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The impact of winning or losing a padel match on heart rate variability

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Abstract

Padel is an intermittent sport that has significantly increased its practice in the past years. Previous studies showed that physical demands significantly differed depending on the results of the match (win or lose). However, no previous studies have investigated the effects on the heart rate variability (HRV) of padel players. The present study examined the impact of winning or losing a padel match on the player's HRV. A total of 27 players, with a mean age of 37.26 (9.42) years old and a body mass index (BMI) of 26.26 (3.21) participated in our study. The participant's HRV was assessed before, during and after a padel match. The match results were used to divide the sample between winners and losers. Time domain, frequency domain and non-linear measures were extracted. Results showed that both groups significantly decreased their HRV during and after the match. However, significant differences ($p > 0.05$) were not found between winners and losers in the HRV while playing padel or after the match. These differences could indicate that the physical load was similar in the two groups. Results highlight the importance and usefulness of analysing the HRV as an indicator of post-competitive fatigue in medium-level padel players.

Keywords

Autonomic nervous system, fatigue, racket sports, training load

Introduction

Biological signals can be employed to control and evaluate training load and the effects of training on the athletes' organism.[1,2] Scientific and technological advances have allowed the development of portable tools to monitor training load and adaptations to training.[3] Thus, biomarkers that inform us regarding athletes' fatigue changes are highly appreciated. Among these biomarkers, the heart rate variability (HRV) emerged as a non-invasive index that evaluates the balance between sympathetic and parasympathetic activity, studying the successive heartbeats variation over time.[4] A low HRV indicates a predomination of the sympathetic activity which could be related to a reduced regulatory capacity of the organism.[5] Thus, lower values of HRV have been considered a biomarker of fatigue and overtraining,[6,7] and correlated with low sports performance.[8]

Participation in the sport of padel has exponentially increased since 2010.[9] Currently, 65 national federations are recognized by the International Padel Federation.[10] This practice is a long-lasting intermittent medium/high-intensity sport [11] which can induce several benefits in the physical, psychological, personal and social spheres.[12,13] Previous studies have analysed the physiological demands of this intermittent sport, revealing an average point duration of 7.24 seconds with an average rest of 14.12 seconds,[14] being higher in female padel players.[15,16]

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These demands have shown a mean heart rate (HR) of 148.30 beats/min, while the mean VO2 corresponded to 24.06 ml/kg/min (43.7% VO2 max) and the level of lactate ranged between 1.9 and 2.88 mmol/l.[17] In addition, García et al.[18] observed that recreational padel players spent almost 85% of their time in the aerobic zone. Regarding HRV a previous study characterized padel match games in amateur players.[19] This study showed that HRV was significantly reduced after a padel game, exhibiting changes in the time domain, frequency domain and non-linear measures.[19]

Fatigue induced by sport should be managed and controlled to avoid negative effects on physical performance in athletes.[20–23] Previous researchers have studied the impact of the match results on physical, physiological and psychological variables.[24,25] In racket sports, different results have been found depending on the modality of the sport.[24–28] In tennis, winners cover longer distances at higher speeds than losers.[26] Similar results were found in wheelchair tennis winners, covering longer distances than losers.[27] However, in wheelchair padel tennis and squash losers covered more distance by rally and showed higher mean HR than winners.[24,25,29] In the same line, Roldán-Márquez et al.[28] showed that losers padel players exhibited greater HR and physical responses (higher distance, mean velocity or sprint numbers) than winners. Also, Ramón-Llin et al.[30] observed how high-level players ran faster to the offensive position, covered a greater distance and spent less time between serve and return impacts than beginners. This information would help coaches and physical trainers to adapt training programs to the competition demands based on match results.[31]

These findings together could suggest that the results of a match might have a significant impact on the players' HRV. Furthermore, HRV is also sensitive to emotions and cognitive processes.[32–34] Previous studies reported that athletes experience well-being and mood alterations after losing,[35,36] with higher depression, anxiety and social dysfunction.[36] Together, they could lead to being significantly reduced after losing a match. To the best of our knowledge, no previous study has investigated the impact of the results on the HRV of padel players. Thus, this study aimed to investigate the impact of winning or losing a padel match on the HRV of players. We hypothesized that HRV would be decreased after both matches (a match that was won and a match that was lost). However, HRV would be significantly reduced after losing a match compared to after winning a match.

