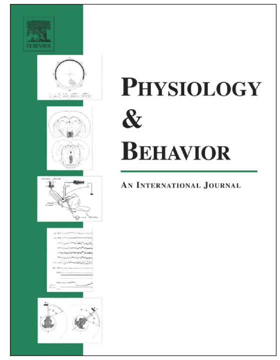
Accepted Manuscript



In-season training load quantification of one-, two- and three-game week schedules in a top European professional soccer team

Rafael Oliveira, João Brito, Alexandre Martins, Bruno Mendes, Francisco Calvete, Sandro Carriço, Ricardo Ferraz, Mário Marques

PII: S0031-9384(18)30585-7
DOI: https://doi.org/10.1016/j.physbeh.2018.11.036
Reference: PHB 12386

To appear in: *Physiology & Behavior*

Received date: 30 July 2018
Revised date: 20 October 2018
Accepted date: 28 November 2018

Please cite this article as: Rafael Oliveira, João Brito, Alexandre Martins, Bruno Mendes, Francisco Calvete, Sandro Carriço, Ricardo Ferraz, Mário Marques , In-season training load quantification of one-, two- and three-game week schedules in a top European professional soccer team. Phb (2018), https://doi.org/10.1016/j.physbeh.2018.11.036

In-season training load quantification of one-, two- and three-game week schedules in a top European professional soccer team

Rafael Oliveira[a,c,d,e]; João Brito[a,d], Alexandre Martins[a], Bruno Mendes [b]; Francisco Calvete[b]; Sandro Carriço[b], Ricardo Ferraz[c,e,f], Mário Marques[c,e]

[a] ESDRM-IPS - Sports Science School of Rio Maior – Polytechnic Institute of Santarém, Av. Dr. Mário Soares, 2040-413 Rio Maior, Portugal.

[b] Benfica Lab of Human Performance, Caixa Futebol Campus, Quinta da Trindade, 2840-600, Seixal, Portugal

[c] CIDESD - Research Centre in Sport Sciences, Health Sciences and Human Development, Quinta de Prados, Edifício Ciências de Desporto, 5001-801, Vila Real, Portugal,

[d] CIEQV - Research Centre on Quality of Life, Complexo Andaluz, Apartado 279 2001-904, Santarém, Portugal

[e] UBI - University of Beira Interior, R. Marquês de Ávila e Bolama, 6201-001 Covilhã, Portugal.

[f] Castelo Branco Football Association

Corresponding Author: João Brito

Sports Science School of Rio Maior – Polytechnic Institute of Santarém, Av. Dr. Mário Soares, 2040-413 Rio Maior, Portugal, Email: jbrito@esdrm.ipsantarem.pt

Declarations of interest: none.

Abstract

Top European soccer teams that play in UEFA competitions often participate in one, two- or three-games per week. Therefore, it is necessary to understand the variations in training load (TL) according to each team's competitive schedule. The aim of this study was to quantify internal and external TLs within five microcycles: M4 and M5 – one-game weeks; M1 and M3 – two-game weeks; M2 – three-game week). The sample consisted of thirteen elite soccer players. A global positioning system (GPS) was used to measure the total distance covered and distances of different exercise training zones (1-5), the session ratings of perceived exertion (s-RPE) scores and the amount of creatine kinase (CK) created during daily training sessions for the 2015-2016 in-season period. The data were analysed with respect to the number of days prior to a given match. The main results indicate that there was a significant difference in training intensity for zone 1 between M5 and M3 (4010.2±103.5 and 4507.6±133.0 m, respectively); a significant difference in training intensity for zone 3 between M4 and M2 (686.1±42.8 and 801.2±61.2 m, respectively); a significant difference in the duration of the training sessions and matches between M5 and M2 (69.2±2.1 and 79.6±2.3) and M1 and M2 (69.7±1.0 and 79.6±2.3); and finally, there was a significant difference in CK between M1 and M5 (325.5±155.0 and 194.4±48.9). Moreover, there was a significant decrease in TL in the last day prior to a match, for all microcycles and all variables. There was no significant difference with respect to s-RPE. This study provides the first report of daily external and internal TLs and weekly accumulated load (training sessions and match demands) during one, two, and three-game week schedules in a group of elite soccer players. Expected significant differences are found in daily and accumulated loads for within- and between-game schedules. A similar pattern is

exhibited for one- and two-game week microcycles regarding the day before the match, which exhibits a decrease in all variables.

Keywords: soccer training; internal load; external load; training load; periodization; GPS.

1. Introduction

Generally, in soccer, games occur once every week. However, teams that play in UEFA competitions and domestic league/cup competitions may participate in more games (two or three) per week [1-3]. More games per week, and thus more games per season, can make it difficult for coaches to manage the training load (TL) and avoid accumulated fatigue, while ensuring that players remain at an optimal level of physical fitness. In fact, the inappropriate management of TL has quickly become one of the main risk factors in no-contact injuries [4]. Quantifying and comparing the TL experienced during microcycles with different number of games could help explain the changes between microcycles (both overall and between player positions) throughout the competitive season. Indeed, a high number of games and daily training sessions can lead to increased levels of fatigue, as well as higher risk of illness and injury [5]. Therefore, it is very important to monitor TL to ensure optimal match-day performance and recovery [6,7].

Training load includes both external and internal loads. External TL is associated with the physical work performed during a training session or match, while internal TL is related to biochemical (physical and physiological) and biomechanical stress responses [8,9]. Initially, soccer teams were limited to the use of subjective scales to monitor TL, in particular, the use of the rating-of-perceived-exertion (RPE) scale initially developed by Borg [10], and later adapted by Foster [11]. Another simple, time-efficient and cost-effective method of assessing TL is to multiply the total exercise duration (in minutes) by the rating of perceived exertion (using an adapted Borg [10] category ratio). This is referred to as the session rating of perceived exertion (s-RPE) and was devised by Foster [12,13] and Impellizzeri et al. [14]. In recent years, this method has incorporated the use of heart-rate (HR) telemetry systems, which include semi-automated multi-camera systems, local positioning systems and global positioning systems (GPS). Biochemical markers have also been used to analyse the impact of internal TL. One of the most commonly used markers is Creatine Kinase (CK). Indeed, CK is widely considered to be a marker of fatigue status [15,16] and skeletal muscle fibre damage

[17]. Thus, CK should be considered and analysed in addition to other TL values to improve reliability of the results [18].

Several studies have examined the in-season phase, which includes short training microcycles of 1-2 weeks [8,19,20], mesocycles of 4-10 weeks [14,21,22] and longer training blocks of 3-4 months [23]. Manzi et al. [24] have attempted to quantify TL throughout the pre-season and Jeong et al. [25] have conducted a comparison of TL during the pre-season and the in-season. However, the majority of these studies only provide limited information about TL, since they only consider the duration and session of RPE and do not include GPS data. In addition, few studies [26-28] have attempted to quantify TL with respect to changes between mesocycles and microcycles (both overall and between player's positions) across a full competitive season. None of the studies have analysed and compared internal and external TL simultaneously across microcycles with 1-, 2- and 3-game week during the competitive soccer phase.

Furthermore, the physical demands of training on elite professional soccer players are not currently well documented and are limited to reports of a single week exposure [29]. However, elite soccer players often play two (e.g. Sunday-to-Saturday) or three (e.g. Sunday-Wednesday-Saturday) games over a seven-day period. This is largely due to involvement in numerous competitions (i.e. domestic league/cup competitions and UEFA competitions) and periods of intense schedules, such as in the winter [3].

There is also currently limited information regarding TL in teams that play in UEFA leagues like the Champion league. Periodized or tapering approaches, which means a decrease in TL until the day before the match, were reported within the literature have attempted to facilitate a progressive TL [30] or reduce the risk of injury [31]. Only recently sports scientists have begun to describe the in-season training periodization practices of elite football teams in more detail, including a comparison of training days within weekly micro-cycles [2,27,32,33]. Malone et al. [27] have found that only the last training session before a match differs from other training days with regard to several internal

and external load variables. Moreover, Akenhead et al. [32] have reported a similar decrease in total distance and high-speed running distances (HSRD) for training sessions closer to match-day.

Nevertheless, there are limited data regarding the single-week exposure of TL in professional and elite soccer players [19]. Therefore, it is important to further examine how TL is managed on days between games for one, two and three game week schedules (weekly training frequency is five, four and two, respectively). This information could be important for coaches and sports scientists to determine the correct approach [34].

Thus, the primary aim of this study was to quantify TL and match load during for three different weekly game schedules: one-, two- and three-game week during the 2015–2016 season for elite European soccer players.

2. Material and methods

2.1 Participants

Thirteen elite outfield soccer players belonging to a top European team that played in a UEFA Champions league with a mean ± SD age, height and mass of 26.2 ± 4.1 years, 183.5 ± 6.1 cm and 78.7 ± 5.1 kg, respectively, participated in this study. We adapted inclusive criteria from Steven et al. (2017) using the records of players who played for at least 60 minutes on the microcycle. All participants were familiarised with the training protocols prior to investigation. This study was conducted according to the requirements of the Declaration of Helsinki and was approved by the Research Unit of the University of Beira Interior.

2.1.1 Design

Training load data were collected over a 39-week period during the 2015-2016 annual season (July 2015 to May 2016). The team used for data collection competed in four official competitions across the season, including the European Champions league, the national league and two more national

cups from their own country, which often meant that the team played one, two or three games per week. For the purposes of the present study, all sessions conducted during the main team sessions were considered. Moreover, all data collected from matches for the period chosen were considered. Only data collected from the training sessions and the matches were considered. Data from rehabilitation or recuperation were excluded. The duration of the training sessions includes the warm-up, main and slow-down phases, plus stretching.

The weeks were chosen based on the number of games played (one, two, or three), in addition to the inclusion of four training sessions within the week, following one or two days off for recovery and one or two in-house recovery sessions (Figure 1).

