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Are male soccer players accumulating sufficient load across varying microcycle structures? Examining the load, wellness and training/match ratios of a professional team

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Abstract

Professional soccer involves varying numbers of training sessions and matches each week, which can influence load distribution. Understanding the exact distribution may allow appropriate load periodisation and planning for players. Thus, this study aimed to (i) compare accumulated load and wellness between weeks with different numbers of training sessions and (ii) compare training/match ratio (TMr) of external and internal load between weeks with different numbers of training sessions. Ten players with a minimum of 45 minutes of weekly match-play were analysed over 16 weeks. The microcycle structures consisted of three (3dW), four (4dW), five (5dW) and six (6dW) training sessions plus match-day per week. The following measures were used for analysis: duration, fatigue, quality of sleep, muscle soreness, stress, mood, rating of perceived exertion (RPE), session-RPE (s-RPE), high-speed running distance (HSR), sprint distance (SPD), number of accelerations (ACC) and decelerations (DEC). Accumulated wellness/load were calculated by adding all training and match sessions, while TMr was calculated by dividing accumulated load by match data. The main results showed that accumulated wellness and load were significantly different, with moderate to very large effect sizes, except regarding mood, duration, s-RPE, SPD during 5dW *vs.* 6dW and s-RPE, HSR, SPD, ACC and DEC during 3dW *vs.* 4dW (all $p > 0.05$). Moreover, 6dW was significantly higher than 4dW regarding TMr of duration ($p < 0.05$, moderate effect size), RPE, HSR and SPD (all $p < 0.05$ with very large effect sizes) and for 3dW of HSR and ACC ($p < 0.05$ with very large effect sizes). This study showed that 5dW and 6dW had higher training measures than 3dW or 4dW. Additionally, higher wellness was presented in the microcycles with higher training frequencies. These findings suggest that physical load and wellness were not adjusted according to the number of training sessions within a microcycle.

Keywords

External load; Fatigue; Internal load; Mood; Load quantification; Muscle soreness; Sleep; Stress; Training load; Well-being

1. Introduction

Quantifying wellness, training and match load/demands in soccer players is a common practice [1–3]. Specifically, the monitorisation of athletes include quantifying training/match demands (*e.g.*, locomotor/mechanical and psychophysiological) and the wellness and readiness of players [4]. On the one hand, wellness is usually measured by questionnaires, as previously proposed by Hooper and Mackinnon [5] using the Hooper Index or by McLean *et al*. [6]. While the Hooper Index includes fatigue, quality of sleep, muscle soreness and stress, measured *via* a seven-point scale [6], the wellness questionnaire by McLean *et al*. [6] includes the same subjective items plus mood status, measured on a five-point scale. Regardless of the questionnaire, wellness variables depend on the load applied [4]. Meanwhile, locomotor/mechanical demands or physical demands are associated with external load/intensity monitoring using global positioning system (GPS) variables (*e.g.*, distances covered at various running speeds or accelerations), whereas psychophysiological demands are associated with internal load/intensity monitoring using subjective or objective measures such as rating of perceived exertion (RPE) and heart rate [2, 7].

Internal and external training stimuli may vary for players according to the number of training/match sessions per week/microcycle, the aims/objectives of training sessions and the periodisation/planning strategies of the coach [8]. For instance, a recent systematic review reporting external and internal load in professional soccer revealed that three to six training sessions were performed per week [9], highlighting that different strategies were applied. Other factors that impact load include the use of specific drills and games during training (*e.g.*, small-sided games, long sprints, repeated sprints, interval training and medium- to large-sized games) [10]. Regarding match-play, load quantification can vary due to the dynamics of matches and their contextual factors [11].

Previous studies have suggested that the number of training sessions affects the training load [12, 13]. Oliveira *et al.* [13] showed similar average values for running distance measures and RPE/session-RPE across five different weeks/microcycles with four training sessions and one, two or three matches. Meanwhile, Anderson *et al.* [12] showed that microcycles with only one match accumulated a total distance of ~14,000 meters during training sessions and ~11,000 meters during matches. Moreover, Oliveira *et al.* [13] reported a range for high-speed running distance (HSR, 19–24 km/h) between 17–398 meters during training sessions, while distances of 465–681 meters were recorded during matches. Furthermore, Anderson *et al.* [12] also reported a range for HSR (19.8–25 km/h) of 8–104 meters during training sessions, while distances of 682–727 meters were covered during match-play.

A method to improve the understanding of the physical demands induced by training and competitive match-play is to calculate the training/match ratio (TMr) [8, 14]. This ratio is calculated by dividing the accumulated weekly load by the match load [8]. If the TMr provides a value lower than one, it suggests that the accumulated load of the week is lower than the match load; a value above one suggests that the training load is greater than the match load [8].