Materials and methods

Participants

A total of 27 medium-level padel players participated in this cross-sectional study. Participants had a mean age of 37.26 (9.42) years old and a body mass index (BMI) of 26.26 (3.21) kg/m^2. The measurements took place in an indoor padel facility. Participants who regularly practice padel (between 4 and 6 hours per week), with more than 2 years of padel experience and were classified as medium-level by a padel expert participated in this study. Furthermore, participants were excluded if they had a condition that make padel contraindicated or took any substance or drug which affected the autonomic nervous system 48 hours before starting the protocol.

Participants were informed about the procedures and agreed to participate in the study. Procedures were approved by the university research ethics committee (approval number: 89/2018) and followed all ethical guidelines under the European Standard of Good Clinical Practice (ICH-GCP Guidelines) and the Declaration of Helsinki.

Procedure

A technician randomly allocated the 27 participants into 7 groups of 4. Then, couples were randomly allocated. Before starting the match, participants were heighted and weighted using a bioimpedance device TANITA MC-780MAP (ROS Ltd, Riga, Letonia) and a stadiometer (SECA 225, SECA, Hamburg, Germany) to calculate the BMI. After 15 minutes at rest, HRV was assessed for 5 minutes in the dressing room by controlling temperature and humidity (22.3 (1.0) °C; 46.4 (2.8) %) at rest in a sitting position. The dressing room was calmed, and participants were encouraged to be silent to avoid distractions or interactions between players. Subsequently, participants conducted a warm-up (10 minutes in the padel court). After warm-up, a 90-minute padel match was measured. HRV was measured while participants played the match. After the match, HRV was assessed for 5 minutes (in the same conditions as the baseline assessment). Figure 1 summarizes these procedures.

The technician registered the match's results. Based on that information, participants were classified into two groups: (i) the winning group and (ii) the losing group (see Table 1 for descriptive data). All the matches were played in the evening between 19:00 and 21:00 hours. The technician who registered the matcheś result did not participate in the database creation or statistical analyses. Recommendations from Catai et al.[37] the European Society of Cardiology and the North American Society of Pacing and Electrophysiology [38] were used for assessing and reporting HRV results.

Instruments and outcomes

Four Polar RS800CX (Finland) HR monitors [39] were used to assess the HRV before, during and after padel matches. These HR monitors have a sampling frequency of

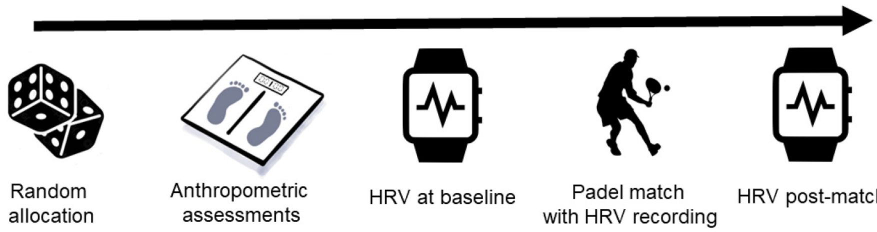

Figure 1. Timeline of main procedures in the study.

Table 1. Descriptive data of participants.

Variable	Winning group Mean (SD)	Losing group Mean (SD)	*P*-value
Age (years)	37.67 (8.86)	36.75 (10.46)	0.864
Height (cm)	175.40 (4.92)	175.08 (5.43)	0.750
Weight (kg)	79.59 (10.36)	82.45 (15.50)	0.714
Body mass index (BMI) (kg/m^2)	25.83 (2.80)	26.67 (3.58)	0.542
Fat mass (%)	21.44 (5.44)	21.33 (6.85)	1.000

1000Hz. Data were exported to Kubios software (v. 3.3) [40] which allowed to preprocess and calculate time domain, frequency domain and non-linear variables of the HRV. Artefacts were filtered using a middle filter which allowed investigators to identify those RR intervals shorter/longer than 0.25 seconds compared to the average of the previous beats. A cubic spline interpolation was used to correct and replace the artefacts.