Insert Figure 1.

Total minutes of the matches did not include time spent warming up before a match. Although compensation minutes were included in the collected data, this number is not given because the administration of the soccer club does not want to any information disclosed that could reveal which team was studied.

2.2 Methodology

Training and match data were collected over the course of five different 7-day periods (microcycles): for one-game week, microcycle M4 against one medium/bottom-level opponent and M5 against one top-level opponent from the national league; for two-game week, microcycle M1 against a top-level opponent from the European Champions league and a medium/bottom-level opponent from the national league, plus microcycle M3 against two medium/bottom-level opponents from two national leagues; for three-game week, microcycle M2 against medium/bottom-level opponents from the national league, national cup league and national league, respectively. Although other weeks also fit

the descriptions provided, the five different weeks selected met the criteria for participants, meaning that they completed all training sessions during the chosen weeks and completed at least one game during the timeframe. A total number of 20 training sessions (260 individual) and 9 games (117 individual) were observed during this investigation. This study did not influence or alter the training sessions in any way. Training and match data were collected at the soccer club's outdoor training pitches. The data were analysed in relation to the day of the weekly microcycle (i.e. day 1, day 2… and day 7). Moreover, we also included the "match day minus" approach used by Malone et al. [27] to increase clarity with regard to the different weekly scenarios.

2.2.1 External training load – training data

Each player's physical activity during each training session was monitored using a portable GP unit (Viper pod 2, STATSports, Belfast, UK). Research has shown this system to be a valid and reliable marker of assessment for monitoring a team player's movements [35]. This device provides position velocity and distance data at 10 Hz. Each player wore the device inside a custom-made vest across the upper back, between the left and right scapula. In this position, the GPS antenna is exposed to allow for clear satellite reception. This type of system has previously been found to provide valid and reliable estimates of instantaneous and constant velocity movements during linear, multidirectional and soccer-specific activities [36,37]. All devices were activated 30 minutes before data collection to allow for the acquisition of satellite signals and to ensure that the GPS clock was synchronised with the satellite's atomic clock [38]. Following each training session, GPS data were downloaded using the respective software package (Viper PSA software, STATSports, Belfast, UK) and were cut to only include movements that occurred during the training session (i.e. the beginning of the warm-up to the end of the last organised drill). In order to avoid inter-unit errors, players wore the same GPS device for each training session [39,40].

Thus, the following variables were selected: total duration of training session, total distance, distance of different exercise intensity zones: zone 1 (0 – 10.9 Km/h), zone 2 (11 – 13.9 Km/h), zone 3 (14 –

18.9 Km /h), zone 4 (19 – 23.9 Km/h) and zone 5 (> 24 Km/h). The run-speed threshold categories used are in accordance with extant research [41,42].

2.2.2 External training load – match data

Each player's match data were examined using a tracking system (DatatraX®) to provide real-time analysis.

Thus, the following variables were selected: total duration of match, total distance, distance of different exercise intensity zones: zone 1 (0 – 10.9 Km/h), zone 2 (11 – 13.9 Km/h), zone 3 (14 – 18.9 Km /h), zone 4 (19 – 23.9 Km/h) and zone 5 (> 24 Km/h).

2.2.3 Internal training load – training data

Thirty minutes after each training session, the players were asked to provide an RPE rating, using the modified CR10-scale by Foster [11]. All players were familiarized with the RPE scale prior to the commencement of the study. Players were prompted to track their RPE individually using a custom-designed application on a portable computer tablet. Each player selected their RPE rating by touching the respective score on the tablet, which was then automatically saved to the player's profile. This method helped minimise factors that could influence a player's RPE rating, such as peer pressure and replicating other players' ratings [43]. Each individual RPE value was multiplied by the session duration to generate a session-RPE (s-RPE) value [12-14].

Forty-eight hours before the matches, we measured the concentration of plasma CK found in each player [7]. To accomplish this, the skin was first cleaned using a 95% ethyl alcohol. After drying, 32 μL of capillary blood was collected using an automatic lancet. The blood was saved in a heparinized capillary tube (Reflotron Plus, Roche Diagnostics) and immediately pipetted onto a reactive CK strip (Reflotron Plus, Roche Diagnostics), to be placed in a Boehringer Mannheim Reflotron Analyser®.

2.3 Statistical Analysis

Data were analysed using the SPSS version 22.0 (SPSS Inc., Chicago, IL) for Windows statistical software package. Initially, descriptive statistics were used to characterize the sample. Shapiro-Wilk and Levene tests were conducted to determine normality and homoscedasticity, respectively. Once variables obtained a normal distribution (Shapiro-Wilk>0.05), the variables were compared for each of the seven days of the week. This process was repeated to also allow a comparison between all microcycles/weeks. The results are significant in the interaction ($p \leq 0.05$).

3. Results

3.1 Day-to-day variations in training load across one-, two and three-game weeks

Duration of activity and distance covered within specific speed zones are presented in Tables 1 and 2, respectively. In addition to the global indices of training and match load, the main effects (all $p < 0.05$) across the 7-day period for distance completed within each speed category were also observed for each week (see Tables 1 and 2). To address issues with brevity, pairwise comparisons between specific days are reported in Tables 1 and 2 as well. We adopted the same method for data presentation as Anderson et al. (2016).

Insert table 1.

Insert table 2.

3.2 Comparisons between microcycles

Duration and distance covered for training sessions and matches were rated according to a perceived exertion scale; s-RPE and CK values from the training sessions were compared for all microcycles. There are no differences for total distance, training intensity of zones 2, 4, and 5, s-RPE and RPE, $P<0.05$.

However, there were significant differences between several of the microcycles for some variables. For example, there is significant difference in training intensity of zone 1 between M5 and M3 (4010.2±103.5 vs 4507.6±133.0 m, respectively).

Insert Figure 2.

There was also a significant difference in training intensity of zone 3 between M4 and M2 (686.1±42.8 vs 801.2±61.2 m, respectively), as well as a difference in duration of training sessions and matches between M5 and M2 (69.2±2.1 vs 79.6±2.3, respectively) and M1 and M2 (69.7±1.0 vs 79.6±2.3, respectively).

Insert Figure 3.

Insert Figure 4.

Insert Figure 5.

Finally, there was significant difference in CK between M1 and M5 (325.5±155.0 vs 194.4±48.9, respectively).

Insert Figure 6.

4. Discussion

The main aim of this study was to determine the TLs of weekly microcycles, in which a different number of matches occur, for a professional male elite soccer team. To the best of our knowledge, this study provides the first report of daily external and internal TL and weekly accumulated load (training sessions and match demands) for one, two, and three-game week schedules in a sample of elite soccer players. This study could find significant differences in daily and accumulated loads for the within- and between-game schedules.

4.1 Comparison between days of the week-pattern microcycles

In general, the TL is different between training sessions depending on the number of games (one, two, or three) per week.

The internal TL analyzed through s-RPE does not seem to have a pattern in the different microcycles. These results contradict previous studies [2,23,44], which have found an intense s-RPE pattern exists in the beginning of the different microcycles.

The s-RPE is a viable method to characterize training responses in players [12,13,14,45], however, our results indicate that s-RPE does not follow the same pattern as the external TL variables. Indeed, several studies have stated that RPE may be a physiological and volatile construct that could differ depending on the cognitive focus of a given player [46-49]. Also, Renfree, Martin, Micklewright and Gibson [50] have reported that RPE can be dissociated from the physiological process through a variety of psychological mechanisms. For this reason, RPE may be an oversimplification of the psychophysiological perceived exertion and a non-conclusive measure to capture a wide range of experienced sensations [47,48,50]. It is also important to note that RPE was collected 30 minutes after the end of each training session and it would be pertinent to check whether there are any atypical variations during the training sessions, as stated by Ferraz et al. [48]. These arguments may explain why there were no differences in s-RPE between training days, as well as why there appears to be a lack of relationship between s-RPE and the external TL variables.

When s-RPE was analyzed in the 1-game week microcycle, there was no significant difference in s-RPE for days 4 and 5 (MD-3 and MD-2, respectively), although there was a slight difference when compared to day 6 (MD-1). Thus, it is likely that days 4 and 5 (MD-3 and MD-2, respectively) were

higher loading days, while day 6 (MD-1) was a tapering session for the match. There were no differences in s-RPE between days 3 and 6 (MD-4 and MD-3, respectively), being the first one of recovery and the other of tapering. The load distribution found in this study is similar to that reported in several other studies [2,25,28].

With regard to the 2-game week microcycle (M1 and M3), there were no differences in s-RPE for days 4 and 5 (respectively, MD-3 and MD-2). Days that exhibited higher TL (MD-4) appear to be merely coincidental in our study, although Anderson et al. [2] have reported that MD-3 regularly exhibits higher TL than other days. In the study conducted by Anderson et al. [2], one day-off was given after each match-day, which likely meant that MD-4 was a recovery training session and would therefore, exhibit lower TL.

Singularly, for M2 (for the 3-game week microcycle), the day after the match exhibited greater s-RPE (MD-2, corresponding to days 2 and 5 of the week) but no significant difference was found. Only considering RPE, however, there was a significant difference between MD-2 and MD-1 (corresponding to day 2 and day 3; and day 5 and day 6, respectively). This 3-game week microcycle did not have a single day-off, unlike in the study conducted by Anderson et al. [2], occurring 2 training sessions between matches.

