Profile of Weekly Training Load in Elite Male Professional Basketball Players

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Abstract

Manzi, V, D'Ottavio, S, Impellizzeri, FM, Chaouachi, A, Chamari, K, and Castagna, C. Profile of weekly training load in elite male professional basketball players. *J Strength Cond Res* 24(5): 1399–1406, 2010—The aim of this study was to examine the training load (TL) profile of professional elite level basketball players during the crucial parts of the competitive season (pre–play-off finals). Subjects were 8 full-time professional basketball players (age 28 $\pm$ 3.6 years, height 199 $\pm$7.2 cm, body mass 102 $\pm$ 11.5 kg, and body fat 10.4 $\pm$ 1.5%) whose heart rate (HR) was recorded during each training session and their individual response to TL monitored using the session-rate of perceived exertion (RPE) method (200 training sessions). The association between the session-RPE method and training HR was used to assess the population validity of the session-RPE method. Significant relationships were observed between individual session-RPE and all individual HR-based TL (*r* values from 0.69 to 0.85; $p < 0.001$). Coaches spontaneously provided a tapering phase during the competitive weeks irrespective of the number of games played during it (i.e., 1 or 2 games). The individual weekly players' TL resulted in being not significantly different from each other ($p > 0.05$). Elite male professional basketball imposes great physiological and psychological stress on players through training sessions and official competitions (1–2 per week). Consequently, the importance of a practical and valid method to assess individual TL is warranted. In this research, we demonstrated that session-RPE may be considered as a viable method to asses TL without the use of more sophisticated tools (i.e., HR monitors). The session-RPE method enabled the detection of periodization patterns in weekly planning in elite professional basketball during the crucial part of the competitive season (1 vs. 2 weekly fixtures model).

Key Words periodization, team sports, conditioning, fitness assessment, heart rate

Introduction

Professional Basketball has been reported to impose important physiological loads on players during competition (39). Consequently, physical conditioning is considered as a prerequisite to compete at elite level in modern basketball (1,4,46,48,50).

To increase the fitness level of athletes, the training loads (TLs) should be accurately prescribed to induce sport-specific physiological adaptations (23,24,32). Many studies have stressed the importance of varying the daily and short-medium term TLs (i.e., alternation of hard and easy periods of training) to achieve optimal performance (16,20,21,47). Given that, coaches and fitness trainers periodize their training interventions to achieve the set performance goals (17,34,43,44,51).

Recently, a number of descriptive studies analyzed the volume vs. intensity distribution of TLs in endurance sports. These studies showed evidence for a sport-specific pattern in TL distribution in endurance sports (i.e., long distance, cycling, and cross country skiing) (5,21,47). Furthermore, training interventions showed that when equated for individual responses low-intensity (i.e., below anaerobic thresholds zone) training were more effective than medium-intensity training (i.e., within anaerobic thresholds zone) provided that the contribution of high-intensity training remains sufficient (20).

Differently from endurance sports where TLs are prescribed on individual bases, in team-sports TLs are often similar for each player because of the extensive use of group drills (24). Consequently, the training response (internal load) to a given imposed load (external load) may result in being different among players (24,32). This occurrence is of importance for the coach and fitness trainer because extreme training responses (i.e., low or excessive responses) may result in training maladaptations (12,14,15). In this regard, the assessment of

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the internal load could result in being helpful to guide the training process in team sports (24,32).

Although many studies examined the game demands and the fitness profile of elite basketball players in the international literature (1,3,8–10,25,27,30,37–39,41,42,45,46,52), no research addressed the weekly TL distribution of professional basketball players during the competitive season. Therefore, the purpose of this study was to examine the profile of the individual response to TLs of elite professional male basketball players during the competitive season. It was hypothesized the existence of a marked individual response to training among basketball players (24).

