.13
Fat (%)	10.42 ± 2.03
Fat-free mass (kg)	63.70 ± 7.63
Basal metabolic rate (kcal)	1,881.85 ± 164.56

SD = standard deviation

PROCEDURES

The athletes were evaluated in the sports gymnasium that hosted the target competitions. Measurement of total height was performed in a single pre-game moment, while the evaluation of total body mass, bioimpedance body water and resting frequency variability were performed 1 h and 30 minutes pre and up to 20 minutes post-game. All evaluations were performed before the athletes warmed up for the game.

To measure total height, a portable stadiometer (Seca®, Hamburg, Germany) with an accuracy of 0.1 cm was used. For this measure, the athlete was instructed to remain in the orthostatic position, barefoot, wearing as little clothing as possible, heels together and toes about 60º apart, distributing body mass equally between both feet and the head oriented. in the Frankfurt plane parallel to the ground (Guedes, Guedes, 2006).

Total body mass was measured on a portable platform-type scale (Filizola®, Filizola S.A., Brazil) with 100 g accuracy. For this evaluation, the athlete was instructed to stand upright with his eyes directed forward and with his feet spread parallel on the platform dressed only in swim trunks (Guedes, Guedes, 2006).

The bioimpedance assessment method was employed using a full-body tetra-polar apparatus (Maltron®, BF906, United Kingdom) with an electrical frequency of 50 Hz. To perform this procedure, the athlete was asked to remove all metallic objectives that were carrying, such as earrings, bracelets, watch, piercings, among others. Next, the athlete was placed in a supine position for the placement of four electrodes on the right side, two detecting electrodes attached inline between the radial and ulnar styloid processes on the back of the wrist and on the line between the medial and lateral malleoli at the instep. The other two source electrodes were placed overlapping the head of the third metacarpal on the instep and the third metatarsal on the instep (Micheli and collaborators, 2014).

In addition to the bioimpedance body water measurement method, to evaluate the athletes' dehydration levels, the recommendations proposed by (Sepeda; Mendes; Loureiro, 2016) which are expressed as follows:

Relative fluid loss = initial body mass (kg) - final body mass (kg)
Sweating Rate (mL/min) = Initial Body Mass (kg) - Final Body Mass (kg) x 1000/Activity Time
% Dehydration = relative water loss x 100/initial mass (kg)

It is noteworthy that during the match of the official games was provided with bottles and glasses of water for ingestion. However, water intake was ad libitum.

To verify the autonomic modulation of the athletes, the method of analysis of heart rate variability was used. For this, a system composed of a small portable sensor (WCS Pulse, Brazil) with previous validation for this type of analysis was used [24], powered by a cable with USB connection and a thoracic transmitter (Polar®, Coded T-31, Finland). The software recorded the RR intervals, which were saved in a notebook. Kubios HRV version 2.2 software was used for analysis and generation of HRV related information. The total duration of the exam was seven minutes so that the cut-off area was the first and seventh minutes to, in the end, analyze only five minutes at rest, with the athlete lying supine, eyes closed and with the transmitter a thoracic line attached to the xiphoid process line (Guidelines, 1996). There were no pretest instructions since the objective of the research was to evaluate individuals in a competitive environment.

Finally, to estimate the playing time of each athlete, we used a report, prepared by the researcher himself, of players leaving/entering the court during the match. After this record, the calculation of the time differences in which the player left and entered the court and the sum of these values to obtain the total time of the player's performance during the match. In addition to the player's playing time during the match, the warm-up time was added to obtain the total individual activity value of each athlete.

Statistical Analysis

Data were stored in a spreadsheet of Microsoft® Office Excel software (version 2016, Washington, USA) and analyzed using BioEstat software (Mamirauá Institute, version 5.3, Tefé, Brazil). Initially, the Shapiro-Wilk test was used to verify the normality of the data, finding their symmetry. Next, the parametric t student test for independent samples was approached to confirm whether there was a significant difference between the pre and post-game data. Finally, the Pearson correlation test was approached to verify the interaction between dehydration levels and heart rate variability parameters. Data were presented as mean and standard deviation. For all treatments, the significance value for $p<0.05$ was assumed.

RESULTS

Table 2 presents the results of body water in liters in pre and post-game conditions and the difference (Δ) between these measurements. The mean values for the dehydration rate and dehydration percentage was 13.76 ± 9.62 mL/min and 0.81 ± 0.58% respectively. No significant values ($p<0.05$) were found between dehydration variables.

