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In-season training periodization of professional soccer players

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ABSTRACT: The aim of this study was to quantify the seasonal perceived respiratory and muscular training loads (i.e., sRPEres-TL and sRPEmus-TL) completed by elite-oriented young professional soccer players. Twenty-four players (20.3 ± 2.0 years) belonging to the same reserve team of a Spanish La Liga club participated in this study. Only the players that were available to train for a whole week with the team and also to play the weekly game were considered: Starters, players that participated in the match for at least 45 min and Non-Starters, players that did not participate or played less than 45 minutes in the match. The competitive period was analysed after the division into 5x6-8 week blocks and 35x1 week microcycles. Data were also analysed with respect to number of days before the immediate match. Weekly TL variation across the in-season blocks was trivial-small for both groups except between Block 2 and Block 3 (ES= moderate). Substantial TL differences (ES= small–very likely) were found between training days, the TL pattern being a progressive increase up to MD-3 followed by a decrease until MD-1. Except for the match, sRPEres-/sRPEmus-TL was very similar between Starters and Non-Starters. In summary, perceived TL across the season displayed limited variation. Coaches periodized training contents to attain the highest weekly TL 72 hours before the match to progressively unload the players between MD-3 and the match day. The data revealed that the TL arising from the weekly game was solely responsible for the observed higher weekly TL of Starters in comparison with Non-Starters.

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INTRODUCTION

In high-performance sports, the goal of periodization is to appropriately manipulate training contents to optimise competitive performance [1]. In soccer, players' competitive performance is a complex construct where physical fitness is blended with tactical, technical and mental aspects. Thus, the assurance of physical stress, via appropriate training loads (TL), might not be the main goal when manipulating training contents in order to achieve optimal competitive performance in professional soccer players. Regardless of its relative importance in the final competitive performance, accumulated external and/or internal TL has been shown to be related to both positive and negative changes in physical fitness performance relevant to match play [2–7] and injury occurrence [8,9]. Accordingly, the quantification of the TL has been widely adopted in professional soccer. However, team periodization strategies are relatively unknown [10,11].

Pivotal to the periodization process is the training dose-adaptive response relationship [12]. In soccer training, due to the extensive use of soccer group exercises and the different physical (e.g., running) requirements associated with each position [13–16], training demands can vary greatly between individuals [2,4,6,17]. Moreover, due to individual differences, a given external load can elicit a different internal load for each player [7], making the prescription and optimization of the individual training doses (i.e., TL) even more difficult. As a result, within the same team, considerable external and/or internal between-player TL differences can be found [2,4,6,17]. Those between-player differences in TL could potentially be amplified when considering that only 11 players can start each official game, indicating that a considerable number of players per team are not exposed to the TL of the game. It is worth noting that, typically, competitive games have been quantified as the most demanding session (i.e., greatest TL) of the week [3,18,19]. Thus, competitive games are likely to be the element producing the greatest TL individual differences between players. In this regard, Kraemer et al. [20] found that physical fitness performance decrements exacerbated in starters over non-starters in male collegiate soccer players during the season. In addition to the potential impact on physical fitness, the increase in game-related TL that a usually-non-starting player has when starting a game might lead to injuries [8,21,22]. However,

current TL responses and periodization practices in professional soccer teams in regard to starting and non-starting players are unknown.

Among other methods, the overall session perceived exertion [23] has been extensively used to quantify TL in soccer [6,10,14,17–19] because it is simple, cheap, versatile, and it can be used for assessing the competition [27] and self-regulating interval training [28]. However, overall perceived exertion may lack sensitivity when measuring the intermittent nature of the team sports [29,30], and the differentiation between at least respiratory and muscular perceived exertions [31,32] can enhance the sensitivity of TL measurement [2,3,26,27,33]. Specifically, Los Arcos et al. [2,3] found substantial associations between differentiated perceived load/TL and changes in some physical fitness variables in professional young soccer players, and several authors have described small practical differences between respiratory and muscular perceived exertion during soccer [27,34] and Australian football matches [33]. However, little is known about the respiratory and muscular TL distribution across the different periods of the season and during the training week [2].

Therefore, the aim of this study was to compare the respiratory and muscular perceived TL accumulation in elite-oriented young professional soccer players during the in-season competitive period and during typical weeks depending on the participation of those players in the official matches.