Time domain, frequency domain and non-linear measures were included. In the time domain, variables such as mean heart rate (mean HR), RR intervals, RR50 count are divided by the total number of all RR ranges (Pnn50) and the square root of differences between adjacent RR intervals (RMSSD). In the frequency domain, we included the low frequency (LF, 0.04–0.15 Hz) and high frequency (HF, 0.15–0.4 Hz) ratio (LF/HF) and total power. Regarding non-linear measures, the RR variability from heartbeat to short-term Poincaré graph (width) (SD1), RR variability from heartbeat to long-term Poincaré graph (length) (SD2) and the sample entropy (SampEn) were extracted. In addition, the stress index, the parasympathetic nervous system index (PNS index) and the sympathetic nervous system index (SNS index) were calculated. The stress index is the square root of the Baevsky's stress. The PNS index was calculated based on the mean RR (ms), the RMSSD (ms) and the SD1 (%). The SNS index was calculated based on the mean HR (bpm), the Baevsky's stress index and the SD2 (%). The Baevsky's stress index is calculated as follows:

$$Stress\ Index = \frac{AMo \times 100\%}{2Mo \ \times MxDMn}$$

where AMo is the so-called mode amplitude presented in percent, Mo is the mode (the most frequent RR interval) and MxDMn is the variation scope reflecting the degree of RR interval variability. The mode Mo is the median of the RR intervals. The AMo is obtained as the height of the normalized RR interval histogram (bin width 50 msec) and MxDMn as the difference between the longest and shortest RR interval values. In order to make stress index less sensitive to slow changes in mean HR (which would increase the MxDMn and lower AMo), the very LF trend is removed from the RR interval time series using the smoothness priors method.[41] In addition, the square root of SI is taken to transform the tailed distribution of SI values towards normal distribution. Higher values of SDNN, RMSSD, PNS as well as lower values of LF/HF are associated with higher parasympathetic influence.[42–46]

Statistical analyses

The IBM Statistical Package for Social Sciences (SPSS) (version 25) statistical software was employed to conduct the analyses. Since participants were less than 50, the Shapiro–Wilk test was chosen to explore the data distribution.[47] Considering the results of Shapiro–Wilk and the small sample size, non-parametric analyses were conducted. Differences between baseline, during the match and after match and HRV variables were explored using the Friedman test for each group (winning and losing groups). In order to explore differences between the two groups at baseline, the Mann–Whitney U test was conducted. In addition, HRV during match and post-match was normalized using the baseline data (calculating the difference between match or post-match and baseline data for each HRV variable). Then, Mann–Whitney U tests were conducted to explore differences in the HRV during the match and post-match between the winning and the losing groups. In order to reduce the probability of Type I error,

p-values were corrected using Bonferroni correction for multiple comparisons. The effect sizes, r and Kendall's W, were calculated for Mann–Whitney test and Friedman test, respectively. Effects size were classified as follows: > 0.5 is a large effect, between 0.5 and 0.3 a medium effect and < 0.3 is considered a small effect.[48,49]

Results

Differences were not found in age, weight, height, BMI or fat mass (%) at baseline (Table 1). In addition, Mann–Whitney U tests did not show significant differences between losing and winning groups in any of the HRV variables at baseline.

Table 2 shows the values of the HRV at baseline, during the match and after the match in the participant who lost their match. Friedman test showed significant differences between these three measurements in time domain, frequency domain and non-linear measures ($p < 0.05$) with a large effect size. Significantly higher HRV values were found before the match. Lower values of HRV were found during the match. However, initial levels of HRV were not recovered since significant differences were found between baseline and post-competition in most of the studied variables.

