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Psychophysiological responses during the microcycle with the start of the national championship: A case study of a volleyball team

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Abstract The aim of the study was to monitoring psychophysiological responses among volleyball players in the microcycle with a high-performance competition game scheduled. Methods: Ten male athletes (26.6 $\pm$ 5.3 years) from an adult volleyball team participated in the study. The variables session Rating of Perceived Exertion (Session RPE), Total Quality of Recovery scale (TQR), Well-being questionnaire (WB), testosterone, cortisol, and testosterone/cortisol Ratio (T:C ratio) were evaluated during the microcycle before the game. Results: Differences were observed in the daily training load ($F = 23.776$; $p < 0.001$), TQR ($F = 10.687$; $p < 0.001$), WB ($F = 6.736$; $p < 0.001$), cortisol ($F = 8.253$; $p < 0.001$) and T:C ratio ($F = 3.862$; $p = 0.01$). Conclusion: The behavior of the variables fluctuated with factors such as training load, number of training days and time off, and due to the psychophysiological stress of the match.

Introduction

Volleyball is a sport with an intermittent characteristic, with short periods of high intensity, composed of small displacements and vertical jumps, interspersed with moments of low intensity.[1] In Brazil, the central Championship (Superliga) is played throughout 5 to 6 months, with games once or twice a week, including travel.[2] Therefore, monitoring these athletes is important to maintain performance and also avoid negative training adaptations.[3]

Accordingly, appropriate periodization with the quantification of loads and recovery, and control of the psychophysiological responses of the athletes is designed to obtain the best performance.[4] Thus, the use of subjective and

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objective methods for control and quantification of the internal training load, as well as the state of recovery are important to monitor the athletes throughout the season and prevent negative outcomes of the training.[5] Subjective markers are used in several studies because they are simple, easy to implement, and have a low cost.[6] The session Rating of Perceived Exertion (RPE-session), is a tool widely used in team sports, including volleyball[2,7,8] for monitoring the training load, as well as the Total Quality Recovery (TQR) and wellbeing scale, simple tools for monitoring recovery, demonstrating a relationship with the applied training load.[9,10]

Throughout the season, athletes are subjected to different types of stress, physical and psychological, causing physiological responses, such as changes in cortisol, a hormone secreted during stressful situations, found in saliva, serum (blood), and urine, so that it can be collected by non-invasive methods.[11] Thus, this hormone can be used as a marker of psychophysiological stress.[12]

During the competitive period, some studies have demonstrated the behavior of variables such as recovery and training load (TL) in volleyball, during the competititve period.[8,10] However, despite the knowledge regarding the behavior of these variables in the competitive period, some psychophysiological responses of athletes in specific moments of this period, such as during the opening week of a national competition, still need to be further investigated. Thus, the study aimed monitor the psychophysiological responses of the athletes during the microcycle, in the competitive period, with their beginnings in the national volleyball championship.

Methods

Participants

The sample comprised 10 male athletes who were members of a professional volleyball team that plays in the Brazilian Volleyball Supper League (26.6 ± 5.3 years, 95.6± 8.0 kg, 197.0 ± 7.9 cm, and 7.3 ± 1.6% body fat). The study was approved by the Institutional Local Ethical Committee of Federal University of Juiz de Fora-MG, Brazil (protocol number, 1.300.342), and all subjects signed an informed consent form of their voluntary participation in the study. No subjects were below 18 years of age.

Study design

The study was conducted during the microcycle, in the competitive period. The athletes started the microcycle after 3 days of rest, with an official match of Superliga scheduled at the end of the microcycle. The variables session Rating of Perceived Exertion (Session-RPE), Total Quality Recovery (TQR) and Well-Being Questionnaire (WB) were collected daily, with the exception of the fifth day when there was no training session. The saliva sample was collected on the first, fourth, sixth, seventh, eighth and ninth days. The description of the training plan and the volume during this period is shown in Table 1.