As match-day approaches, external TL (as total distance and distances covered at different running speed thresholds during training) decreases in almost all week-pattern microcycles. Moreover, our results indicate that external TL is highest at the beginning of the microcycle: this is likely done to ensure that fatigue is minimal as match-day nears. The struggle between binomial fatigue and recovery has been extensively studied with regard to soccer [51], although uncertainties remain about the underlying mechanisms [52,53]. Several studies have stressed the importance of varying

daily TLs (i.e. alternation of low- and heavy-load training days) to achieve optimal performance on match-day [2,20,25]. Stevens et al. [33] have reported the highest external TL on the first training-day of the week. Akenhead et al. [32] have found that, for an entire season, the highest external TL typically occurs on the second training-day of the 1-game week. Also, Anderson et al. [2] have reported highest external TL on the second for 1- and 2-game week. The findings of Malone et al. [27] indicate no differences in external TL between the first three training-days of the week, but their study analyzed a 6-week pattern of 1-game week. Several studies involving English Premier League teams have also found that during a typical week-pattern microcycle – 6 full days between matches – the last training-day before the match (MD-1) commonly has the lowest load [2,27,32]. These results indicate that differences exist in the distribution of TL between high-level football teams, especially in the first three training-days of the microcycle of a full training week-pattern microcycle. The present study found that the first day of a week's training sessions exhibits higher TL values, which decrease until MD-1, independent of the number of games per week.

In one-game week microcycles, the training-days with higher TLs were not coincident. In M4, the MD-2 exhibited greater total distance and high-speed running zones (>19km/h), whereas in M5, the MD-4 exhibited higher TL. The load distribution pattern of M5 after the first training session of the week for a 1-game week is similar to those reported within the literature [2,27,32,33]. Possible reasons for these differences could be the association between the different training session durations (table 1) and the different levels of intensity applied by the coach. For example, M4 in MD-2 exhibited a longer duration (88min) and therefore, higher values. However, M5 had higher values in MD-4 with a duration of only 32 minutes. This can possibly be explained by the application of a high-intensity training approach or simply due to the context and competitive schedule and the objectives related to the training load management.

With regard to the 2-game week microcycle (M1), all external TL variables decreased from MD-4 to MD-1, and there was a significant difference of MD-1 for all days. However, M3 exhibited a different pattern: MD-4 > MD-3 < MD-2 > MD-1, which means that MD-4 and MD-2 exhibited higher TL. Anderson et al. [2], when examining the same week pattern, reported that MD-3 exhibits the highest TL. However, it is important to note that in their study, there was a day-off after the match-day, which likely means that MD-4 was used for a recovery training session and therefore, would exhibit a lower TL.

Singularly, in the M2 (3-game week microcycle), the day with the greater external TL was the day after the match (MD-2, corresponding to days 2 and 5 of the week) for total distance and all covered distances (zones 1, 2, 3, 4 and 5) and there were significant differences between MD-2 and MD-1 (corresponding to day 2 and day 3, and day 5 and day 6) with the exception of zone 5, high-speed running distance (>25km/h), which did not exhibit any significant differences. Moreover, this 3-game week microcycle did not have a day-off, unlike in the study conducted by Anderson et al. [2], occurring 2 training sessions between matches. Similarly, high-speed running zone 5 (>25km/h) decreased as match-day approached, however no differences were observed between all training days within each week-pattern microcycle (table 2). Moreover, no pattern was determined for these days, except for the day before the match.

4.2 Comparison between microcycles

In the present study, there wereno significant differences between internal TL, s-RPE and RPE for microcycles of one-, two- or three-game weeks (see Figures 2-6). In contrast, Clemente et al. [26] found significant differences in s-RPE between microcycles of one- and two-game weeks and found smaller values of s-RPE in two-game weeks compared to one-game week. The results suggest that s-RPE may be sensitive to congested periods, but not sensitive to regular periods of training during

one-game week [26]. Furthermore, as reported above, RPE may be a psychophysiological and volatile construct [46-49].

A comparison of the weekly internal load for the 3-game week microcycles found that, despite a different distribution of loads across the training microcycle (7 days), the overall TL remains constant (i.e. training sessions plus games loads). Moreover, despite the number of games played in a week, there is no significant difference between weekly s-RPE imposed during actual week-pattern microcycles (1-, 2-, and 3-game weeks, respectively).

Considering the accumulated weekly TL, it is possible to obtain more detailed information regarding the actual subjective response to training prescription for coaches [14,54]. In the present study, there is no difference between microcycle for s-RPE and their mean range weekly TL was 243-277 arbitrary units (AU). The weekly s-RPEs collected by this study are in accordance with what has previously been found by Scott et al. [22], in the range of 38–936 AU, but higher than 187 AU for elite soccer players [25]. Unlike in our study, Jeong et al. [25] only used professional Korean soccer players while the present study comprises top European soccer players who compete in UEFA competitions. Moreover, the mean for the total weekly TL (based on s-RPE) corresponds to a range of 970-1110 AU, as a reference for training session prescriptions.

With regard to concentrations of plasma CK, it appears that coaches use this approach to determine whether athletes are ready to compete in upcoming matches [55]. They use this measurement to prevent injury, observe the effectiveness of an implemented training program, maintain athlete performance and prevent overtraining [56]. In fact, several studies have reported significant correlations between CK and running speeds >4 $m.s^{-1}$, accelerations and decelerations over a certain magnitude (moderate to high). It has even been suggested that a certain volume of movement at these speeds is necessary for the movement to be strongly associated with CK levels [57]. However, the data collected only reveal a significant difference between M1 and M5 (325.5±155.0 and

194.4±48.9, respectively), as can be observed in figure 6. M1 has higher values of CK, which may be associated with high-intensity training sessions, accumulated TL or incomplete recovery of players 48 hours before a given match.

For external TL with 1-, 2- and 3-game weeks, the average data obtained are as follows: training duration (67.4; 70.5 and 85.5 min, respectively), total distance (5340.5; 5668.7 and 5105.5m, respectively), running (195.1; 148.4 and 175.6m, respectively) and high-speed running (58.5; 46.1 and 22.6m, respectively). All obtained data are in similar ranges to what other studies have demonstrated (65–77 min, 3898–5667 m, 220–591 m and 41–205 m, respectively) [2,22,27,32,33]. We also found no significant differences between microcycles for total distance and for high-speed running distance for zone 5 (>25km/h). The only difference found concerned the training intensity of zone 4 between M4 and M2. One plausible reason for this may be that there was no change in TL during the microcycles studied, and possibly during all microcycles for the entire in-season. Indeed, coaches and fitness trainers may have imposed a similar weekly TL throughout the entire competitive season, despite the number of games, in the attempt not to overload players.

Anderson et al. [2] have found that, with regard to 2-game weeks, the total weekly accumulated distance and duration of activity is higher than in the 1-game week schedule and includes significantly more time spent in high-intensity zones. However, our results are in accordance with several other studies [58], which have reported no differences between total distance and intensity training zones for 1- and 2-game week microcycles. Once again, these differences may be associated with differences in training session duration (table 1) and intensity, neither of which were controlled for this study.

Anderson et al. [2] have also stated that the total duration of training sessions and games was higher in the 2-game weeks than in the 1- and 3-game week microcycles. These results contradict the findings in this study, which indicate a higher total duration in the 3-game week microcycles.

However, it is important to note that the results of the training sessions during the microcycles studied by Anderson et al. [2] were different from our study. For instance, in a 3-game week microcycle, there were only two training sessions, while in our study there were four.

Moreover, Anderson et al. [2] determined a higher total distance covered in the 3-game week compared with the 1-game week. In our study, however, we did not find any significant difference likely due to the distances covered during matches. The study of Anderson et al. [2] revealed that the coach adjusts the load for different week-pattern microcycles. Indeed, the coach increased the total distance covered in a 1-game week training session, then decreased it in a 2-game week, and then further decreased it during a 3-game week.

In accordance with the findings of Owen et al. [59], it is expected to reduce TL two days before a match to reduce the number of physical stressors imposed upon the players. This statement agrees with our results if we consider the values of all internal and external TL for the last day of all the microcycles studied. As reported by Stevens et al. [33], in different full-week microcycles there is limited time for recovery and physiological conditioning, since the last days were too close to the match and therefore would most probable cause pre-match fatigue. Our TL data conforms to this statement (table 2).

Although several studies determined that training sessions differed depending on how many games were played each week (one, two, or three), our study reveals that, during in-season for a top European soccer team, matches are probably the most important physiological stimulus during the competitive season.

5. Conclusions

To the best of our knowledge, this is the first study to report a specific analysis of 1-, 2-, and 3-game weeks of internal and external TL simultaneously. Indeed, this study quantifies the daily training and

accumulative weekly and match load in professional elite European soccer team during a one-, two- and three-game week schedule. It is important to note that customary TLs did not exhibit a regular pattern for one- and two-game week microcycles for either external TL (distances of different exercise training intensity zones) nor internal TL (s-RPE, CK). Moreover, the evidence indicates a particular concern of periodisation in training during the day before a match, because all external and internal TL variables were reduced. Another major finding is that the values of external TL for distances of different exercise training intensity (zones 1-4) were never reached in training sessions with the exception of M2 (three-game weeks) in comparison to the values reported in matches. The values recorded during games also indicate that a high-running speed distance (zone 5, > 24 Km/h) was never reached. The enzymatic parameter CK did not increase in weeks with two- or three-game weeks as expected, which confirms that weekly match load was likely considered in the daily management of TL (during training sessions).

Our study also reveals that internal training and external training differ on a daily basis during different microcycles. Moreover, in each analysis performed, there may be no correspondence between them. As such, a careful analysis of each variable should be conducted for each day or each microcycle. Future studies should also consider, for example, an individualized analysis of the TL (external and internal) in accordance with the position of the players. Furthermore, is important to understand whether several contextual variables, such as the opponent level, the match result or the time during the season, could affect the results.

6. Practical Applications

This study provides useful information regarding the TLs of an elite European soccer team that plays in a European Champions league. It provides further evidence of the value of using a combination of different monitoring measures to fully evaluate the TL patterns observed across a full competitive season. Moreover, appropriate doses of training stimulus could improve performance and protect

against possible injury [52]. It is, therefore, important for physical fitness and sports technicians to determine the optimum quantity of training required for a player to continue improving his/her physical fitness, while reducing the probability of injury, in order to maximize his/her performance during competition.

