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Quantification of Perceived Effort in Elite Young footballers Throughout a Season

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Abstract

Objective. To analyse the differences between the mean internal load via perceived effort (IL PE) recorded by elite young players throughout a season. *Methodology*. Nineteen Sub-19 footballers belonging to a professional club participated in the study. The players were classified into regulars and reserves. The competitive period was divided into 2 periods, 5 blocks and 30 micro-cycles *Results*. The IL PE was significantly higher during period 2 ($p < .01$; ES = 0.35; low) than during period 1 among the regulars. Furthermore, the IL PE recorded in block 3 was significantly lower ($p < .05$; ES = 0.79; moderate) than in block 5 in the regulars. Finally, significant differences were found in the IL PE of the different types of micro-cycles in both regulars and reserves ($p < .01$; ES = 0.68-1.94; moderate-high). *Conclusions*. The results show that the IL PE remains relatively stable throughout the season in young footballers; however, weekly results may vary according to the type of micro-cycle, bearing in mind the location of the previous and subsequent matches.

Keywords: timing, training load, subjective perception of effort, play time, football

Introduction

The timing of training is an essential strategy to improve footballers' performance throughout the season (Malone et al., 2018; Sparks et al., 2017). However, this is a complicated task given that a host of factors (technical-tactical, psychological and conditional) can influence the attainment of optimal performance. Nonetheless, it has been proven that accumulation of the weekly training load may be associated with an improvement in performance (Jaspers et al., 2017). Furthermore, it has been observed that an appropriate distribution of the load may reduce injury rate (Gabbett, 2016). Therefore, quantifying may be a useful strategy to ascertain the distribution of loads throughout the micro-cycles during the season.

Objective methods have been used to determine the training load in football, such as global positioning devices (GPS) (Malone et al., 2015), which provide information on physical parameters (total distance run, distance run at different speeds, number and magnitude of accelerations, decelerations and changes in direction), or heart rate (HR) monitors (Lacome et al., 2018), which provide information on HR (maximum HR, mean HR and time between different intensity zones). Furthermore, more subjective methods have been used, such as perceived effort (PE), which sheds light on the internal load (IL) recorded by the players. This tool is readily accessible, relatively easy to use and does not require excessive time to process the data (Los Arcos et al., 2014), in addition to having previously been validated for use with footballers (Impellizzeri et al., 2004). Despite this, few studies have used it to ascertain load distribution throughout the season (Los Arcos et al., 2017; Malone et al., 2015, 2018) and it would therefore be interesting to gain further knowledge of it in order to show the possible variations in PE stated by the players according to the different times in the season.

Ascertaining the distribution of IL through PE (IL PE) throughout the micro-cycles, blocks and periods of a season could be interesting in order to optimise training and apply specific recovery protocols at each point in the season. Some studies have shown that the IL PE remains relatively stable throughout the competitive period in senior footballers, with minor differences between periods (Los Arcos et al., 2017; Malone et al., 2015). However, research that addresses this aspect in young players is needed.

Therefore, the main objective of this study was to analyse the differences between the mean internal load via perceived effort (IL PE) recorded by elite young players throughout a season.

Methodology

Participants

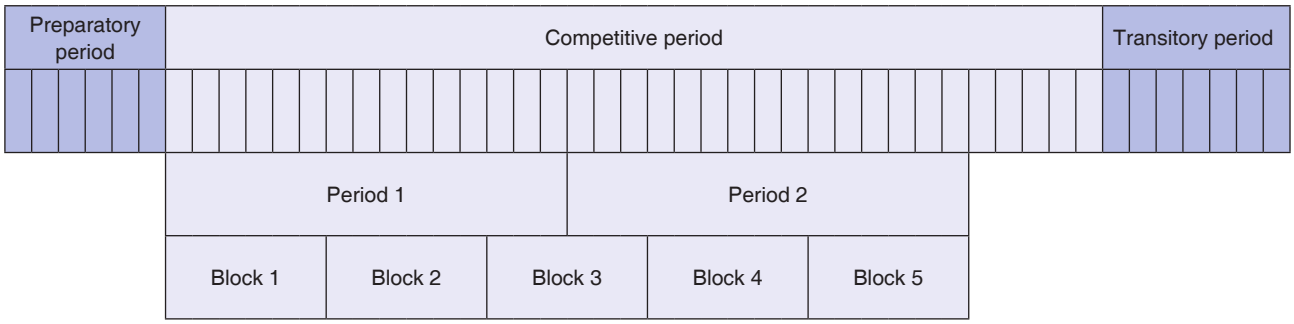
Nineteen elite young footballers (age: 18.5 ± 0.5; height: 178 ± 6 cm; weight: 72.1 ± 6.3 kg; body mass index (BMI) 21.8 ± 1.7 kg $\cdot$ m^{-2}) belonging to the same youth football team (Sub-19, with 5 ± 4 years of experience in the club) from a Second Division football club in Spain participated in this study. The players trained 4 times per week and played the official matches at weekends (Saturday or Sunday). The team comprised 3 goalkeepers, 7 defensive players, 8 midfielders and 4 forwards. The goalkeepers were excluded from the subsequent analyses due to their role in training and matches. Before starting the study, all the participants were informed of the research protocol and they all signed informed consent forms, as did the parents or legal guardians of players under the age of 18. The study followed the guidelines set forth in the Helsinki Declaration (World Medical Association, 2013), was approved by the Ethics Committee at the University Isabel I (CEI004) and was conducted following the ethical standards established for sport science and exercise research (Harriss & Atkinson, 2015).

