

Is the internal training load different between starters and nonstarters volleyball players submitted to the same external load training? A case study

A carga interna de treinamento é diferente entre atletas de voleibol titulares e reservas? Um estudo de caso.

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Abstract – The same training stimulus can provide different physiological adaptations for athletes of the same team. Thus, the aim of this study was to analyze and compare the load training of starters and nonstarters players, athletes of a men's volleyball team at different times of the season. The sample consisted of fifteen men's volleyball superleague athletes who were divided into two groups of starters and nonstarters players. The training load of the ten weeks of the team's preparation period for the main championship season in which no games were performed was selected for the study. The method of subjective perceived of effort (session-RPE) proposed by Foster et al. (2001) was used to quantify the training load. The group of starters players had higher total weekly training load (TWTL) and RPE values in the average of the ten weeks of training ($p < 0.05$). Higher TWTL values for starters players in the preparatory and pre-competitive period compared to nonstarters players was also demonstrated ($p < 0.05$). When different weeks were analyzed separately, weeks three and seven presented higher TWTL and RPE values for starters players compared with nonstarters players ($p < 0.05$). The results presented in this study showed that starters players showed greater internal training load compared to nonstarters players.

Key words: Athletes; Training; Volleyball.

Resumo – O mesmo estímulo de treinamento pode proporcionar diferentes adaptações fisiológicas para os atletas de uma mesma equipe. Dessa forma, o objetivo do estudo foi analisar e comparar as cargas de treinamento de atletas titulares e reservas de uma equipe de voleibol masculino em diferentes períodos da temporada. A amostra foi composta por quinze atletas da superliga masculina de vôlei que foram divididos em dois grupos de titulares e reservas. A carga de treinamento de dez semanas pertencentes ao período de preparação da equipe para o campeonato principal da temporada em que não houve a realização de jogos foi selecionada para o estudo. Foi utilizado para a quantificação da carga de treinamento o método da percepção subjetiva do esforço da sessão (PSE) proposto por Foster et al. (2001). O Grupo titular apresentou maiores valores de carga de treinamento semanal total (CTST) e de PSE na média das 10 semanas de treinamento ($p < 0,05$). Foi demonstrado também maior valor de CTST para os titulares no período preparatório e competitivo em relação aos reservas ($p < 0,05$). Quando as diferentes semanas foram analisadas separadamente, a semana 3 e 7 apresentaram a CTST e a PSE maiores para os titulares comparado com os reservas ($p < 0,05$). Os resultados apresentados pelo presente estudo mostraram que atletas considerados titulares apresentaram maior carga interna de treinamento em comparação aos atletas considerados reservas.

Palavras-chave: Atletas; Treinamento; Voleibol.

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INTRODUCTION

Volleyball is an intermittent sport modality with moments of explosive effort interspersed with short periods of recovery^{1,2}. From the start of the rally with the service until the end of it, there is an average period of 4 to 10 seconds³. Considering the limited size of the volleyball court⁴, players cover relatively long distances during a game, reaching 1757 ± 462 meters in a 4-set game. These efforts are manifested through short high speed races, dives and jumps in different directions of the game court, requiring high demand of the neuromuscular system¹. With these actions occurring repeatedly throughout the game with an average duration of approximately 90 minutes, the volleyball athlete needs to have well-developed anaerobic alactic system through the ATP-CP system, as well as a good development of the aerobic oxidative system¹. Thus physical fitness, components such as velocity, agility, power of lower and upper limbs and also maximal aerobic power, are of fundamental importance for volleyball athletes².

Positions in volleyball are defined by setters, right side hitters, outside hitter (opposite), middle blocker and libero, with each of the positions having specific functions and movements during the game⁵. Sheppard et al.¹, for example, identified different frequencies of attack and block jumps per set in Olympic and International level volleyball games, as well as anthropometric differences between athletes of different functions. Despite the differences manifested by each position in volleyball, athletes generally present high stature and considerable body mass, with the majority presenting ectomorphic traits as a body characteristic of somatotype⁶.