Table 2 - Dehydration indicators (n = 24)

Variables	Mean ± SD Pre	Mean ± SD Post	Mean ± SD Δ	Test t	p-value
H_2O (L)	46.76 ± 5.94	46.48 ± 5.60	0.28 ± 1.22	0.167	0.433
H_2O (%)	65.64 ± 1.32	65.76 ± 1.88	-0.13 ± 1.61	-0.267	0.396
RWL (kg)	71.39 ± 9.00	70.80 ± 8.86	0.58 ± 0.42	0.226	0.411

SD = standard deviation; Δ = delta (difference between pre and post-game); H2O = water; L = liters; % = percentage; RWL = relative water loss.

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Table 3 - Difference (Δ) between pre and post-game moments of HRV variability in time and frequency domain (n = 24)

Variables	Média ± DP			Teste t	p-valor
	Pré	Pós	Δ		
MEANRR (ms)	923.45 ± 85.23	731.91 ± 99.95	191.54 ± 134.24	7.397	<0.0001*
SDNN (ms)	85.13 ± 28.29	52.32 ± 21.74	32.80 ± 36.30	4.505	<0.0001*
rMSSD (ms)	59.17 ± 18.15	32.12 ± 17.97	27.05 ± 24.86	5.188	<0.0001*
pNN50 (%)	37.49 ± 15.50	12.57 ± 14.21	24.92 ± 21.11	5.805	<0.0001*
LF (un)	56.90 ± 14.83	74.38 ± 13.83	-17.48 ± 20.22	-4.223	<0.0001*
HF (un)	42.93 ± 14.82	25.56 ± 13.82	17.37 ± 20.25	4.200	<0.0001*
LF/HF (un)	1.61 ± 0.92	4.95 ± 4.78	-3.34 ± 4.64	-3.367	0.001*

SD = standard deviation; Δ = delta (difference between pre and post-game); ms = milliseconds; un = standard units; MEANRR = RR interval mean; SDNN = standard deviation of RR intervals; rMSSD = square root of the squared mean of the differences between RR intervals; pNN50 = percentage of adjacent RR intervals with duration difference greater than 50 ms; LF = low frequency; HF = high frequency; LF/HF = low frequency/high frequency; * = $p<0.05$

Referring to the parameters of heart rate variability, in the time and frequency domain, table 3 presents the pre and post-game mean values and the difference (Δ) between these conditions, which showed a statistically significant difference ($p<0.05$) for all parameters.

Table 4 shows the correlation between dehydration indicators and the delta (Δ) of the time domain heart rate variability parameters. According to Pearson's correlation test, a weak positive correlation was found between H2O (L) x ΔSDNN and H_2O (L) x ΔrMSSD. Weak negative correlation was evidenced between H_2O (%) x ΔMEANRR. There was a weak positive correlation between PHR (kg) x ΔMEANRR, PHR (kg) x ΔrMSSD and PHR (kg) x ΔpNN50. Finally, a weak positive correlation was presented between dehydration (%) x ΔrMSSD and dehydration (%) x ΔpNN50. However, none of the correlations showed statistically significant values ($p <0.05$).

Table 4 - Correlation between dehydration levels and delta (Δ) of time domain HRV parameters (n = 24)

	ΔMEANRR		ΔSDNN		ΔrMSSD		ΔpNN50	
Variáveis	r	p-value	r	p-value	r	p-value	r	p-value
H_2O (L)	-0.009	0.968	0.340	0.104	0.291	0.168	0.245	0.249
H_2O (%)	-0.328	0.118	-0.001	0.998	-0.148	0.489	-0.147	0.494
RWL (kg)	0.293	0.165	0.229	0.282	0.337	0.107	0.403	0.051
SR (mL/min)	0.114	0.596	0.036	0.867	0.117	0.587	0.239	0.261
Dehydration (%)	0.246	0.246	0.139	0.519	0.280	0.186	0.367	0.077

H_2O = water; L = liters; % = percentage; RWL = relative water loss; SR. = sweating rate; mL min = milliliters/minute; % = percentage; MEANRR = RR interval mean; SDNN = standard deviation of RR intervals; rMSSD = square root of the squared mean of the differences between RR intervals; pNN50 = percentage of adjacent RR intervals with duration difference greater than 50 ms; r = Pearson correlation

Table 5 - Correlation between dehydration levels and delta (Δ) of HRV parameters in the frequency domain (n = 24)

	ΔLF		ΔHF		ΔLF/HF	
Variables	r	p-value	r	p-value	r	p-value
H_2O (L)	-0,094	0,664	0,105	0,624	0,002	0,992
H_2O (%)	0,125	0,562	-0,110	0,610	0,103	0,633
RWL (kg)	-0,101	0,640	0,093	0,665	-0,027	0,900
SR (mL/min)	-0,157	0,464	0,153	0,476	-0,039	0,855
Dehydration (%)	-0,147	0,494	0,139	0,518	-0,077	0,720

H_2O = water; L = liters; % = percentage; RWL = relative water loss (pre and post-game body mass); mL/min = milliliters/minute; % = percentage; LF = low frequency; HF = high frequency; LF/HF = low frequency/high frequency; r = Pearson correlation

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Table 5 shows the correlation between dehydration indicators and delta (∆) of heart rate variability parameters in the frequency domain. Among the correlations presented none of them showed greater than a small correlation. Moreover, none of the interactions was statistically significant ($p < 0.05$).