Internal training load

The internal training load monitoring was measured using the Session-RPE method. Approximately 30 min after the end of each training session, athletes answered the question "How was your training?" based on the Borg CR10 scale adapted by Foster et al. 2001,[13] which ranges from 0 (rest) to 10 (maximum). The Session-RPE was calculated by the product of the intensity (perceived, based on the scale) and volume (total session time in minutes), generating a value in arbitrary units (AU). On the fifth day of the microcyle, there was no training session. Thus, the value of the training load on that day was zero.

Recovery Status

To monitor the recovery state, the TQR scale was used. Before each training session athletes answered the question "How do you feel about your recovery?", based on the scale proposed by Kentta and Hassmen 1998,[14] in which 6 corresponds to "Not recovered" and 20 indicates "Completely recovered." This scale was proposed to evaluate general recovery.

To evaluate the subjective perception of fatigue, sleep quality, general muscular pain, stress level, and mood, the WB proposed by McLean, Coutts et al., 2010[15] was used, based on the recommendations of Hooper and Mackinnon 1995.[16] This is a psychometric questionnaire in which the five parameters mentioned above are evaluated on a scale ranging from one (worst values) to five (best values) points, and each of these values is accompanied by a specific descriptor of the item evaluated. The total sum of all values is considered to evaluate the Total Well-Being. Before each training session, the athletes filled the questionnaire. On the fifth day of the microcyle, there was no training session. Thus, recovery and well-being were not evaluated.

Procedure for collecting and analyzing the saliva samples

The saliva samples were collected at rest, after the athletes woke up from sleep. The subjects were prevented from consuming food and caffeine products for at least 2 hours before saliva collection. Saliva was collected naturally without stimulation for 5 minutes in 15 mL sterile tubes. The saliva samples were refrigerated at 0 to 10°C until testing.

The testosterone and cortisol were determined, each in duplicate, using the immunosorbent assay (Salimetrics ©, EUA) bound to the enzyme according to the manufacturer's instructions. The testosterone-to-cortisol ratio (T:C ratio) was calculated from these data.

The days for saliva collection were chosen because they are days when the athletes return after a break (first and sixth days), the day before the break (fourth day) and the day of the game (eighth day) and the day following the game (ninth day).

Statistical analysis

The results are presented as mean ± standard deviation. To test the difference in variables at the moments analyzed during the training period, repeated measures ANOVA was used. When statistically significant differences were detected,

Table 1 Description of training plan and volume in minutes.

Training	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9
Block	60					60			
Defense		60					60		
Serve-Receive	30	30	30	20		40	20	40	30
Tactical	80	70	80	65		85	60		50

repeated contrast analysis was performed. The analysis of the F statistic was performed from the Pillai trace. The assumptions of normality and sphericity of the variance-covariance matrix were evaluated by the Kolmogorov-Smirnov test and by the Box M test respectively. When sphericity was violated, Huynh-Feldt's Epsilon correction factor was used. The effect size (ES) was calculated using the partial Eta-squared method. it has been suggested that an effect size of 0.1 represents a small effect size; 0.25 a medium effect; and 0.4 a large effect.[17] All analyzes were performed using the SPSS statistical software version 20.0 (IBM Corp., Armonk, NY), with a significance level of 5% ($p \leq 0.05$).

Results

Statistically significant differences were observed in TL over the microcycle (F= 23.776; $p < 0.001$; ES= 0.72). As shown in Fig. 1, there was a consecutive reduction in the TL from the first to the third day of training, followed by maintenance of the load on the fourth day. Subsequently, there was a significant increase in the TL on the sixth day, followed again by a consecutive reduction in the load on days 7 and 8.