Procedure

The declared PE of the players was collected for 120 sessions and 30 official matches in the 2016-2017 season (September-May). The players were classified into two groups: 1) regulars, those who started the match and played at least 45 minutes ($n = 291$ observations), and b) reserves, those who did not participate in the match or did so for less than 45 minutes ($n = 201$ observations). The season was divided into two parts: period 1 (first round of competition, 15 matches and 60 training sessions) and period 2 (second round of competition, 15 matches and 60 training sessions). Furthermore, each period was divided into five 6-week blocks, which in turn were broken down into 30 micro-cycles (Figure 1). The weeks when the team was not playing in official competition were excluded from the subsequent analyses (around Christmas), as were players who were not available for some of the training sessions.

With the goal of comparing the PE declared by the footballers between the micro-cycles, taking competition as the reference, four types of micro-cycles were recorded: 1) Saturday-Saturday (M1, 7-day micro-cycle, 6 cases); 2) Saturday-Sunday (M2, 8-day micro-cycle, 6 cases); c) Sunday-Saturday (M3, 6-day micro-cycle,

Figure 1
Experimental design scheme used in this study



5 cases); and 4) Sunday-Sunday (M4, 7-day micro-cycle, 13 cases). The distribution of the technical-tactical and conditional contents in each type of micro-cycle is shown in Table 1.

Mean internal load via perceived effort (IL PE)

The IL PE of the training was measured using the method used by Foster et al. (2001). Ten minutes after the end of each training session, each footballer was shown the RPE scale from 0-10 (Foster et al., 2001), and the player declared a value which was later multiplied by the total length of each training session. The players answered the question, "How hard was the training?", always asked by the same person (physical trainer of the team) (Los Arcos et al., 2017). The players declared their PE randomly, without the presence of their peers and with access to the values stated by their peers restricted. The players acquainted themselves with the use of the PE scale during the preparatory period. The length of the training was recorded individually from the start of the training session (including warm-up and recovery periods) until

Table 1
Distribution of the technical-tactical and conditional contents in each type of micro-cycle

	Previous match		Weekly trainings					Next match	
	SA	SU	M	T	W	TH	F	SA	SU
M1	M	D	Recovery and prevention (regulars) Compensatory work (reserves) (50-70 min)	R	PP and AP in a small space (75-90 min)	PP and PA in a medium-large space (75-90 min)	AP in a small space, SPM (50-60 min)	M	R
M2	M	D	Recovery and prevention (regulars) Compensatory work (reserves) (50-70 min)	R	PP and AP in a small space (75-90 min)	PP and PA in a medium-large space (75-90 min)	AP in a small space, SPM (60-70 min)	R	M
M3	R	P	Recovery and prevention (regulars) Compensatory work (reserves) (50-70 min)	R	PP and AP in a small space (75-90 min)	PP and PA in a medium-large space (75-90 min)	AP in a small space, SPM (50-60 min)	M	R
M4	R	P	Recovery and prevention (regulars) Compensatory work (reserves) (50-70 min)	R	PP and AP in a small space (75-90 min)	PP and PA in a medium-large space (75-90 min)	AP in a small space, SPM (60-70 min)	R	M

Note. M: match; R: rest; M1: Saturday-Saturday micro-cycle; M2: Saturday-Sunday micro-cycle; M3: Sunday-Saturday micro-cycle; M4: Sunday-Sunday micro-cycle; AP: actions performed; PP: position play; SPM: set-piece moves.

its end (excluding cool-down exercises), as in previous studies with elite young footballers (Los Arcos et al., 2017).