Table 3 shows the values of the HRV at baseline, during and after the match in the participants who won their padel game. Friedman test showed significant differences, with large effect size, between these three measurements in time domain, frequency domain and non-linear measures ($p < 0.05$). Significantly higher HRV values were found before the match. Lower values of HRV were found during the match. However, initial levels of HRV were not recovered since significant differences were found between baseline and post-competition in most of the studied variables.

Table 4 shows the comparison between the losing and the winning groups in the normalized HRV data corresponding to during match assessment (the difference between match and baseline data for each HRV variable was calculated and reported in Table 4 for each group). Significant differences were not found in any of the variables studied ($p > 0.05$).

Table 5 shows the comparison between the losing and the winning groups in the normalized HRV data corresponding to post-match assessment (the difference between baseline and post-match data for each HRV variable was calculated and reported in Table 5 for each group). Significant differences were not found in any of the variables studied ($p > 0.05$).

Discussion

The present study aimed to investigate the impact of match results on the HRV of padel players. We hypothesized that players who lose the padel match would exhibit a lower HRV than players who win the padel match. Our results did not show significant differences in HRV of players winning or losing either during or after the padel match. Independently of the results (winning or losing), HRV was significantly reduced after the match.

Previous studies have reported the impact of match results on racket sports.[24–28] Results showed that the physiological and physical impact of winning or losing are dependent of the sport modality. Whereas in tennis [26] and wheelchair tennis.[27] the winners showed longer distances at higher speed, in wheelchair padel and squash,[24,25,29] the losers exhibited more distance by rally and higher values of HR than winners. Similar results were reported in a previous study focused on padel.[28] In this study, losers padel players showed greater HR and physical responses (higher distance, mean velocity or sprint numbers) than winners. However, our results did not show significant differences between losers and winners' players on the HRV while playing a padel game. Although non-significant, losers' players exhibited higher HR and lower HRV. Specifically, effect sizes showed a large effect of mean HR, with greater HR observed in losers' players during the padel match. Changes in HRV have been found to decrease with increasing intensity of exercise.[50] This could be due to the extracardiac output required while exercising that increase the HR by increasing the sympathetic modulation.[51,52] Furthermore, proinflammatory cytokines [52] induced by exercises of high duration and intensity [53] can also increase sympathetic modulation. In this line, previous studies have suggested that HRV can be used as a method to calculate exercise threshold.[54,55] Thus, interpreting the results of the present study we may affirm that physical loads during losing and winning matches were similar. Previous studies have reported differences in distances covered and player's maximum velocity depending on the players level and service tactic formation.[30] In this sense, it was observed that high-level players covered more distance and moved faster than beginners as beginners make more errors and the point duration is lower than high-level players.[56] In addition, service tactic formation had a great influence on these parameters. However, future studies should replicate our study enrolling elite players to investigate if this pattern is also observed at that level.

Our results did not show significant differences in the HRV after a padel game between losers and winners. Previous studies have shown that losing a match or a competition could induce higher depression symptoms, anxiety and social dysfunction.[36] HRV is also sensitive to these emotional states.[32–34] Thus, our results showed that both emotional and physical impact of winning and losing a padel match could be similar. This could be true since matches were not conducted under a competitive sphere

Table 2. Heart rate variability (HRV) at baseline, during and after a match of participants who lost a padel match.

