Artículo original

Recovery behavior after matches for returning to training in volleyball athletes

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Summary

The aim of this research was to evaluate the behavior of vertical jumps performance in professional volleyball athletes during matches and training and their relationships with fatigue and recovery through heart rate variability (HRV), ratings of perceived exertion (RPE) and perceived recovery status (PRS). Nine male professional volleyball athletes participated in the study, with mean age: 25.66 ± 5.7 years, mean body mass: 97.81 ± 8.65 Kg and mean height: 200.94 ± 5.19 cm, with experience in national and international competitions. HRV and PRS were evaluated in the morning of matches and in the presentation for the first day of training after matches. RPE was collected immediately after matches and at the end of training days. Jumps performance was monitored during the matches and during the first days of training. The data was grouped by matches and training sessions. Significance level adopted was $\alpha \leq 0.05$. There were no alterations in HRV and PRS evaluated after matches and before training sessions, as well as in RPE after training. Jumps height was greater during the matches ($p < 0.013$) and there were no differences in the number of jumps. There was a positive correlation between the number of jumps during matches and PRS before matches ($r = 0.336$, $p = 0.015$) and a negative correlation between the number of jumps during training and pre-training PRS ($r = -0.318$, $p = 0.002$). We conclude that the recovery period proposed by the team proved to be sufficient for the athletes to maintain the same condition for returning to training. This information can assist physical trainers to prescribe training loads for the return to training.

Key words:
Heart rate. Physical exertion. Recovery of function. Sports.

Comportamiento de la recuperación de jugadores de voleibol para el regreso al entrenamiento tras los juegos

Resumen

El objetivo de este estudio fue evaluar el comportamiento del desempeño de salto vertical en judadores de voleibol profesional durante juegos y entrenamientos y su relación con fatiga y recuperación por medio de la variabilidad de la frecuencia cardíaca (VFC), calificaciones de esfuerzo percibido (RPE) y estado de recuperación percibido (PRS). Nueve atletas de voleibol profesionales participaron del estudio, con media de edad: 25,66 + 5,7 años, media de masa corporal: 97,81 + 8,65 kg y media de altura: 200,94 + 5,19 cm, con experiencia en competiciones nacionales e internacionales. La VFC y PRS fueran evaluadas en la mañana de los juegos y en la presentación para el primer día de entrenamiento tras los partidos. La RPE fue evaluada luego después del fin de los juegos y al fin de los días de entreno. Saltos fueron monitoreados durante los partidos y durante el primer día de entreno tras los juegos. Los dados fueron agrupados en juegos y sesiones de entreno. El nivel de significancia adoptado fue $\alpha < 0,05$. No hubo alteraciones en la VFC y PRS evaluados pre juegos y pre entrenos y en la RPE pos entrenamientos. La altura de los saltos fue mayor en los juegos ($p < 0,013$) y no hubo diferencias para el número de saltos. Hubo correlación positiva del número de saltos de juegos con la PRS antes de los juegos ($r = 0,336$, $p = 0,015$) y correlación negativa del número de saltos de entreno con la PRS pre entreno ($r = -0,318$, $p = 0,002$). Concluimos que el período de recuperación propuesto por el equipo se ha mostrado suficiente para los jugadores mantenerme la misma condición para el regreso a los entrenos. Y esta información ayuda preparadores físicos a planear las cargas de entrenamiento para el regreso a los entrenos.

Palabras clave:
Frecuencia cardíaca. Esfuerzo físico. Recuperación de función. Deportes.

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Introduction

Competitive periods require balance between training loads and appropriate recovery[1,2] in order to avoid an impairment in performance[3,4]. For monitoring athletes, the choice of simple and easy application methods that combine physical, psychological and physiological indicators seem to provide relevant information on training-load adaptation and recovery for teams[1]. Heart rate variability (HRV) and ratings of perceived exertion (RPE) and perceived recovery status (PRS) consist in assessment parameters of practical applicability and good accuracy.