Thus, for volleyball athletes to be in optimal conditions for the performance of their functions, the process of systematic training and monitoring of activities is of fundamental importance to achieve sporting success⁷. As in other sporting modalities, monitoring volleyball training loads is critical to assessing the consistency of planned and executed loads. According to Impellizzeri et al.⁸, the external load is the prescribed training (time, distance traveled, number of jumps, speed) and internal load is the psychophysiological effort of the athlete to perform a certain external training load (heart rate, rating of perceived exertion, lactate concentration). In this sense, internal load monitoring can promote positive effects (increase in performance) and reduce negative effects (fatigue, nonfunctional overreaching, and injuries).

Recently, different methods have been proposed for the monitoring of training loads in collective sports such as: heart rate monitoring; lactate blood concentration; monitoring of the distance traveled by GPS (global positioning satellite system) and accelerometers; rating of perceived exertion^{3,9,10,11}. However, some of the aforementioned training monitoring methods may not be practical to use in a daily training routine. In this sense, the rating of perceived exertion (session-RPE proposed by Foster et al.¹²) stands out as a simple and practical method to monitor the internal training load, and may be an alternative to methods that require high-cost electronic equipment or invasive methods such as blood collection¹³.

This method has been studied in collective sports^{7,14,15,16} and is valid for monitoring the internal load in volleyball athletes^{14,16,17}.

Basically, session-RPE represents a subjective measurement evaluation after the exercise session, which reflects the psychophysical response generated and stored in the central nervous system, due to the efferent neural impulses coming from the motor cortex^{12,18,19}. RPE can also be defined as a conscious sensation of task intensity, with sensory activation of some areas of the brain related to proprioception, pain and thermal discomfort²¹. Recent studies have investigated factors that may be directly related to the rating of perceived exertion, such as number of motor actions, techniques and specific characteristics of some sports modalities^{17,22}.

A peculiar characteristic of collective sports is the division of teams in relation to being starters or nonstarters players. From games and training sessions, a starter team is formed, with only occasional changes occurring throughout the season²²⁻²⁵. The search for a place in the starters team can promote an internal competition during the training and games of the competitive season to consolidate the position in the starters team. This can cause athletes from the same team to perform the same external training load with different effort. Kraemer et al.²⁵ identified differences between starters and nonstarters players and reported that there are few research studies between starters and nonstarters soccer players regarding physiological and performance parameters. In another study, Caterisano et al.²² also identified differences between starters and nonstarters basketball players. According to the authors, a possible explanation for these results would be related to differences in the time of exposure to games of the season by starters and nonstarters players^{22,25}.

This makes us think if there is any difference in the rating of perceived exertion of the training session by players who gain the position of starters compared to the other players of the team. Factors such as physical fitness level, psychophysiological status and stress tolerance associated with the way the athlete manages to deal with stressors inherent to training are also identified as possible influencers of the internal training load²³. Moreover, factors such as the team's characteristic, opponent's level, player's position, technical ability and specific abilities are analyzed by coaches at the moment of defining the first team²⁴. Thus, the aim of the present study was to analyze the training loads of starters and nonstarters players of a male volleyball team and compare these groups in different periods of the season.

METHODOLOGICAL PROCEDURES

Sample

This study included 15 male high-performance volleyball athletes participating in the Men's Volleyball Superleague, the most important competition of the sport modality in the country. The team was composed of 2 setters, 4 right side hitters, 5 middle blockers, 2 opposites and 2 liberos. These athletes have played in official competitions for at least five years.

Athletes were divided into two groups: starters players (7 players aged 25.9 ± 3.8 years, 100.8 ± 9.8 kg, 194.0 ± 5.8 cm and $8.0 \pm 1.4\%$ fat) and nonstarters players (8 players aged 23.1 ± 3.1 years, 93.4 ± 8.0 kg, 194.6 ± 7.7 cm and $6.0 \pm 2.0\%$ fat). The study was approved by the local Ethics Committee under opinion No. 036159/2013. The athletes attested the voluntary participation allowing the use and disclosure of information.

Procedures

On the first day of the training season, athletes were submitted to medical and anthropometric evaluation. The first training activity occurred the next day consisting of resistance training with weights and specific technical training in the volleyball court. Monitoring of the training load began on the same day after familiarization with the method. These athletes were monitored during the initial 20 weeks of training using the Session Rating of perceived exertion (session-RPE) method proposed by Foster et al.¹². Among these 20 weeks, 10 were excluded, having as criterion the existence of friendly and official games (state and regional championships), and the team performed a total of 24 games in the analyzed period. In this way, 10 weeks were selected (W1, W2, W3, W4, W5, W7, W13, W14, W15 and W19) where only training sessions occurred.