Variable	Baseline mean (SD)	Match mean (SD)	Post-competition mean (SD)	*P*-value	Effect size	Pairwise comparison
PNS index	−1.43 (0.90)	−3.90 (0.32)	−2.29 (0.52)	<0.001	4	A > B B < C A > C
SNS index	0.17 (1.04)	9.16 (2.19)	4.02 (1.63)	<0.001	4	A < B B > C A < C
Stress index	10.40 (2.96)	26.57 (7.23)	20.26 (5.81)	<0.001	3.444	A < B A < C
Mean HR	65.79 (9.82)	143.63 (12.17)	99.03 (10.85)	<0.001	4	A < B B > C A < C
RR	929.97 (132.80)	420.51 (35.79)	612.56 (66.81)	<0.001	4	A > B B < C A > C
pNN50	15.81 (11.83)	0.09 (0.17)	1.17 (1.34)	<0.001	3.444	A > B A > C
RMSSD	35.55 (12.15)	5.35 (2.13)	13.69 (5.33)	<0.001	4	A > B B < C A > C
HF	30.31 (18.47)	15.36 (4.31)	20.37 (15.09)	0.105	0.750	-
LF	69.62 (18.49)	84.58 (4.32)	79.55 (15.14)	0.105	0.750	-
LF/HF	4.39 (4.50)	6.14 (2.60)	6.79 (5.15)	0.105	0.750	-
Total power	1698 (1298)	80 (73)	366 (312)	<0.001	4	A > B B < C A > C
SD1	25.18 (8.61)	3.78 (1.50)	9.69 (3.77)	<0.001	4	A > B B < C A > C
SD2	50.50 (14.89)	11.57 (4.74)	26.05 (8.86)	<0.001	4	A > B B < C A > C
SampEn	1.73 (0.24)	1.42 (0.17)	1.27 (0.40)	0.001	1.755	A > B A > C

Note: A: baseline, B: during match; C: post-match.
HR: heart rate; LF/HF: low frequency (LF) ratio (ms2)/high frequency (HF) (ms2); PNS index: parasympathetic nervous system index; pNN50: percentage of intervals >50 ms different from the previous interval; RR: time between intervals R-R; RMSSD: the square root of the mean of the squares of the successive differences of the interval RR; SNS index: sympathetic nervous system index and stress index; SD1: dispersion, standard deviation, of points perpendicular to the axis of line of identity in the Poincaré plot; SD2: dispersion, standard deviation, of points along the axis of line of identity in the Poincaré plot; SampEn: sample entropy; Total power: the sum of all the spectra.

(all of them were friendly matches). In this regard, a previous study focused on youth tennis players showed that pre-competitive anxiety significantly impacted the HRV before a tournament.[57] Therefore, future studies are encouraged to explore if the results of an official competition match could alter the HRV of padel players.

A previous study showed significant changes in time domain, frequency domain and non-linear variables of HRV during a padel match when compared to baseline and post-match measurements. Our results showed that a padel match significantly impacted all the HRVs studied. Furthermore, HRV was also monitored for 5 minutes after the end of the match. Results showed that players did not fully recover to HRV baseline levels. This could indicate the appearance of acute fatigue. Thus, HRV has been proposed as a useful tool to control and manage fatigue and overtraining.[58–60] Previous studies have indicated the usefulness of RMSSD as a biomarker of fatigue[7,61] and, therefore, as a variable to control training load.[61] In addition, SampEn, a non-linear measure that informs us about the complexity of the system,[62] showed a different pattern. Whereas time domain and frequency domain variables exhibited a pattern of recovery in the post-match measurements, this non-linear index significantly reduced its value compared to baseline in both losers and winners' players. This reduction indicated a more regular pattern. Previous studies have highlighted the connection between entropy and allostasis (the point at which a system leaves a

Table 3. Heart rate variability (HRV) at baseline, during and after a match of participants who won a padel match.

Variable	Baseline mean (SD)	Match mean (SD)	Post-competition mean (SD)	*P*-value	Effect size	Pairwise comparison
PNS index	−0.14 (1.27)	−3.66 (0.51)	−2.10 (0.94)	<0.001	3.751	A > B B < C A > C
SNS index	0.22 (1.14)	8.34 (2.11)	4.01 (3.03)	<0.001	4	A < B B > C A < C
Stress index	9.46 (2.62)	24.44 (5.93)	21.31 (11.89)	<0.001	2.897	A < B A < C
Mean HR	68.62 (11.64)	139.57 (17.12)	95.01 (14.93)	<0.001	4	A < B B > C A < C
RR	896.35 (141.46)	436.19 (55.40)	645.45 (95.88)	<0.001	4	A > B B < C A > C
pNN50	19.09 (19.75)	1.28 (3.98)	2.19 (4.71)	<0.001	2.446	A > B A > C
RMSSD	42.01 (23.80)	8.78 (10.12)	16.50 (16.46)	<0.001	2.613	A > B A > C
HF	29.60 (15.60)	19.66 (18.15)	18.27 (15.56)	0.011	1.191	A > C
LF	70.35 (15.64)	80.25 (18.29)	81.69 (15.58)	0.011	1.191	A < C
LF/HF	3.35 (2.29)	5.79 (2.59)	7.81 (6.74)	0.011	1.191	A < C
Total power	2210 (1411)	106 (82)	816 (710)	<0.001	3.484	A > B B < C A > C
SD1	29.75 (16.87)	6.21 (7.15)	11.68 (11.65)	<0.001	2.613	A > B A > C
SD2	60.07 (13.69)	14.33 (6.37)	32.84 (17.35)	<0.001	3.480	A > B B < C A > C
SampEn	1.63 (0.27)	1.28 (0.23)	1.12 (0.29)	0.002	1.724	A > B A > C