For coaches, this study could provide important information to be considered when planning training sessions. The significant differences found in daily and accumulated loads within- and between-game schedules could have implications for weekly periodization. To ensure that fatigue is properly managed, TLs should be adjusted at various times during the different week microcycles. Based on the data obtained, it is possible to retrospectively examine load–performance relationships and to enable appropriate planning for TLs depending on the number of games. Data may also be useful for team selection and determining which athletes are ready for the demands of competition.

Data collected from the training monitoring can also be useful to facilitate communication between the support staff and the coaching staff.

Acknowledgements

The authors would like to thank the team's coaches and players for their cooperation during all data collection procedures.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declarations of interest

None.

References

[1] R.T. Thorpe, A.J. Strudwick, M. Buchheit, G. Atkinson, B. Drust, W. Gregson, Tracking Morning Fatigue Status Across In-Season Training Weeks in Elite Soccer Players. Int. J. Physiol. Perform. 11 (7) (2016) 947-952.

[2] L. Anderson, P. Orme, R. Di Michele, G.L. Close, R. Morgans, B. Drust, J.P. Morton, Quantification of training load during one-, two- and three-game week schedules in professional soccer players from the English Premier League: implications for carbohydrate periodisation. J. Sports Sci. 34 (13) (2016) 1250-9. doi: 10.1080/02640414.2015.1106574. Epub 2015 Nov 4.

[3] R. Morgans, P. Orme, L. Andreson, B. Drust, J. Morton, An intensive winter fixture schedule induces a transient fall in salivary IgA in English Premier League soccer players. Res. Sports Med. 22 (2016) 346-354.

[4] T. Soligard, M. Schwellnus, J.M. Alonso, R. Bahr, B. Clarsen, H.P. Dijkstra, T. Gabbett, M. Gleeson, M. Hägglund, M.R. Hutchinson, C. Janse van Rensburg, K.M. Khan, R. Meeusen, J.W. Orchard, B.M. Pluim, M. Raftery, R. Budgett. L. Engebretsen, How much is too much? (Part 1) International Olympic Committee consensus statement on load in sport and risk of injury. Br. J. Sports Med. 50 (17) (2016) 1030-41. doi: 10.1136/bjsports-2016-096581.

[5] C.M. Jones, P.C. Griffiths, S.D. Mellalieu, Training load and fatigue marker associations with injury and illness: a systematic review of longitudinal studies, Sports Med 47 (5) (2017) 943–974. Available from: http://link.springer.com/10. 1007/s40279-016-0619-5.

[6] R. Morgans, D. Adams, R. Mullen, C. McLellan, M. Williams M. Technical and physical performance over and English championship league season. Int. J. Sport Sci. Coaching 14 (2014) 493-503.

[7] M. Nédélec, A. McCall, C. Carling, F. Legall, S. Berthoin, G. Dupont, Recovery in soccer: Part I – post-match fatigue and time course of recovery. Sports Med. 42 (2012) 997-1015.

[8] F.M. Impellizzeri, E. Rampinini, S.M. Marcora, Physiological assessment of aerobic training in soccer. J. Sports Sci. 23 (2005) 583-592. PubMed doi:10.1080/02640410400021278

[9] J. Vanrenterghem, N.J. Nedergaard, M.A. Robinson, B. Drust, Training load monitoring in team sports: A novel framework separating physiological and biomechanical load-adaptation pathways. Sports Med. (2017) 47 (11) 2135-2142. doi: 10.1007/s40279-017-0714-2.

[10] G. Borg, Perceived exertion as an indicator of somatic stress. Scand. J. Rehabil. Med. 2 (1970) 92-98.

[11] C. Foster, Monitoring training in athletes with reference to overtraining syndrome. Med. Sci. Sports Exerc. (1998) 30 1164–1168. doi:10.1097/00005768-199807000-00023

[12] C. Foster, L. Hector, R. Welsh, M. Schrager, M. Green, A. Snyder. Effects of specifc versus cross-training on running performance. Eur. J. Appl. Physiol. Occup. Physiol. (1995) 70 (4) 367-72. doi:10.1007/BF00865035

[13] C. Foster, J.A. Florhaug, J. Franklin, L. Gottschall, L.A. Hrovatin, S. Parker, P. Doleshal, C. Dodge, A new approach to monitoring exercise training. J. Strength Cond. Res. 15 (2001) 109–115.

[14] F.M. Impellizzeri, E. Rampinini, A.J. Coutts, A. Sassi, S.M. Marcora, Use of RPE-Based Training Load in Soccer. Med. Sci. Sports Exerc. 36 (6) (2004) 1042-1047

[15] A. Ascensão, A. Rebelo, E. Oliveira, F. Marques, L. Pereira, J. Magalhães, Biochemical impact of a soccer match—analysis of oxidative stress and muscle damage markers throughout recovery. Clin. Biochem. 41 (2008) 841-851. doi: 10.1016/j.clinbiochem.2008.04.008

[16] M. Russell, J. Northeast, G. Atkinson, D.A. Shearer, W. Sparkes, C.J. Cook, L.P. Kilduff, Between-match variability of peak power output and creatine kinase responses to soccer

match-play. J. Strength Cond. Res. 29 (8) (2015) 2079-2085. doi: 10.1519/JSC.0000000000000852

[17] V. Mougios Reference intervals for serum creatine kinase in athletes. Br. J. Sports Med. 41 (10) (2007) 674–678.

[18] M.F. Heisterberg, J. Fahrenkrug, J.L. Andersen, Multiple blood samples in elite soccer players. Is it worthwhile? J. Sports Sci. 32 (13) (2014) 1324–1327.

[19] A.L. Owen, P. Wong, G. Dunlop, C. Groussard, W. Kebsi, A. Dellal, R. Morgans, H. Zouhal, High intensity training and salivary immunoglobulin - A responses in professional top-level soccer players: effect of training intensity. J. Strength Cond. Res. 30 (9) (2016) 2460-9. doi: 10.1519/JSC.0000000000000380.

[20] R. Wrigley, B. Drust, G. Stratton, M. Scott, W. Gregson, Quantification of the typical weekly in-season training load in elite junior soccer players. J. Sports Sci., 30 (2012) 1573-1580.

[21] P. Gaudino, F.M. Iaia, G. Alberti, A.J. Strudwick, G. Atkinson, W. Gregson, Monitoring training in elite soccer players: a systematic bias between running speed and metabolic power data. Int. J. Sports Med. 34 (11) (2013) 963-8. doi: 10.1055/s-0033-1337943.

[22] B.R. Scott, R.G. Lockie, T.J. Knight, A.C. Clark, X.A. Janse de Jonge, A comparison of methods to quantify the in- season training load of professional soccer players. Int. J. Sports Physiol. Perform. 8 (2) (2013) 195-202.

[23] D. Casamichana, J. Castellano, J. Calleja-Gonzalez, J. San Román, C. Castagna, Relationship between indictors of training load in soccer players. J. Strength Cond. Res. 27 (2013) 369-374.

[24] V. Manzi, A. Bovenzi, F.M. Impellizzeri, I. Carminati, C. Castagna, C. Individual training-load and aerobic-fitness variables in premiership soccer players during the precompetitive season. J. Strength Cond. Res. 27 (2013) 631-636.

[25] T. Jeong, T. Reilly, J. Morton, S. Bae, B. Drust, Quantification of the physiological loading of one week of “pre-season” and one week of “in-season” training in professional soccer players. J. Sports Sci. 29 (11) (2011) 1161-1166, DOI: 10.1080/02640414.2011.583671

[26] F. Clemente, B. Mendes, P. Nikolaidis, F. Calvete, S. Carriço, A. Owen. Internal training load and its longitudinal relationship with seasonal player wellness in elite professional soccer. Physiol. Behav. 179 (2017) 262-267. http://dx.doi.org/10.1016/j.physbeh.2017.06.021

[27] J. Malone, R. Di Michele, R. Morgans, D. Burgess, J. Morton, B. Drust, Seasonal Training-Load Quantification in Elite English Premier League Soccer Players. Int. J. Sports Physiol. Perform, 10 (2015) 489-497 http://dx.doi.org/10.1123/ijspp.2014-0352

[28] S. Malone, A. Owen, M. Newton, B. Mendes, L. Tiernan, B. Hughes, K. Collins, Wellbeing perception and the impact on external training output among elite soccer players. J. Sci. Med. Sport (2018) 21 (1) 29-34. doi: 10.1016/j.jsams.2017.03.019.

[29] A.L. Owen, D.P. Wong, D. Paul, A. Dellal, Physical and technical comparisons between various-sided games within professional soccer. Int. J. Sports Med. 35 (2014) 286-292. doi: 10.1055/s-0033-1351333.

[30] A.L. Owen, D.P. Wong, A. Dellal, D.J. Paul, E. Orhant, S. Collie, Effect of an Injury Prevention Program on muscle injuries in elite professional soccer. J. Strength Conditioning Res. 27 (2013) 3275-3285.

[31] A.L. Owen, D.P. Wong, D. Paul, A. Dellal, Effects of a periodized small-sided game training intervention on physical performance in elite professional soccer. J. Strength Conditioning Res. 26 (2012) 2748–2754.

[32] R. Akenhead, J.A. Harley, S.P. Tweddle, Examining the external training load of an English Premier League football team with special reference to acceleration. J. Strength Cond. Res. 30 (9) (2016) 2424-32. doi: 10.1519/JSC.0000000000001343.

[33] T. Stevens, C. Ruiter, L. Twisk, G. Savelsbergh, P. Beek, Quantification of in-season training load relative to match load in professional Dutch Eredivisie football players, Sci Med Footb, 1 (2) (2017) 117-125. http://dx.doi.org/10.1080/24733938.2017.1282163

[34] D.J. Smith, A framework for understanding the training process leading to elite performance. Sports Med. 33 (15) (2003) 1103-26. doi:10.2165/00007256-200333150-00003.