Table 6 shows the correlation between the difference (∆) of HRV parameters in the time and frequency domain and the playing time. There were weak positive correlations between ∆MEANRR x playing time, ∆SDNN x playing time and ∆pNN50 x playing time. Moderate positive correlation was found between ∆rMSSD x playing time. However, only the correlations between ∆SDNN, ∆pNN50 and ∆rMSSD x playing time were statistically significant ($p < 0.05$).

Table 6 - Correlation between playing time and delta (∆) of HRV parameters in time and frequency domain (n = 24)

Variables	Playing time	
	r	p-valor
∆MEANRR	0.277	0.191
∆SDNN	0.469	0.021*
∆rMSSD	0.526	0.008*
∆pNN50	0.476	0.019*
∆LF	0.013	0.954
∆HF	-0.018	0.936
∆LF/HF	-0.017	0.936

MEANRR = RR interval mean; SDNN = standard deviation of RR intervals; rMSSD = square root of the squared mean of the differences between RR intervals; pNN50 = percentage of adjacent RR intervals with duration difference greater than 50 ms; LF = low frequency; HF = high frequency; LF/HF = low frequency/high frequency; r = Pearson correlation; * = $p<0.05$

DISCUSSION

The present study aimed to verify the association between dehydration indicators, heart rate variability parameters and playing time of professional male Futsal athletes in pre and post-game conditions, which hypothesis consisted of a significant positive correlation between the level of dehydration the sympatho-vagal balance.

However, the values reported by the water loss indicators did not reflect an accentuated level of dehydration and, therefore, did not show strong correlations with the parameters of heart rate variability in either the time domain or the frequency domain.

This research showed a mean percentage dehydration level of 0.81 ± 0.58% resulting from the loss of body mass (Table 2).

In the research proposed by García-Jiménez and Yuste (2010), designed with a similar sample, the authors evaluated the dehydration level of these athletes over six official matches, whose water intake was ad libitum, and found a mean percentage value of 1.25 ± 1.08%. Another study conducted by García-Jiménez and collaborators (2015) reported a mean percent dehydration value of 1.04 ± 1.06% in male professional Futsal athletes during official competitions.

In addition, the RLW reported in this study was 0.58 ± 0.42 kg, whose values differ from those found in the García Jiménez and collaborators (2010), also performed with professional Futsal players, as assessed dehydration over three official matches per game position, with an average RLW of 1.27 ± 0.61 kg, 0.55 ± 1.1 kg and 1.27 ± 1.1 kg for goalkeepers, defenders and strikers respectively. According to the same study, a dehydration level of 1% from RLW reflects increased cardiac work and reduced aerobic performance.

In the meantime, when analyzing the dehydration indicators, it was found that the athletes presented percentage values below 1% about the loss of body mass not reflecting in a dehydration state. This phenomenon can be explained by climatic conditions (temperature and relative humidity), time of the games, season (winter) and the athlete's perception of thirst, given that water replacement was ad libitum.

Referring to the autonomic modulation during the evaluated matches (Table 3), a statistically significant difference was found between the values obtained in the pre and post-game conditions for all evaluated parameters.

This phenomenon can be explained by the antagonistic functioning of the autonomic nervous system in regulating the organism so that the sympathetic pathway remains elevated during and shortly after exercise, whereas the parasympathetic pathway increases its activity at rest (Esco and collaborators, 2010).

In this sense, the pre-match MEANRR parameter presented mean values of 923,45 ± 85,25 ms, which differs from the findings in the study by Oliveira and collaborators (2012), with professional Futsal players, highlighting average values of 808.00 ± 124.10 ms before the competitive preseason period. The MEANRR and SDNN parameters are controlled by both the sympathetic and the parasympathetic pathways of the ANS, and these, in turn, are directly influenced by exercise type and intensity (Clemente-Suárez, Arroyo-Toledo, 2018). In another context, previous studies (Benichou and collaborators, 2018) emphasize that reduced values of these parameters are directly related to greater cardiovascular impairment and risk of acute myocardial infarction in patients with heart disease and type 2 diabetes mellitus.