During weeks from W1 to W5, the starters team was not defined. This period was planned and defined as preparatory. From W6 week, when the team began to participate in games (competitive period), the starters team was defined. Thus, data analysis during all 10 weeks, stratifying starters and nonstarters players, was based on the athletes' position from week W6.

Athletes who started matches in more than 65% of the games played were considered as a criterion for definition of the starters team. Athletes who had less than 65% of the games played as starters were considered nonstarters players. It is important to point out that of the seven starters athletes, four of them achieved a percentage of 80% of games in the analyzed period with the other starters athletes having lower percentages but over 65% of the total games played.

Training program

The training program was designed and implemented by the technical committee throughout the season and aimed at developing hypertrophic strength (FH) / pure strength (FP), power (P), speed / agility (S / A) and technical and tactical skills (STT). Strength and power training sessions were performed using weight-lifting exercises and functional exercises that approached the demands of the sport. As an example, vertical jump and deep jump exercises aimed at the development of the jump power highly demanded in volleyball. For the training of speed and agility, exercises of short displacements, characteristic of the modality, were carried out with intervals and at high intensity. Specific ball exercises (serving and passing, blocking, defense, attack precision), simulated and collective games were used to develop technical and tactical skills. An overview of the training

program and the spatial distribution of the different objectives over the two periods analyzed, as well as the number of games performed during the competitive period, are shown in Table 1.

Table 1. Training description in the period analyzed

Training activities									
Preparatory period					Competitive period				
Training weeks with no games									
W1	W2	W3	W4	W5	W7	W13	W14	W15	W19
TT	TT	TT	FUN	TT	TT	TT	TT	TT	FUN
CORD	FUN	FUN	F/H	FUN	FUN	FUN	FUN	FUN	S/A
R/F	CORD	F/H	ABI	F/H	F/P/M	F/H	S/A	S/A	F/P/M
ABI	F/H	ABI	TEC	ABI	POW	R/A	F/H	F/H	R/E
TEC	ABI	TEC		TEC	ABI	ABI	R/E	R/E	TEC
	TEC			TAT	TEC	TEC	ABI	TEC	TAT
					TAT	TAT	TEC	TAT	
							TAT		
Training weeks with games / Competitive period									
W6	W8	W9	W10	W11	W12	W16	W17	W18	W20
FUN	FUN	FUN	FUN	S/A	S/A	TT	TT	FUN	S/A
F/P/M	S/A	S/A	F/P/M	F/P/M	R/F	FUN	FUN	S/A	F/P/M
ABI	POW	F/P/M	POW	TEC	POW	S/A	S/A	F/H	POW
TEC	TEC	POW	TEC	TAT	TEC	F/H	F/H	R/E	TEC
TAT	TAT	TEC	TAT		TAT	R/E	R/E	TEC	TAT
		TAT				TEC	TEC	TAT	
						TAT	TAT		
4G	2G	2G	2G	2G	2G	2G	2G	2G	5G

W = week; TT = tests; CORD = coordination; R / F = force resistance; HAB = ability; TEC = technical; FUN = functional; F / H = hypertrophic force; TAT = tactical; F / P / M = pure / mixed force; POT = power; R / A = aerobic resistance; S / A = speed / agility; R / E = special resistance; G = game.

Training load quantification

In order to quantify the internal training load of Starters and Nonstarters teams, the rating of perceived exertion (RPE) method was used. This method consists of responding 30 minutes after the end of the session to the following question: “How was your training session?” The response is provided through the CR10 scale proposed by Borg in 1982 and modified by Foster et al.¹⁹, which ranges from 0 (rest) to 10 (maximum effort). According to Foster et al.¹⁹, athletes respond in relation to their rating of perceived exertion by pointing to a number and descriptor in the scale. The value answered by athletes was then multiplied by the total net duration of the training session, thus reflecting the session training load in arbitrary units (AU). On days that presented two training shifts, the training loads were added, obtaining, thus, the daily training load (DTL). On days when there were no training sessions, DTL was considered zero. In all weeks, composed of seven days, the total weekly training load (TWTL) was calculated from the sum of the DTL of these weeks. The total weekly training load (TWTL), the rating of perceived exertion of the session and the training weeks, as well as the volume of training sessions were recorded for starters and nonstarters players separately for later analysis of possible differences in the internal training load.