[35] D. Jennings, S. Cormack, A. Coutts, L. Boyd, R. Aughey, The validity and reliability of GPS units for measuring distance in team sport specific running patterns. Int J. Sports Physiol Perform. 5, (2010) 328-341.

[36] J. Castellano, D. Casamichana, J, Calleja-Gonzalez, J. Roman, S. Ostojic, Reliability and accuracy of 10 Hz GPS devices for short-distance exercise. J. Sports Sci Med. 10 (2011) 233-234.

[37] A. Coutts, R. Duffield, Validity and reliability of GPS devices for measuring movement demands of team sports. J. Sci. Med. Sport 13 (2010) 133-135.

[38] R. Maddison, C. Ni Mhurchu, Global positioning system: A new opportunity in physical activity measurement. Int. J. Behav. Nutr Phys Act, 6, 73 (2009).

[39] M. Buchheit, Monitoring training status with hr measures: do all roads lead to Rome? Front Physiol, 5, 73 (2014). PubMed doi:10.3389/ fphys.2014.00073

[40] D. Jennings, S. Cormack, A. Coutts, L. Boyd, R. Aughey, Variability of GPS units for measuring distance in team sport movements. Int. J. Sports Physiol. Perform. 5 (2010) 565-569.

[41] V.B. Issurin, New horizons for the methodology and physiology of training periodization. J. Sports Med. 40 (2010) 189-206.

[42] V. Di Salvo, A. Collins, B. McNeill, M. Cardinale, Validation of Prozone: a new video-based performance analysis system. Int. J. Perform. Anal. Sport 6 (2006) 108-109.

[43] D. Burgess, B. Drust, Developing a physiology-based sports science support strategy in the professional game. In: Williams M, ed. *Science and Soccer: Developing Elite Performers*. Oxon, UK: Routledge, (2012) 372-389.

[44] A.L. Owen, G. Dunlop, M. Rouissi, M. Haddad, B. Mendes, K. Chamari, Analysis of positional training loads (ratings of perceived exertion) during various-sided games in European professional soccer players, Int. J. Sports Sci. Coach. 11 (3) (2016) 374-381. Available from: http://journals.sagepub.com/doi/10.1177/ 1747954116644064.

[45] A.J. Coutts, E. Rampinini, S.M. Marcora, C. Castagna, F.M. Impellizzeri, Heart rate and blood lactate correlates of perceived exertion during small-sided soccer games. J. Sci. Med. Sport 12 (2009) 79-84.

[46] D.A. Baden, T.L. McLean, R. Tucker, Effect of anticipation during unknown or unexpected exercise duration on rating of perceived exertion, affect, and physiological function. Br. J. Sports Med. (2005) https:// doi.org/10.1136/bjsm.2004.016980 PMID: 16183771

[47] R. Ferraz, B. Gonçalves, D. Coutinho, D. Marinho, J. Sampaio, M. Marques, Pacing behaviourof players in team sports: Influence of match status manipulation and task durationknowledge. PLoS ONE, 13 (2) (2018) e0192399. https://doi.org/10.1371/journal.pone.0192399

[48] R. Ferraz, B. Gonçalves, R. Van Den Tillaar, S. Jimenez, J. Sampaio, M. Marques, Effects of knowing the task duration on players' pacing patterns during soccer small-sided games. J. Sport Sci. (2017) 1-7. https://doi.org/10.1080/24733938.2017.1283433 PMID: 28134013

[49] S.A.C. Gibson, E.V. Lambert, L.H.G. Rauch, R. Tucker, The role of information processing between the brain and peripheral physiological systems in pacing and perception of effort. Sports Med. (2006) https://doi. org/10.2165/00007256-200636080-00006

[50] A. Renfree, L. Martin, D. Micklewright, A. Gibson, Application of decision-making theory to the regulation of muscular work rate during self-paced competitive endurance activity. Sports Med, 44 (2) (2014) 147-58. https://doi.org/10.1007/s40279-013-0107-0 PMID: 24113898

[51] D. Marqués-Jiménez, J. Calleja-González, I. Arratibel1, A. Delextrat, N. Terrados, Fatigue and Recovery in Soccer: Evidence and Challenges. The Open Sports Sci. J., 10 (Suppl 1: M5) (2017) 52-7 DOI: 10.2174/1875399X01710010051

[52] T.J. Gabbett, B. Walker, S. Walker, Influence of prior knowledge of exercise duration on pacing strategies during game-based activities. Int. J. Sports Physiol. Perform. 10 (3) (2015) 298–304. https://doi.org/10. 1123/ijspp.2013-0543 PMID: 25158210

[53] S.L. Hooper, L.T. Mackinnon, Monitoring overtraining in athletes. Sports Med., 20 (5) (1995) 321-327. Available from: http://link.springer.com/10.2165/ 00007256-199520050-00003.

[54] F.M. Impellizzeri, S.M. Marcora, C. Castagna, T. Reilly, A. Sassi, F.M. Iaia, E. Rampinini, Physiological and performance effects of generic versus specific aerobic training in soccer players. Int. J. Sports Med. 27 (2006) 483-492.

[55] S. Halson, Monitoring Training Load to Understand Fatigue in Athletes. Sports Med. 44 (Suppl 2) (2014) 139-147. Doi: 10.1007/s40279-014-0253-z

[56] K. Taylor, Fatigue monitoring in high performance sport: a survey of current trends. J. Aus. Strength Cond. 20 (2012) 12-23.

[57] W.B. Young, J. Hepner, D.W. Robbins, Movement demands in Australian rules football as indicators of muscle damage. J. Strength Cond. Res. 26 (2) (2012) 492-496.

[58] A. Dellal, C. Lagos-Peñas, E. Rey, K. Chamari, E. Orhant, The effects of a congested fixture period on physical performance, technical activity and injury rate during matches in a professional soccer team. Br. J. Sports Med, 49 (2015) 390-394.

[59] A.L. Owen, G. Dunlop, M. Rouissi, M. Chtara, D. Paul, H. Zouhal, P. Wong, The relationship between lower-limb strength and matchrelated muscle damage in elite level professional

European soccer players, Journal of Sports Sciences, 33 (20) (2015) 2100-2105, DOI: 10.1080/02640414.2015.1064155

Table 1. Training and match duration (minutes) during the 7-day testing period for squad average.

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	MD+1	MD-5	MD-4	MD-3	MD-2	MD-1	MD
M4- 1-game week, n=10	x	x	36.5±7.1[b, c,d,e]	60.9±3.3	88±0	83±0	**87.1±1.9**
M5-1-game week, n=10	x	x	32.2±20.9[b, c,d,e]	65±10.9	77±0	76±0	**82.9±21.0**
	MD	MD+1	MD-4	MD-3	MD-2	MD-1	MD
M1-2-games week, n=8	**79.3±22.1**	x	31.7±25.9[a, b,c,d]	81±0	75±0	75±0	**84.4±8.1**
	MD	MD+1	MD-3	MD-2	MD-1	MD	MD+1
M3- 2-games week, n=8	**81.4±20.7**	65.1±34.2	60.8±11.4[c]	71.3±0.7[c, d]	97.7±0.9	**86±9.9**	**x**
	MD	MD-2	MD-1	MD	MD-2	MD-1	MD
M2- 3-games week, n=8	**73.1±11.7**	87±0 [a]	**90.2±0.6**	54.1±11.0	74.4±33.3	88±0	**56±12.9**

Bold indicates data obtained from matches. *a* denotes difference from day 3, *b* denotes difference from day 4, *c* denotes difference from day 5 and *d* denotes difference from day 6, *e* denotes difference from day 7, all $P < 0.05$.

Table 2. Distances covered at different speed thresholds (representative of squad average data) during training and matched completed in the 7-day testing period.