Despite the practical implication of such analyses, only four studies were found to make such an investigation [8, 14–16]. Specifically, one study [8] described the TMr of different external load measures—total distance, running distance, HSR, sprint distance (SPD), player load, number of high accelerations (ACC), and number of high decelerations (DEC)—during a full professional soccer season while analysing the variations between varying types of weeks (three, four and five training sessions/week). The study showed that weeks with five training sessions had higher values for all external load ratios than weeks with three or four training sessions. Additionally, HSR distance and SPD measures presented substantially lower ratios than other variables such as total running distance, ACC, DEC and player load [8].

Another study compared the loads of a professional soccer team among training days and matches and between starters and non-starters using TMr. Specifically, in weeks with four training sessions, the weekly training load represented a load equal to 4.4 matches, high accelerations represented a load of 3.9 matches, high decelerations represented a load of 3.3 matches, and HSR represented 2.1 matches [14]. Furthermore, Modric *et al.* [15] analysed the relationship between TMr and match outcomes (wins, draws and losses). However, whereas previous studies [8, 14] used accumulated weekly data divided by match data, Modric *et al.* [15] divided the data for each training session by match data. Finally, Szigeti *et al.* [16] also used TMr to analyse external load in under-17 soccer players and their main findings highlighted that ACC represented 2.84 of match load, while HSR represented 0.95 of a match in weeks with three training sessions.

None of the previous studies mentioned above included wellness and internal load. Moreover, those that included external load did not provide full details of participant inclusion for TMr calculations [8] and, contrastingly, included an additional session to replace the official match for non-starters [14]. Therefore, the present study aimed to (i) compare accumulated external and internal load and wellness between weeks with different numbers of training sessions and (ii) compare the TMr of external and internal load between weeks with different numbers of training sessions. According to the previous study of Clemente *et al.* [8], who observed similar load distributions across the week, it is speculated that weeks with more training sessions may contribute to higher TMr values. Thus, it was hypothesised that weeks with fewer training sessions are associated with lower accumulated load and TMr values.

2. Materials and methods

2.1 Design

In this observational study, soccer players were monitored daily for wellness measures (sleep quality, muscle soreness, fatigue, stress and mood), internal and external load. The study lasted 16 weeks from the 2022/23 in-season period (July to November) and comprised 70 training sessions and 15 official matches.

Following the same procedures used in a similar study, all weeks with one official match and three or more training sessions were included in this analysis [8]. This decision was made to reduce the variability among comparisons. Thus, only 15 weeks were included in the analysis, as one microcycle only included two training sessions. The week types were classified based on the number of training sessions: weeks with three training sessions (3dW, n = 3), weeks with four training sessions (4dW, n = 3), weeks with five training sessions (5dW, n = 4), and weeks with six training sessions (6dW, n = 5).

2.2 Participants

Ten professional male soccer players (age: 25.30 ± 2.11 years; body mass: 71.90 ± 6.23 kg; body height: 179.4 ± 6.88 cm; fat mass: 8.69 ± 0.95%; professional experience: 7.5 ± 2.07 years) participated in the current study [17–20]. Players belonged to a European soccer team that played in the national first division. Of the players included, four were defenders, three were midfielders, and three were attackers.

The eligibility criteria for participant inclusion were as follows: (i) participating in 80% of all training sessions (for the full session duration) [21], (ii) completing wellness and training reports over the data collection period and (iii) participating in a minimum of 45 minutes of the weekly match [8].

Prior to data collection, the club, coaches and participants were fully informed of the study design and signed an informed consent form.

2.3 Wellness quantification

The wellness questionnaire developed by McLean *et al.* [6] was applied individually 30 minutes before each training/match session through a Google form specifically designed. The questionnaire uses a scale of 1–5 arbitrary units (A.U.) and contains five questions about fatigue, quality of sleep, muscle soreness, stress and mood (5 = very fresh, very restful, very great, very relaxed and very positive mood, respectively; 1 = always tired, insomnia, very sore, highly stressed and highly annoyed/irritable/down, respectively). All players were already familiar with the questionnaire from the previous season.

2.4 Internal load quantification

The CR-10 Borg's scale [22] was used to monitor the players' rating of perceived exertion (RPE). Following the usual training procedures, 20–30 minutes after each session, every player provided a perceived exertion value using a Google form by answering the following question: "How intense was the training session?" The scale varied from 0 to 10 A.U. (0 = nothing to all, 0.5 = extremely weak, 1 = very weak, 2 = weak, 3 = moderate, 4 = somewhat strong, 5 = strong, 7 = very strong, and 10 = extremely strong).

RPE was used to measure internal perception of effort. In addition, the duration of the entire training session or match, in minutes, was multiplied by the RPE to generate the session-RPE (s-RPE), measured in A.U. [23, 24]. All players were already familiar with the questionnaire from the previous season.

2.5 External load quantification

Locomotor demands were measured using a GPS Vector S7 (Catapult Innovations, Melbourne, Australia). The same unit was used for each player throughout the analysis period to avoid inter-unit bias. The unit was placed on the upper back of each player 30 minutes before each session (training and match) and removed immediately after the session.