Methods

Experimental Approach to the Problem

In the present investigation, an objective descriptive design was used (53). Indeed, the real evaluation of the TL (i.e., volume and intensity) experienced by each player was monitored according to coach prescription without any external intervention (e.g., sport scientist advice). The players internal load was assessed using the session-rate of perceived exertion (RPE) method according to Foster et al. (24). The session-RPE method showed to be a valid method to assess internal load in male college basketball players and in young soccer players (24,32). However, the applicability of this method to quantifying exercise training during a variety of training types of exercise was not tested in professional basketball players. Therefore, the first concern of the authors of this study was to assess the population validity of the session-RPE method in professional highly competitive basketball players. It was assumed that the mainly high-intensity demands (i.e., anaerobic domain) imposed on professional basketball players (28) could possibly alter the relationship between heart rate (HR) and RPE (24).

Validity was assessed as association between session-RPE and training HR (22–24,32). The session-RPE responses were also compared with 2 objective HR-based methods, described by Edwards (19) and Banister et al. (2), assumed as the criterion validity (32). The evolution of the TL profile of these professional basketball players was examined during the most crucial part of the competitive season (1e month before play-off tournament) where players were gaining success in the regular season (ranked second). As elite professional basketball teams are involved in cup tournament during the regular season, the weekly TL profile of the players in this study was assessed during 2 typical weekly microcycles with 1 or 2 competitions fixtures. For comparison, the different 2 weekly TL profiles (i.e., training microcycles) were studied against an average training week where no competitions took place (control microcycle). Reliability of the session-RPE method was assessed before the commencement of the observational study as intraclass class correlation coefficient and coefficient of variation. The corresponding values were 0.95 and 1%, respectively.

Subjects

The subjects of this study were 8t first division (Lottomatica Virtus Basket Roma, Serie A1–first/elite division) full-time professional players (age 28 ± 3.6 years, height 202 ± 7.9 cm, body mass 102 ± 11.3 kg, and body fat 11.0 ± 1.4%). Players' performance on the Yo-Yo Intermittent recovery test at the time of the study was 1,945 ± 144 m (8). Players were observed in-season (12 weeks) during the 2006–2007 Italian Serie A1 Basketball Championship. At the time of the investigation, players had at least 6 years of experience in the current competitive level. All players were starters and during the course of the investigation played similar game time (10,35). Before the commencement of the study, all subjects received written and verbal explanations of the procedure involved in the study informing them of all risks and benefits associated with participation, and written informed consent

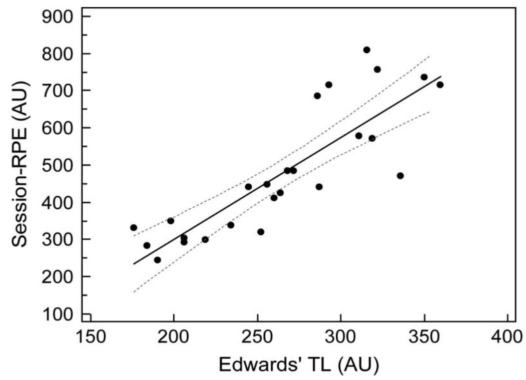
Table 1. Training activities undertaken by players during the championship weeks monitored.

Day	Training activity: No game	1 Game	2 Games
Monday	Technical/tactical	Rest	Rest
Tuesday	Strength training + technical	Strength training + technical	Explosive weights + technical
Wednesday	Technical/tactical	Technical/tactical	Tactical
Thursday	Explosive weights + technical	Explosive weights + technical	Game
Friday	Technical/tactical	Technical/tactical	Tactical
Saturday	Tactical	Tactical	Technical/tactical
Sunday	Rest	Game	Game
Weekly load	3,334	2,928	2,791
Monotony (mean weekly load/*SD*)	1.70	1.59	1.62
Strain (load × monotony)	5,678	4,666	4,534

Table 2. (A) Individual relationship between session-RPE TL and Edwards TL method ($n = 25$); (B) individual relationship between session-RPE and Banister et al. method (TRIMP, $n = 25$).*

	r	CI (95%) upper − lower	$p<$
A. Edwards' TRIMP vs. session-RPE TL			
S1	0.69	(0.87–0.33)	0.001
S2	0.83	(0.93–0.59)	0.0001
S3	0.83	(0.93–0.62)	0.0001
S4	0.81	(0.92–0.62)	0.0001
S5	0.80	(0.91–0.57)	0.0001
S6	0.83	(0.93–0.59)	0.0001
S7	0.77	(0.89–0.54)	0.0001
S8	0.85	(0.93–0.68)	0.0001
B. Banisters' TRIMP vs. session-RPE TL			
S1	0.70	(0.88–0.34)	0.001
S2	0.78	(0.92–0.50)	0.0001
S3	0.80	(0.92–0.54)	0.0001
S4	0.75	(0.88–0.51)	0.0001
S5	0.75	(0.89–0.48)	0.0001
S6	0.82	(0.93–0.57)	0.0001
S7	0.78	(0.90–0.56)	0.0001
S8	0.81	(0.91–0.62)	0.0001

*TL = training load; RPE = rate of perceived exertion.



