OBJECTIVE AND SUBJECTIVE VARIABLES FOR MONITORING OF DIFFERENT SEASON CYCLES IN BASKETBALL PLAYERS

EXERCISE AND SPORTS MEDICINE CLINIC

ORIGINAL ARTICLE

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ABSTRACT

The present study aimed to evaluate, compare and relate load and training tiredness during a periodization cycle in basketball players. Eight professional male athletes aged 21.9 ± 3.4 years, all of whom participated in the São Paulo basketball championship, special division, took part in this study. The macrocycle analyzed encompassed 19 weeks divided into the following periods: Preparatory, Competitive I, and Competitive II (having 4, 6, and 9 weeks, respectively). The authors daily evaluated the athletes on subjective perception of tiredness and training load and monitored the athletes' upper limb power by quantifying their ability to throw a medicine ball. Athletes presented less fatigue ($p < 0.005$) in the Preparatory period (13.71 ± 1.30) compared with the Competitive I (14.68 ± 1.51) and Competitive II (14.63 ± 1.22) periods. Their ability to throw the medicine ball decreased ($p < 0.005$) in the Competitive period II (3.59 ± 0.30) compared with the Preparatory (3.80 ± 0.36) and Competitive I (3.86 ± 0.26) periods. Their monotony decreased ($p < 0.001$) in the Competitive period II (1.18 ± 0.43) compared with the Preparatory (2.50 ± 2.01) and Competitive I (2.10 ± 1.61) periods. The results revealed the effectiveness of monitoring load and tiredness of athletes by means of the proposed method to assist in training organization during a macrocycle.

Keywords: sports performance, athletic performance, physical education and training.

INTRODUCTION

Researchers had the aim to control and monitor athletes during physical training and stressed the importance of follow-up to the athletic performance during the sports season[1-3].

Studies related some parameters of physiological parameters with training variables[4], such as quantitative (volume) and qualitative aspects and their interrelation with training load[5]. Although there is a relation between these parameters with training, the use of physiological monitoring remains very limited due to the high operational costs, considering the need for specific equipment and staff.

Other studies searched for accessible and valid methodologies which could exist in the training process for many sports, including soccer[6], speed running[7], and long-distance running[8], cycling[9], cross--country skiing[10], and triatlons[11].

Borg[12] presented a proposal relating the subjective perceived exertion (SPE) during physical exercise as an instrument for general information on muscular work and the cardiovascular, respiratory and central nervous systems. In this aspect, Foster[13] proposed that the training load of a session could be monitored by the relation between SPE (intensity) and training volume (in minutes), considering that as a whole, it would be possible to calculate training load through a simple multiplication of the scores found.

Foster[13] also presented the terms training strain and monotony, which would indicate load alterations in a week (monotony) and the rate of weekly exertion (stress) related to the load and its variations. Notably, when these indicators present high variance concerning the other weeks, the athletes can be susceptible to diseases and injuries[7,14].

Some studies[5,7,15] monitored athletic training with SPE and physiological indicators and of performance and revealed that a possible relation between them would help in the monitoring of athletic training. However, scarce studies associated low cost and accessible methodologies with training process for basketball athletes. Thus, this study had the aim to evaluate load and fatigue caused by training and correlate them with performance of basketball players during a season.

METHODS

Experimental method for the problem

Researchers had the aim to control and monitor athletes during physical training. Studies related some monitoring physiological parameters with training variables, such as quantitative aspects (volume) and e qualitative aspects and its interrelation with training load. We performed season follow-up of the team studied for determination of the training load. The training periods were divided in preparatory (PP), competitive I (CPI) and competitive II (CPII), for a total of 19 micro cycles, which included: 20 matches, 34 resistance training sessions and 78 technical tactical training sessions. The following variables were analyzed during the sports season: load and tiredness evaluation and evaluation of the medicine ball throw.

Subjects

Initially 13 athletes were selected, but only eight completed all the study's procedures. Eight basketball players participated in the complete study (mean ± SD; age: 21.9 ± 3.4 years; body mass: 99.1 ± 14.0kg; height: 195 ± 6cm; body fat: 12.3 ± 5.9%). The participants included basketball players who had participated in the first division championship of the São Paulo state, Brazil. None of the basketball players had stopped playing for more than three years of the study, and none of them had history of injury before recruiting. The local ethics committee of the Methodist University of Piracicaba approved this study and all volunteers provided written consent form before the participation.

Procedures

Follow-up for the studied team was performed for determination of training load. The training periods were divided in preparatory (PP), with four microcycles; competitive I (CPI), with six microcycles; and competitive II (CPII) with nine microcycles, for a total of 19 microcycles (with each microcycle consisting of one week). During the 19 microcycles we monitored 103 days of activity, which included: 20 matches, 34 strength training sessions, and 78 technical tactical training sessions. The same training assistants performed all the procedures in the same places and times[16]. Table 1 presented the periodization model developed by the technical commission and used by the team studied.