MATERIALS AND METHODS

Participants

Twenty-four outfield young professional soccer players (1.79 ± 0.05 m; 73.0 ± 5.6 kg; 20.3 ± 2.0 years) belonging to the same reserve team of a Spanish La Liga club participated in this study. The participating players consisted of 4 central defenders (CD), 5 wide defenders (WD), 5 central midfielders (CM), 6 wide midfielders (WM) and 4 strikers (ST). They trained 4-5 times and competed in the Spanish 2nd B division Championship once per week. All participants were notified of the research procedures, requirements, benefits and risks before giving informed consent. The study was conducted according to the ethical standards of the Helsinki Declaration and was approved by the local Ethics Committee.

Experimental design

Perceived TL data were collected over a 35-week in-season period during the 2012-2013 season. The in-season period started (i.e., first competitive match) on the 26th of September and ended (i.e., last competitive match) on the 19th of May (i.e., full competitive season). This competitive period was divided into 5 blocks of 6-8 weeks [10]. Weeks with friendly matches (2 cases), physical fitness testing (3 cases) and the Christmas break week were not included in the analysis. Therefore, TL from the remaining weeks (30) were retained for comparison between session blocks. Typically, home and away matches were played on Saturday (Sat) and Sunday (Sun), respectively. Taking the game as a reference, the training week types were: a) Sat-Sun (8-day microcycle, 10 cases), b) Sun-Sat (6-day microcycle, 9 cases), c) Sun-Sun (7-day microcycle, 8 cases) and d) Sat-Sat (7-day microcycle, 3 cases). In order to analyse the TL distribution throughout the week we selected the most frequent week type (i.e., Sat-Sun), being the training days MD-6 (Monday), MD-5 (Tuesday), MD-4 (Wednesday), MD-3 (Thursday), MD-2 (Friday), and MD-1 (Saturday): 6, 5, 4, 3, 2 and 1 days before the match, respectively. In addition, only those players available to train for the whole week with the team and also to compete at the weekend were considered. The available players were distributed in two groups: 1) players that completed all training sessions and participated for at least 45 min in the official match (Starters) and b) players who completed all training sessions but did not participate, or played for less than 45 minutes in the official match (Non-Starters). Typically, the players who played less than 45 min carried out a compensatory football training session immediately after the official game.

TL was quantified with the sRPE-TL method [23]. Ten min after each training session and game [2] and using Foster's 0-10 scale [23], all the players in the group were asked by the same person (i.e., fitness coach) on all occasions to register their perceived levels of exertion for respiratory and leg musculature efforts separately: respiratory and muscular perceived exertions [2,3,26,27,33]. Players responded to 2 simple questions in a unique evaluation sheet and always in this order: how hard was your session on your chest?, and, how hard was your session on your legs? Players were allowed to mark a plus sign (interpreted as 0.5 point) alongside the integer value [2,3,27]. Each player completed the 0-10 scale randomly without the presence of other players and unaware of the values declared by other participants. All players were familiarized with this method during the pre-season period (5-weeks). Both sRPEres-TL and sRPEmus-TL were calculated by multiplying the sRPE values by the duration of the training session or the match [2,3]. Training duration was recorded individually from the beginning of the training session (including warm-up and recovery periods) to the end of the session (excluding the cool-down or stretching exercises) [2,3]. The match duration was recorded excluding the warm-up and the half-time rest period [3,34].

Statistical analysis

Descriptive results are presented as means ± standard deviations (SD). The chances that the difference in TL was greater/similar/smaller than in the other group were assessed by calculating the Cohen's d effect size [35]. Effect sizes (ES) between < 0.2, 0.2-0.6, 0.6-1.2, 1.2-2.0, and 2.0-4.0 were considered as trivial, small, moderate, large and very large, respectively. Probabilities were also calculated to establish whether the true (unknown) differences were lower, similar or higher than the smallest worthwhile difference or change (0.2 multiplied by the between-subject SD, based on Cohen's effect size principle). Quantitative chances of higher or lower differences were evaluated qualitatively as follows: < 1%, almost certainly not; 1–5%, very unlikely; 5–25%, unlikely; 25–75%, pos-

sible; 75−95%, likely; 95−99%, very likely; > 99%, almost certain. If the chances of having greater or lower values than the smallest worthwhile difference were both > 5%, the true difference was assessed as unclear. Data analysis was performed using a modified statistical Excel spreadsheet [36,37].