HRV has been proving to be an important physiological marker for recovery patterns[5,6], able to provide important information on fatigue, adaptation and recovery[5,7–9], and also on pre-competitive anxiety and stress effects[10–12]. High HRV indicates signals of good adaptation, showing healthy and efficient autonomic mechanisms, and inversely, low HRV is an indicator of abnormal and insufficient adaptation of autonomic nervous system (ANS) and may indicate the presence of physiological malfunction[13,14]. HRV alterations allow clinical comparisons able to distinguish between parasympathetic and sympathetic chronic fatigue symptoms. Parasympathetic type is more frequently observed and is characterized by persistent rates of high fatigue, apathy, mood changes, intolerance for prolonged exercise, and sympathetic type seems to be more related with psychoemotional aspects of stress[15].

Specifically in volleyball, studies have not finding significant differences in HRV in evaluations performed before and after training periods[16–19]. On the other hand, after matches there were significant reductions in HRV indexes, due to increased physical demand in relation to the assessment conducted on the morning of match days[19]. Regarding the effects of pre-competitive anxiety and stress, D'Ascenzi *et al.*[20] showed that there were no significant differences in pre-competitive situations evaluated in the morning of matches and baseline values of training days. However, there is still no response on the recovery behavior of athletes after matches when returning to training.

The index, root mean square of the successive differences successive differences between adjacent RR intervals (RMSSD) is the most used of HRV indexes for monitoring athletes of different modalities and showing to be sensitive to alterations in training loads and physical requirements, being representative of parasympathetic system alterations[5,7–9]. The standard deviation of the NN interval (SDNN) index presents similar responses than RMSSD and represents overall variability, without differentiating between changes arising from sympathetic and parasympathetic systems[21–23].

Vertical jumps, for volleyball, appear as the biggest performance criterion, whose monitoring is of fundamental importance[24,25]. The performance of jumps, in a continuous and intermittent way, produces reduction of peak power, increased perceived muscle soreness, increased lactate concentration in the bloodstream, increased HR and decreased performance[26–28].

Among psychological parameters, RPE and PRS have been widely used for monitoring athletes[29–32]. RPE is useful for the assessment of physical stress, intensities prescription, monitoring of training loads and prediction of maximal capacity[31,33]. On the other hand, PRS was created to allow access to the individual recovery state, which is important for identifying decreases in performance associated with the athlete's feeling of not being recovered[34]. Both perceptions scales serve as complement to traditional physical assessments.

However we could not find studies that evaluated the recovery behavior of volleyball athletes for the return to training. Thus, in order to understand the alterations in fatigue levels that high-level competitions could trigger in volleyball athletes and how is the return to training behavior over competitive periods, this study aimed to evaluate the behavior of vertical jumps performance in professional volleyball athletes during matches and training sessions and their relationships with fatigue and recovery through HRV, RPE and PRS. Our hypothesis was that the physical demands of the matches would reduce HRV indexes and PSR, and increase the RPE in first training day after matches.

Material and method

Experimental approach

The purpose of this research was to evaluate the behavior of vertical jumps performance in professional volleyball athletes during matches and training days and their relationships with fatigue and recovery through heart rate variability (HRV), ratings of perceived exertion (RPE) and perceived recovery status (PRS). HRV and PRS were assessed in the morning of matches and in the presentation of the first training day after matches. RPE was collected immediately after matches and at the end of training days. Jumps performance was monitored during the matches and during the first training days (Table 1).

Table 1. Experimental design and procedures.

Matches (n 11)			First training after matches (n 11)		
Pre Matches	**Matches**	**Post Matches**	**Pre Training**	**Training**	**Post Training**
HRV (SDNN) (RMSSD) Perceptions of recovery (PR)	Height and number vertical jump	Perceptions of effort (PE)	HRV (SDNN) (RMSSD) Perceptions of recovery (PR)	Height and number vertical jump	Perceptions of effort (PE)

Heart rate variability (HRV), standard deviation of all normal-to-normal RR intervals (SDNN), square root of the mean of the squared differences between adjacent normal R-R intervals (RMSSD), number (n).