The GPS Vector S7, sampling at 10 Hz, was used to monitor the locomotor demands of players during all sessions. This device was previously validated for accuracy and reliability regarding various measures, such as distance, velocity and average acceleration [25]. The following measures were used for analysis: (i) high-speed running distance (HSR, 20–25 km/h), sprint distance (SPD, >25 km/h) [26], number of accelerations (ACC, >2 m/s^2) and number of decelerations (DEC, <2 m/s^2) [27].

2.6 Accumulated wellness/load and training/match ratio

Accumulated wellness/load consisted of the sum of each measure during all training sessions of the microcycle and was calculated per player, thus providing the weekly load for each measure (match included) [28–33].

Moreover, accumulated load was calculated without match data to determine the TMrs for all internal and external measures. Ratios were then calculated by dividing accumulated load (without match data) by match data (TMr = weekly load/match demands) [8, 14]. Consequently, the following measures were obtained: RPE ratio (RPEr); session RPEr (s-RPEr); high-speed running distance ratio (HSRr); sprint distance ratio (SPDr); accelerations ratio (ACCr) and decelerations ratio (DECr). The same ratio was calculated for session duration (Dr) by dividing accumulated duration (without match data) by the match duration. All TMr calculations of load and duration measures provided clear descriptions of the microcycle structures applied.

2.7 Statistical analysis

Descriptive statistics are presented as mean ± standard deviation. The normality of the different variables was analysed (and not confirmed) using the Shapiro-Wilk test. Thus, Friedman's test was used to compare the different week types, while the Wilcoxon test was used for pairwise comparisons. Significant results were considered at $p < 0.05$.

When a significant result was detected, Hedges' effect size was calculated to determine the effect magnitude based on the difference between two means divided by the standard deviation according to the data. The results were categorised based on the following criteria: <0.2 = trivial effect, 0.2–0.6 = small effect, 0.6–1.2 = moderate effect, 1.2–2.0 = large effect, and >2.0 = very large effect [34].

All statistical procedures were executed in IBM SPSS Statistics for Windows (version 23.0, IBM Corp, Armonk, NY, USA).

3. Results

Following the Friedman test, all variables showed $p < 0.001$, except for SPD ($p = 0.002$). Table 1 presents the pairwise comparisons for accumulated training demands (match data included) and wellness for all variables.

The Friedman test was also applied for TMr; all variables showed $p < 0.001$ except for Dr ($p = 0.004$), s-RPE ($p = 0.013$) and SPDr ($p = 0.001$). Fig. 1 represents the mean match data, accumulated weekly data and TMr considering the different weeks' schedules. Table 2 represents the pairwise comparisons for all TMr.

4. Discussion

This study aimed to (i) compare accumulated load and wellness between weeks with different numbers of training sessions and (ii) compare the TMr values of external and internal load between weeks with a different number of training sessions. The hypothesis that weeks with fewer training sessions would present lower accumulated load and TMr was confirmed. Specifically, the main results of the study show that accumulated wellness and load demands were higher in the weeks with the most training sessions and progressively decreased in weeks with fewer training sessions (6dW > 5dW > 4dW > 3dW), with moderate to very large effect sizes. Although the results were insignificant, TMr showed the same tendency (see Fig. 1 and Table 2), while the main findings reported the highest values for 6dW compared to 4dW for RPEr, Dr, HSRr and SPDr and compared to 3dW for HSRr

TABLE 1. Comparisons of different microcycles for accumulated wellness and load demands.