Load and tiredness evaluation

Before the beginning of this study the athletes understood all the used procedures. One group of players (n = 10, including the participants of the present study) participated in two identical training sessions with one week between them for determination of test-retest reliability of the used scales. The intraclass correlation coefficients and standard error of the measures were 0.96, 0.98, and 3%, 4%, respectively for the fatigue scale and training intensity. In all training sessions or matches the duration of each activity was determined in minutes, and the athletes used the self-perceived intensity scale (SPI)[13]. This procedure defined the load of each activity by the multiplication of the volume by the intensity of a training session. After each microcycle, the weekly load (TL), the mean and standard deviation, monotony and training (Mon), and strain were determined as proposed by Foster[13]. The perceived exertion scale of each athlete was collected daily: before (IC) and after (FC) the training sessions or matches as based on the Borg exertion scale[17] adapted for tiredness[11].

Medicine ball throw evaluation (MBT)

The athletes performed a general warm-up (10-15 minutes) of light activity before throwing the medicine ball (3kg) from a sitting position on a chair, without moving the trunk[17]. Subsequently, the subjects had at least 15s of rest between each throw. The highest value of the three throws was used. The throw was determined during all weeks (19), in the beginning (MBBT) and at the end (MBET) of each microcycle.

Statistical analyses

Data normality and homogeneity were confirmed by the Kolmogorov-Smirnov and Levene tests, respectively. Subsequently, analysis of variance (ANOVA) with repeated measures was used to compare mean differences between conditions. A Bonferroni test served as a *post hoc* with multiple comparisons[19]. The Pearson and Spearman correlations were used to verify the association between variables. Alpha of 0.05 was used for all the statistical tests.

RESULTS

The distribution of the training content and competition directly related to the season planning. Figure 1 presents the quantity of the training content volume performed by the athletes during the training season: exercise type (general, special and competitive) and

Table 1. Periodization during the sports season (physical training: ME = muscular endurance; MS = maximal strength; P = power).

Period			**Preparation**						**Competitive I**						**Competitive II**					
Month		**July**			**August**				**September**			**October**					**November**			**December**
Micro cycle		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Total days in activity		6			24				25				23					23		2
Matches	wins		-					3								2				
	losses		-					7								8				
Technical/tactical training		5	5	5	5	5	4	4	3	4	3	4	5	3	4	5	5	4	5	3
Physical training	Quantity	3	5	5	3	5	4	3	3	3	-	-	-	-	-	-	-	-	-	-
	Content	ME	ME	ME	F M	F M	MS	P	P	P	-	-	-	-	-	-	-	-	-	-

period (preparatory and competitive I and II). Differences concerning the volume quantity appeared: general (33.4%), special (50.5%) and competitive (16.1%). The volume of the competitive I period (4,432 minutes) and competitive II period (4,549 minutes) should be separated. Both competitive periods (I and II) were higher than the preparatory period.

The analysis of the training sessions presented in table 2 reveals a high intensity in the competitive I period when compared to the other training periods and higher sessions volume in the competitive II period ($p < 0.05$).

Higher tiredness perception occurred in the competitive I and II periods when compared with the preparatory period ($p < 0.005$). The results of the medicine ball throw decreased in the competitive II period when compared with the other periods, regardless of having been evaluated in the beginning or end of the training week. Monotony and strain also decreased in the competitive II period compared with the other periods ($p < 0.001$).

Significant associations were observed among the tiredness evaluations; medicine ball throw; vertical jump; total load; monotony and strain (table 3).

Figure 2 presents the medicine ball throw in the beginning and in the end of the weeks during the training season. Decrease in the throwing capacity occurred along the training weeks.

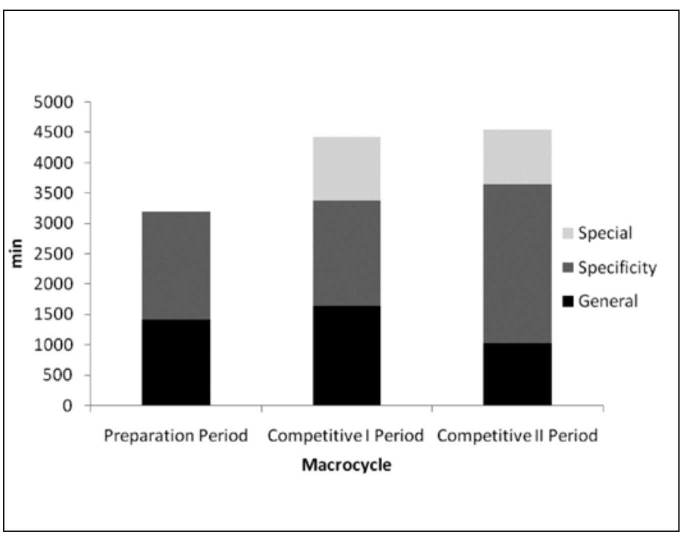

Figure 1. Training distribution during different periods related to training content.