Subjects

Nine male professional athletes participated in the study, with mean age: 25.66 ± 5.7 years, mean body mass: 97.81 ± 8.65 Kg and mean height: 200.94 ± 5.19 cm. As inclusion criteria, the athletes should belong to a Brazilian high-performance volleyball team, they should have at least two years of experience in national and international competitions, to present a training volume of at least four hours per day, and should not present previous cardiac surgeries. Those athletes, who were not able to perform the tests proposed (by guidance of the team's medical department) and to participate in the competitions, had their data excluded.

The athletes read and signed the free and informed consent form that contained all pertinent information about the study. The study was approved by the Ethics Committee in Research of Federal University of Rio Grande do Sul (number: 2.622.441).

Procedures

Assessments were performed during the second phase of the Brazilian Volleyball Superliga, the country's most important competition of the modality. It included 11 matches and 11 training sessions in an 11-week period, with matches performed once to twice one to two times a week, recovery periods between matches and training days of 24h and 36 h. All matches occurred during the afternoon. Training sessions were composed by physical skills and techniques during the morning, and tactical and blocking trainings in the afternoon, with a total daily duration between 5 and 8 hours.

HRV and PRS collections were performed before matches, in the morning, at the moment of the athletes' presentation to the training. Performance variables, represented by mean jumps height and mean total jumps number, were collected during all matches and in the first technical, tactical and blocking training sessions that succeeded the matches. RPE was collected after matches and after the first training day subsequent to the matches.

Acquisition and analysis of HRV. All HRV assessments were performed following the same protocol. The subjects remained lying in a supine position for 5 minutes before the HRV collections started. R-R intervals were obtained using a heart rate strap (Polar H7, Kempele, Finland) during 5 minutes in supine position. Each athlete used a heart rate strap for the data collection and all athletes were assessed at the same moment. Assessments were performed in an environment without noise and external interference. Polar H7 Strap collects R-R intervals and does not require additional data processing[35]. R-R intervals values were analyzed in the time domain using the software Kubius HRV (Kubios HRV, Kuopio, Finland). The variables analyzed were: standard deviation of all normal-to-normal RR intervals (SDNN), root mean square of the successive differences between adjacent normal R-R intervals (RMSSD) and the logarithm of RMSSD index (LogRMSSD). SDNN and RMSSD indexes are represented in miliseconds (ms).

Vertical jumps. In the present study, the number of vertical jumps and the mean height of vertical jumps obtained during the matches and training sessions were considered as performance outcomes.

For data acquisition, an inertial measurement unit tool (VERT, Florida, EUA) was used, inserted in an elastic band at the waist height of athletes. This tool captures the average height of vertical jumps and the number of vertical jumps performed[36]. The data collected were immediately transferred to a smartphone via Bluetooth. The capture methodology of these variables was performed according to the study of MacDonald *et al.*[37]. All vertical jumps patterns that comprised matches and training sessions were captured for data analysis of performance.

PRS and RPE. Through the PRS scale used by Laurent *et al.*[34], the athletes' perceived recovery was evaluated. The athletes were asked to answer the following question: What is your perception of recovery at the moment? They should point their response on the scale, before matches and training starts. The scale has scores ranging from 0 to 10, in which 0 is equivalent to no recovery and 10 is equivalent to total recovery.

RPE assessment was collected using the CR-10 scale[38,39]. The athletes were asked to answer the following question: What is your perception of effort for today's match or training? They should point their response on the scale, after the end of matches and training. The scale indexes vary from 0 to 10, in which 0 is equivalent to no effort and 10 is equivalent to maximal effort.

Mean values presented by athletes in RPE and PRS scales were calculated for matches and training days. The athletes were previously familiarized with the scales, with at least two years of experience.

Statistical analysis

All data are presented as means and standard deviations. Normality of the data was confirmed with the Shapiro-Wilk test. The data were grouped in matches and training days. For the comparison between means of the games and training for the HRV indices, PRS and RPE paired t-test was used for the normally distributed data and Wilcoxon test was used for the non-normally distributed data.

