RBCDH Brazilian Journal of KINANTROPOMETRY and Human Performance

DOI: http://dx.doi.org/10.5007/1980-0037.2012v14n6p671

original article

Monitoring of the internal training load in futsal players over a season

Monitoramento da carga interna de treinamento em jogadores de futsal ao longo de uma temporada

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Abstract – There is a need for studies on methods for control of load and description of periodization in futsal teams. The objective of this study was to report and analyze the internal training load in a macrocycle of futsal using the session rating of perceived exertion (session-RPE) method. The sample consisted of 13 athletes of the National League. We calculated the total weekly training load (TWTL), monotony and strain over 37 weeks. Using the paired Student's t Test, the preparation period (PP) showed higher TWTL, strain and monotony than the competitive period (CP). The ANOVA test of repeated measures, followed by the Bonferroni post-hoc test showed significant differences in the TWTL among the mesocycles: 1 > 2, 4, 5, 6, 8, 9; 7 > 4, 5, 8, 9; 2, 3 and 6 > 5, 8, 9; 4 > 5; 8 > 5 ($p<0.05$). The training loads (TL) were higher in the PP with reduction in the CP, with cycles of high load being required during the CP. The TL presents an oscillatory feature, and is adapted to the competition schedule.

Key words: Athletes; High performance; Periodization; Rating of perceived exertion; Team sports.

Resumo – *Existe a necessidade de estudos sobre métodos para controle da carga e descrição da periodização em equipes de futsal. O objetivo do estudo foi descrever e analisar a carga interna de treinamento em um macrociclo de futsal utilizando-se o método de Percepção Subjetiva do Esforço da sessão. A amostra foi composta por 13 atletas de Liga Nacional. Calculou-se carga de treinamento semanal total (CTST), monotonia e strain durante 37 semanas. Utilizando Teste t de Student pareado, o período de preparação (PP) apresentou CTST, strain e monotonia maiores que o competitivo (PC). Utilizando ANOVA de medidas repetidas, seguida pelo post-hoc de Bonferroni, observaram-se diferenças significativas para CTST entre mesociclos: 1 > 2, 4, 5, 6, 8, 9; 7 > 4, 5, 8, 9; 2, 3 e 6 > 5, 8, 9; 4 > 5; 8 > 5 ($p>0,05$). As cargas de treinamento (CT) foram mais elevadas no PP com redução no PC. A CT apresenta uma característica ondulatória, adaptando-se ao calendário competitivo.*

Palavras-chave: *Alto rendimento; Esportes coletivos; Percepção subjetiva do esforço; Periodização.*

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Received: 01 February 2012
Accepted: 22 June 2012

INTRODUCTION

In order to reach an optimal fitness in elite athletes it is necessary to use a periodized training program, based on the precise quantification and adequate distribution of the training load (TL), which results in specific adaptations and performance improvements[1,2]. The Brazilian futsal has an annual schedule characterized by a long competitive period (CP) and a relatively short preparation period (PP), and needs a particular periodization schedule[3-5].

In the current perspective of sports training, the team sports athletes consistently perform in group training activities (e.g. 3x3, 4x4, 5x5 matches) for improvement of the technical skills and tactical basements, which may demand a significant physical effort itself. In such case, the athletes may undergo a similar external load, but the internal load may be different for each one of them[1,6-9]. Thus, studies have pointed to the need of a better understanding of the internal load, which consists in the athlete's physiological response to the stress imposed by the training[9-11], so it can be better distributed in order to offer the appropriate stimulus while avoiding undesirable adjustments[1,10-13]. However, Nakamura et al.[11] state that graphics of load distribution have been frequently reported in the textbooks, but with no explanations of how the loads were quantified.

The use of the session-RPE method has proved to be an effective form to quantify the internal training load[13-17]. This method has shown a significant correlation with other methods based on the heart rate in karate athletes[18], socker[7,9] and basketball players[1]. Furthermore, the session-RPE shows a positive correlation with the blood lactate levels, with the advantage of being considered a global marker of the exercise intensity[6,17-18]. Besides being effective, this method is a low cost and simple strategy for the construction of periodization graphics[1,9,11-13].