Variable	3dW	4dW	5dW	6dW	*p*-value	Effect size
Quality of sleep (A.U.)	16.60 ± 1.77^{a,b,c}	18.76 ± 1.50^{b,c}	23.05 ± 1.44^{c}	26.20 ± 2.88	3dW *vs.* 4dW: <0.001 3dW *vs.* 5dW: <0.001 3dW *vs.* 6dW: <0.001 4dW *vs.* 5dW: <0.001 4dW *vs.* 6dW: <0.001 5dW *vs.* 6dW: 0.002	3dW *vs.* 4dW: 0.83 3dW *vs.* 5dW: 2.47 3dW *vs.* 6dW: 3.67 4dW *vs.* 5dW: 2.79 4dW *vs.* 6dW: 2.85 5dW *vs.* 6dW: 1.21
Fatigue (A.U.)	13.28 ± 2.31^{a,b,c}	16.85 ± 2.42^{b,c}	20.29 ± 2.80^{c}	23.61 ± 3.14	3dW *vs.* 4dW: <0.001 3dW *vs.* 5dW: <0.001 3dW *vs.* 6dW: <0.001 4dW *vs.* 5dW: <0.001 4dW *vs.* 6dW: <0.001 5dW *vs.* 6dW: <0.001	3dW *vs.* 4dW: 1.43 3dW *vs.* 5dW: 2.65 3dW *vs.* 6dW: 3.53 4dW *vs.* 5dW: 1.21 4dW *vs.* 6dW: 2.20 5dW *vs.* 6dW: 1.06
Muscle Soreness (A.U.)	13.13 ± 2.31^{a,b,c}	16.87 ± 2.65^{b,c}	19.73 ± 3.24^{c}	22.55 ± 3.15	3dW *vs.* 4dW: <0.001 3dW *vs.* 5dW: <0.001 3dW *vs.* 6dW: <0.001 4dW *vs.* 5dW: <0.001 4dW *vs.* 6dW: <0.001 5dW *vs.* 6dW: 0.018	3dW *vs.* 4dW: 1.44 3dW *vs.* 5dW: 2.89 3dW *vs.* 6dW: 3.39 4dW *vs.* 5dW: 1.54 4dW *vs.* 6dW: 2.14 5dW *vs.* 6dW: 0.74
Stress (A.U.)	14.17 ± 2.02^{a,b,c}	17.72 ± 2.51^{b,c}	21.60 ± 3.15^{c}	24.0 ± 3.98	3dW *vs.* 4dW: <0.001 3dW *vs.* 5dW: <0.001 3dW *vs.* 6dW: <0.001 4dW *vs.* 5dW: <0.001 4dW *vs.* 6dW: <0.001 5dW *vs.* 6dW: 0.046	3dW *vs.* 4dW: 1.48 3dW *vs.* 5dW: 2.61 3dW *vs.* 6dW: 2.85 4dW *vs.* 5dW: 1.28 4dW *vs.* 6dW: 1.72 5dW *vs.* 6dW: 0.62
Mood (A.U.)	14.00 ± 2.00^{a,b,c}	17.35 ± 2.28^{b,c}	21.71 ± 2.78	24.29 ± 3.69	3dW *vs.* 4dW: <0.001 3dW *vs.* 5dW: <0.001 3dW *vs.* 6dW: <0.001 4dW *vs.* 5dW: <0.001 4dW *vs.* 6dW: <0.001 5dW *vs.* 6dW: 0.056	3dW *vs.* 4dW: 1.49 3dW *vs.* 5dW: 2.99 3dW *vs.* 6dW: 3.19 4dW *vs.* 5dW: 1.62 4dW *vs.* 6dW: 2.06 5dW *vs.* 6dW: 0.73
RPE (A.U.)	18.77 ± 3.07^{a,b,c}	23.70 ± 2.79^{b,c}	31.71 ± 3.33^{c}	36.98 ± 3.12	3dW *vs.* 4dW: 0.042 3dW *vs.* 5dW: <0.001 3dW *vs.* 6dW: <0.001 4dW *vs.* 5dW: <0.001 4dW *vs.* 6dW: <0.001 5dW *vs.* 6dW: <0.001	3dW *vs.* 4dW: 1.66 3dW *vs.* 5dW: 3.87 3dW *vs.* 6dW: 5.70 4dW *vs.* 5dW: 2.45 4dW *vs.* 6dW: 4.28 5dW *vs.* 6dW: 1.63
Duration (min)	154.78 ± 24.55^{a,b,c}	208.50 ± 26.42^{b,c}	273.94 ± 23.71	294.51 ± 26.05	3dW *vs.* 4dW: 0.004 3dW *vs.* 5dW: <0.001 3dW *vs.* 6dW: <0.001 4dW *vs.* 5dW: <0.001 4dW *vs.* 6dW: <0.001 5dW *vs.* 6dW: 0.147	3dW *vs.* 4dW: 2.03 3dW *vs.* 5dW: 4.99 3dW *vs.* 6dW: 5.36 4dW *vs.* 5dW: 2.74 4dW *vs.* 6dW: 3.29 5dW *vs.* 6dW: 0.79
s-RPE (A.U.)	969.42 ± 251.08^{b,c}	1256.52 ± 253.94^{b,c}	1721.61 ± 318.76	1868.51 ± 266.19	3dW *vs.* 4dW: 0.144 3dW *vs.* 5dW: 0.001 3dW *vs.* 6dW: <0.001 4dW *vs.* 5dW: 0.004 4dW *vs.* 6dW: 0.002 5dW *vs.* 6dW: 0.419	3dW *vs.* 4dW: 1.13 3dW *vs.* 5dW: 2.36 3dW *vs.* 6dW: 3.38 4dW *vs.* 5dW: 1.46 4dW *vs.* 6dW: 2.30 5dW *vs.* 6dW: 0.55

TABLE 1. Continued.