DISCUSSION

Many researchers have studied the athletic preparation over the last years[20-23]. According to these authors, the present study mainly tried to monitor a basketball season and evaluate the effects of the training loads applied during such periodization. The 19-week periodization was divided in three periods: preparatory, competitive I and competitive II.

These training periods present specific characteristics concerning the training load and performance of the athletes, and the optimum results, as expected, occurred in the competitive period. Charniga Jr *et al.*[24] found high volume and reduced intensity in the preparatory period, while such ratio was contrary in the competitive period. The results of the present study corroborate this other study, as evidenced by the increase in intensity and decrease in volume in the training periods. Such situation has not been found in the competitive II period, where the intensity decreased compared to the competitive I period and increased volume compared to the other periods. Such fact evidences a pattern different from the one presented by the literature for the competitive II period[24].

The load applied in the distinct training periods did not present difference, revealing that the load magnitude altered during the

Table 2. Descriptive values of the variables measured during the sports season.

Variable	Training periods			
	Preparation PP	Competitive I (CPI)	Competitive II (CPII)	p values
Intensity (a,u)	5.58±1.8*	6.43±2.3	5.67±2.1*	P<0.05
Volume (minutes)	93.9+33.8*	87.0±26.9**	100.3+33.3#	P<0.05
IC	11.14±1.21	11.08=1.09	10.65=1.00	P>0.05
FC	13.71=1.3	14.68=1.51#	14.63±1.22	P<0.05
TC	3776.6 1156.6	3745.4 1719.8	31.34 1158.2	P>0.05
Mon	2.50±2.01**	2.10±1.61**	1.18±0.43	P<0.01
Strain	9887.8±9097.6**	7360.5±6272.3**	4144.9±2768.4	P<0.01
MBBT	3.80±0.36**	3.86±0.26	3.59±0.30	P<0.01
MBET	3.85±0.32**	3.89±0.27**	3.58±0.27	P<0.01

*Different from the Competitive Period I; **Different from the Competitive Period II; #Different from the Preparatory Period. The SVI, SVF, Mon and stress variables are presented as median ± total semi amplitude. CT: weekly load; Mon: training monotony; scales of perceived exertion collected daily: before (CI) and after (CF) the training sessions or match; medicine ball throw in the beginning (MBBT) and end (MBET) of each micro cycle.

Table 3. Measures of linear association between all the analyzed variables.

	FC	MBBT	MBET	TC	Mon	Strain
IC	0.65##	0.27#	0.14**	0.29#	0.04	0.13
FC		0.13	0.10	0.30##	-0.11	0.06
MBBT			0.87##	0.30##	0.18	0.26#
MBET				0.32##	0.26#	0.30##
TC					0.20	0.57##
Mon						0.85##

* ($p < 0.05$); ** ($p < 0.01$); # ($p < 0.005$); ## ($p < 0.001$); no symbol ($p > 0.05$). Spearman correlation were used for Mon and Strain. The remaining associations were verified by Pearson correlation. TC: weekly load; Mon: training monotony; scales of perceived exertion collected daily: before (IC) and after (FC) the training sessions or match; medicine ball throw in the beginning (MBBT) and end (MBET) of each microcycle.

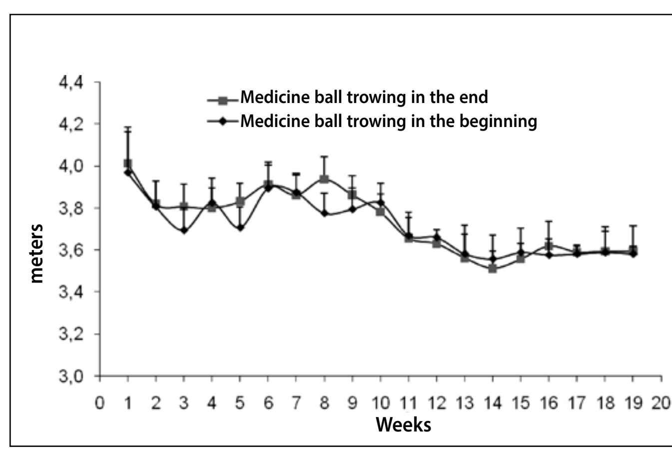

Figure 2. Distribution of the medicine ball throw in the beginning and in the end of the week during different weeks related to training.

periods, despite the content and characteristics of these loads had been different (no competitive exercise in the preparatory period). It is important to stress the training control and content (figure 1), while volume and intensity were different (table 1), the load was similar between periods (table 2). Foster[13] stated that the training load alone does not sufficiently reflect the stimuli that the athletes experience in their respective responses in the long run.