RESULTS

In-season block analysis

Intra-group differences between the accumulated sRPEres-TL and sRPEmus-TL during the blocks (i.e., weekly TL) were in the most cases trivial (Table 1) for Starters and Non-Starters in all the blocks.

Furthermore, Starters accumulated most likely (100/0/0) greater respiratory and muscular perceived TL than Non-Starters in every season block: Block 1, sRPEres-TL (ES = 2.00 ± 0.36) and sRPEmus-TL (ES = 1.63 ± 0.32); Block 2, sRPEres-TL (ES = 2.21 ± 0.31) and sRPEmus-TL (ES = 1.72 ± 0.30); Block 3, sRPEres-TL (ES = 1.27 ± 0.30) and sRPEmus-TL (ES = 1.15 ± 0.29); Block 4 sRPEres-TL (ES = 1.29 ± 0.30) and sRPEmus-TL (ES = 1.57 ± 0.28); Block 5 sRPEres-TL (ES = 1.26 ± 0.24) and sRPEmus-TL (ES = 1.35 ± 0.25).

Weekly perceived TL variation across the in-season blocks was trivial-small (ES = 0.17-0.41) for both Starters and Non-Starters except between Block 2 and Block 3, where a small-moderate TL decrease was found (ES = -0.56 – -1.20) (Figure 1).

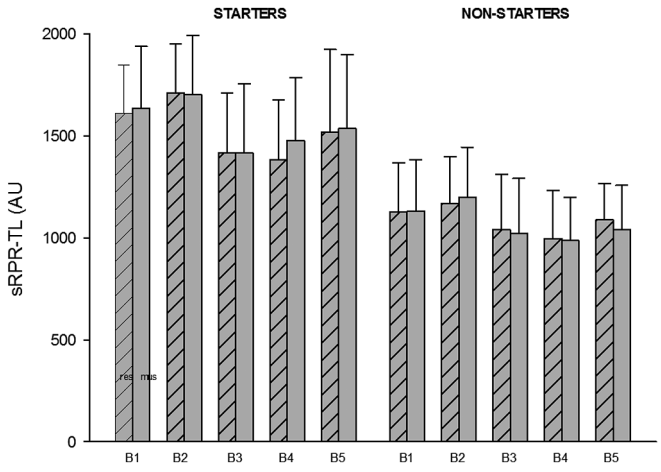

FIG. 1. Weekly perceived TL across the in-season blocks (B1, B2, B3, B4 and B5). STARTERS (sRPEres-TL/sRPEmus-TL) B1 vs B2 Small**/Small* B2 vs B3 Moderate****/Moderate**** B3 vs B4 Trivial*/Trivial* B4 vs B5 Small**/Small* NON-STARTERS (sRPEres-TL/sRPEmus-TL) B1 vs B2 Small*/Small* B2 vs B3 Moderate****/Moderate**** B3 vs B4 Trivial*/Trivial* B4 vs B5 Small**/Small* *Possibly; **Likely; ***Very Likely; ****Most Likely

In-season week analysis

Within-group (i.e., Starters and Non-Starters) differences between the accumulated sRPEres-TL and sRPEmus-TL from each training

TABLE 1. Accumulated training load data for respiratory and muscular ratings of perceived exertion (RPEres-TL and RPEmus-TL, respectively) across 5 consecutive 6-8-week blocks in Starters and Non-Starters. Legend: CV = coefficient of variation; MBI = magnitude-based inference.