Note: A: baseline, B: during match; C: post-match.
HR: heart rate; LF/HF: low frequency (LF) ratio (ms2)/high frequency (HF) (ms2); PNS index: parasympathetic nervous system index; pNN50: percentage of intervals >50 ms different from the previous interval; RR: time between intervals R-R; RMSSD: the square root of the mean of the squares of the successive differences of the interval RR; SNS index: sympathetic nervous system index and stress index; SD1: dispersion, standard deviation, of points perpendicular to the axis of line of identity in the Poincaré plot; SD2: dispersion, standard deviation, of points along the axis of line of identity in the Poincaré plot; SampEn: sample entropy; Total power: the sum of all the spectra.

homeostatic region).[63] Thus, results could be related to allostatic processes to recover the homeostasis after exercise. In this regard, Thayer and Sternberg [64] discussed that vagal function was associated with glucose regulation, inflammatory processes and hypothalamic–pituitary–adrenal axis function by regulation of prefrontal cortex and amygdala. Interestingly, these processes are significantly impacted by exercise,[65–67] and could mean that the organism after exercise is trying to recover homeostasis through multiple physiological processes such as muscle glycogen stores or thermoregulation processes. Thus, future studies should investigate the role of SampEn as an indicator of homeostasis recovery.

This study has some limitations that should be acknowledged. The study was focused on medium-level padel players, so results cannot be extrapolated to elite padel players or athletes that practice other sports. Furthermore, the evaluations were conducted during friendly matches. Thus, it is possible that results extracted from an official competition or tournament would be influenced by emotional factors and, therefore, the HRV would be altered. In our case, the HRV alteration might be due to the physical load induced by padel. Thus, we suggest that future studies should explore the impact of physical and emotional factors on the HRV of padel players, including and comparing friendly and competitive (official tournament matches) matches. In addition, it should be interesting to investigate the impact of friendly and real competition on HRV. Furthermore, The HRV was registered during the whole match. It is possible that HRV would vary in the different match phases (active and passive phases such as points or rests). Thus, the change in HRV between players within a

Table 4. Impact of winning or losing a padel match on heart rate variabilty (HRV).

Variable	Losing match	Winning match	*P*-value	Effect size
HRV				
PNS index	−3.75 (0.74)	−3.51 (1.23)	0.188	0.334
SNS index	8.99 (1.72)	8.12 (1.70)	0.329	0.183
Stress index	16.17 (6.45)	14.98 (5.53)	0.845	0.007
Mean HR	77.84 (10.11)	70.94 (17.23)	0.407	0.132
RR	−502.46 (112.48)	−460.16 (142.69)	0.242	0.264
pNN50	−15.73 (11.74)	−17.82 (20.53)	0.807	0.011
RMSSD	−30.20 (10.58)	−33.22 (25.77)	0.696	0.029
HF	−14.95 (16.74)	−9.93 (24.05)	0.807	0.011
LF	14.96 (16.75)	9.89 (24.19)	0.770	0.016
LF/HF	1.74 (3.25)	2.44 (2.82)	0.696	0.029
Total power	−1618 (1285)	−2104 (1419)	0.380	0.148
SD1	−21.39 (7.50)	−23.54 (18.25)	0.696	0.029
SD2	−38.93 (13.81)	−45.74 (14.98)	0.306	0.059
SampEn	−0.31 (0.27)	−0.35 (0.43)	0.807	0.011