Variable	3dW	4dW	5dW	6dW	p-value	Effect size
HSR (m)	535.12 ± 165.88^{b,c}	744.26 ± 248.34^{b,c}	946.03 ± 190.41^{c}	1142.07 ± 297.13	3dW *vs.* 4dW: 0.360 3dW *vs.* 5dW: 0.002 3dW *vs.* 6dW: 0.002 4dW *vs.* 5dW: 0.006 4dW *vs.* 6dW: 0.001 5dW *vs.* 6dW: 0.023	3dW *vs.* 4dW: 0.84 3dW *vs.* 5dW: 2.16 3dW *vs.* 6dW: 2.05 4dW *vs.* 5dW: 1.05 4dW *vs.* 6dW: 1.34 5dW *vs.* 6dW: 0.66
Sprint Distance (m)	124.05 ± 49.75^{b,c}	172.02 ± 92.84^{c}	238.41 ± 58.09	274.6 ± 77.26	3dW *vs.* 4dW: >0.999 3dW *vs.* 5dW: 0.008 3dW *vs.* 6dW: 0.013 4dW *vs.* 5dW: 0.061 4dW *vs.* 6dW: 0.001 5dW *vs.* 6dW: 0.299	3dW *vs.* 4dW: 0.53 3dW *vs.* 5dW: 1.98 3dW *vs.* 6dW: 1.98 4dW *vs.* 5dW: 1.10 4dW *vs.* 6dW: 1.31 5dW *vs.* 6dW: 0.47
Accelerations (nr)	150.27 ± 32.82^{b,c}	195.08 ± 29.24^{b,c}	261.25 ± 3.10^{c}	305.12 ± 41.93	3dW *vs.* 4dW: 0.093 3dW *vs.* 5dW: <0.001 3dW *vs.* 6dW: <0.001 4dW *vs.* 5dW: <0.001 4dW *vs.* 6dW: <0.001 5dW *vs.* 6dW: 0.007	3dW *vs.* 4dW: 1.51 3dW *vs.* 5dW: 3.17 3dW *vs.* 6dW: 3.72 4dW *vs.* 5dW: 9.61 4dW *vs.* 6dW: 2.64 5dW *vs.* 6dW: 1.06
Deceleratior (nr)	141.42 ± 32.85^{b,c}	183.57 ± 24.88^{b,c}	246.48 ± 29.16^{c}	282.21 ± 33.54	3dW *vs.* 4dW: 0.092 3dW *vs.* 5dW: <0.001 3dW *vs.* 6dW: <0.001 4dW *vs.* 5dW: <0.001 4dW *vs.* 6dW: <0.001 5dW *vs.* 6dW: 0.025	3dW *vs.* 4dW: 1.51 3dW *vs.* 5dW: 3.55 3dW *vs.* 6dW: 4.18 4dW *vs.* 5dW: 2.16 4dW *vs.* 6dW: 2.96 5dW *vs.* 6dW: 1.07

RPE: rating of perceived exertion using the CR-10 Borg's scale; s-RPE: multiplication of time of session by the score of RPE; A.U.: arbitrary units; m: meters; min: minutes; HSR: high speed running (20–25 km/h); a denotes significant difference from 4dW; b, denotes significant difference from 5dW, c, denotes significant difference from 6dW (all, p < 0.05); bold: significant results.

and ACCr.

Regarding the first aim, wellness was higher in weeks with more training sessions considering that in the questionnaire applied (based on a scale ranging from 0–5), the value of 5 A.U. suggested very fresh, very restful, very great, very relaxed and very positive mood. Similarly, a previous study examining youth soccer players revealed that higher external and internal intensities were associated with improved sleep (quality and quantity) and feeling rested [35]. Contrastingly, another study on youth soccer players showed that high-intensity training did not impact the following night's sleep quality [36]. A further study on professional soccer players reported that sleep quality was not impacted by higher-intensity sessions (match included) [37]. However, these studies did not have identical designs, and more research is needed to confirm the results of the present study.

Regarding the second aim of TMr analysis, Clemente *et al*. [8] observed professional soccer players and showed that ACC and DEC (>3 m/s^2) presented values of 2.2 ± 1.8 and 1.6 ± 0.9, respectively, during 3dW which then reached 4.1 ± 1.6 and 3.4 ± 1.9, respectively, during 5dW. Moreover, the TMr of HSR was 1.1 ± 0.8 during 3dW and 2.3 ± 1.5 during 5dW. However, when applying a different approach in professional soccer players and considering the comparison of starters versus non-starters in microcycles with four training sessions and a match, Stevens et al. [14] reported the following values for starters and non-starters, respectively: HSR, 2.1/1.5; medium ACC, 3.1/2.6; high ACC, 3.9/3.6; medium DEC, 3.4/3.0; high DEC 3.3/2.7.

Recently, Szigeti *et al*. [16] found that 3dW showed 2.84 of ACCr and 0.95 of HSRr, while other measures such as SPDr and DEC presented values between 1 and 2 A.U. in under-17 soccer players. The values reported in these previous studies are much higher than those presented in the current study regardless of the number of training sessions per week, which may be associated with the different periodisation/planning practices of the coaches or the possibility of supplementary sessions. Additionally, to our knowledge, the present work is the first study in which TMr was calculated using both RPE and s-RPE, and thus, no comparison can be made based on the ratios.