In order to verify possible associations between variables, Pearson product-moment test was used for the normally distributed data and the Spearman's rho correlation test was used for the non-normally distributed data. Qualitative assessment of correlation coefficients considers from 0 to 0.30 small correlation, 0.31 to 0.49 moderate correlation, 0.5 to 0.69 strong correlation, 0.7 to 0.89 very strong correlation and from 0.9 to 1 perfect correlation[40,41]. Statistical tests were performed in the SPSS software version 22.0 (IBM, Chicago, USA).

Moreover, effect sizes (ES) were calculated to compare means of matches and training sessions by Cohen's d calculation[42,43]. Qualitative assessment considers <0.19 insignificant effect, from 0.20 to 0.49 small effect, 0.50 to 0.79 medium effect and from 0.80 to 1.29 large effect.

Results

Of the athletes evaluated, two were excluded from the study, one due to cardiac surgery and another due to injury. The data were grouped in matches and training days. The collected HRV, PRS and RPE data of athletes were used in the analysis when their data were also evaluated in the performance analysis. Thus, 48 subjects were analyzed for HRV data, 51 subjects were analyzed for PRS data and 61 subjects were analyzed for RPE data of matches and training sessions. For the performance data, all evaluations of athletes who had their data collected in the matches and training were considered, resulting in 70 subjects.

No differences were observed between HRV indexes before matches and pre-training moments (Table 2).

In the performance variables, the number of vertical jumps performed in matches and training sessions did not show differences. On the other hand, vertical jumps height was higher during matches when compared to training (Table 3).

There was no difference between the PR evaluated before matches and the PR evaluated pre-training. PE also showed no difference between post-matches and post-training (Table 4).

The correlation analyses showed that the number of jumps during matches presented moderate positive correlation with PR in pre-matches moment (r= 0.336, p= 0.015) (Figure 1 A). And the number of jumps during training presented moderate negative correlation with PR in pre-training moment (r= -0.318, p= 0.002) (Figure 1 B).

Table 2. Data evaluated in matches and training with mean ± standard deviation, p value and ES (CI) for HRV through SDNN index (ms), RMSSD index (ms) and LogRMSSD (natural logarithm of RMSSD index) evaluated in the morning of match days and in the moment of re-presentation of athletes for the first day of training after matches.

	n	Match	Training	p	Power	ES (IC)
SDNN (ms)	48	81.95±73.74	144.52±503.95	0.791[b]	0.203	0.17 (-0.23; 0.57)
RMSSD (ms)	48	76.53±69.14	98.81±172.99	0.359[b]	0.203	0.17 (-0.25; 0.55)
LogRMSSD	48	1.88±0.39	1.99±0.39	0.346[a]	0.314	0.17 (-0.25; 0.55)

[a]Student's t test. [b] Wilcoxon test. Heart rate variability (HRV), standard deviation of all normal-to-normal RR intervals (SDNN), square root of the mean of the squared differences between adjacent normal R-R intervals (RMSSD), logarithm of RMSSD (LogRMSSD), effect size (ES), confidence interval (CI) and number of subjects (n).

Table 3. Data evaluated in matches and training with mean ± standard deviation, p value and ES (CI), for the number of jumps performed in matches and technical and tactical training sessions and jumps height (cm) performed in matches and technical and tactical training sessions.

	n	Match	Training	P	Power	ES (CI)
Number of jumps	70	73.08±36.13	78.76±34.57	0.411[a]	0.374	0.16 (-0.19; 0.48)
Jumps height (cm)	70	56.39±10.30	54.53±9.04	0.013*[b]	0.334	0.19 (-0.14; 0.52)

*significant when p value ≤0.05. [a]Student's t test. [b] Wilcoxon test. Effect size (ES), confidence interval (CI) and number of subjects (n).