However, although the understanding the TL values is recognized as necessary for a better structuring of the periodization based on quantitative data, only few futsal studies have used the session-RPE to control the TL[2]. Furthermore, despite the need of using a particular periodization scheme in this sports modality[2] there is a lack of studies that have monitored a season of training with the session-RPE method, providing information on the magnitude and distribution of the TL[11] used in the contemporary futsal. Thus, the objective of this study was to report and analyze the dynamics of the internal training load of futsal players over a macrocycle using the session-RPE method.

METHODS

Sample

We conducted a prospective descriptive study[19] that included thirteen male athletes (26.9 ± 5,4 years, 73.8 ± 4.7 kg, 1.74 ± 0.1 m and 8.5 ± 2.9 % body fat) from a high performance futsal team – Petrópolis Esporte Clube - a

team that participates on the National League, the most important competition on this sports modality in the country. These athletes had been participating in official competitions for at least five years.

The purposes of the study, as well as the possible risks, were explained to the athletes, who attested their voluntary participation and authorized the use and disclosure of the information. The study was approved by the Research Ethics Committee of Universidade Federal de Juiz de Fora, report nº 266/2010.

Procedures

We analyzed the 37 weeks that comprised the National League (main competition), which consisted of 12 weeks of preparation period (PP) and 25 weeks of competition period (CP). During this period, the team also participated in other less important competitions.

In order to monitor the internal training load we used the session-RPE method[12], in which the training load (TL) was calculated by the product of the intensity, estimated by the 10 points RPE scale adapted by Foster et al.[15], and the training volume, expressed by the total time of the training session in minutes. Thirty minutes after the end of each training session, the athletes should answer to the question "How was your training?" by pointing their answer on the scale.

On days with two training rounds, the TL of the sessions were added, and the total daily load (TDL) was estimated. On days when there was no training, the TDL was zero. In each microcycle, consisting of seven days, we calculated the total weekly training load (TWTL), by the addition of the TDL. For each mesocycle (meso) we estimated the mean of the TWTL.

We also calculated the monotony and strain indices as proposed by Foster[12]. The monotony indicates the load variability between the training sessions, in which high indices can contribute to negative adjustments to the training[12,20-21]. This variable was calculated using the ratio between the mean and standard deviation of the TDL in a week. The strain is also associated with the level of adjustment to the training, in which periods with high load associated with high monotony can increase the incidence of infectious diseases and injuries[21]. This index was calculated by the multiplication of the TWTL and the monotony.

Statistical analysis

When an athlete participated in less than 75% of the training sessions in a week we performed a statistical adjustment using the mean values obtained by the group in the week for that athlete.

We tested the assumptions of normality and homoscedasticity of the data using the Shapiro-Wilk and Levene tests, respectively. With the parametric assumptions of the most variables met, we tested the differences among the means of the TWTL, Monotony and Strain of the 9 mesocycles using the ANOVA of repeated measures, followed by the multiple comparisons of the means with the Bonferroni correction. The assumption

of sphericity was corrected by the Huynh-Feldt epsilon. The differences between the means of the periods were tested using the t-Student test for paired samples. The data are presented as mean ± standard deviation. All the data were analyzed using the SPSS software (v.16, SPSS Inc, Chicago, IL), considering a significance level $\alpha = 0.05$.

RESULTS

Over a season we found the mean values of 1879±754 (440 to 3215 A.U.), 1.13±0.31 (0.49 to 1.61 A.U.) and 2270±1294 (213 to 4771 A.U.) for the TWTL, Monotony and Strain, respectively. Tables 1 and 2 show the values of the internal load for each mesocycle and week of training. Figure 1 shows the DTL over the season.

The mean values of the TWTL (t_{12}=6.465; p=0.000), Monotony (t_{12}=2.430; p=0.03) and Strain (t_{12}=5.675; p=0.000) were higher in the PP compared with the CP (TWTL: 2279±312 vs. 1687±202 A.U.; Monotony: 1.18±0.10 vs. 1.11±0.08 A.U.; Strain: 2764±535 vs. 2032±292 A.U.).

Table 1. Description of the main features and internal load of futsal players in each mesocycle over a season.