Edwards' TL *vs* Session-RPE TL			
r	CI (95%) Upper - Lower	$P<$	Effect size
0.85	(0.93 - 0.68)	0.0001	0.64

Figure 1. Relationship between session-rate of perceived exertion training load (TL) and Edwards TL method (pooled data $n = 200$, $r = 0.85$, $p < 0.0001$, 95% CI 0.93–0.68, effect size 0.64).

was obtained from all of them. The study was approved by the local Institutional Review Board before the start of the study. All the procedures involved in this study were in accordance with the Declaration of Helsinki.

Procedures

The HR and subjective perception of effort as session-RPE were assessed in each player (i.e., for each training session) for 12 weeks during the regular competitive season (from February to April). Heart rates were recorded (5-second sampling rate) using short-range telemetry (Polar Team System, Polar Electro Oy, Kempele, Finland). According to Krustrup et al. (36), exercise maximal HR was assessed in each player using a basketball-specific endurance field test (8) such as the Yo-Yo Intermittent recovery test (level 1). The mean HR recorded during the pretraining briefing before each training session was used as rest HR (2).

After every training session, HR data were downloaded on a laptop computer (Acer Aspire 5000, Hong Kong, China) using the specific software (Polar Team System, Polar Electro Oy, Kempele, Finland) and subsequently exported and analyzed using the Excel software (Microsoft Corporation, USA). Subjects' RPEs were assessed using the Borg 10-point scale modified by Foster et al. (23). Players were educated and familiarized with the use of the Borg 10-point scale, during the 2 weeks before the beginning of the experiment.

To ensure that the perceived effort was referred to the whole training session, each subject's RPE was recorded on an individual basis about 30 minutes after completion of each training session (24,32). Each player reported the subjective perception of training sessions and games effort pointing his

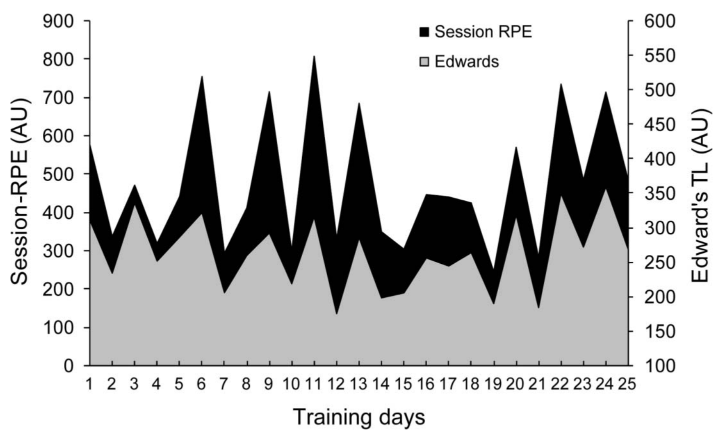


Figure 2. Profile of session-rate of perceived exertion training load (TL) vs. Edwards TL method across the training sessions examined ($n = 200$).

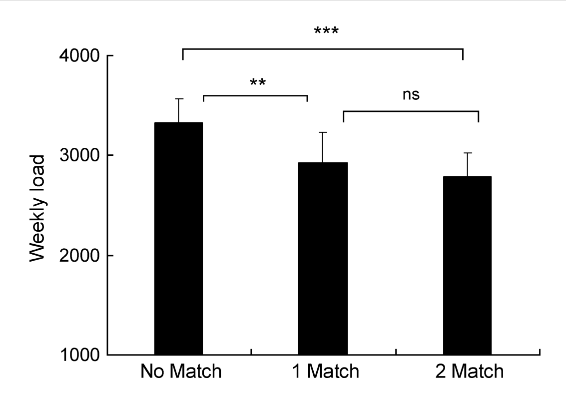


Figure 3. Comparison among weekly training loads during the control (no game) and 1- and 2-games a week training microcycles ($n = 8$, 200 observations).

