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Original Article

COMPARISON OF THE TRAINING LOAD OF PROFESSIONAL ATHLETES BETWEEN MODES OF VOLLEYBALL SPECIFIC DRILLS AND STRENGTH CONDITIONING

COMPARAÇÃO DA CARGA DE TREINAMENTO DE ATLETAS PROFISSIONAIS ENTRE MODOS DE TREINOS ESPECIFICOS DO VOLEIBOL E DE FORÇA

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RESUMO

O objetivo deste estudo foi comparar a carga de treinamento em três tipos de treinamentos de uma equipe de voleibol profissional.. Participaram do estudo 28 jogadores (26,6 ± 4,7 anos; 91,5 ± 8,5 Kg; 194,1 ± 6,0 cm). Foi realizada uma análise descritiva de 29 sessões de treino técnico, 84 tecnico-tático e 75 de musculação e isoladamente das variáveis que compõem a carga de treinamento, PSE e o tempo de duração da sessão, posteriormente sendo reunidos em média e desvio padrão de acordo com tipo de treino. Para análise dos dados foi adotado o teste de *Shapiro-Wilk* e em seguida aplicou-se o teste *Anova Two-Way* com o *Post Hoc* de *Tamhane* e também foi utilizado o tamanho do efeito para análise das comparações. Os resultados demonstraram respostas significativas e grande tamanho de efeitos quando comparados técnico e técnico-tático com a musculação na carga interna de treinamento TxM (TE=1,2: grande; p= 0,002); TTxM (TE=1,3: grande; p= 0,001) e no tempo de duração da sessão TxM (TE=1,7: grande; p= 0,001); TTxM (TE=2,0: grande; p= 0,001), já a PSE da sessão apresentou apenas uma diferença sigifcativa TTxM (TE= 0,8: moderado; p= 0,001). Os estímulos de treinamentos específicos de quadra como técnico e técnico-tático promoveram maior carga interna nos atletas do que o treino de força, através principalmente pela influencia da variável tempo de duração da sessão que refletiu a carga externa.

Palavras-chave: Periodização. PSE da sessão. Volume de Treinamento. Treinamento Específico.

ABSTRACT

The aim of this study was to compare the training load in three types of training of a professional volleyball team. Participants were 28 players (26.6 ± 4.7 years, 91.5 ± 8.5 kg; 194.1 ± 6.0 cm). A descriptive analysis of 29 technical training sessions, 84 technical-tactical training sessions and 75 training sessions, and of the variables that compose the training load, PSE and the duration of the session were performed, and were then collected on average and standard deviation according to with type of training. To analyze the data, the Shapiro-Wilk test was adopted, and then the Anova Two-Way test was applied with Tamhane's Post Hoc and the effect size was also used for analysis of the comparisons. The results demonstrated significant responses and a large effect size when compared to technical and tactical-to- strength training (T = 1.2: large; p = 0.002); TTxM (TE = 1.3: large, p = 0.001) and the duration of the session / external load in the TxM training (TE = 1.7: large; p = 0.001); TTxM (TE = 2.0: large, p = 0.001), whereas the PSE of the session showed only a sigifcant difference TTxM (TE = 0.8: moderate; p = 0.001). The stimuli of specific training of court as technician and technician-tactician promoted greater internal load in the athletes than the strength training, mainly through the influence of the variable time of the session that reflected to external load.

Keywords: Periodization. Rating of Perceived Exertion of Session (session RPE). Training volume. Specific Training.

Introduction

The significance of a well-planned and well-applied periodization is widespread in the scientific literature and among sports professionals. In fact, this is one of the decisive factors to obtain high physical conditioning and good sports performance[1,2]. In order to achieve a high level of physical and sports performance, the ideal training load (TL) must be considered, thus, controlling the variables that constitute it is required. This load can be understood separately according to the model by Impellizzeri et al.[3] as external training load (ETL) - training prescribed by the coach in terms of quantity (volume), quality (intensity), that is, the periodization itself; and as internal training load (ITL) - stress level imposed on the body as a result of the adaptations demanded by training. Therefore, the analysis between

ETL and ITL can determine the ideal amount of training required so as to achieve maximum performance and minimize the negative effects of excessive training load[4,5].