Mesocycles	1	2	3	4	5	6	7	8	9
Main objectives	MS-R	EP-V	V-TT	TT-Re	TT-Re	TT-R	TT- V	TT-Re	TT-Re
Nº Weeks	4	4	4	4	4	4	4	6	3
Matches	0	0	2	9	9	8	6	12	2
Period	PP	PP	PP	PC	PC	PC	PC	PC	PC
TWTL	2509±332	2165±311	2163±442	1724±345$^{\dagger\#}$	1170±217$^{\dagger\#\$*}$	2027±269†	2313±419	1474±228$^{\dagger\#\$}$	1464±357$^{\dagger\#\$}$
Monotony	1.07±0.8†	1.17±0.10	1.30±0.15	1.26±0.17	0.96±0.10$^{\dagger\#\$*}$	1.16±0.14	1.21±0.10	1.06±0.10†*	0.99±0.14$^{\dagger\#\$*}$
Strain	2760±474	2591±491	2941±832	2223±666$^{\#}$	1196±275$^{\dagger\#\$}$	2461±617	2995±635	1640±301$^{\dagger\#}$	1824±605$^{\dagger\#}$

R= resistance; MS= maximal strenght; EP= explosive power; V= velocity; TT= technical-tactic; Re= recuperation between matches; TWTL: †lesser than meso 1; $^{\#}$lesser than mesos 2, 3 and 7; $^{\$}$lesser than meso 6; *lesser than meso 4; Monotony: †lesser than mesos 3 and 4; $^{\#}$lesser than meso 2; $^{\$}$lesser than meso 6; *lesser than meso 7; Strain: †lesser than mesos 1, 2 and 6; $^{\#}$lesser than meso 3 and 7; $^{\$}$lesser than meso 4 ($p<0.05$).

Table 2. Description of the internal load of futsal players in each week over a season.

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
TWTL	2732	2783	2703	1818	1936	1699	2667	2361	2382	2401	1742	2126	1622	1730	1957	1590	1367	1292	1243
SD	426	434	356	412	457	459	404	327	506	564	490	557	304	391	414	427	421	327	336
Monotony	1.07	1.17	1.16	0.9	1.16	1.11	1.25	1.13	1.32	1.61	1.00	1.26	1.23	1.43	1.21	1.17	1.09	1.11	0.97
SD	0.06	0.12	0.14	0.11	0.18	0.24	0.12	0.12	0.25	0.32	0.09	0.31	0.26	0.26	0.20	0.15	0.16	0.18	0.20
Strain	2924	3287	3159	1672	2326	1990	3346	2701	3233	4001	1744	2787	2030	2535	2437	1894	1517	1456	1253
SD	449	722	620	482	793	814	634	579	1147	1481	513	1193	635	952	875	681	596	530	592
Week	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
TWTL	779	2051	2638	2155	1264	2268	2052	1723	3213	1644	1187	1983	1531	1406	1097	2505	1448	440	
SD	297	354	491	339	402	595	471	752	910	495	373	296	423	327	369	616	442	234	
Monotony	0.67	0.83	1.39	1.36	1.07	1.23	1.35	0.8	1.47	1.17	0.82	1.32	1.09	1.07	0.8	1.41	1.07	0.49	
SD	0.10	0.11	0.28	0.25	0.18	0.19	0.28	0.18	0.19	0.34	0.18	0.21	0.20	0.19	0.12	0.27	0.18	0.06	
Strain	557	1730	3781	2941	1394	2831	2869	1510	4771	2031	1025	2638	1716	1520	910	3641	1618	212.7	
SD	308	447	1408	755	555	945	1109	1054	1570	1131	456	642	636	510	387	1161	711	118	