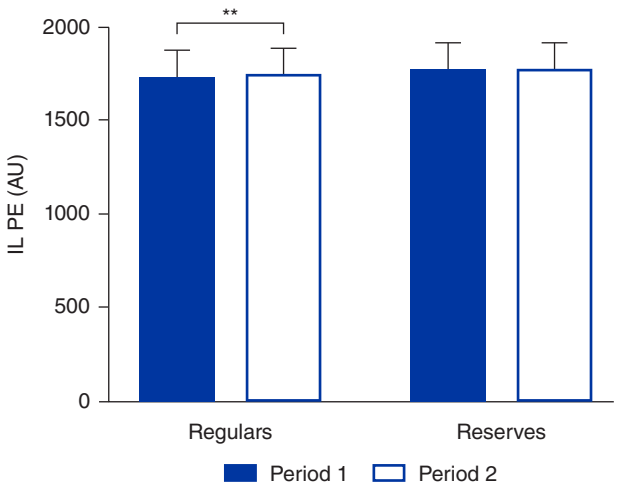
Statistical Analysis

The results are presented as mean ± standard deviation. A *t*-test for independent samples was used to compare the IL PE in different periods in the season between regulars and reserves. Furthermore, a repeated measures ANOVA was used with the post-hoc Bonferroni adjustment to compare the IL PE between the different parts of the season, as well as between the different kinds of micro-cycles (e.g., M1, M2, M3 and M4) independently for each group (regulars and reserves). In order to ascertain the magnitude of the differences for practical purposes, the effect size (ES) was calculated using Cohen's *d*-statistic, and its interpretation followed these criteria: trivial, under 0.2; low, between 0.2 and 0.5; moderate, between 0.5 and 0.8; high, higher than 0.8 (Cohen, 1988). The statistical analysis was performed with the *Statistical Package for Social Sciences* (SPSS® Inc, version 24.0 Chicago, IL, USA) software. The level of statistical significance was set at $p \leq .05$.

Results

The regulars recorded a similar IL PE during the training sessions (ES = 0.11; trivial) to what the reserves recorded (1785.00 ± 173.97 vs. 1765.86 ± 138.05 AU).

Figure 2
Mean internal load via perceived effort (IL PE) between periods 1 and 2 of the season in regulars and reserves

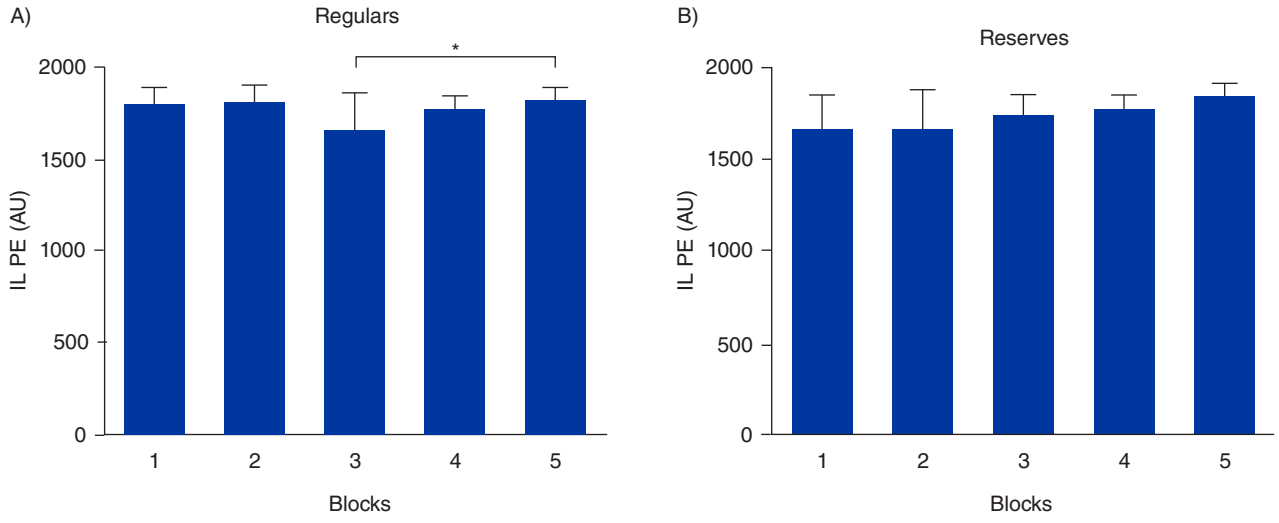


* Significant differences (p <.05); ** Significant differences (p <.01).