Table 4. Data evaluated in matches and training with mean ± standard deviation, p value and ES (CI), PR evaluated on the morning of match days and at the moment of re-presentation of athletes for the first day of training after matches, PE evaluated after matches and after the first day of training after matches.

	n	Match	Training	P	Power	ES (CI)
PR	51	7.47±0.58	7.71±1.04	0.461	0.481	0.28 (-0.16; 0.62)
PE	61	5.57±1.84	5.47±1.38	0.930	0.073	0.06 (-0.34; 0.37)

Perceived recovery (PR), perceived effort (PE), effect size (ES), confidence interval (CI), number of subjects (n).

Figure 1. A. Correlation of mean number of jumps during matches with mean PR previous to matches. B. Correlation of mean number of jumps during training with mean PR previous to training.

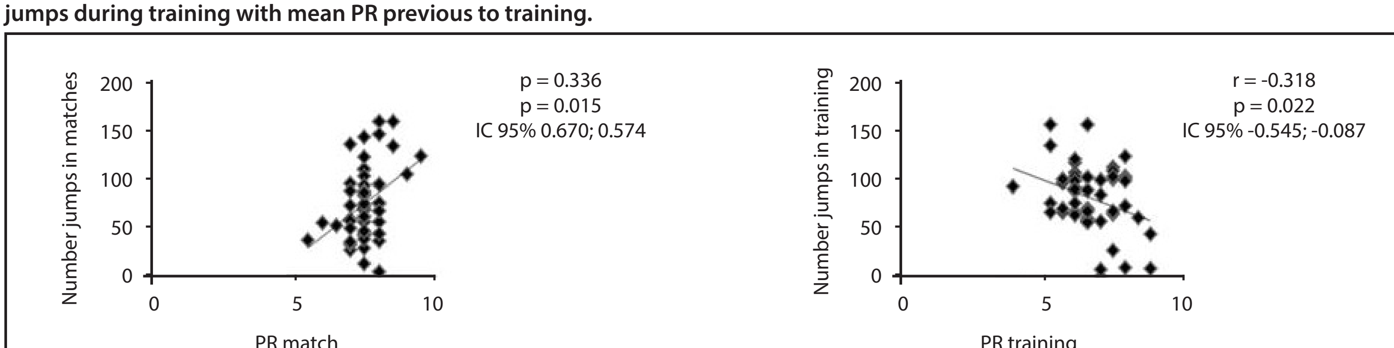

Table 5. Correlations data of mean number of jumps performed in matches and training and mean jumps height performed in matches and training with mean PR of matches and training and mean PE of matches and training.

	PR Matches	PR Training	PE Matches	PE Training
Number of jumps in matches	ρ =0.336 95%CI 0.670; 0.574 Power 0.837 p=0.015	r=0.099 95%CI -0.238;0.429 Power 0.130 p=0.484	r=0.038 95%CI -0.236; 0.294 Power 0.061 p=0.770	ρ =-0.035 95%CI -0.382; 0.223 Power 0.059 p=0.787
Number of jumps in training	ρ =0.077 95%CI -0,222;0.360 Power 0.097 p=0.585	r=-0.318 95%CI -0.545;-0.087 Power 0.790 p=0.022	r=0.047 95%CI -0.269;0.255 Power 0.067 p=0.717	ρ =-0.013 95%CI -0.334;0.213 Power 0.051 p=0.918
Jumps height in matches (cm)	ρ =-0.241 95%CI -0.464;0.022 Power 0.535 p=0.085	ρ =-0.160 95%CI -0.411;0.117 Power 0.267 p=0.258	ρ =-0.191 95%CI -0.445;0.158 Power 0.361 p=0.140	ρ =0.036 95%CI -0.264;0.283 Power 0.060 p=0.782
Jumps height in training (cm)	ρ =-0.036 95%CI -0.291;0.242 Power 0.060 p=0.800	r=-0.066 95%CI -0.386;0.246 Power 0.084 p=0.642	r=-0.249 95%CI -0.434;0.025 Power 0.563 p=0.053	ρ =0.073 95%CI -0.220;0.364 Power 0.092 p=0.575

r: from Pearson product-moment correlation test; ρ: from Spearman's rho correlation test.

Table 6. Correlations data of mean number of jumps performed in matches and training and mean jumps height performed in matches and training with mean SDNN index of matches and training, mean RMSSD of matches and training and mean LogRMSSD of matches and training.