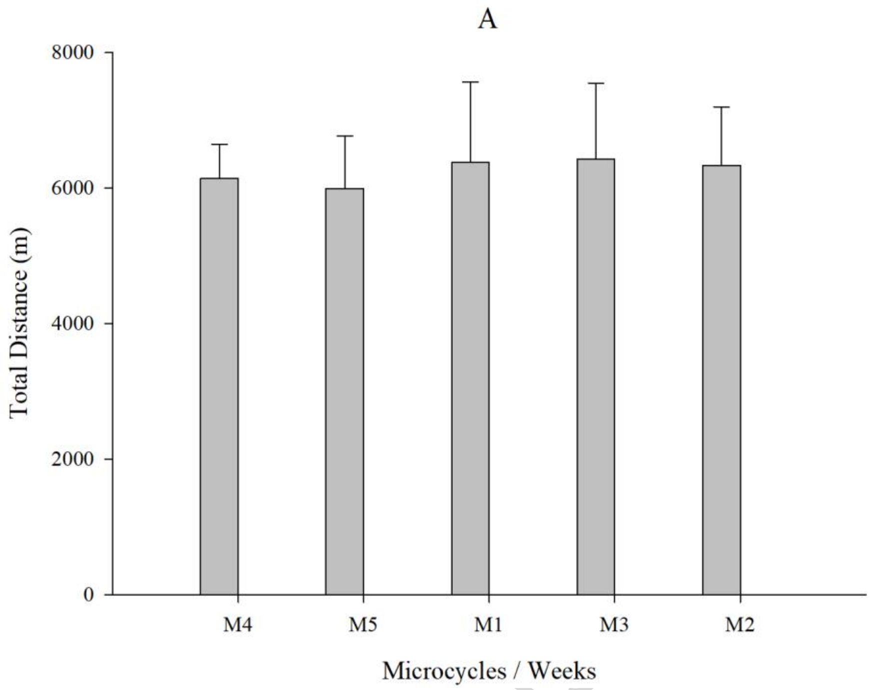
	Day						
	1	2	3	4	5	6	7
M4 - 1-game week	x	x	MD-4	MD-3	MD-2	MD-1	MD
Total Distance (m), n=10	x	x	6689.4±292.8 ^{b,d,e}	5388±1207.8 ^{c,d,e}	6708.5±483.2 ^{d,e}	2735.3±407.1 ^{e}	**10011.4±1097.7**
Zone1 (m), n=10	x	x	4559.8±118.5 ^{d,e}	3616.6±878.5 ^{c,e}	4802.5±183.0 ^{d,e}	2412.3±332.4 ^{e}	**5987.1±537.5**
Zone2 (m), n=10	x	x	1025.4±164.7 ^{d,e}	1007.2±292.6 ^{d,e}	836.5±139.0 ^{d,e}	185.8±57.6 ^{e}	**1842.1±375.6**
Zone3 (m), n=10	x	x	789.0±139.4 ^{d,e}	563.3±255.4 ^{d,e}	765.4±181.8 ^{d,e}	119.9±55.9 ^{e}	**1387.5±349.4**
Zone4 (m), n=10	x	x	243.4±28.4 ^{d,e}	162.6±98.3 ^{c,d,e}	255.1±66.4 ^{d,e}	16.6±16.9 ^{e}	**572.6±162.2**
Zone5 (m), n=10	x	x	87.4±0	31.2±35.5	24.9±6.1	2.7±2.9	**265.0±161.2**
RPE (AU), n=13	x	x	3.4±1.6	3.7±1.0 ^{d}	4.8±1.3 ^{d}	2.2±1.0	**MD**
s-RPE (AU), n=13	x	x	171.4±138.2 ^{c}	241.4±88.8 ^{d}	432.0±116.2 ^{d}	184.4±88.2	**MD**
M5-1-game week	x	x	MD-4	MD-3	MD-2	MD-1	**MD**
Total Distance (m), n=10	x	x	8409±190.1 ^{b,c,d}	6794.7±377.5 ^{c,d,e}	4023.9±559 ^{d,e}	2778.4±235.9 ^{e}	**10089±2691.7**
Zone1 (m), n=10	x	x	4856.3±2.6 ^{c,d}	4603.0±233.3 ^{c,d}	3006.9±360.2 ^{d,e}	2452.3±154.3 ^{e}	**5642.7±1489.6**
Zone2 (m), n=10	x	x	1341.9±161.4 ^{b,c,d,e}	1082.8±229.4 ^{c,d,e}	429.0±131.1 ^{d,e}	176.1±36.2 ^{e}	**1936.1±567.9**
Zone3 (m), n=10	x	x	820.1±35.1 ^{c,d,e}	789.8±148.2 ^{c,d,e}	423.0±99.3 ^{d,e}	117.8±60.3 ^{e}	**1601.4±504.8**
Zone4 (m), n=9	x	x	285.0±40.1 ^{c,d,e}	251.7±70.4 ^{c,d,e}	134.4±75.3 ^{d,e}	34.2±30.2 ^{e}	**680.6±215.4**
Zone5 (m), n=4	x	x	107.3±7.6	67.5±26.9	38.5±20.2	3.8±3.0	**293.3±76.5**
RPE (AU), n=13	x	x	3.7±2.2	5.4±1.9 ^{d}	3.9±1.5 ^{d}	2.2±0.8	**MD**
s-RPE (AU), n=13	x	x	227.2±202.8	412.4±156.7 ^{d}	301.0±115.3 ^{d}	168.9±60.3	**MD**
M1-2-game week	MD	x	MD-4	MD-3	MD-2	MD-1	MD
Total Distance, n=8	**9509.4±2581.7** ^{b,c}	x	7232.0±73.9 ^{b,c,d}	6583.9±1016.3 ^{c,d}	5324.2±667.3 ^{d,e}	3991.6±615.9 ^{e}	**9911.4±1883**
Zone1(m), n=8	**5369.4±1498.4**	x	4903.7±40.2 ^{c,d}	4506.3±400.8 ^{d}	3847.1±440.9 ^{d,e}	3192.6±291.5 ^{e}	**5626.8±1215.4**
Zone2 (m), n=8	**1805.8±647.9** ^{a,b,c}	x	1105.6±80.8 ^{c,d,e}	979.9±354.7 ^{d,e}	640.0±210.9 ^{d,e}	405.8±186.4 ^{e}	**2128.1±462.5**
Zone3 (m), n=8	**1378.3±526.8** ^{c,d}	x	733.2±31.2 ^{c,d}	779.6±315.1 ^{c,d}	536.6±70.9 ^{d,e}	288.8±138.3 ^{e}	**1250.1±426.5**
Zone4 (m), n=8	**637.4±161.8** ^{a,b,c}	x	397.8±34.1 ^{b,c,d,e}	238.6±62.4 ^{d,e}	223.7±91.8 ^{e}	84.6±41.8 ^{e}	**610.6±113.9**

Zone5 (m), n=5	**323.4±143.9**	x	48.3±0	72.0±27.6	89.8±69.2	31.8±14.0	**248.8±92.2**
RPE (AU), n=13	MD	x	3.5±1.6	4.8±1.2 ^{b}	4.3±1.2 ^{b}	2.5±1.4	**MD**
s-RPE (AU), n=13	MD	x	208.3±170.7 ^{b}	388.3±98.1 ^{d}	320.5±87.1 ^{d}	187.5±108.3	MD
M3- 2-game week	MD	MD-4	MD-3	MD-2	MD-1	MD	x
Total Distance (m), n=7	**9815.9±3072.3 ^{a,c}**	7531.7±8.0 ^{a,c,d}	4862.9±827.2 ^{d}	6181.5±850.7 ^{d}	3911.6±545.8 ^{d}	**10355.4±859.7**	x
Zone1 (m), n=8	**5225.9±2638.2**	5646.1±19.4 ^{a,b,c}	3711.2±201.6 ^{d}	4514.7±188.6 ^{c,d}	2910.7±67.1 ^{d}	**6364.8±237.3**	x
Zone2 (m), n=8	**1584.0±773.3**	892.7±46.5 ^{d}	871.4±309.7 ^{d}	876.5±226.8 ^{d}	527.0±383.7 ^{d}	**1821.8±174.3**	x
Zone3 (m), n=8	**1242.4±552.4 ^{c}**	627.8±26.7 ^{a,c,d}	299.7±145.9 ^{b,d}	710.1±159.4 ^{c,d}	343.9±69.8 ^{d}	**1495.6±320.9**	x
Zone4 (m), n=7	**435.1±193.4 ^{a,c}**	329.1±34.0 ^{a,b,c}	50.1±29.8 ^{b,c}	150.9±43.0 ^{d}	95.1±48.9 ^{d}	**498.6±174.7**	x
Zone5 (m), n=5	**136.8±71.2**	90.2±52.1	14.2±15.6	25.4±15.0	36.5±17.0	**126.8±51.3**	x
RPE (AU), n=13	**MD**	2.9±1.3b	2.8±1.1 ^{b}	4.5±1.3	2.9±0.8	**MD**	x
s-RPE (AU), n=13	**MD**	198.9±131.1	167.6±79.8 ^{b,c}	330.3±123.1	273.4±66.8	**MD**	x
M2- 3-game week	MD	MD-2	MD-1	MD	MD-2	MD-1	MD
Total Distance (m), n=8	**8805.9±4040.4**	5855.6±246.5 ^{a,d}	4427.6±318.5 ^{c,d}	**6657.5±3776.7**	6691.9±690.4 ^{d}	3619.8±356.8	**7444.1±4639.6**
Zone1 (m), n=8	**4979.8±2328.7**	4361.2±220.6 ^{a,d}	3469.8±187.9 ^{c,d}	**3666.0±2343.7**	4519.7±442.0 ^{d}	2994.8±199.7	**3789.5±2408.2**
Zone2 (m), n=8	**1751.9±776.3 ^{a,d}**	642.5±116.9 ^{a,d}	446.3±96.2 ^{c,d}	**1304.1±749.3**	941.9±263.9 ^{d}	289.6±85.9	**1507.1±930.2**
Zone3 (m), n=8	**1312.1±741.1**	616.5±145.3 ^{c,d}	404.3±152.6 ^{c}	**1071.8±560.7 ^{d}**	900.5±177.4 ^{d}	255.4±98.4	**1348.5±963.7**
Zone4 (m), n=8	**555.4±311.2**	206.8±57.1 ^{a,d}	98.3±45.2	**464.8±231.9 ^{d}**	280.6±120.2 ^{d}	70.1±32.8	**573.8±364.6**
Zone5 (m), n=6	**250.5±145.6**	33.4±19.9	6.8±3.6	**164.5±104.0**	49.9±31.8	12.8±9.2	**203.0±189.5**
RPE (AU), n=13	**MD**	3.6±0.3 ^{a,d}	2.6±0.3 ^{c}	**MD**	3.6±0.3 ^{d}	2.8±0.3	**MD**
s-RPE (AU), n=13	**MD**	316.4±95.8	241.0±90.7	**MD**	272.7±70.9	246.4±78.7	**MD**

MD= matchday MD (-)= matchday minus (4, 3, 2, 1); AU= arbitrary units; m= meters; RPE= rating of perceived effort exertion; s-RPE= session rating of perceived effort; X= Day Off. Bold indicates data obtained from matches. a denotes difference from day 3, b denotes difference from day 4, c denotes difference from day 5, d denotes difference from day 6 and e denotes difference from day 7, all P < 0.05.