Statistical analysis

Data were presented as mean \pm standard error. Assumptions of normality and homoscedasticity of data were evaluated by the Shapiro-Wilk test and the Levene test, respectively. Once the parametric assumptions were met, the difference of TWTL means between starters and nonstarters players was tested using one-way ANOVA of repeated measurements, followed by the multiple comparisons of means with Bonferroni correction. To detect in which weeks differences occurred, Student's t-test for independent samples was used. The difference of RPE means and training volume separately between starters players and nonstarters players was also tested using ANOVA for repeated measures. The effect size was calculated by Cohen's d. All analyses were performed using SPSS software v.19 (SPSS Inc, Chicago, IL), considering significance level of 5% ($p \leq 0.05$).

RESULTS

In the analysis of the 10 training weeks, a significant effect was observed for the repeated measure factor ($F_{9,117} = 24.781$, $p < 0.001$) and for the factor being starters player or not ($F_{1,13} = 6.625$, $p = 0.02$). The behavior of TWTL of the 10 weeks analyzed in the study is presented in figure 1. Over the 10 weeks, starters players presented higher TWTL when compared to nonstarters players (4.132 ± 140 vs. 3.636 ± 131 AU, $p = 0.02$, $TE = 3.66$). In the multiple comparisons of means, there was a significant interaction between starters players and nonstarters players in the week 3 of the preparatory period and in the week 7 of the competitive period (Figure 1).

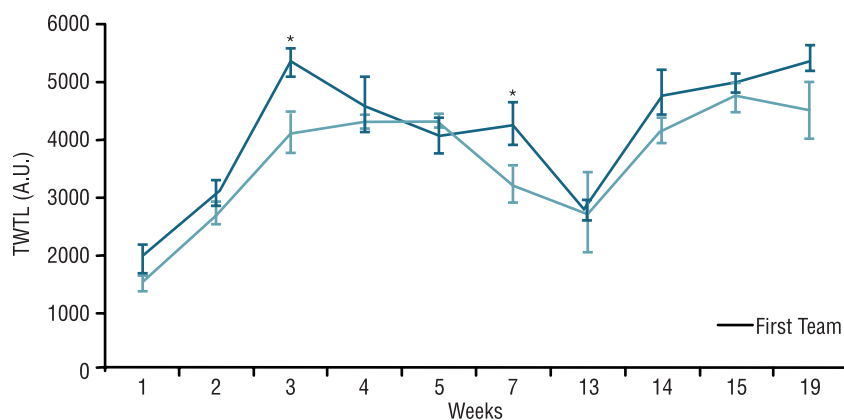


Figure 1. Mean \pm standard error of the total weekly training load (TWTL) of starters (First Team) and nonstarters athletes over 10 weeks of training. * Significant difference between starter and nonstarters players ($p < 0.05$).

In the 10 weeks analyzed, starters and nonstarters players did not present significant difference in the training volume (814.6 ± 11.9 vs. 809.0 ± 11.1 minutes, $p = 0.73$), but in relation to RPE, starters athletes presented significantly higher RPE values when compared to nonstarters athletes (5.6 ± 0.19 vs. 4.9 ± 0.18 ; $p = 0.02$; $TE = 3.56$), (Figure 2).

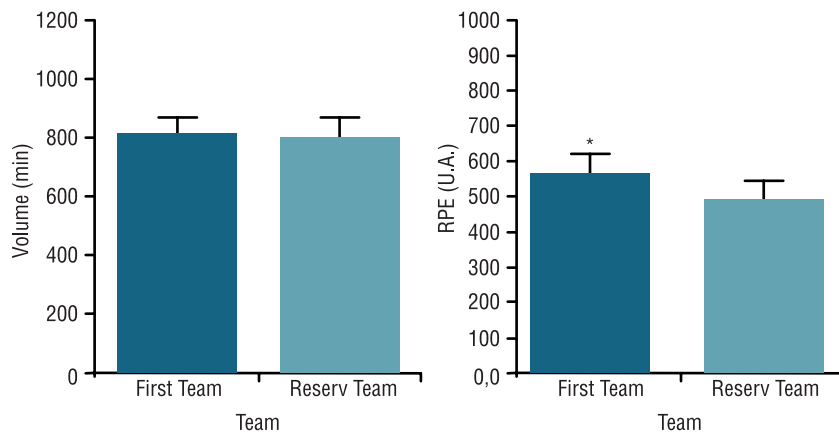


Figure 2. Mean \pm standard error of the volume (minutes) and RPE of sessions of starters players (First Team) and nonstarters players (Reserv Team) during the 10 weeks of training analyzed. * Significant difference between starters and nonstarters players ($p < 0.05$).