Moreover, some TMr values were lower than 1.0 A.U., which suggests that the accumulated training load was lower than the match load. Such values occurred in the weeks with three and four training sessions for the measures of s-RPEr, HSRr, and SPDr. The same scenario occurred for ACCr and DECr (but only during 3dW). Nevertheless, in the present study, higher TMr values for ACC and DEC were found regardless of the number of training sessions, which suggests that more small-sided games were performed during training,

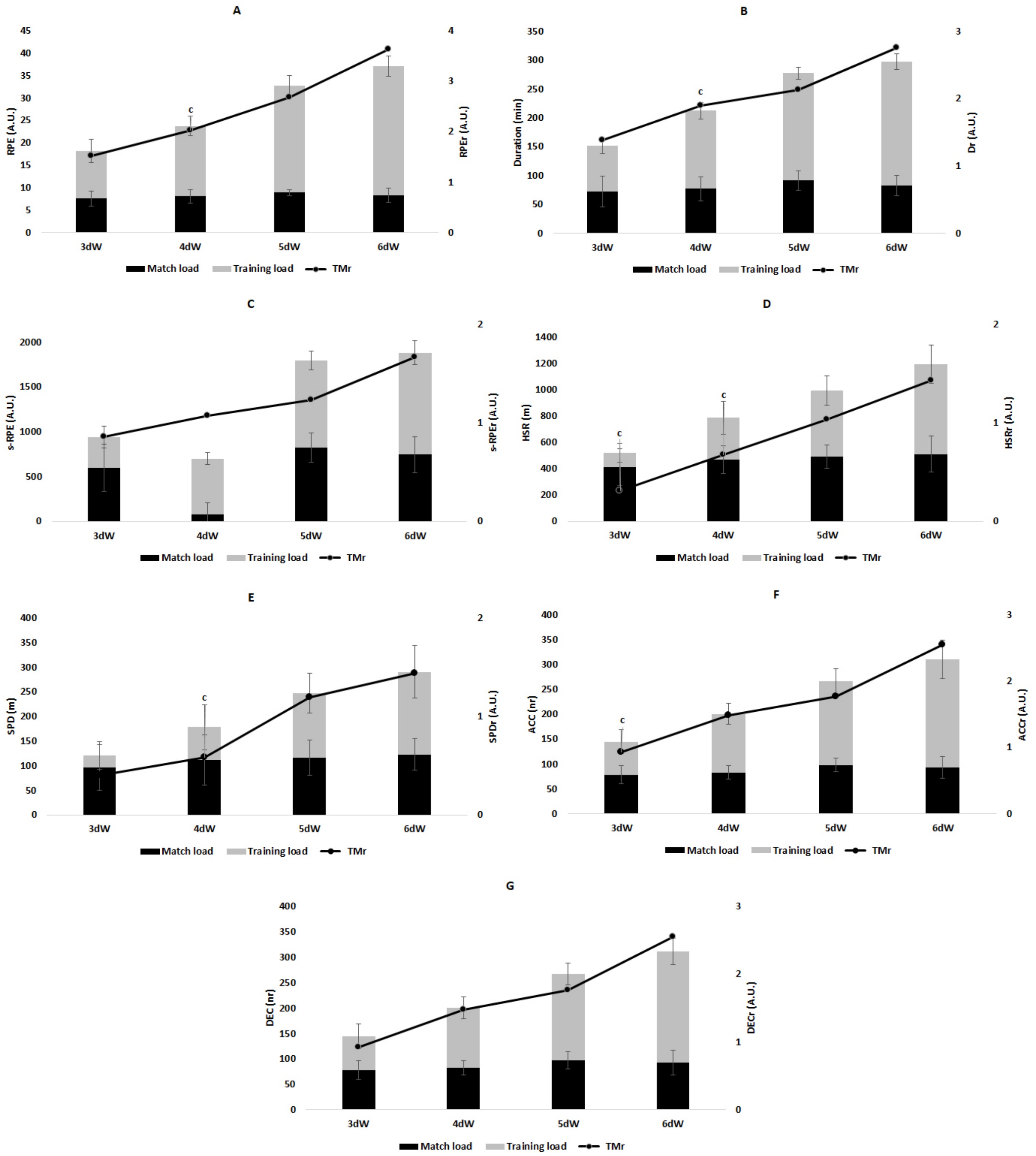

FIGURE 1. Accumulative weekly training load, match load and training/match ratios. c denotes significant difference from 6dW ($p < 0.05$). RPE: rating of perceived exertion; A.U.: arbitrary units; TMr: training/match ratio; HSR: high speed running; SPD: sprint distance; ACC: number of accelerations; DECr: decelerations ratio.

as this type of training increases the number of ACC/DEC and decreases HSR and SPD covered [38, 39]. Although this variable was not controlled in the present study, coaches must manage the number of small-sided games performed during different training weeks since they can induce higher TMr values for ACC and DEC. Moreover, additional training should be performed in weeks with low HSR and SPD covered.