Block		Occurrences	sRPEres-TL (AU)	CV	sRPEmus-TL (AU)	CV	ES	MBI	Rating
1	Starters	55 (15 players x 1-6 weeks)	1612 ± 238	15%	1636 ± 304	18%	0.08; ±0.19	15/84/1	Likely Trivial
	Non-Starters	34 (14 players x 1-5 weeks)	1129 ± 240	21%	1133 ± 251	22%	0.02; ±0.22	8/87/5	Likely Trivial
2	Starters	55 (16 players x 1-6 weeks)	1712 ± 241	14%	1703 ± 291	17%	-0.03; ±0.20	3/88/9	Likely Trivial
	Non-Starters	50 (16 players x 1-6 weeks)	1171 ± 228	20%	1198 ± 247	21%	0.11; ±0.14	16/84/0	Likely Trivial
3	Starters	49 (16 players x 1-5 weeks)	1419 ± 293	21%	1418 ± 339	24%	0.00; ±0.16	2/96/2	Very likely Trivial
	Non-Starters	61 (20 players x 1-6 weeks)	1042 ± 269	26%	1022 ± 270	26%	-0.07; ±0.11	0/97/3	Very likely Trivial
4	Starters	54 (15 players x 1-6 weeks)	1383 ± 294	21%	1478 ± 309	21%	0.31; ±0.20	81/19/0	Likely Small
	Non-Starters	42 (15 players x 1-5 weeks)	998 ±236	24%	987 ± 212	22%	-0.05; ±0.18	1/91/8	Likely Trivial
5	Starters	62 (17 players x 1-6 weeks)	1519 ± 336	22%	1537 ± 362	24%	0.05; ±0.17	8/91/1	Likely Trivial
	Non-Starters	55 (16 players x 1-6 weeks)	1090 ± 176	16%	1040 ± 219	21%	-0.24; ±0.20	0/35/65	Possibly Small

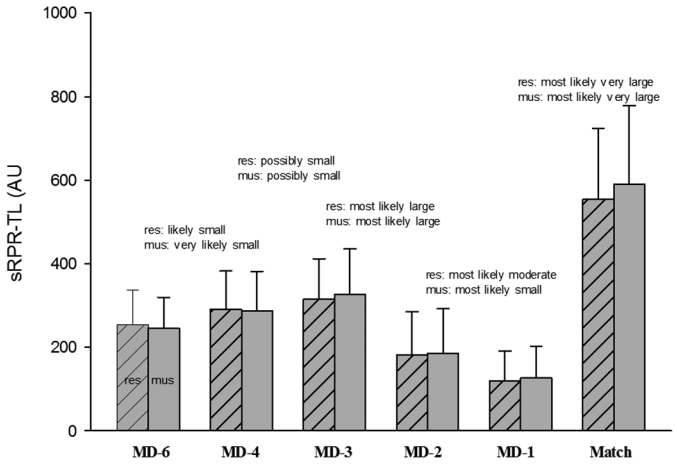

FIG. 2a. Perceived TL accumulation during the week for STARTERS (Saturday-Sunday week). sRPEres-TL/sRPEmus-TL *Possibly; **Likely; ***Very Likely; ****Most Likely MD-6 <1 MD-4 <2 MD-3 >3 MD-2 >4 MD-1 <5 Match 1: Small**/Small*** 2: Small*/Small* 3: (-)Large****/(-)Large**** 4: (-)Moderate***/(-)Small*** 5: Very large****/ Very large**** MD-6 MD-2: (-)Moderate****/(-)Moderate****; >MD-1: (-)Large****/(-)Large****; MD-2: (-)Moderate****/(-)Moderate****; >MD-1: (-)Large****/(-)Large****; MD-1: (-)Very Large****/(-)Very Large****