M4 and M5, one-game week						
Day 1 (MD+1)	Day 2 (MD-5)	Day 3 (MD-4)	Day 4 (MD-3)	Day 5 (MD-2)	Day 6 (MD-1)	Day 7 (MD)
day-off	day-off	training session	training session	training session	training session	**MD**
M1, two-games week						
Day 1 (MD)	Day 2 (MD+1)	Day 3 (MD-4)	Day 4 (MD-3)	Day 5 (MD-2)	Day 6 (MD-1)	Day 7 (MD)
MD	day-off	training session	training session	training session	training session	**MD**
M3, two-games week						
Day 1 (MD)	Day 2 (MD+1)	Day 3 (MD-3)	Day 4 (MD-2)	Day 5 (MD-1)	Day 6 (MD)	Day 7 (MD+1)
MD	training session	training session	training session	training session	**MD**	day-off
M2, three-games week						
Day 1 (MD)	Day 2 (MD-2)	Day 3 (MD-1)	Day 4 (MD)	Day 5 (MD-2)	Day 6 (MD-1)	Day 7 (MD)
MD	training session	training session	**MD**	training session	training session	**MD**

Figure 1. Weekly training for microcycles with one-, two- and three-games week. Abbreviations MD-=matchday minus (5, 4, 3, 2, 1); MD+1= matchday plus 1.



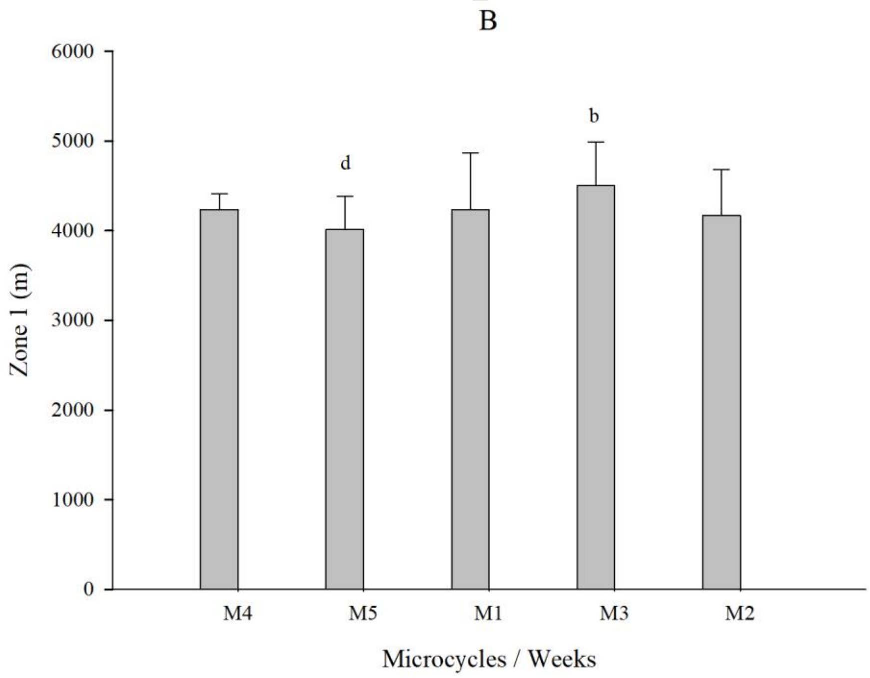
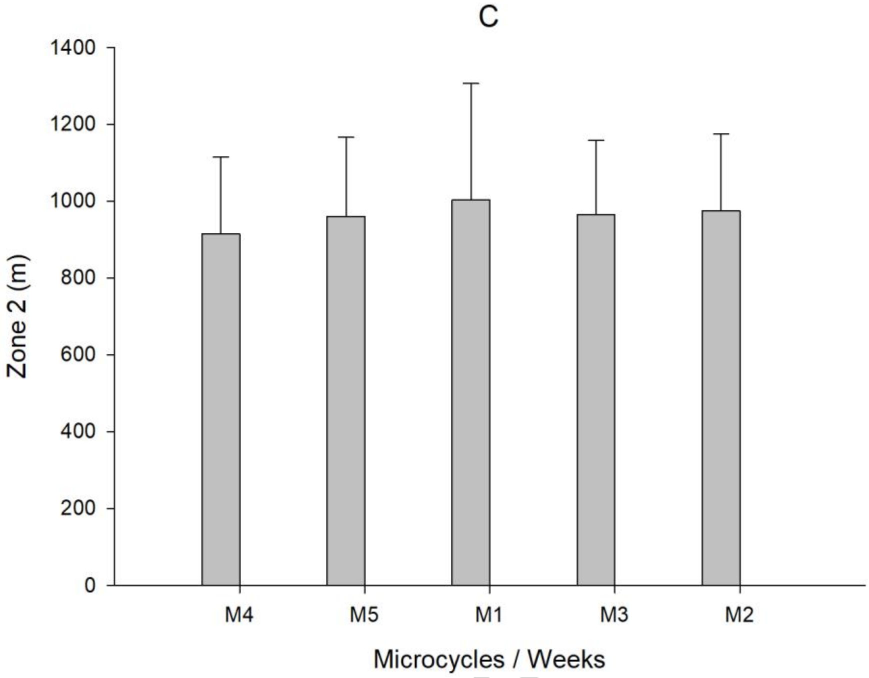


Figure 2. Comparisons between 5 microcycles/weeks for total distance and training intensity of zone 1 (0-19km/h). *a* denotes difference from M4, *b* denotes difference from M5, *c* denotes difference from M1, *d* denotes difference from M3 and *e* denotes difference from M2, all $P < 0.05$.



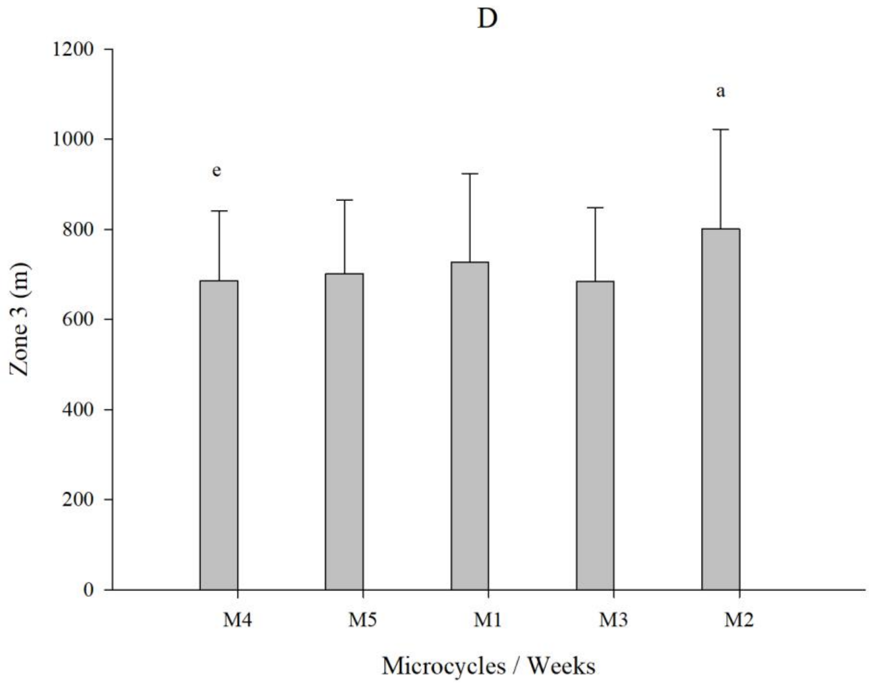
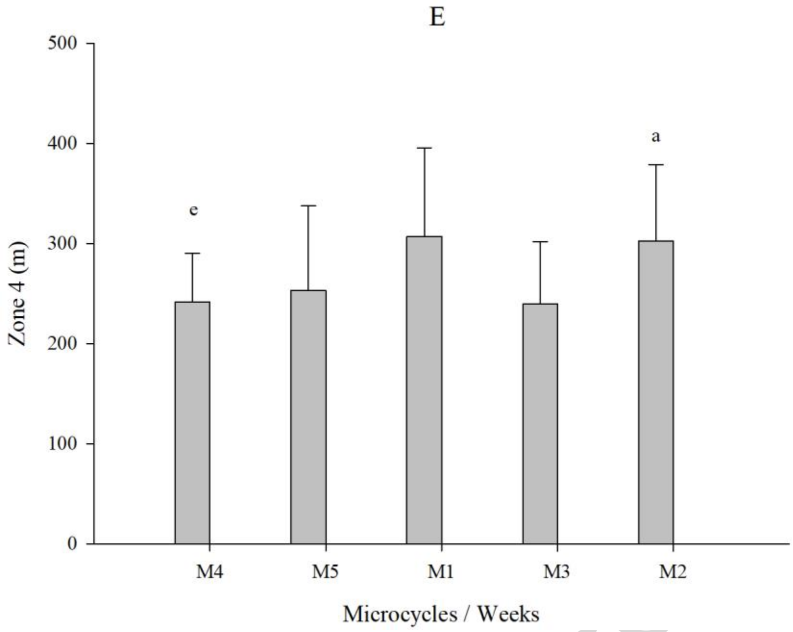
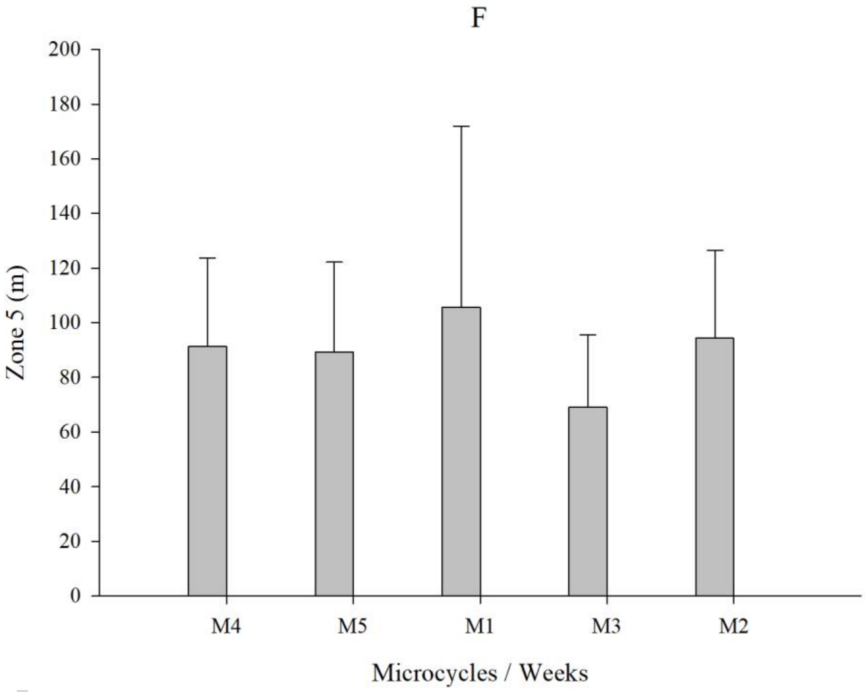


Figure 3. Comparisons between 5 microcycles/weeks for training intensity of zones 2 (11-13.9 km/h) and zone 3 (14-18.9 km/h). *a* denotes difference from M4, *b* denotes difference from M5, *c* denotes difference from M1, *d* denotes difference from M3 and *e* denotes difference from M2, all P < 0.05.