	SDNN Matches	SDNN Training	RMSSD Matches	RMSSD Training	LogRMSSD Matches	LogRMSSD Training
Number of jumps in matches	ρ=-0.128 IC95% -0.409;0.152 Power 0.186 p=0.391	ρ=0.108 IC95% -0.222;0.416 Power 0.145 p=0.471	ρ=0.225 IC95% -0.046;0.509 Power 0.478 p=0.124	ρ=0.239 IC95%-0.062;0.477 Power 0.528 p=0.102	r=0.172 IC95% -0.054;0.388 Power 0.301 p=0.241	r=0.183 IC95%0.039;0.392 Power 0.335 p=0.212
Number of jumps in training	ρ=-0.108 IC95% -0.412;0.189 Power 0.186 p=0.468	ρ=0.142 IC95% -0.161;0.421 Power 0.145 p=0.339	ρ=-0.046 IC95%-0.319;0.239 Power 0.478 p=0.756	ρ=0.166 IC95% -0.138;0.424 Power 0.528 p=0.260	r=-0.028 IC95% -0.281;0.231 Power 0.301 p=0.852	r=0.-187 IC95% -0.067;0.419 Power 0.335 p=0.203
Jumps height in matches (cm)	ρ=-0.252 IC95% -0.020;0.505 Power 0.574 p=0.087	ρ=0.121 IC95% -0.182;0.409 Power 0.171 p=0.418	ρ=-0.049 IC95% -0.329;0.228 Power 0.068 p=0.741	ρ=-0.024 IC95% -0.298;0.256 Power 0.054 p=0.873	ρ=-0.054 IC95% -0.329;0.226 Power 0.073 p=0.717	ρ=-0.024 IC95% -0.298;0.256 Power 0.054 p=0.873
Jumps height in training (cm)	ρ=-0.130 IC95% -0.405;0.181 Power 0.191 p=0.383	ρ=-0.080 IC95% 0.431;0.241 Power 0.101 p=0.591	ρ=-0.182 IC95% 0.449;0.099 Power 0.332 p=0.214	ρ=-0.108 IC95% -0.439;0.207 Power 0.145 p=0.465	r=-0.131 IC95% -0.382;0.117 Power 0.193 p=0.373	r=-0.017 IC95% -0.338;0.303 Power 0.052 p=0.910

r: from Pearson product-moment correlation test; ρ: from Spearman's rho correlation test.

The other performance variables during matches and training presented small correlations with mean PR of matches and training and with mean PE of matches and training (Table 5).

The correlations of the performance variables were small with matches and training SDNN indexes, with matches and training RMSSD indexes and with matches and training LogRMSSD (Table 6).

Discussion

HRV and psychometric outcomes showing to be sensitive to the physical demands imposed to athletes during matches and training sessions[21–23]. In order to evaluate the recovery pattern of athletes when returning to training after matches, our findings demonstrate that there were no HRV alterations evaluated by SDNN, RMSSD and LogRMSSD indexes between the evaluations performed in the morning of the match days and in the morning of the first training days performed after matches, contradicting our hypothesis. Despite the higher jump heights during the matches in comparison to training sessions, but without difference in the number of jumps performed.

The literature shows that high-intensity exercises generate ANS alterations as acute response, generating reductions in HRV indexes. These reductions occur linearly to the intensity, and also alter post-exercise recovery responses[21–23]. studies show that in volleybal athletes, no HRV changes were found before and after training periods[16–18]. But after volleyball matches, reductions in HRV indexes were found when compared to baseline values, due to the physical demands imposed during matches[19].

Our study shows that after the proposed recovery period for the team to return to training, the possible changes in HRV indexes resulting from matches did not remain until the moment of the subsequent training session, despite the physical demands imposed to the athletes during matches are greater in comparison to training, evidenced by the greater means of vertical jumps height in matches.