HR: heart rate; LF/HF: low frequency (LF) ratio (ms2)/high frequency (HF) (ms2); PNS index: parasympathetic nervous system index; pNN50: percentage of intervals >50 ms different from the previous interval; RR: time between intervals R-R; RMSSD: the square root of the mean of the squares of the successive differences of the interval RR; , SNS index: sympathetic nervous system index and stress index; SD1: dispersion, standard deviation, of points perpendicular to the axis of line of identity in the Poincaré plot; SD2: dispersion, standard deviation, of points along the axis of line of identity in the Poincaré plot; SampEn: sample entropy; Total power: the sum of all the spectra.

Table 5. Acute effects of losing or winning a padel match on the heart rate variability (HRV).

Variable	Losing match	Winning match	*P*-value	Effect size
HRV				
PNS index	−2.14 (0.57)	−1.83 (0.97)	0.223	0.286
SNS index	3.85 (1.23)	3.79 (2.46)	0.884	0.004
Stress index	9.86 (5.58)	11.86 (11.01)	0.884	0.004
Mean HR	33.24 (5.55)	26.38 (12.53)	0.097	0.529
RR	−317.41 (84.02)	−250.91 (131.33)	0.130	0.440
pNN50	−14.65 (11.13)	−16.90 (20.79)	0.845	0.007
RMSSD	−21.86 (10.25)	−25.50 (28.48)	1.000	<0.001
HF	−9.93 (11.61)	−11.32 (24.10)	0.526	0.077
LF	9.93 (11.61)	11.34 (24.14)	0.558	0.066
LF/HF	2.40 (5.74)	4.46 (7.28)	0.329	0.183
Total power	−1331 (1070)	−1393 (1502)	0.961	<0.001
SD1	−15.49 (7.26)	−18.07 (20.17)	1.000	<0.001
SD2	−24.45 (12.86)	−27.23 (19.56)	0.435	0.117
SampEn	−0.47 (0.34)	−0.50 (0.33)	0.845	0.007

HR: heart rate; LF/HF: low-frequency (LF) ratio (ms2)/high-frequency (HF) (ms2); PNS index: parasympathetic nervous system index; pNN50: percentage of intervals >50 ms different from the previous interval; RR: time between intervals R-R; RMSSD: the square root of the mean of the squares of the successive differences of the interval RR; SNS index: sympathetic nervous system index and stress index; SD1: dispersion, standard deviation, of points perpendicular to the axis of line of identity in the Poincaré plot; SD2: dispersion, standard deviation, of points along the axis of line of identity in the Poincaré plot; SampEn: sample entropy; Total power: the sum of all the spectra.

pair or within shorter time periods (point, game or set) should be addressed by future studies. Moreover, we reported the HRV after five minutes of recovery, showing that this time is not enough to recover the HRV baseline levels fully. Future studies should monitor HRV during the following hours after a padel match to investigate recovery protocols in padel players. Results would be relevant to reduce the risk of overtraining.[68] Apart from limitations, we should highlight that this is the first study that compares the impact of the results on psychophysiological variables in padel. Therefore, different practical applications emerged from this study. For instance, physical trainers or coaches should equally plan physical load in winners and losers' medium-level players. In addition, physical trainers should include the HRV as a potential tool to manage and control the training load. Variables such as RMSSD are sensible to physical and emotional load. Thus, we can control these two relevant aspects of our athletes.

Conclusions

A padel match significantly reduced the HRV of medium-level padel players. However, the result of a padel match (win or lose) did not significantly impact the HRV of medium-level padel players. This could indicate that the physical load of winning or losing a padel match is similar during friendly matches. This could have significant implications when programming training load.

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Data availability statement

Data will be available upon reasonable request to the corresponding author.

Institutional review board statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Universidade de Évora (Portugal) (Protocol 89/2018).

Informed consent statement

Informed consent was obtained from all subjects involved in the study.

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