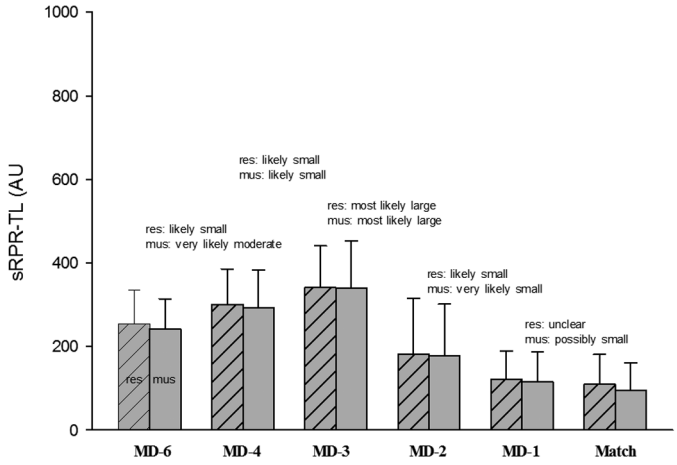

FIG. 2b. Perceived TL accumulation during the week for NON-STARTERS (Saturday-Sunday week). sRPEres-TL/sRPEmus-TL *Possibly; **Likely; ***Very Likely; ****Most Likely MD-6 <1 MD-4 <2 MD-3 >3 MD-2 >4 MD-1 >5 Match 1: Small**/Moderate*** 2: Small**/Small** 3: (-)Large****/(-)Large**** 4: (-)Small**/(-)Very likely Small*** 5: Unclear/(-)Small* MD-6 MD-2: (-)Very likely Moderate***/(-)Very likely Moderate***; >MD-1: (-)Very large****/(-)Most likely Moderate****; >Match: (-)Large****/(-)Very large**** MD-4 >MD-2: (-)Large****/(-)Large****; >MD-1: (-)Very large****/(-)Large****; >Match: (-)Very large****/(-)Very large**** MD-3 > MD-1: (-)Very large****/(-)Very large****; >Match: (-)Very large****/(-)Very large****; MD-2 >Match: (-)Small**/(-)Moderate***

TABLE 2. Accumulated training load data for respiratory and muscular rating of perceived exertion on training day with respect to days before a competitive match during the in-season period between Starters and Non-Starters. Legend: CV = coefficient of variation; MBI = magnitude-based inference; sRPEres-TL = respiratory session-rating of perceived exertion-training load; sRPEmus-TL = muscular session-rating of perceived exertion-training load; MD-6 = training session 6 days before the match; MD-5 = training session 5 days before the match; MD-4 = training session 4 days before the match; MD-3 = training session 3 days before the match; MD-2 = training session 2 days before the match; MD-1 = training session 1 day before the match.

Session		Starters	CV	Non-Startes	CV	ES	MBI	Rating
MD-6	sRPEres-TL	255 ± 82	32%	255 ± 80	32%	-0.01; ±0.33	15/69/16	Unclear
	sRPEmus-TL	246 ± 73	30%	242 ± 72	30%	-0.06; ±0.33	10/66/24	Unclear
MD-4	sRPEres-TL	291 ± 92	32%	301 ± 85	28%	0.11; ±0.23	27/72/1	Possibly Trivial
	sRPEmus-TL	242 ± 72	30%	292 ± 91	31%	0.67; ±0.37	98/2/0	Very likely Moderate
MD-3	sRPEres-TL	316 ± 96	30%	341 ± 100	41%	0.26; ±0.26	65/35/0	Possibly Small
	sRPEmus-TL	326 ± 109	33%	340 ± 113	33%	0.13; ±0.24	32/66/1	Possibly Trivial
MD-2	sRPEres-TL	182 ± 103	56%	181 ± 134	74%	-0.01; ±0.29	11/75/13	Unclear
	sRPEmus-TL	186 ± 106	57%	177 ± 125	71%	-0.08; ±0.27	4/72/24	Possibly Trivial

Session		Starters	CV	Non-Startes	CV	ES	MBI	Rating
MD-1	sRPEres-TL	119 ± 73	61%	121 ± 68	56%	0.03; ±0.23	11/85/5	Unclear
	sRPEmus-TL	126 ± 76	61%	115 ± 72	63%	-0.14; ±0.23	1/65/34	Possibly Trivial
Match	sRPEres-TL	554 ± 170	31%	109 ± 72	66%	-2.59; ±0.20	0/0/100	Most likely Very Large
	sRPEmus-TL	590 ± 189	32%	94 ± 67	71%	-2.60; ±0.20	0/0/100	Most likely Very Large

day were in most of the cases trivial (Figures 2a and 2b). Substantial TL differences (ES = small–very likely) were found between training days for both groups, the TL pattern being a progressive increase until MD-3 with a subsequent decrease until MD-1. Substantial differences were found between training days: MD-6 < MD-4 < MD-3 > MD-2 > MD-1 (Figures 2a and 2b). The match was the most demanding session of the week only for the Starters.

Except for the match, in most cases (i.e., training sessions) sRPEres- and sRPEmus-TL were very similar for Starters and Non-Starters (Table 2).