Despite its contributions, the present study had some limitations. The main limitation is the small sample size derived from only one team and a restricted period of 16 weeks. Moreover, playing position differences were not considered even though some positions, such as wingers and wide defenders, generate higher accumulated values, TMr or perceived different wellness statuses than other positions since these positions require greater effort and more running than other positions [29]. Moreover, playing status (starters versus non-starters) was not considered due to the restricted inclusion criteria of the present study. It would be worthwhile to investigate whether non-starters are completing enough training to participate in matches. Consequently, future studies should analyse larger sample sizes, consider different playing statuses, and analyse regular weeks with one match versus congested periods with

TABLE 2. Comparisons of the different microcycles for TMr.

Variable	3dW	4dW	5dW	6dW	*p*-value	Effect size
RPEr (A.U.)	1.64 ± 0.73	1.75 ± 0.72[c]	3.16 ± 1.55	3.22 ± 1.19	3dW *vs.* 4dW: >0.999 3dW *vs.* 5dW: 0.064 3dW *vs.* 6dW: 0.107 4dW *vs.* 5dW: 0.435 4dW *vs.* 6dW: 0.003 5dW *vs.* 6dW: >0.999	3dW *vs.* 4dW: 0.14 3dW *vs.* 5dW: 1.71 3dW *vs.* 6dW: 1.88 4dW *vs.* 5dW: 1.58 4dW *vs.* 6dW: 1.75 5dW *vs.* 6dW: 0.04
Dr (A.U.)	1.36 ± 0.98	1.67 ± 0.85[c]	2.55 ± 1.52	2.35 ± 1.02	3dW *vs.* 4dW: >0.999 3dW *vs.* 5dW: 0.447 3dW *vs.* 6dW: 0.179 4dW *vs.* 5dW: >0.999 4dW *vs.* 6dW: 0.038 5dW *vs.* 6dW: >0.999	3dW *vs.* 4dW: 0.29 3dW *vs.* 5dW: 1.08 3dW *vs.* 6dW: 0.92 4dW *vs.* 5dW: 0.88 4dW *vs.* 6dW: 0.72 5dW *vs.* 6dW: 0.17
s-RPEr (A.U.)	0.87 ± 0.84	0.92 ± 0.54	2.12 ± 2.90	1.40 ± 0.67	3dW *vs.* 4dW: >0.999 3dW *vs.* 5dW: >0.999 3dW *vs.* 6dW: 0.788 4dW *vs.* 5dW: >0.999 4dW *vs.* 6dW: 0.081 5dW *vs.* 6dW: >0.999	3dW *vs.* 4dW: 0.05 3dW *vs.* 5dW: 1.47 3dW *vs.* 6dW: 0.57 4dW *vs.* 5dW: 2.32 4dW *vs.* 6dW: 0.80 5dW *vs.* 6dW: 0.74
HSRr (A.U.)	0.31 ± 0.25[c]	0.59 ± 0.28[c]	1.31 ± 1.04	1.25 ± 0.65	3dW *vs.* 4dW: 0.220 3dW *vs.* 5dW: 0.110 3dW *vs.* 6dW: 0.008 4dW *vs.* 5dW: 0.558 4dW *vs.* 6dW: 0.010 5dW *vs.* 6dW: >0.999	3dW *vs.* 4dW: 1.02 3dW *vs.* 5dW: 1.32 3dW *vs.* 6dW:4.70 4dW *vs.* 5dW: 3.72 4dW *vs.* 6dW: 2.39 5dW *vs.* 6dW: 0.08
SPDr (A.U.)	0.41 ± 0.60	0.49 ± 0.34[c]	1.44 ± 1.05	1.28 ± 0.72	3dW *vs.* 4dW: >0.999 3dW *vs.* 5dW: 0.126 3dW *vs.* 6dW: 0.071 4dW *vs.* 5dW: 0.262 4dW *vs.* 6dW: 0.024 5dW *vs.* 6dW: 0.999	3dW *vs.* 4dW: 0.12 3dW *vs.* 5dW: 1.68 3dW *vs.* 6dW: 1.33 4dW *vs.* 5dW: 3.61 4dW *vs.* 6dW: 2.36 5dW *vs.* 6dW: 0.20
ACCr (A.U.)	0.92 ± 0.48[c]	1.34 ± 0.65	2.06 ± 1.00	2.22 ± 1.23	3dW *vs.* 4dW: 0.441 3dW *vs.* 5dW: 0.064 3dW *vs.* 6dW: 0.036 4dW *vs.* 5dW: 0.879 4dW *vs.* 6dW: >0.999 5dW *vs.* 6dW: >0.999	3dW *vs.* 4dW: 0.79 3dW *vs.* 5dW: 2.18 3dW *vs.* 6dW:2.51 4dW *vs.* 5dW: 0.99 4dW *vs.* 6dW: 1.18 5dW *vs.* 6dW: 0.14
DECr (A.U.)	0.81 ± 0.47	1.04 ± 0.50	1.87 ± 1.20	1.90 ± 0.99	3dW *vs.* 4dW: 0.999 3dW *vs.* 5dW: 0.177 3dW *vs.* 6dW: 0.053 4dW *vs.* 5dW: 0.713 4dW *vs.* 6dW: >0.999 5dW *vs.* 6dW: >0.999	3dW *vs.* 4dW: 0.44 3dW *vs.* 5dW: 2.17 3dW *vs.* 6dW: 2.18 4dW *vs.* 5dW: 1.50 4dW *vs.* 6dW: 1.56 5dW *vs.* 6dW: 0.02