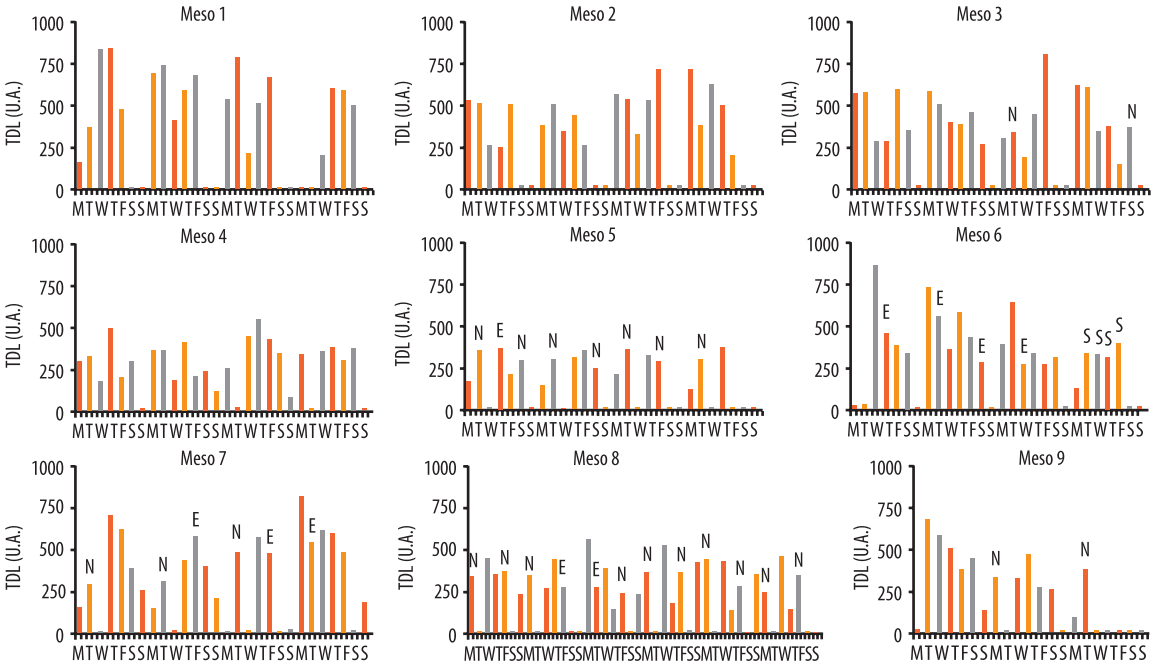

Figure 1. Distribution of the Daily Training Load (mean) of futsal players over a season (Legend: M,T,W,T,F,S,S, = Days of the week in sequence from Monday to Sunday; TDL = Total daily load; N = National League matches; E = State Championship; S = Southest league).

We observed the application of high daily loads throughout the PP, usually followed by days with no training in the weekends. During the CP, the days without training usually followed the days of matches of the National League. This strategy of variation of the training loads aimed the psychological and physiological recovery of the athletes, and was important for the maintenance of low levels of Monotony. Another relevant point is the high daily loads observed in some games of the State Championship, consequent to the application of training sessions with considerable load in the morning period. Such procedure was adopted taking into account that those games were not the main objective at that time. Furthermore, we observed that along the CP the TWTL showed a gradual decrease until week 20, when it reached its lowest values. From that point on, the loads tended to alternate and reached their maximal values at week 28.

When we analyzed the pattern of the TWTL along the mesos, we observed similar loads in the first 3 mesos, followed by a decrease in meso 4. Meso 5 showed a decrease in load, with an increase in meso 6 and maintenance in meso 7. In meso 8 the load decreased again, and kept stable in meso 9.

DISCUSSION

The main finding of this study consists in the description of the dynamics of the internal training loads using the session-RPE method, which presented an oscillatory pattern, particularly in the second half of the season as a form of adaptation to the competition schedule. Furthermore, the athletes underwent a high TL during the PP, and a further reduction in

the beginning of the CP. However, due to the long duration of the CP in futsal, high loads were used in the periods with fewer matches regarding the main competition, aiming to maintain physical fitness.

Our results showed that the PP had a higher TL in comparison with the CP. We observed that the pattern of load distribution and the objectives outlined in the mesocycles (Table 1) are similar to the concepts of block periodization, which proposes a methodological sequence with a general mesocycle focused on the coordinated and aerobic training, a specific mesocycle aiming the development of the specific energetic mechanisms and competitive velocity, and a competitive block with load decrease that culminates in the competition, usually followed by a short recovery period [4,5].

We observed that the objectives shown in Table 1 follow this methodology, besides applying a high TL in the first three mesocycles, which imposes an imbalance to the athlete's homeostasis. Later, in the beginning of the competitive season, there is a load reduction in meso 4 to provide an over-compensation to the organism and, consequently, an improvement in performance[3-5]. Meso 5, finally, has a low TL with the main objective of recovery, in which the athletes consistently perform regenerative trainings (such as running or recreational activities, both with low intensities) in the intervals between the matches.