The IL PE recorded by the regulars was significantly higher ($p < .01$; ES = 0.35; low) in period 2 (1786.70 ± 136.51 AU) than in period 1 (1732.73 ± 153.03 AU). In contrast, these differences were not found in the reserves (ES = 0.22; low). Furthermore, no significant differences were found in the IL PE recorded by regulars and reserves in the periods analysed (Figure 2).

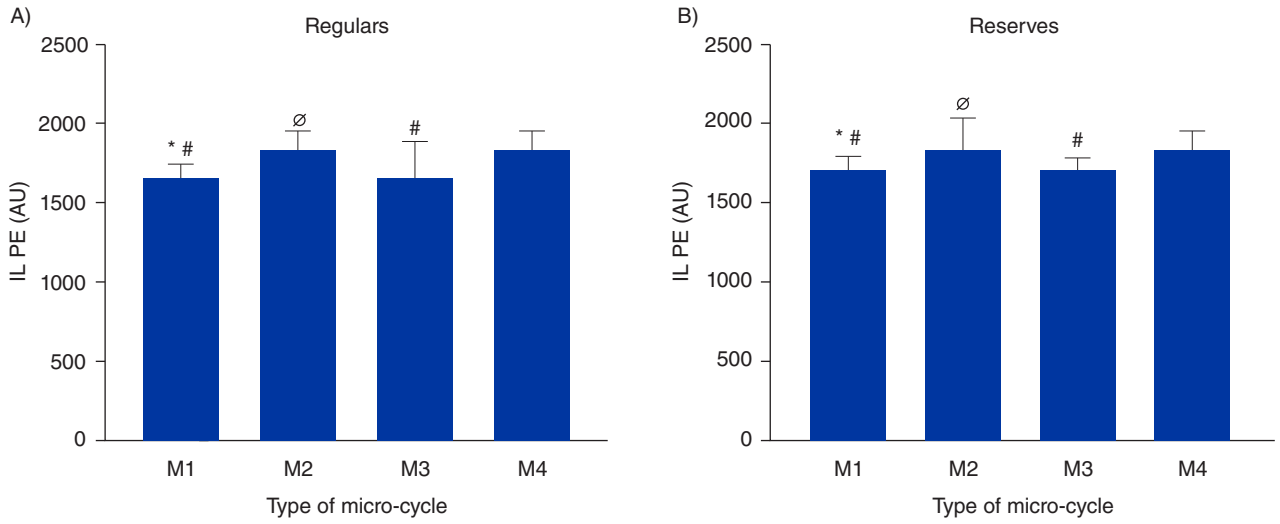
Figure 3 shows the IL PE recorded by the regulars and reserves during each competition block. The regulars recorded a higher IL PE in block 3 than in block 5 ($p < .05$; ES = 0.79; moderate). On the other hand,

Figure 3
Results of the mean internal load via perceived effort (IL PE) in each of the blocks of the season in regulars (A) and reserves (B)



* Significant differences (p <.05); ** Significant differences (p <.01).

Figure 4
Results of the mean internal load via perceived effort (IL PE) in each of the micro-cycles



Note. M1: Saturday-Saturday; M2: Saturday-Sunday; M3: Sunday-Saturday; M4: Sunday-Sunday in regulars (A) and reserves (B).
* Significant differences in the IL PE compared to micro-cycle 2 ($p < .01$); Ø Significant differences in the IL PE compared to micro-cycle 3 ($p < .01$); # Significant differences in the IL PE compared to micro-cycle 4 ($p < .01$).

no significant differences ($p < .05$) were found in the IL PE between the regulars and reserves in the competitive parts.

Figure 4 shows the IL PE recorded by the regulars and reserves in the different micro-cycles. The IL PE was significantly higher in M2 and M4 compared to M1 ($p < .01$; ES = 1.17-1.77; high), in M2 compared to M3 ($p < .01$; ES = 0.68-1.48; moderate-high) and in M4 compared to M3 ($p < .01$; ES = 0.76-1.94; moderate-high) for both regulars (Figure 4A) and reserves (Figure 4B).