Most studies suggest methods to obtain ITL that use the session-rating of perceived exertion (RPE) and heart rate (HR), since they have greater applicability[6-8]. In the case of the training load quantification method by using RPE, proposed by Foster et al.,[7] it is necessary to compute the product between the perceived exertion indicators described in the scale and the session duration in minutes. This method is the most accessible one to quantify the ITL for having nearly no financial cost.

The ITL quantification methods have mainly been assessed in certain team sports, such as rugby, American football and soccer[4,9,10]. In general, in team sports, controlling the training load of the athletes can be a little more complex for the coaching staff, since group training sessions are imperative and predominant. This can have negative consequences in some athletes because of the excess of ITL or, on the other hand, they might not reach the training load planned and, consequently, a drop or stagnation of performance occurs, according to the principle of biological individuality or due to different levels of physical conditioning.[11,12]. These potential disadvantages of team sports training should draw attention to the need to use a more accessible valid method to accurately quantify individual and collective ITL with regard to several modes of specific training of each modality.

Understanding the different appropriate methods to quantify individualized training loads is essential in order to stimulate positive physiological adaptation[13,14]. Considering court sports, basketball is the most often evidenced one in scientific investigations when assessing the training load, even more than volleyball and tennis, for example[15,17]. However, although several studies use ITL quantification methods in different designs, some investigations that have assessed, described and compared the effects of several types of sport-specific trainings on ITL are still lacking. The study by Scanlan et al.[18] is the most classical example, which showed significant ITL responses, either by using RPE or HR method in specific isolated basketball training (basic conditioning, specific conditioning and games/tactics), also verifying strong magnitude training load correlations through RPE with the HR methods.

In volleyball, a significant portion of the physical exercise performed with short-term efforts at high intensity predominantly uses alactic metabolism as energy supply[19,20]. In this sense, high-intensity and short-term effort associated with technical-tactical training may be more demanding on the central nervous system, which can be represented by a higher perceived exertion with a scale, such as the RPE. According to Borg's model[21], the physiological understanding of RPE is based on the assumption that an integrative relationship exists between peripheral signals of muscular and joint metabolic receptors and central chemoreceptors, which enables researchers to interpret the exertion on the sensory cortex, generating general and/or local perceived exertion to accomplish a given task. Recently, Marcora et al.[22] added some factors to this model, which can influence the increase in RPE itself, such as the session duration and another factor that is more adverse to the complexity imposed on the task.

Therefore, knowing these different ITL responses in distinct specific trainings of other sports is needed, such as technical and technical-tactical volleyball, which can influence both, the RPE with different and/or similar volumes, and ultimately the training process as a whole. Thus, the present study aimed at comparing the responses of the ITL, RPE and session duration with regard to volleyball specific training modes and strength.

Methods

Participants

Twenty-eight professional players of a male volleyball team were included in this study (Age 26.6 ± 4.7 years old; Body mass 91.5 ± 8.5 Kg; Height 194.1 ± 6.0; BMI 22.0 ± 7.5 Kg/m²). All the athletes were submitted to anthropometric measurements to characterize the sample. Data were collected during 29 technical training sessions, 84 technical-tactical training sessions and 75 strength training sessions. The content specifications referring to each training mode are shown in Table 1. As inclusion and exclusion criteria of the sample volunteers, the following parameters were standardized: a minimum attendance of 75% at all sessions, in addition to 75% of the time on court in each session; any athlete returning from a period of injury or still injured would be excluded, regardless of the injury degree. All the athletes of the present sample met these requirements. The study procedures followed the international norms on research with humans according to the Declaration of Helsínquia (1975), and approved by the Standing Committee on Ethical Research with Humans of the Brazilian university referred to as *Universidade Federal de Juiz de Fora* under Opinion nº 278/2010. The athletes signed a consent form allowing data collection and dissemination. As an inclusion criterion, players should be training and participating in competitions.