The pattern of load distribution in the CP showed the choice for a new application of high TL in the mesocycles 6 and, particularly, in the mesocycle 7, which has similar loads to the mesos 1, 2 and 3. We also observed that these mesos with higher loads had larger magnitudes of daily loads. This occurs as a consequence of the choice for a training prescription that may possibly be explained by the long duration of the competitive season, and because the improvements in the physical and sportive fitness obtained in the PP cannot be maintained throughout this period. Furthermore, a detailed observation of the TWTL (Table 2) shows that it presents a variable pattern, specially in the second half of the season, which is similar to the TL of a Japanese running athlete[5,21].

This dynamics of the TL confirms the findings of the literature, which emphasize the need for a particular periodization for team sports, which must be adapted to the competition calendar[3,5]. One of the singularities observed in this study consists in the use of a high TL in the first weeks of the PP, with no progressive increase, which may be related to the poor initial fitness of the athletes, resulting in a higher internal load[6]. Another particular feature is the large oscillation of the load along the CP, mainly in the second half of the season, when in weeks with only one or no games of the main competition it was possible to apply higher TL , with a decrease in the TL in the weeks with more games.

Our findings show that during the PP the TWTL were high in the three mesocycles. These values of the TL were close those observed along 6 weeks of intensive training of rugby players, with the loads applied ranging from 1391±160 to 3107±289[14], and from 1387±105 to 3296±298 A.U.[22]. The TWTL are also similar to those reported by Milanez et al.[6] for futsal players in the

state championship during three weeks of a PP (2994, 2886 and 2969 A.U.). These values, however, are slightly lower than those found for basketball players during one week with no competitive matches - 3334±256 A.U.[1]. Such difference may be explained by the methodology used in the study by Manzi et al.[1], which used the total time of the session, including the resting period between the activities. Regarding the CP, we observed that our values are similar to those reported by Manzi et al.[1] in two competitive weeks of basketball, with TL of 2928±303 and 2791±239 A.U.

Figure 1 shows the oscillation that occurred in the TDL (alternating between high loads and recovery days) in the different training weeks, which contributed to the low monotony observed. Foster et al.[23] suggest that monotony values > 2.0 can contribute to the development of the overtraining syndrome. In the present study we observed that, during the season, this index reached its maximum value of 1.61±0,3 at week 10. Furthermore, the monotony along the season showed means and oscillation similar to the monotony pattern of a 400 meter athlete reported by Suzuki et al.[21]. We also noted that, over the season, the strain index reached its maximum value of 4771.4±1570 at week 28, and was lower than that reported by Foster[12] as the lower threshold that favors the development of diseases (6000 AU).

The high degree of load variability, as shown by the low levels of monotony, suggests an adequate distribution of the TL along the season, and despite the high TWTL imposed on the athletes, we observed that the level of strain was not high. This possibility of applying high TL, since appropriately distributed, may have been a major factor for the team to reach the pre-set objective of being among the 8 best rated teams in the national competition. This fact once again emphasizes the need of a judicious and scientific control of the training load, as well as the importance of its adequate distribution. Nevertheless, we found few studies[12,20-21] that addressed this issue and that evaluated the values of monotony and strain, making comparisons difficult.

A limitation of this study consists on the subjectivity of the method, which requires experience and sincerity of the subjects. The use of objective methods for quantification of the internal load (e.g. pulse of training based on the heart rate) could have strengthened this study. It is noteworthy, however, that the validity of the method has been proved in prior studies[7,9,11-12]. Another limitation is the lack of performance assessments, considering that these data would allow a better understanding of the real needs of the application of new cycles with high TL.

Further studies that control and report the internal training load in futsal using this method are necessary to allow a better discussion about the behavior of the load in this modality. Also, studies that correlate the load behavior with performance are needed.

CONCLUSIONS

We conclude that the dynamics of the internal load of training was reported

using the session-RPE method, which presented an oscillatory feature, especially in the second half of the season as a form of adaptation to the competition calendar. Besides, the athletes underwent a high TL in the PP and a subsequent reduction in the beginning of the CP. However, due to the long-term of the CP in futsal, it was chosen for the application of high loads in the periods with lesser games in the CP, aiming the maintenance of physical fitness. The monotony was controlled throughout the study period, which led to low values of strain.

The present study is also one of the first to report reference values of TL for futsal players based on the session-RPE method, and may be used as reference for future trainings planning.

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