Discussion

The objective of this study was to analyse the differences between the IL PE recorded by elite young players in the course of a season. The main results showed that: a) the IL PE recorded by regulars and reserves was similar; b) regulars declared a higher IL PE in period 2 of the season; c) the IL PE was higher in block 5 than in block 3 among the regulars; and d) the IL PE recorded in M2 and M4 was significantly higher than in M3 and M1.

Participating systematically in official competition allows players to maintain and even improve their physical condition level throughout the season (Silva et al., 2011). However, it has been proven that the physical condition of footballers who are not subjected to this stimulus (reserves or those not called up) may be negatively affected (Paraskevas & Hadjicharalambous, 2018). To counter this decrease and thus offset the effects of competition to which the reserves have not been exposed, one strategy commonly used by technical staff is applying compensatory work on the day after a match by the footballers who participated in the previous match for less than 45 minutes (Los Arcos et al., 2017); this was also done in our study by prescribing compensatory work. However, this study found no significant differences in the IL PE recorded by regulars and reserves in the periods, blocks and micro-cycles analysed. These results suggest that the post-match session did not fulfil its intended objectives and that therefore including new training strategies which can replicate the demands required in competition by reserves might be worthwhile.

With the goal of maintaining a high level of physical condition throughout the season, technical staff vary the distribution of training tasks to lower the IL in the second period of the season (Brito et al., 2016). Although the opposite might have been expected, this study found a higher IL PE ($p < .01$; ES = 0.35; low) during period 2 (1786.70 ± 136.51 AU) than period 1 (1732.73 ± 153.03 AU) in the regulars. This shows that cumulative fatigue over the season is associated with higher PE (Moalla et al., 2016). In this sense, it has been demonstrated that young footballers tolerate the same IL worse than senior footballers (Al Haddad et al., 2015), and our study specifically found a higher IL PE towards the end of the season in the

regulars. However, this difference was not found in the reserves, primarily because they had not accumulated the load of official matches, which has been proven to be higher than the micro-cycle (Los Arcos et al., 2017). Similarly, another influential factor seems to be that the compensatory sessions proposed for the reserves did not have the overload effect expected or at least did not replicate the demands of competition.

In terms of the IL PE recorded in each block, this study found no significant differences in either regulars or reserves except that a lower IL PE was recorded in part 3 than in part 5 among the regulars. In this sense, Malone et al. (2015) only found significant differences in the IL in the third block of the season, compared to the first one ($p < .01$, ES = 0.49). Other authors have also found this absence of variations in the IL in professional Sub-23 footballers (Los Arcos et al., 2017). These results seem to demonstrate the existence of a stable IL throughout the season in order to avoid major fluctuations in IL and consequently reduce the risk of injury in footballers (Gabbett, 2016).

Technical staff vary the distribution of IL throughout the season according to the previous and forthcoming fixture schedule in order to reach an optimal physical condition level in the players that guarantees optimal competition fitness (Los Arcos et al., 2017). In this sense, Azcárate et al. (2018) demonstrated that the length of the micro-cycle (e.g., 6-8 days) did not influence the IL PE recorded by footballers. In contrast, this study found significant differences in both regulars ($p < .01$; ES = 0.68-2.00; moderate-high) and reserves ($p < .01$; ES = 1.17-1.98; high) in the different types of micro-cycles analysed (Figure 4). More specifically, it found that the IL PE recorded in M2 (Saturday-Sunday) was significantly higher than in M3 (Sunday-Saturday) and M1 (Saturday-Saturday) for both regulars and reserves. These differences reported in both studies may be due primarily to the footballers' competitive level, since professional teams can adapt their weekly structure to competition, whereas in minor-league football, the training days are predetermined, so only the intensity of each training can be changed according to previous and forthcoming fixtures as a way of modulating training load.

Conclusions

The main results of this study showed a similar IL PE recorded in the regulars and reserves which does not vary substantially throughout the season, although a slightly higher IL PE is recorded in period 2, a moderately higher IL PE in block 5 than in block 5 for regulars, and a higher IL PE in the longer micro-cycles in both regulars and reserves. The results provide valuable information for technical staff who seek to improve the timing of training loads in football and thus optimise training strategies.

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