On average, higher internal load values were observed for the first team when compared to reserve team both before the definition of the starters team (Week 3: 5.370 ± 320 vs. 4.130 ± 300 AU) and after the definition (Week 7: $4,277 \pm 354$ vs. $3,232 \pm 331$ AU). It is interesting to note that even before the definition, training period prior to week 6, the week that started the team's competitive period, athletes who later came to be considered starters presented higher training load values compared to athletes considered as nonstarters players, as shown in Figure 1.

In the analysis of the preparatory and competitive period, a significant effect was observed for the repeated measure factor ($F_{1,13} = 12.364$, $p = 0.004$) and for the factor being starters player or not ($F_{1,13} = 6.625$, $p = 0.02$). There was no significant interaction between weeks and being starters player or not ($F_{1,13} = 0.268$, $p = 0.61$). On average, starters players presented higher TWTL values in relation to nonstarters players in the preparatory period ($3,806 \pm 503$ vs. $3,393 \pm 284$ AU) and in the competitive period ($4,460 \pm 528$ vs. $3,879 \pm 617$ AU) (Figure 3).

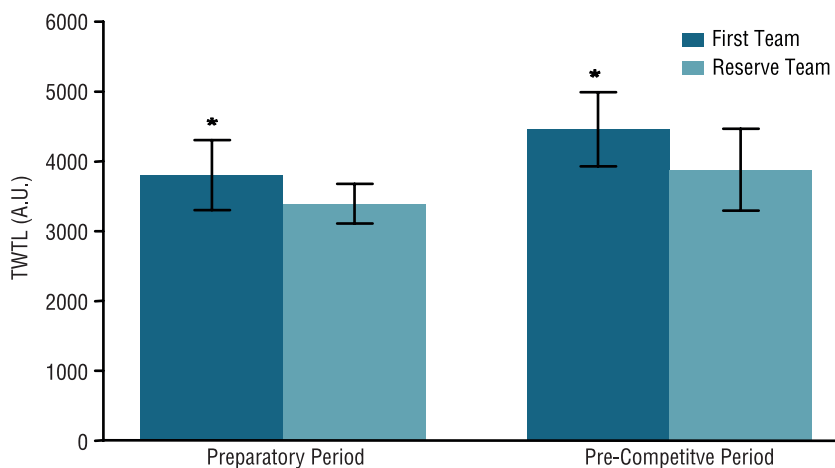


Figure 3. Mean \pm standard error of the total weekly training load (TWTL) of male starters (First Team) and nonstarters (Reserve Team) volleyball players during the preparatory and competitive period. * Significant difference between starters and nonstarters players ($p < 0.05$).

DISCUSSION

The main aim of the present study was to analyze the behavior of the internal load between starters and nonstarters players in the routine of high-performance volleyball training. It was found that starters athletes presented higher internal training load when compared to the group of athletes considered nonstarters players. This finding is reinforced by the fact that athletes received the same external training load over the weeks. In a way, this result corroborates the findings of other researchers, since athletes receiving the same external training load may present different internal loads⁸. When comparing TWTL between starters and nonstarters players, respectively, in the two periods analyzed, Preparatory (3.806 ± 503 vs. 3.393 ± 284 AU) and Competitive (4.460 ± 528 vs. $3,879 \pm 617$ AU), significant differences were observed between groups in the present study. Impellizzeri et al.⁸ investigating methods of evaluating the internal load in soccer, verified that in a team receiving the same external load, athletes with higher internal loads recorded in the training had greater improvements in aerobic fitness compared to athletes with lower internal loads.

We have no information about other studies that have analyzed the behavior of the internal load through the method of the rating of perceived exertion (RPE) between starters and nonstarters players in volleyball or in any other sport modality, making a direct discussion in relation to the training load more difficult. However, some studies have analyzed performance indicators and physiological markers between starters and nonstarters players of different sports modalities, presenting results that point to some specificities in relation to this characterization of athletes in collective sports teams^{26,27}.