Regarding recovery, statistically significant differences were observed in TL over the microcycle (F= 10.687; $p < 0.001$; ES= 0.54). there was a decrease from the first to the fourth day of training (Fig. 1). On the sixth day, there was a return of the recovery values close to the values on the first day of training, followed by a drop on the seventh day, which was sustained until the ninth day. In the WB score, statistically significant differences were observed over the microcycle (F= 6.736; $p < 0.001$; ES = 0.42). As shown in Fig. 1, there was a drop in WB from the first to the fourth day of training. On the sixth day of training, there was a return of the values of WB close to the values on the first day of training, followed by a drop on the seventh day, which was sustained on the eighth day, followed by another drop on the ninth day of training.

As for the hormonal variables, there were statistically significant differences in the cortisol levels over the microcycle (F= 8.253; $p < 0.001$; ES= 0.42). There was an increase in the cortisol levels from the sixth to the eighth day ($p = 0.002$) and a decrease in the levels from the eighth to the ninth day ($p < 0.001$) - Table 2. The cortisol values on the first and ninth days were similar. No statistically significant differences were observed in the testosterone levels over the seven days of training (F= 1.555; $p = 0.20$; ES= 0.24). Statistically significant differences in the T:C ratio were also observed over the seven days of training (F= 3.862; $p = 0.01$; ES= 0.29). An increase in the T:C ratio was

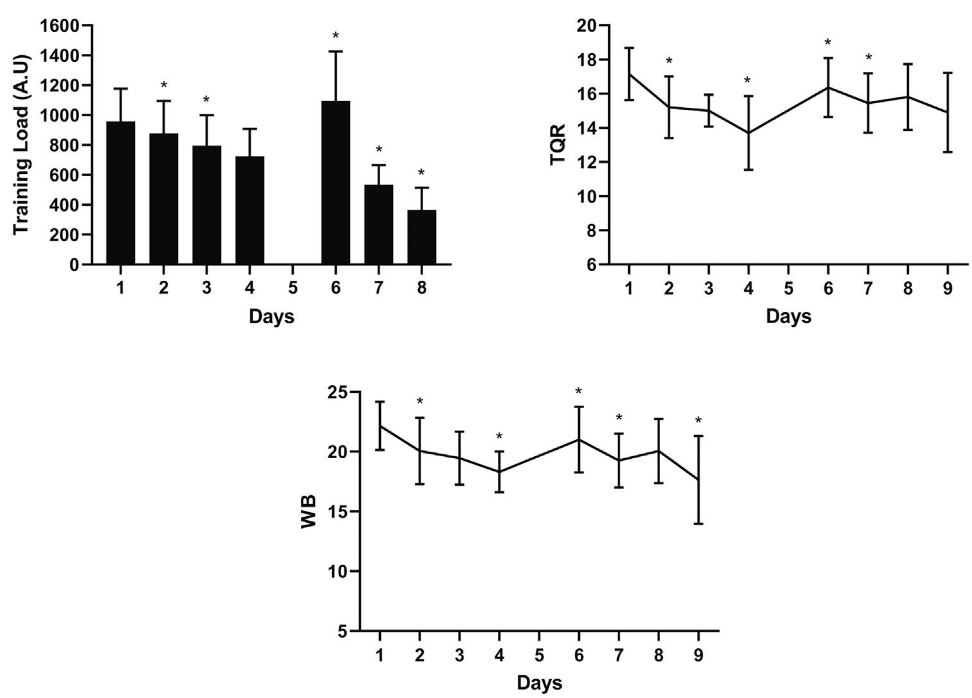

Fig. 1 Mean ± standard deviation of the daily training load (A), Total Quality of Recovery (TQR) (B) and Well-Being (WB) (C) during the evaluated period. * Difference from the previous measure.

Table 2 Mean ± standard deviation of cortisol and testosterone and testosterone: cortisol ratio during the evaluated period.