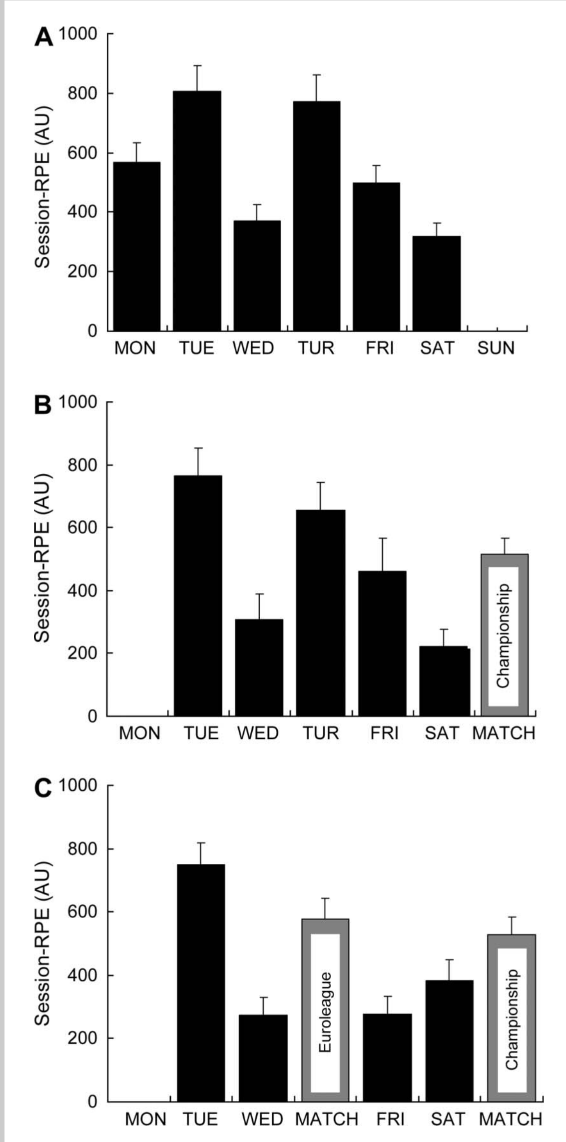


Figure 4. (A) Session-rate of perceived exertion (RPE) training load (TL) profile of the training week that comprised no game ($n = 8$); (B) session-RPE TL profile of the training week that comprised 1 game a week ($n = 8$); (C) session-RPE TL profile of the training week that comprised 2 games a week ($n = 8$).

finger on the Borg 10-point scale. The duration of a session was recorded from the start to the end of the session, including recovery periods. The game session duration (excluding warm-up) was recorded from the start to the end of the game including all stops (game stops, injury stops, time-outs, and in-between quarter-times stops). Data were collected for 2 different weekly training periodizations involving 1 or 2 games per week. As control microcycle, the average TL of 2 training weeks where no competitions were undertaken was used. All the training sessions examined were prescribed by the head coach and fitness trainer of the team with no external training advice (i.e., sport scientist advice).

During this period of the season, most of the physical conditioning training was performed using small-sided games drills. Training usually included 1–2 strength training sessions per week, consisting of circuit weight training (50–80% 1 repetition maximum, Complex training) (18) and explosive power (i.e., plyometrics) training sessions. Training-session duration ranged from 80 to 120 minutes. Details about the weekly training activities are depicted in Table 1. Throughout the period of the study, athletes took part in 16 official matches (i.e., 9 national championship and 7 Euro-league).

Data from 40 training sessions were collected for each player. Field testing sessions were performed on the basketball pitch where players undertook their daily training session.

Statistical Analyses

The results are expressed as means ± *SD*s. Before using parametric tests, the assumption of normality was verified using the Shapiro–Wilk *W* test. Pearson product–moment correlation coefficients with linear regression analysis (and corresponding 95% confidence intervals, 95%CI) were calculated to determine whether there was a significant relationship between session-RPE and the various HR-based TL, and between the Yo-Yo IR1 performance (distance covered) and mean weekly session-RPE.