Plan and structure of the training sessions

The athletes were monitored during all the periodization phases, from the pre-season to the competitive one. The training sessions consisted of warm-up and strength work either during strength training or on court, separately. Considering court work, training demanding technical and/or technical-tactical skills was applied. The training content and structures are described below and can be seen in Table 1.

• *Technical training (T)*

The T training consisted of exercises with relays among small groups in which the athletes repeatedly performed the technical fundamentals of serve, pass, set, defense, attack and block.

• *Technical-tactical training (TT)*

The TT training sessions comprised tactical attack movements that simulated game situations of the offensive and defensive systems.

• Strength training (ST)

Strength training consisted of special (or specific) exercises for volleyball players. The sessions comprised an average of 9 strength training exercises divided into two worksheets, A and B. The training intensity was established between 4 and 15 maximum repetitions, that is, between 65 and 90% of 1 RM with intervals between sets from 1 to 2 minutes as shown in Table 1.

Table 1. Distribution and description of the sessions structures of the training modes used

Frequency of the technical training modes used in 29 sessions	
	Number of sessions performed
Serve	26
Pass and set	26
Block	24
Defense	13
Attack	7
Frequency of the technical-tactical training modes used in 84sessions	
	Number of sessions performed
Side-out: attack combinations	58
Counter attack	26
Main characteristics of the sessions structure of the 75 strength training sessions	
	Specific values for each variable
Number of sets· exercise· session^{-1}	Between 2 and 4
Number of sets performed · muscular group in the 76 sessions	228
Number of sessions·microcycle^{-1} for each training (A and B)	2
Number of sessions for each training (A and B) in the 76 sessions	38
Purpose of the Repetitions·sets $^{-1}$	between 4 and 15
Interval between the sets in seconds	between 60 and 120

Source: The authors

Determination of the internal load (ITL) trough RPE method

The training load was determined by using the RPE method, which consists of computing the product between the intensity, identified using the 10-point RPE scale adapted by Foster et al.,[23] and the training volume, expressed by the total time of the training session in minutes. Thirty minutes after completing each training session, the athletes were asked to answer the question: 'How was your training?' by indicating the session-rating perceived exertion from 0 to 10 on the scale adapted by Foster et al.[7], considering 0 as being in rest and 10 maximum exertion. Therefore, after computation, the ITL value was obtained in arbitrary units (AU).

Statistical analysis

For data analysis, statistics were adopted based on the comparison of means and standard deviations. In order to ascertain the sample distribution, Shapiro-Wilk test was used. Having met all the assumptions of normality and homogeneity of variances, the Anova Two-Way test was applied with Tamhane's Post Hoc so as to make comparisons between each training mode applied - technical (T), technical-tactical (TT) and strength training (ST) considering the respective variables assessed (RPE, session duration, internal load). As statistical validation, the significance value $p \leq 0.05$ was adopted. SPSS software version 20.0 (SPSS, Inc., Chicago, ITL, USA) was used to perform the statistical analysis. In order to measure the practical effect among the training modes, the effect size was calculated, considering between 0 and 0.25 = trivial; between 0.25 and 0.50 = small; between 0.50 and 1.0 = medium; greater than 1.0 = large; as described by Rhea[24].

Results

Initially, a data descriptive analysis of the two variables was carried out, which comprised the results of the ITL, RPE and training session duration. Data are expressed as mean and standard deviation in Table 2 that shows the comparisons of the session perceived exertion in different training modes regarding the volleyball physical-technical-tactical preparation, and taking into account the training session duration. These comparisons showed

significant differences in all load variables that involved the ITL, however, for PSE it occurred only when comparing technical-tactical training with strength training ($p < 0.05$). Considering the session duration there were two significant differences and a large effect size for technical and technical-tactical trainings when compared to strength training ($p < 0.05$). Finally, regarding ITL, the comparisons showed significant differences and a large effect size likewise the session duration, that is, the technical and technical-tactical trainings showed significantly greater ITL than the strength training ($p < 0.05$).