DISCUSSION

The aim of this study was to compare the respiratory and muscular perceived TL accumulations during the in-season competitive period and during typical weeks depending on the participation of the players in the official match in young professional soccer players. Considering that within-and between-player differences in TL could have an impact on both training outcomes and/or injury risk [2–5,7,31], and considering that competitive games represent the greatest TL players typically experience during a week [3,18,19], learning about the potential TL periodization strategies experienced by both starters and non-starters appears to be relevant. The main findings of the present study were: a) the respiratory and muscular perceived TL variations across the competition period were limited (ES = trivial-small) for both Starters and Non-Starters; b) Starters accumulated greater (large/very large) perceived TL than the Non-Starters, the official matches being the source of such differences; c) a progressive TL increase until mid-week and subsequent decrease until the training day prior to the match was found during the training weeks; and d) most differences between sRPEres-TL and sRPEmus-TL were trivial.

Despite the fact that during the second part of the season the TL accumulation was lower (ES = from – 0.56 to -1.20) in comparison with the first in-season months, typically, between-block TL differences were limited (Figure 1) during the in-season period: Block 1 vs Block 2 (ES = small), Block 2 vs Block 3 (ES = moderate), Block 3 vs Block 4 (ES = trivial), Block 4 vs Block 5 (ES = small). Similarly, after the division of the in-season phase into 6 × 6-week blocks, Malone et al. [10] only found substantial differences in elite soccer players on two occasions: the total distance covered during the training sessions was greater (ES = 0.84) in the first block of the season than in the last block, and the %HRmax response in the players was higher (ES = 0.49) during the third block than the first block. Altogether, these results and present data suggest that in-season variability in TL is very limited and only minor decrements in TL across the season might occur. This relatively stable soccer training load along the competitive period could be due to the importance of the recovery activities following matches and the decisions made to reduce TL between matches in order to prevent fatigue during this period [38].

The large to very large differences found in TL accumulation between Starters and Non-Starters (Table 2) were solely related to the playing time in the weekly match. That is, competition time was the main source of between-player weekly differences in accumulated TL. Even though the members of the squad who played fewer minutes performed a complementary training session to compensate for the missing match, TL for the Starters was largely higher than in the Non-Starters. Thus, the magnitude of the TL arising from that compensatory training session carried out for Non-Starters was substantially lower than the magnitude produced by the official game. The impact that this reduced TL experienced by the Non-Starters could have on players' fitness levels is currently unknown as the connection between indicators of TL and training outcomes is relatively unexamined in soccer players [7]. A higher training intensity and/or volume during the compensatory training session carried out by the Non-Starters might be recommended to try to approach the game's TL experienced by the Starters. Alternatively, the Non-Starters could also perform additional compensatory training sessions in the 1-2 days following the match. However, the precise content and magnitude of those compensatory training sessions for Non-Starters is yet to be elucidated. It has been reported in male collegiate soccer players that non-starting male collegiate soccer players decreased physical fitness performance to a lesser extent than starters while non-starters were observed to have a significant increase in body fat, a change not reflected in the starters [20].

In relation to match-day-minus training comparison, TL increased progressively until MD-3 and later decreased up to MD-1 for both Starters and Non-Starters (Figure 2a and 2b). Similarly, Malone et al. [10] also found a noticeable consistent variation in TL (overall

sRPE-TL and total distance covered) on MD-1 in elite soccer players, when the load was significantly reduced in comparison with the rest of the training days [39,40]. However, while Malone et al. [10] did not observe differences across the remaining training days, substantial differences were detected between most training sessions in the present study. The most demanding sessions were located in the middle of the week (i.e., MD-4 and MD-3) with TL arising from the MD-3 being substantially higher (small difference) than MD-4. In addition, the reduction of the TL compared to MD-3 was not limited to the day before the match (i.e., MD-1) but was also observed two days before the competition, with a small-moderate reduction from MD-2 to MD-1. Interestingly, no substantial differences between Starters and Non-Starters in perceived TL were observed on any training day (Table 2).

CONCLUSIONS

In summary, this study quantified the differential (i.e., respiratory and muscular) perceived TL employed by an elite-oriented, reserve Spanish La Liga soccer team throughout the full competitive season. The data from the study revealed that coaches periodized training contents to attain the highest weekly TL 72 hours before the match (i.e., MD-3) and to progressively unload the players between MD-3 and the match day. Perceived TL across the season displayed limited variation across the different microcycles.

Only the TL arising from the weekly game was responsible for the observed higher weekly TL of Starters in comparison with Non-Starters. Further research is needed to refine training prescription of compensatory training sessions for Non-Starters to ensure their readiness for competition.

Conflict of interests: the authors declared no conflict of interests regarding the publication of this manuscript.

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