To assess meaningfulness of correlation coefficients, the effect size (ES) was calculated according to Cohen et al. (11). Effect sizes of 0.8 or greater, around 0.5, and 0.2 or less were considered as large, moderate, and small, respectively.

A mixed model 2 way analysis of variance for repeated measures (week periodization × time) was used to examine difference between weekly TLs. When a significant *F*-value was found, Bonferroni's post hoc test was applied. Significance was set at 0.05 ($p \le 0.05$).

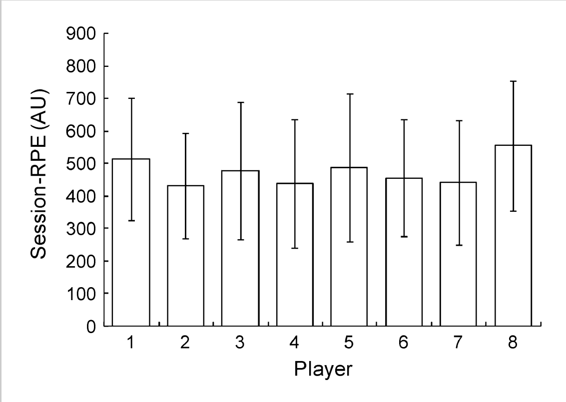


Figure 5. In-between-player comparison of average weekly training load (i.e., pooled data of 1 and 2 games a week microcycles, $n = 8$, 25 observation per player).

Results

The HR-based TL and session-RPE were calculated from 200 training sessions. Significant relationships were found between individual session-RPE and all the HR-based TL (r values from 0.69 to 0.85; $p < 0.001$). Individual correlations are presented in Table 2.

Additionally, a significant correlation between team session-RPE and team Edwards' TL were observed ($r = 0.85$; $p < 0.001$; 95%CI 0.93; 0.68, Figure 1). Figure 2 shows the pattern of session-RPE and Edwards' TL during the 12 weeks of training.

The weekly TL (3,334 ± 256 AU) during the control week (no game) resulted in being significantly different from those accumulated during the 1- or 2-games-a-week microcycles (Figure 3). No significant differences were found in the weekly session-RPE totaled for the 1-a-week and 2-a-week game periodization (2,928 ± 303 vs. 2,791 ± 239 AU, respectively, $p = 0.33$).

The mean session-RPE for Tuesday, Wednesday, Thursday, Friday, and Saturday, were 765 ± 89, 309 ± 80, 656 ± 88, 461 ± 106, and 222 ± 56 AU, respectively ($N = 8$) when the team played 1 match a week. The mean session-RPE TL for the championship games were 522 ± 51 AU. When the team played 2 games a week, the mean session-RPE for Tuesday, Wednesday, Friday, and Saturday were 748 ± 71, 275 ± 54, 276 ± 56, and 384 ± 65 AU, respectively. The mean session-RPE TL for the Euro-league games was 578 ± 67 AU.

A schematic representation of the internal TL profile of the 2 different weekly periodizations is presented in Figure 4. No difference in weekly TL was observed among players in either periodization (i.e., 1 or 2 games a week, $p > 0.05$, Figure 5).

A trend of correlation was detected between The Yo-Yo IR1 performance (distance covered) and session-RPE scores ($r = 0.68$, $p = 0.06$, Figure 6).

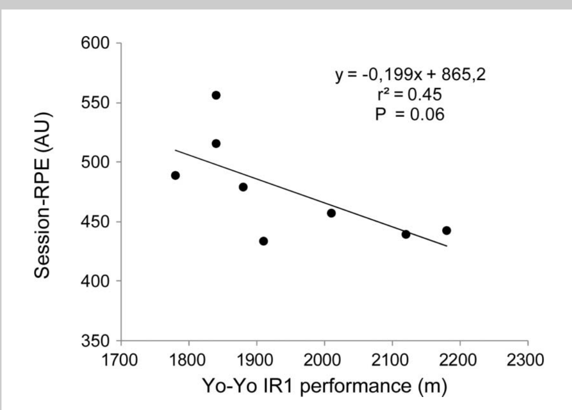


Figure 6. Relationship between Yo-Yo Intermittent recovery test performance and session-rate of perceived exertion training load scores ($n = 8$, 25 observation per player).