E
500
400
300
200
100
0
Zone 4 (m)
e
a
M4
M5
M1
M3
M2
Microcycles / Weeks


F
200
180
160
140
120
100
80
60
40
20
0
Zone 5 (m)
M4
M5
M1
M3
M2
Microcycles / Weeks

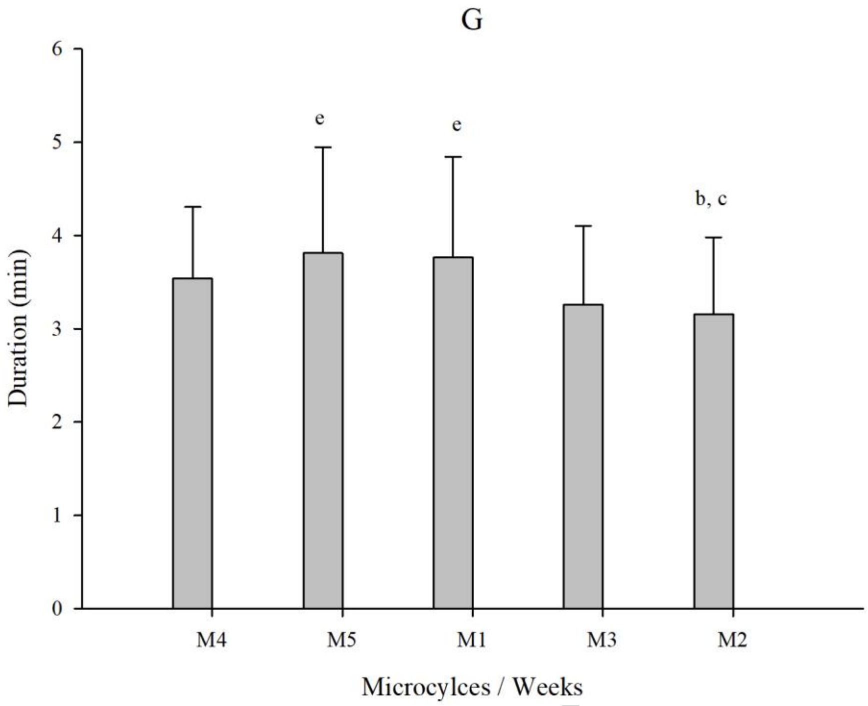
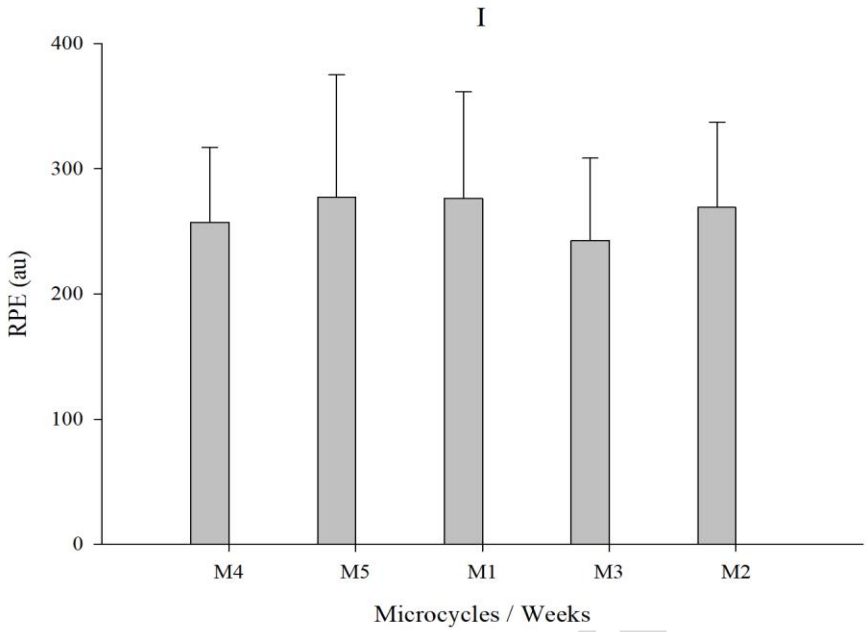


Figure 4. Comparisons between 5 microcycles/weeks for training intensity of zone 4 (19-2.9 km/h) and zone 5 (> 24km/h). *a* denotes difference from M4, *b* denotes difference from M5, *c* denotes difference from M1, *d* denotes difference from M3 and *e* denotes difference from M2, all $P < 0.05$.



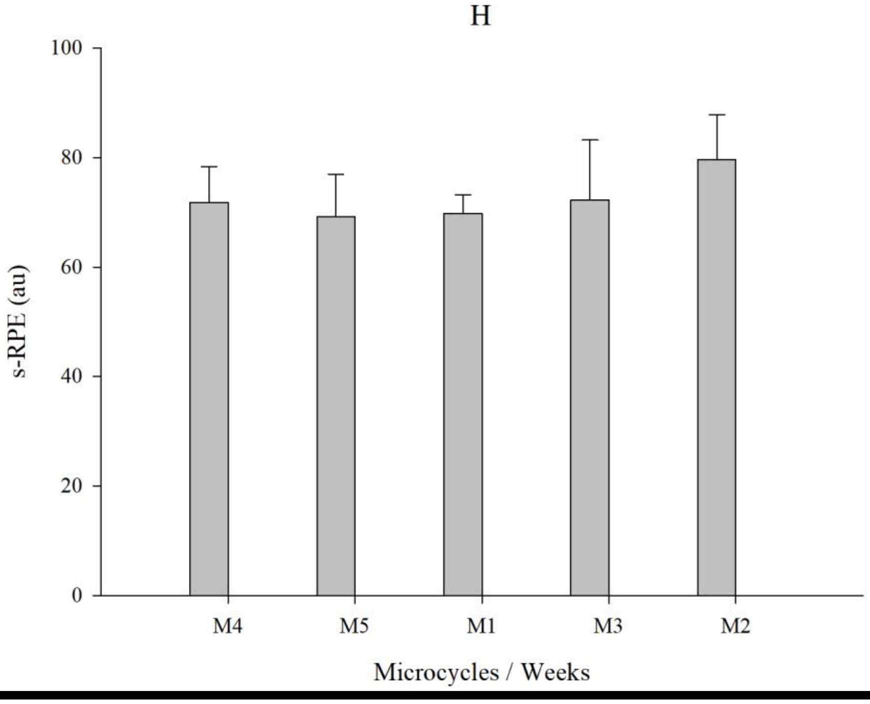


Figure 5. Comparisons between 5 microcycles/weeks for duration and s-RPE. *a* denotes difference from M4, *b* denotes difference from M5, *c* denotes difference from M1, *d* denotes difference from M3 and *e* denotes difference from M2, all $P < 0.05$.

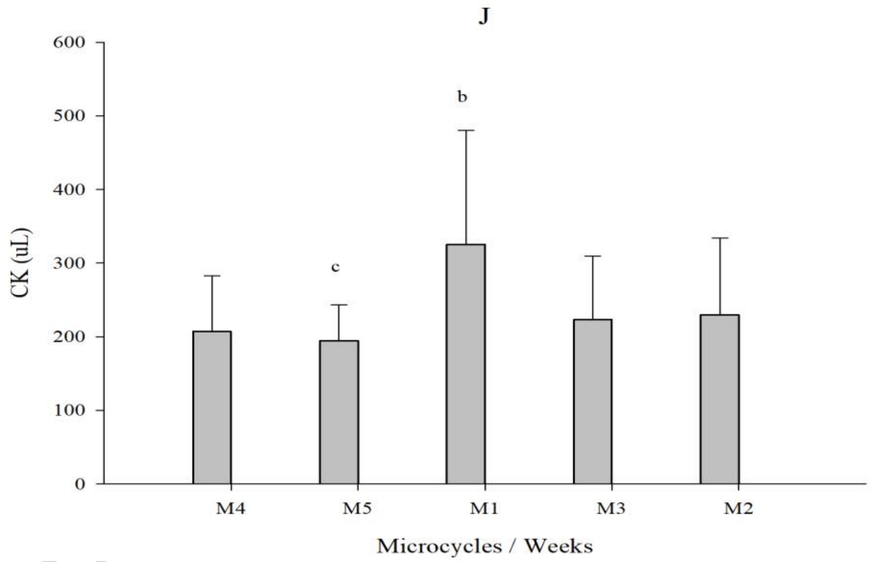


Figure 6. Comparisons between 5 microcycles/weeks for RPE and CK. *a* denotes difference from M4, *b* denotes difference from M5, *c* denotes difference from M1, *d* denotes difference from M3 and *e* denotes difference from M2, all $P < 0.05$.

Highlights

- Similar s-RPE for one-, two- or three-game weeks microcycles.
- Lower values in the last day prior to a match, for all microcycles and variables.
- Higher value of training duration in one- or two-game than three-game weeks.
- Week with two official matches revealed significantly greater values of CK.

ACCEPTED MANUSCRIPT