Besides that the values found for SDNN and RMSSD indexes were very similar to the values showed for aerobically trained athletes[14]. According to the literature, low values of HRV indexes in athletes may represent fatigue conditions and incomplete recovery[9,17,19], which was not found in the athletes evaluated in our study.

Vertical jump is considered an extremely important element in volleyball[24,25,44,45]. In our study, the number of jumps did not show significant difference between matches and training, and the jumps height was greater in matches when compared to that performed in the first training day after matches.

The number of jumps performed was very similar to other study[2]. In addition, jumps height was greater than the values found after weeks of training, evaluated in maximal tests[46,47]. It is noteworthy that in maximal tests, jumps are performed in a controlled manner, and with a pattern defined by the objective of the study. In our study, all patterns were collected in the analysis of matches and training sessions.

The according to our hypothesis greater jumps height performed during matches may result in higher RPE after matches and may lead to reduced HRV indexes and PRS for presentation to training, according to our hypothesis. But these differences between matches and training sessions were not found. Such increase in jumps height during matches may be explained by motivational reasons, because matches are different from training due to the presence of opponents and the pursuit of victory[48].

The findings of RPE and PRS variables support the HRV findings, as significant differences were not found in these outcomes between matches and training. The athletes showed scores that represent a "strong" intensity for RPE of matches and training. The mean RPE found in our study was similar to the values found in the study of Horta *et al*.[2] which also evaluated the competitive phase. The study of Rodrigues-Marroyo *et al*.[49] shows mean RPE as "somewhat strong" score, but the volleybal athletes were evaluated during pre-competitive phase. In our study, mean RPE was higher and may be such difference is due to the phase evaluated, because in competitive phases the training is added to the volume of competitions.

Mean PRS presented scores that represent "very, very good recovery" for matches and training. We did not find other articles that have evaluated PRS in volleyball players. The authors who created the PRS that the importance of the this perceptions scale is to identify decreases in performance in low recovery situations[34]. The use of perception scales for high performance sports must be used along with other assessments, such as performance or physiological ones[1].

In order to verify the existence of associations between the performance variables with other outcomes, our study found moderate positive correlation between the number of jumps performed in the matches and the PRS evaluated on the morning of matches. It shows that in the morning of matches, when the athletes presented higher PRS scores, the number of vertical jumps performed in matches was greater. These findings corroborate Laurent *et al*.[34], creators of the PRS. The authors state that greater recovery levels lead to better performance rates[34].

Instead the number of jumps performed in training days presented moderate negative correlation with mean PRS evaluated in the morning of training days. It shows that higher PRS scores in the morning of training sessions resulted in fewer number of jumps performed during training. This finding contradicts the objectives of the PRS scale. It was expected that higher PRS scores would result in greater mean number of jumps. Motivational factors that differ training from matches may partially explain these findings[48]. Moreover, coaches' requirements may be lower in the first day of training after matches when compared to match days, although the recovery pattern of athletes remains very similar between matches and training.

In this way, the volleyball athletes evaluated did not present significant alterations between the evaluations performed on the morning of matches and on the day of re-presentation of these athletes to training, which demonstrates that the recovery period proposed by the team is enough to maintain the recovery rates for the return to training. The lack of differences between the two moments evaluated may be due to the athletes' high conditioning level, which leads them to present a high physical and psychological tolerance to matches and training loads.

Our biggest limitation was not having evaluated HRV after matches, in order to understand possible ANS alterations. In addition, the fact that we did not collect all variables in all athletes at the same moment, which resulted in different number of subjects, a situation caused by the conduction of collections with minimal interference in the team routine. Strengths of our study are to have evaluated 11 matches and 11 training sessions in an 11-week period with high levels of volleyball performance.

Practical applications

Monitoring recovery patterns help coaches and physical trainers to better prescribe training. And if necessary, to alter recovery periods or training loads to improve the physical conditioning of athletes and to avoid chronic fatigue and possible overtraining.

Compliance with Ethical Standards

The study was approved by the Ethics Committee in Research of Federal University of Rio Grande do Sul (number: 2.622.441).

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Conflict of interest

The author do not declare a conflict of interest.

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