Discussion

The main finding of this study was the occurrence of different weekly TL profiles in elite male professional basketball. This difference was related to the number of game played per week. Specifically, when only a week-end game was planned, a clear precompetitive unloading phase was evident (6). This occurrence is similar to what previously reported by Impellizzeri et al. (32) in young soccer players that showed a progressive decrement of the individual response to training approaching the competitive day (i.e., Saturday). When 2 games per week where undertaken the first competitive (i.e., Thursday) task was tackled with a tapering approach similar to that adopted during the 1-a-week game scheme. Although the second pregame TL (Saturday) resulted in being higher than that reported for the single game periodization week, this difference was not significant ($p = 0.77$).

This occurrence may be because of the accumulated fatigue experienced by the players and/or by intervention of coaches. Training schedule analysis showed that the day before the second contest of the week, the team coaches tended to increase the external TL. This possibly is the attempt to compensate for TL lost because of previous tapering strategies (i.e., prefirst game). Because no external intervention was provided (i.e., sport scientist support) for load distribution across the training week, this load pattern may be attributed to coach experience. However, no evidence-based data are currently available on the effect of such a planning strategy on game outcome (6). Controlled research design to determine which is the best, if any, tapering strategy to prepare competition in basketball is warranted (40).

Analysis of load profile distribution across the week showed that during the single game microcycle (i.e., a week-end game), an exponential unloading strategy was used by coaches and fitness trainers (see Figure 3B). This tapering strategy has been reported to be most effective in inducing positive effects on performance in endurance sport (6). Because of the nature of this study (i.e., descriptive design) and the difficulty in assessing performance in team sports (33,49), it is was not possible to test the effectiveness of this tapering strategy. Future studies involving match and time motion analyses and or game simulations (26,29,31) may result in being helpful in assessing the effectiveness of different tapering strategies in basketball (6).

Interestingly, the session-RPE TLs reported by players as a consequence of competitive stress resulted in being lower than that reported by Impellizzeri et al. (32) for soccer postmatches (525–575 vs. 625 AU). Although the players of this study competed at professional level, the game responses seems to evidence sport-specific game demands. However, because session-RPE TLs are time dependent (23,24), difference in game involvement (i.e., substitutions) may have played a role in the lower perception of effort evidenced by the present study basketball players. Indeed, the basketball players were involved for an average total playing time (i.e., live time plus stoppages) (39) of 70 ± 4.8 minutes. In the Impellizzeri et al. (32) study, soccer match session-RPE TLs were calculated only in players that were deemed to play at least 80 minutes per match. This difference in playing time was probably the reason for the lower mean session-RPE TL score reported by the basketball players of this study. In collegiate male basketball players (n = 14, age 20.2 ± 1.5 years, height 191.4 ± 4.9 cm, and body mass 89.3 ± 7.8 kg), Foster et al. (24) reported session-RPE TL score of 744 ± 84 AU for basketball practices and games. These scores are significantly higher than the mean session-RPE TL scores found in this study in professional basketball players and by Dellatre et al. (16) in young cyclists (311.31 AU). Considering the accumulated weekly TL, it is possible to have more detailed information of the actual subjective response to training prescription (31,32). In this study, the weekly TL corresponded to 2,928 ± 303 and 2,791 ± 239 AU ($p > 0.05$) for the 1-a-week and 2-a-week game periodizations, respectively ($p > 0.05$). The weekly TLs experienced by this study basketball players lies within the upper-range of those reported in the international literature that ranges between 1,386 and 3,725 AU for average level and experienced elite endurance athletes respectively (22,23). In young male soccer players Impellizzeri et al. (31) reported mean weekly TL of 3,475 ± 249 AU performing specific (i.e., small-sided games) soccer training during preseason. The weekly TL suffered a significant decrement (from 3,475 ± 249 to 2 798 ± 322 AU, $p < 0.05$) in the Impellizzeri et al. (31) study showing a period dependent (i.e., preseason vs. competitive season) profile of training responses. In this study, the basketball players were observed during the most demanding phase of the basketball competitive season when players were completing the regular season (second place) and preparing to play off finals (fourth final place). This design was used with the assumption that the information gained in this period of the competitive season were more representative of the typical weekly TL development in professional basketball (i.e., functional balance between conditioning and team-skill performance development) (4,39).