Table 2. Training load variables and volleyball training modes

	Volleyball Training Modes			
Training load variables	nical (T)	ical-Tactical (TT)	gth training (ST)	Effect size (ES)
RPE	±1.6	± 1.11	± 0.71[#]	TxTT(ES= -0.4) (p= 0,153) Trivial TxST(ES= 0.2) (p= 0.743) Trivial TTxST(ES= 0.8) (p= 0.001) Medium
Session duration (min)	± 30.29	) ± 26.53	) ± 7.46[#$]	TxTT(ES=0.0) (p= 0.995) Trivial TxST(ES=1.7) (p= 0,001) Large TTxST(ES=2.0) (p= 0.001) Large
ITL (AU)	± 234.96	.9 ± 188.21	± 54.73[#$]	TxTT (ES=0.1) (p= 0.972) Trivial TxST (ES=1,2) (p= 0.002) Large TTxST (ES=1.3) (p= 0.001) Large

Legend: AU = Arbitrary Unities. [#]significant difference $p \leq 0,05$ between TT e ST; [$] significant difference $p \leq 0,05$ between T and ST
Source: The authors

Discussion

The present study aimed at comparing the ITL, RPE and session duration responses in three training modes used in the periodization of a professional volleyball team. The court training showed a greater internal training load than strength training. There was no significant difference between the means of RPE and the time among T and TT sessions, but only when comparing T with strength training. In addition, there was no difference between TT and strength training for the session duration.

There are some possible reasons that can elucidate how or why the T and TT training had a greater ITL mean than ST. Basically, the external variable of the training load and volume strongly influenced the ITL results. The duration of the sessions performed was significantly higher in T and TT trainings when compared to ST, showing a large effect size for both T and TT (ES = 1.7; ES = 2.0 respectively). In this sense, Scanlan et al.[18] also showed the influence of the session duration on the training load, having greater ITL

responses in technical and tactical trainings/tactical moves when compared to specific and basic conditioning training in semi-professional basketball athletes.

Another significant factor with regard to ITL is the nature of the predominant exercises of the training modes assessed in the present study. Exercises or tasks that require more attention and reasoning can influence RPE. In addition, the technical and technical-tactical trainings were carried out in substantial sessions, that is, when added to time and greater reasoning requirements they influenced the RPE and, consequently, the ITL. This study corroborates the findings by Marcora et al.[22], who found influence of time and mental fatigue on the perceived exertion in individuals submitted to concomitant extended exercises performed along with cognitive task, which indicates a characteristic of these training modes. The fact that strength training is an interval non-intermittent training was also seen, which, in general, consists of breaks from 1 to 2 minutes. This peculiarity was shown by Kraemer et al.[25] when assessing the relationship between RPE and strength training. The authors showed lower RPE values, since the greater volume of strength training is not always related to increases in RPE because of some factors, such as absolute load and rest periods between sets, which interfere with the RPE responses.

The main finding of the present study is that the ITL in specific volleyball sessions, that is, isolated technical sessions and combined technical-tactical training sessions, was significantly greater than in strength training. The influence of RPE on the ITL can be considered stronger in TT sessions, since there was a significant difference when comparing the RPE with regard to the ITL in ST, although this influence was not reported as large considering the effect size, but medium (ES = 0.8). On the other hand, T sessions did not show a significantly higher RPE in strength training, despite having a significant difference both in time and ITL. This difference with regard to ITL occurred mainly due to the session duration, which in ST was significantly lower, when compared to 90.20 ± 26.53 minutes of TT sessions. Such a difference is considered to be high due to the effect size, both for T and TT sessions in relation to ST, which proves that volume was determinant for the significant values of the ITL in TT and T sessions, since the maximum values of RPE in TT and ST were very similar (5.5 and 5.3 respectively). These results with regard to the load and training modes reinforce the findings by Gallo et al.[26], who showed greater ITL values in Australian soccer players who participated in ETL sessions involving main abilities, which caused a state of greater fatigue. The results of the present study also corroborate the study by Scanlan et al.[27], who again saw significantly greater ITL differences in basketball in specific combined trainings, such as: development of running speed with change of direction, tactical defense training, repeated sprints (short distances), long-term technical trainings intermittent with reactive moves, when compared to general basic training as repeated linear running/sprints over long distances and speed technique.