RPEr: rating of perceived exertion ratio; Dr: duration ratio; s-RPEr: session rating of perceived exertion ratio; HSRr: high-speed running distance ratio; SPDr: sprint distance ratio; ACCr: accelerations ratio; DECr: decelerations ratio; A.U.: arbitrary units. a denotes significant difference from 4dW; b, a denotes significant difference from 5dW, c, a denotes significant difference from 6dW (all $p < 0.05$); Bold: significant results.

more than one match per week as previously suggested [14].

Furthermore, despite players' familiarisation with the wellness questionnaire in the previous season, reliability was not calculated, which can be considered a limitation. Additionally, the generalisation of these results to other teams, countries, competitive standards and ages is not recommended; thus, further replication studies are required. For instance, a recent study failed to find any external load difference between an under-18 and a first team [40], but an analysis of TMr would provide more insights for coaches. Considering that previous research observed training load variations and the following match outcome [41] and correlations between TMr and the match result [15], the inclusion of these contextual variables should be considered in future longitudinal studies. Finally, a detailed description of training drills in future research may improve practical implementation.

Although these results may depend on the analysed team, this study showed that training sessions were not adjusted according to weekly variations in terms of training sessions. This suggests that coaches need to consider modifying the training load to provide a balance across different types of microcycles. For instance, the present study revealed non-logical load application considering the weeks with few sessions, which presented shorter durations and, consequently, lower loads. Finally, TMr analysis facilitates the interpretation and contextualisation of data and, consequently, allows the training prescription to be planned accordingly to achieve the appropriate load. It also allows coaches and their staff to communicate with each other or with players as previously suggested [14].

5. Conclusions

In conclusion, weeks with fewer training sessions presented lower accumulated load and TMr. Specifically, accumulated wellness and load demands were higher in the weeks with more training sessions and progressively decreased in weeks with fewer training sessions (6dW > 5dW > 4dW > 3dW). On the one hand, higher wellness values are associated with better sleep quality and mood, as well as lower fatigue, muscle soreness and stress, which was associated with higher accumulated load and vice versa. On the other hand, high load values revealed non-logical load application considering that weeks with fewer sessions presented lower duration and consequently lower load. Coaches can plan weeks with fewer training sessions when the priority is for players to recover, as wellness values increased in such weeks during the present study. Of note, the present study analysed the main players on the team who participated in a minimum of 45 minutes in each match. Thus, for teams that only perform three or four training sessions, coaches should consider additional exercises. This could be particularly important for players who do not accumulate playing time.

Moreover, TMr showed the same tendency of higher values for weeks with more sessions, which followed the previous order (6dW > 5dW > 4dW > 3dW). However, some TMr, such as RPEr, HSRr, and SPDr during 3dW and 4dW, as well as ACCr and DECr during 3dW, were lower than 1.0 A.U., which suggests that accumulated training load was lower than match load. This also suggests that coaches may need to provide tailored individualised stimuli of HSR and SPD in weeks with 3dW and 4dW, as well as stimuli of ACCr and DEC in weeks with 3dW, to appropriately manage TMr.

AVAILABILITY OF DATA AND MATERIALS

Due to issues of participant consent related to the new data protection law from 25 May 2018 from the Portuguese data protection law nº. 58/2019 of 08 August, in accordance with the Council and European Parliament (EU) Regulation 2016/679, 27 April 2016, on the protection of individuals regarding the processing of personal data and on the free movement of such data, data will not be shared publicly. Interested researchers may contact the corresponding author.

AUTHOR CONTRIBUTIONS

RO, RCL and JPB—Conceptualization. RO and RCL—methodology. RCL—data collection. RO—formal analysis. RO and RCL—data curation. RO, RCL, RP, JVA, RM and JPB—Writing-original draft preparation; Writing-review and editing. RO, RM and JPB—supervision. RO and JPB—funding. All authors have read and agreed to the published version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study followed the ethical guidelines for human study as suggested by the Declaration of Helsinki. Furthermore, the study was approved by the Research Ethics Committee of the Polytechnic Institute of Santarém, Santarém, Portugal (Nº24-2022ESDRM). All players were informed about study procedures and oral and written consent were obtained from the participants.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. Rafael Oliveira is serving as one of the Editorial Board members of this journal. We declare that Rafael Oliveira had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to DM.

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