Regarding the rMSSD parameter, the present study revealed pre-game mean values of 59.17 ± 18.15 ms in contrast to the average values of 33.00 ± 16.80 ms found in the study by Oliveira and collaborators (2012) before the preseason period. The rMSSD, pNN50 and HF parameters are directly related to the parasympathetic pathway action on the heart and high values of these physiological markers are correlated with a lower risk of developing cardiovascular disease (Benichou and collaborators, 2018; Hernando and collaborators, 2018; Vanderlei and collaborators, 2009).

Also, when comparing sedentary individuals and male athletes, Kawaguchi and collaborators (2007) showed that baroreflex sensitivity is a variable that is influenced by physical training, demonstrating that athletes have greater capacity for autonomic modulation regarding external stimuli when compared with sedentary individuals. However, given that the rMSSD, pNN50 and HF parameters are reduced, it is noteworthy the greater participation of the sympathetic nervous system in the postgame condition suggesting a high level of stress suffered by athletes during competitions.

On the other hand, sympathetic hyperactivity is evident in this study by analyzing the LF and LF / HF parameters in the postgame state. The LF component represents the performance of both ANS pathways, but with sympathetic predominance, while the LF / HF ratio reflects in greater activity of the sympathetic nervous system when these values are greater than 1 un (Benichou and collaborators, 2018; Guidelines, 1996). Wong and collaborators (2021) when analyzing pre- and post-exercise autonomic modulation in healthy men and women, highlight that prolonged sympathetic hyperactivity and post-exercise reactivation increase the risk of acute cardiac events.

Regarding HRV values, both in the time domain and in the frequency domain, they did not present significant correlations with the dehydration indicators (tables 4 and 5). These results refute the initial hypothesis of the study, as it was expected that the higher the values of the dehydration indicators, the greater the sympathetic activity, indicated by the elevation of the post-game LF and LF / HF parameters and reduction of the rMSSD indicators. pNN50 and HF in the same condition.

Considering the absence of significant correlation between the dehydration indicators and autonomic modulation evidenced in the present study (Table 6), Carter and collaborators (2005) reported in their study, conducted with five healthy male adults, higher parasympathetic activity on the heart in the hydrated state, noting that hydration contributed significantly to the restoration of autonomic balance after stress caused by heat generated during the exercise. Furthermore, this information suggests that dehydration alone positively influences parasympathetic HRV control, but the reduction in overall HRV and the decrease in LF and HF changes after exercise results in a general deleterious effect of dehydration on autonomic cardiac stability.

In the study proposed by Oliveira-Silva and Boullosa (2015) , with 11 male fighter pilots, found that high degrees of dehydration reduce autonomic modulation during and after the flight. Besides, in the research by Castro-Sepúlveda and collaborators (2015) with 14 male college athletes, dehydration has been shown to increase sympathetic activity reflected by the LF / HF parameter and to reduce the parasympathetic activity represented by the rMSSD and pNN50 parameters.

Finally, referring to autonomic modulation throughout the game, a weak positive correlation was found between ΔMEANRR x playing time, ΔSDNN x playing time and ΔpNN50 x playing time and moderate positive correlation between ΔrMSSD x playing time. (Table 6), and only the interactions involving the parameters ΔSDNN, ΔpNN50 and ΔrMSSD were statistically significant. Considering that rMSSD and pNN50 represent the parasympathetic nervous system performance (Benichou and collaborators, 2018), these results suggest that the longer the athlete spends more activity, the greater the difference between pre and post-game values, showing less parasympathetic activity and, consequently representing sympathetic hyperactivity.

CONCLUSION

The present study aimed to verify the association between dehydration indicators, heart rate variability parameters and playing time of professional male Futsal athletes in pre and post-game conditions.

The initial hypothesis consisted of a significant correlation between the level of dehydration and the sympathovagal balance, that is, the higher the values of the dehydration indicators, the higher the HRV values that indicate the action of the sympathetic pathway and the lower the values.

HRV values that indicate parasympathetic pathway action. However, the values reported by the dehydration indicators did not reflect an accentuated dehydration level and, therefore, did not show strong correlations with HRV parameters in either the time domain or the frequency domain, negating the study hypothesis.

On the other hand, the present research reflects the reality of a professional futsal competition, so this type of analysis can be used by the coaching staff to verify the athlete's current condition at the time of team composition, as well as to propose interventions with the team in order to enhance its recovery from the point of view of the ANS.

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Received for publication on 16/05/2024
Accepted on 11/09/2024