An intriguing, but interesting factor found in the present study is shown in Table 2. The mean and standard deviation of the sample distribution among the three training groups assessed throughout the entire season showed that the T training had a greater ITL than the TT training, despite having lower averages regarding the RPE and session duration variables (volume). This might be occurred due to the fact that ITL standard deviation and the TT training were shorter. Therefore, the average was less affected by extreme values because the TT sample *n* had 56 sessions more than the T sessions, that is, the ITL dynamics of the TT training was more 'diluted' during the season. Not so recently, Manzi et al.[28] also found this greater ITL response in basketball during weeks that included more technical-tactical training without games than in weeks involving games with less sessions. In addition to the findings of the studies by Scalan et al.[18], Scalan et al.[27] and Manzi et al.[28] about basketball, and the ones of the present study on volleyball, Bara Filho et al.[29] also found a significant influence of different training modes with regard to the load used by soccer players, that is, the technical-

tactical trainings were the closest to the game impulse/load according to TRIMP method by Stagno et al.[30]. Therefore, based on the results of the present study and others shown in the literature, it is assumed, in general, that the justification by Marcora et al.[21] seems to be correct, that is, the time spent in long-term exercises that demand cognitive task influences over mental fatigue and perceived exertion, consequently. Thus, greater technical demanding trainings, such as isolated technical sessions and combined technical-tactical sessions performed by team sports, seems to more significantly influence the RPE and ITL than the strength training as shown in the present study.

This intriguing ITL response in TT and T trainings can be considered a limitation of the training sample *n* for having different numbers of sessions. On the other hand, this distribution represented the reality of a professional team practice according to the periodization programmed and applied to the team. Therefore, this difference in training distribution is assumed to be an example to reflect about with regard to the distribution of the training modes in volleyball planning. Another limitation of the present study to be considered is the fact that the assessment of combined trainings did not allow isolated analyzes of technical and tactical trainings, that is, separately.

Further research is needed in order to obtain a better inference in practice. Among the possible analyzes, comparing the load of other training modes, such as isolated technical ones (pass, block and defense), and carrying out a more detailed study on strength training are recommended. Such investigations should include other specific methods of load control in strength training, correlating it with the purposes and physical capacities worked in strength training, for example, methods of load control and recovery time for gains in hypertrophy, maximum strength and power.

Practical Applications

Training in team sports is an extremely complex process, thus, the training load control must be internal and external. The acute and chronic psycho-physiological adaptations (internal load) that occur during training enable the technical committee to correct and adjust the session duration, the number of sets, overloads and repetitions (external load). Therefore, correlating ETL and ITL by applying quantitative methods of training load enables to reduce errors with regard to the training process. In the present study, the influence of the ETL was shown by the variable that represents the volume – the longer session duration in specific volleyball training promoted greater ITL, thus, respecting the specificity of this sport. On the other hand, despite this coherence, and according to RPE, the results suggest that attention should be given to ETL, in this case represented by the session duration, mainly in technical-tactical trainings due to its higher mental demands. Therefore, throughout the season the long sessions should gradually be increased and/or distributed in a more balanced way since the beginning of the season.

Conclusions

The analysis on possible differences of the ITL responses in different training modes showed that stimuli of specific court training, such as technical and technical-tactical sessions promoted greater ITL in athletes than strength training, mainly due to the volume variable. Therefore, it is necessary to evaluate how to better assign the volume and distribution of T and TT trainings when applying periodization in volleyball.

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