Variables/Days	1	4	6	8	9	Effect size
Cortisol (nmol/L)	6,74±3,74	8,45±2,3	8,76±2,51	11,46±2,64*	5,58±1,53*	0.42
Testosterone (pg/ml)	123,26±43,1	136,1±25,8	139,87±46,41	161,1±48	130,3±25,3	0.24
T:C ratio	23,33±11,73	17,5±6,34	16,9±7,1	14,2±3,7†	24,7±7,1*	0.29

* Difference from the previous measure.
† Difference from day 1.

observed from the eighth to the ninth day ($p = 0.004$), although the values observed on the ninth day were not statistically different from those on the first day of training.

Discussion

The purpose of this study was to monitor hormonal status, internal training load and recovery in volleyball during the competitive period, specifically during the microcycle, with the start of the national volleyball championship.

During this period, there was a significant reduction in the TL from the first to the third day of training and also a reduction in the TL from the sixth day until the day of the game. This reduction in TL with the approach of the game has also been reported in volleyball[10] and also in other sports,[15,18,19] and aims to prevent the build-up of fatigue and negative consequences on the performance of athletes. The high TL on the fifth day of training was because the athletes had returned after a day off, and 72 hours after the match the team was scheduled to play in a new match away from home. The high TL is to compensate for the training missed during the microcycle to maintain their physical performance. In a study with basketball athletes, the daily TL was intensified at least one day, both in weeks with 1 or 2 games.[18] The TL results demonstrate how the training days were used in the microcycle, but there are other forms of organization depending on the number of matches and also trips that may occur.

The results of the variables in TQR and WB showed similar behaviors, with a reduction over the 4 days of training, although there was a decrease in TL over the same days, indicating a build-up of fatigue. There was a significant reduction on the seventh day, due to the magnitude of the TL on the previous day. Thus, TQR and WB appear to be sensitive to the TL during the training process. Our results are in line with those reported by Horta et al., 2020[9] and Buchheit et al., 2013,[20] which demonstrated the sensitivity of both TQR and WB with variations in TL. After the match on the ninth day, there was a significant drop in the WB, although the match load was not high on the other days, indicating that the match is not just limited to the physical stress, but other factors also contribute to a decrease in the athletes' recovery, such as psychological stress, tension, the pressure of results, and changes on the sleep patterns.

In this sense, the trend in cortisol levels throughout the microcycle could explain the psychological stress imposed on athletes, for example the competition[21] and the pressure of an official game.[22] Another factor that might have contributed to the change in cortisol levels was that the team played at home; Carré et al., 2006[23] showed an increase in cortisol levels before games played at home. Additionally, the team had its opening game in the main national championship at home, possibly causing another stress factor. Thus, in the presente study cortisol proved to be an important marker of psychophysiological stress.

Testosterone did not show significant differences over the analyzed period; the TL during this period did not cause significant changes in the testosterone levels indicating that this hormone was not sensitive for the monitoring of TL in this situation. Other studies have also found no significant changes in testosterone levels; however, it was evaluated during the period of intensification of TL and there were no games scheduled during the period.[24,25] The reduction in the T:C ratio over the microcycle is due to the increase in cortisol, and showed a significant increase on the ninth day due to a significant drop in cortisol after the game; the T:C ratio is associated with cellular catabolism and anabolism.[26]

This study provides information about the micorcycle in a volleyball team with an official match, in the debut in a national competition. Although other microcycles can be organized differently due to the presence of a match away from home or two games in the same period. However, this paper presents information about physiological and recovery variables during the microcycle of the game and demonstrated that the preparation of athletes for the game should not only focus on physical and sports performance. Some of the limitations of this study and aspects that must be considered in future studies are evaluating these variables over the entire competitive period, comparing to other microcycle during this period, and including other performance tests and more physiological variables.

Conclusions

In conclusion, the results of this study demonstrated that the training load, TQR, WB, CMJ, cortisol, and T:C ratio were influenced by factors that are part of a professional team's routine, such as the number of training days and time off, and also the psychophysiological stress that an official match imposes on the athletes. In comparison, testosterone did not change during this period. Future studies should compare the behavior of these variables in microcycleswith one and two games.

Conflicts of interest

None.

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