Comparison between the weekly internal load over the 2 competitive weeks load profiles showed that despite a different distribution of loads across the training microcycle (7 days) the overall TL remained constant (i.e., training sessions plus games loads). This, despite the weekly TL imposed during actual training sessions (5 vs. 4 sessions for the 1 vs. 2 games week profile, respectively) resulted to be significantly different (2,436 ± 233 vs. 1722 ± 229, $p = 0.001$). This may mean that spontaneously coaches and fitness trainers may impose across the competitive season a similar weekly TL in the attempt not to overload players. This conflicts with the progressive overload principle usually adopted in endurance sports (20–23,47). A possible explanation of this occurrence may be found in that team sports requiring frequent competitive involvements (i.e., 1–3 games per week), the implementation of a progressive TL across the competitive season is perceived by coaches as detrimental. In this regard, the time of the competitive season where the analysis was performed may have surely played a role (i.e., one month before the play-off finals).

The results of the present study showed that the session-RPE TL may be considered as a valid method to assess individual training responses also in professional basketball players. This finding is similar to that previously reported by several authors for endurance athletes (22,23,47) and by Foster et al. (24) and Impellizzeri et al. (32) for college basketball players and young soccer players, respectively. Indeed, the session-RPE score resulted either strongly related to Edward-TL and Banister et al. (32) TRIMP considered as gold standards when assessing TLs. This occurrence once again supports the notion (22–24,32,47) that session-RPE is a viable method to characterize training responses in players even at professional basketball level where either the training or the competitive demands are more likely to be in the anaerobic domain and consequently less dependent on the physiological marker of the aerobic pathway (i.e. HRs) (13). However, recently, several researches have shown that the aerobic involvement during competitive basketball, played at either youth or professional level is higher than was previously thought (3,4,7,39,41). Also, team-sport studies have shown that the session-RPE method is correlated to anaerobic effort markers such as blood lactate (13).

The findings of the present study showed that despite investigating a group of players training, the individual training responses were similar (Figure 5). This challenged our working hypothesis that was logically supported by previously published research on endurance sports (20–23,47). However, no record of physical demands on ball drills was performed (i.e., acceleration deceleration, etc.), and consequently, although the subjective responses were similar, the objective performance may have resulted in being different (20–23,47). Interestingly, a trend was observed between the mean individual session-RPE TL and Yo-Yo IR1 performance indicating that the more endurance-fit players experienced a lower internal TL. This would mean that specific-endurance fitness probably might play a role in response to training in elite basketball with the fittest players performing similar tasks than unfit players with concomitant lower perceived fatigue (8). This issue is of importance in implementing conditioning strategies in basketball, and consequently, further studies are warranted.

In this study, a descriptive nonexperimental design was adopted in the attempt to examine the spontaneous TL distribution in elite professional basketball. Although 200 training sessions were examined, a definitive inference about the TL distribution across the competitive season in professional basketball player requires a randomized trial design.

Practical Applications

Men's professional basketball imposes great physiological and psychological stress on players through training sessions and official competitions (2–3 per week) (39). Consequently, the importance of a practical and valid method to assess individual TL is warranted. In this research, we demonstrated that session-RPE TL may be considered as a viable method to assess TL without the use of more sophisticated tools (i.e., HR monitors). The session-RPE method enabled the detection of periodization patterns in weekly planning in elite professional players during the crucial part of the competitive season (1 vs. 2 weekly fixtures model). Different precompetition tapering strategies were provided by coaches with prevalence of a marked decrement of the TL the day before a championship week-end game with respect to the Euro-league in-week game.

The use of the session-RPE method may represent a valuable tool for basketball coaches and strength and conditioning professionals to plan the training week in accordance to players' subjective responses (24,32). This may result in a practical (i.e., just asking "How was your workout?" 20–30 minutes after training) and inexpensive way to profile the weekly TLs taking into account the subjective responses to training (i.e., TL individualization) (24).

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