In this context, Marques et al.²⁶ observed during a competitive season of volleyball players difference between starters and nonstarters players only in the maximum strength of the supine test for evaluation of the upper limb strength, and no difference was found in the other tests analyzed (vertical jump test and Medicine Ball throw).

In Basketball, Gonzalez et al.²⁷ observed changes in performance between starters and nonstarters players of the National Basketball League (NBA). The authors concluded that improvements in lower limb strength, repeated jumping ability, and reaction time during the season may be related to the playing time performed by starters players once the team received the same amount of external training load. Sampaio et al.²⁸ analyzed a Portuguese Professional Basketball League team and identified that the greatest strength in the differentiation between groups was related to defensive actions (fouls committed, and defensive rebounds), and in the worst teams (teams not classified for playoffs), a greater number of differentiation variables between the groups of athletes was found.

Kraemer et al.²⁵ with athletes from the American Men's College Football League observed increase in the fat percentage of nonstarters players over the season. Significant decreases in sprint velocity and vertical jump

performance were found only in starters athletes without differences in relation to hormonal variables Testosterone and Cortisol. Caterisano et al.²² with University Basketball players observed increase of 1.1% in VO_2 max in starters athletes and decrease of 9.5% in VO_2 max in nonstarters players over two seasons. Significant decrease in the strength of upper and lower limbs was presented by starters players, and the group of nonstarters players presented decrease only for the lower limbs.

Another important aspect is the technical issue between starters and nonstarters players of a team. This variable can often define the situation of the athlete in relation to being starters player or not. In this sense, Gómez et al.²⁴ analyzing data from the 2005 season of the National Women's Basketball Championship showed that athletes had more success in 2-point baskets, free throws, assists and defensive rebounds, and presented lower values of fouls committed, in relation to nonstarters players. In addition to the technical aspects evidenced by results between starters and nonstarters players, starters athletes would have more confidence and tactical awareness about their performances, demonstrating the psychological factor involved in the selection of these athletes.

It is evident that the use of different methodologies in the attempt to compare physical parameters and specific demands of the most diverse sports modalities in relation to being starters player present inconsistent results. It is possible that other factors, such as the intensity and accumulation that the sequences of games and competitions place on the body of starters athletes in their psychophysiological extension, have a direct influence on the manifestation of positive or negative differences when compared to nonstarters players, who consequently have lower volume of games. In our study, the group of athletes considered nonstarters players performed additional court training and physical training in order to balance their demands with those of athletes who participated in the majority of games. Even though some types of training are similar to the game situation, a number of peculiar characteristics of the game may directly influence the psychophysical state between starters and nonstarters players. According to Moreira et al.²⁹, aspects of official competitions such as pressure to achieve good results, the unpredictability of environments related to official matches, the importance of the game, among others, emerge as potential stressors characteristic of competitive games.

On the other hand, the results presented in the present study show that starters and nonstarters players may present different manifestations of internal load in the training routine. Physical, emotional, psychological, cognitive, social, technical and tactical characteristics may have a direct influence on the results presented. Thus, further studies comparing the physical demands and changes in internal load markers are necessary to better understand the peculiarities of the various sports modalities, specifically volleyball. The findings of the present study indicate the need for individual control of the training load so that discrepancies do not occur within the group of athletes, allowing everyone to reach an optimal level of performance throughout the season and not being only part of the group.

CONCLUSION

It could be concluded that starters players presented greater internal training load in comparison to nonstarters players in all analyzed periods of the season, even in initial weeks in which the definition of the starters team still did not occur. The result presented opens questions that cover a wide field of investigations in the universe of training of collective sports teams. We believe that psychological, technical, physical characteristics, statistical performance results, coach evaluation, characteristics of opposing teams, economic power and level of team performance, are some of several possible factors that can influence the differentiation between starters and nonstarters players of a sports team. This study was limited to analyzing only weeks with normal training routine, without games (friendly or official), or trips, considering that in these weeks, the training load was reduced by the technical commission due to the games. However, we understand that the weeks that were not monitored may have influenced the adaptive responses of both starters and nonstarters players, so these results, although innovative, should be interpreted with caution.

Further studies are needed for future confirmations or not of this behavioral training load pattern of volleyball and other modalities between starters and nonstarters players using the method of rating of perceived exertion (RPE) to quantify the internal load generated by athletes.

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