In this sense, the analysis of the monotony gains importance as suggested by Foster[13] and Foster *et al.*[25], especially since it makes sense to detect differences among the preparatory, competitive I and competitive II periods. This monotony behavior reveals that the training loads present a different distribution pattern between the periods. Fry *et al.*[26] described the importance of the correct load distribution and offer of sufficient rest periods for the improvement of the athletic performance as well as prevention of overtraining. The initial proposal presented by Foster[13] indicated that the monotony joined with the strain could prevent overtraining in athletes. Thus, a higher score (> 2.0 a.u.) would be associated with the unfavorable conditions for an optimum adaptation to training[7,13,25-27].

Monotony was higher than what was established for optimum adaptation to training in the preparatory and competitive I periods[27], which reveals reduced variation in load application during the training periods[14]. With the progression of the weeks with this characteristic (monotony higher than 2 a.u., as presented in table 4) the positive effects of the training may decrease, increasing hence the overtraining risk[7]. However, the monotony values were suitable in the competitive II period, presenting variation of optimum load[27].

Strain was higher in the preparatory and competitive I periods compared to the competitive II period, characterizing a more stressing phase to the athletes. A weekly strain value, understood as the product of weekly load by the monotony, reflects the weekly "effort", as the result of the interrelation between load and weekly variation (monotony). An association between overtraining symptoms and situations in which strain was altered beyond the individual threshold, with increased risk to infections in the upper respiratory tract[13] and alteration in the immune function[14] has occurred. The results of the present study revealed that the basketball players were more susceptible to these symptoms in the preparatory and competitive I periods[28].

Additionally, we believe it is important to evaluate the indices of total load and monotony as supporting tools to the understanding on training adaptations, since we found correlation between both parameters and strain (table 3). Monotony seems to influence more on the weekly strain ($r^2 = 72.5\%$). Such results are in agreement with the ones found by Delattre *et al.*[5], Foster[13], Plutur *et al.*[14] and Foster *et al.*[25], who reported higher monotony value associated to high weekly strain. In order to avoid disproportional increase in weekly strain it is necessary that optimum load distribution occurs, as a result of its relation with some overtraining symptoms[13,14].

Lower tiredness scores in the preparatory period were found when compared to the competitive I and competitive II periods (table 2), besides a correlation of this parameter with total load during the 19 weeks. These differences may have an association with the load content applied in each period, while the competitive exercises present in the competitive periods play an important role over tiredness, resulting from higher intensity of muscular actions in this kind of exercise[22] compared to general[14] and special exercises[3]. Moreover, other authors evidenced that competitive exercises produce greater psychological stress over the atlhetes[29].

The monitoring of the tiredness perception in athletes presents relevance and can motivate coaches to alter the daily and weekly training plans of their athletes, since tired athletes feel even more tired after training, as determined by the correlation between rates of perceived exertion collected before (IC) and after (FC) the sessions.

These training parameters may help understand other variables measured in the present study, such as the correlation found between subjective measures (total load) and objective measures (medicine ball throw). Similarly, Delattre *et al.*[5] proposed that subjective parameters help understand other training variables, both subjective and objective.

No alteration has been found in the medicine ball throw on the first nine weeks of training (figure 2), from the preparatory period to the competitive I period. Gorostiaga *et al.*[15] did not find alteration in the power of lower limb during a training season in high level handball players. Nevertheless, the authors found alterations in the velocity of supported throw, possibly as a result of the high intensity applied in the strength training for upper body of the body, higher intensity than the one applied to the lower part of the body. In the present study, the application of different loads in strength training lasted only 1-3 weeks, a period relatively limited for production of significant alterations in power. Komi[30] suggests that strength training programs designed to increase strength and power should last at least four weeks to produce neuroendocrine adjustment.

Another important point about a correlation between the jumping tests and throws performed in the beginning of the week with those which were performed on the last day of each micro cycle should be mentioned. This finding reveals that there is no need to evaluate power of upper and lower body more than once a week, especially when the aim involves finding a parameter for monitoring of athletic performance.

Practical applications

The results of the present study let us conclude that: 1) subjective indices of tiredness and training load present significant alterations concerning one macrocycle, presenting good sensitivity for training monitoring; 2) variation of weekly load (monotony) is an important tool in the control of athletic stress, as a result its high correlation with strain; 3) observers should weekly monitor objective parameters, since they respond to training alterations; 4) evaluation of power may occur once a week, preferably as a follow-up of the effects of a previous week. Finally, further studies should be carried out in order to better understand the training variables in a macrocycle, to boost training monitoring and optimize loads in different sports. Researchers may easily monitor the power of upper limbs simply by making subjects throw a medicine ball to understand the alterations in percentage variables during the training process.

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