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Effect of training day, match, and length of the microcycle on workload periodization in professional soccer players: a full-season study

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ABSTRACT: The aims of this study were to: (a) describe and compare the volume and intensity from the workload of professional soccer players between training and MD, and (b) analyse the effect that the length of the microcycle had on the workload. A cohort study was designed for a full season in La Liga 123. Wearable tracking systems collected the distance covered in meters (m), total number of high-intensity accelerations (ACC_{HIGH}) and decelerations (DEC_{HIGH}), total number of high-speed running actions (HSRA), high-speed running distance (HSRD), high metabolic load distance (HMLD), and player load (PL) from training days (MD+1, MD-4, MD-3, MD-2, and MD-1) and MD. Significant differences were found between training and MD workload, MD workload being the most demanding for all intensity and volume variables (F = 36.35–753.94; $p < 0.01$; $w_p^2 = 0.21–0.85$). The greatest training intensity and volume were found on MD-4 and MD-3 ($p < 0.05$). In addition, a novel finding was that the length of the microcycle had a significant effect on the workload both in volume and intensity (F = 4.84–14.19; $p < 0.01$; $w_p^2 = 0.03–0.09$), except for relative ACC_{HIGH}, DEC_{HIGH}, and HMLD. Although MD-4 and MD-3 were the most suitable days for loading the players, the results showed that MD elicited a unique stimulus in terms of volume and intensity. Consequently, coaches need to include specific training drills to adapt the players for the competitive demands. Finally, special focus should be placed on MD from short and regular microcycles (5-day, 6-day, or 7-day microcycles) since declines in physical performance were observed in comparison with long microcycles (8-day or 9-day microcycles).

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INTRODUCTION

Electronic performance tracking systems provide valuable information for strength and conditioning coaches, sports scientists, and researchers since a better understanding of the volume and intensity of each training session and match is possible [1, 2]. Specifically, these data allow the analysis of the workload, and therefore, programming strategies for the periodized training plan may be adopted [3]. In addition, these are objective data (e.g., distance covered, high-speed running distance, total number of accelerations) that provide further information to determine the individual profiles of each player [1, 4]. In this regard, the aim of strength and conditioning coaches from professional soccer teams is to find the right balance between loading the players for positive adaptations and reducing the injury risk [5, 6].

Although previous investigations suggested that the training sessions should promote effective transfer to the competitive environment (e.g., physical, technical, and tactical components) [7, 8], different studies showed that the workload is greater on the match days compared to the training days [8–10]. For instance, professional soccer players from an English Premier League team may cover ~4349 m in training sessions four days before the match, ~5212 m three days before the match, ~3117 m two days before the match, ~2910 m the day before the match, and ~10317 m in the match, considering a competitive week in which all starting players on match day (MD) completed all training sessions [9]. However, these data are just related to the volume of the sessions, and little is known about the intensity, which may be measured as the performance relative to time (e.g., distance covered per minute) [4, 11]. In this regard, a recent study analysed the intensity of match play through the worst-case scenarios and significant differences were found between training and match days [12]. Specifically, the results showed that the intensity of players during worst-case scenarios from training days did not meet the intensity of the match [12]. Nevertheless, the performance in the worst-case scenario is not representative of performance from a whole training session or match within a microcycle given that these scenarios are just related to specific periods of play (e.g., 1 minute or 5 minutes) [12].

In addition, the microcycles are weekly training periods, which count from the day after the match to the following match, whose length may vary depending on the competitive calendar [4, 13]. Specifically, previous studies showed that the length of the microcycle may have an impact on the workload from soccer players [4, 9, 12, 14]. For instance, the results from recent studies showed that the training load increased with longer microcycles [13, 14]. However, limited research is available to date regarding the effect of the length of the microcycle on the workload from professional soccer players in terms of volume and intensity.

In summary, few studies have analysed load dynamics within the competitive period considering both training and match days in professional soccer [15]. Therefore, since this information has vast implications for workload prescription and recovery strategies [13], the aims of this study were to: 1) describe the volume and intensity from the workload of professional soccer players and compare the workload between training and match days (MD); 2) analyse the effect that the length of the microcycle had on the workload from training and MD.

MATERIALS AND METHODS

Experimental approach to the problem

A cohort study was conducted in a professional soccer team during the 2018–2019 season in La Liga 123. Informed consent was obtained for the data collection and the study was approved by the ethics committee. The data collected by electronic performance tracking systems from match and training sessions were categorized as Match Day (MD), MD-1 (1 day prior to the match), MD-2 (2 days prior to the match), MD-3 (3 days prior to the match), MD-4 (4 days prior to the match), and MD+1 (1 day after the match). The microcycles with -5MD or MD+2 were not included since these sessions were only available for eight-day microcycles. Considering that the average length of the microcycles was 7 days, each microcycle was categorized as shorter than the average (five-day or six-day microcycles), regular microcycles (seven-day microcycles), and longer than the average (eight-day or nine-day microcycles) (Table 1).

Subjects

Data were collected from 30 professional soccer players (age: 27.2 ± 3.8 years; height: 181.8 ± 6.2 cm; weight: 75.3 ± 6.8 kg). Players from different playing positions were included in the study (forwards, $n = 6$; midfielders, $n = 7$; wide midfielders, $n = 6$; fullbacks, $n = 6$; central defenders, $n = 5$). Also, full-match participation was considered as an inclusion criteria for MD data collection. However, goalkeepers were not included in the study because this playing position shows a different nature of the workload profile [8, 16]. The study was approved by the ethics committee of the university (Reg. Code 2061/2018) and the club allowed the research team to access players' data and informed consent was provided.

Procedures

WIMU Pro tracking systems (RealTrack Systems, Almeria, Spain) were used for the data collection. These tracking systems are considered as valid and reliable instruments for the analysis of workload parameters in soccer players [17]. Also, these instruments have the FIFA Quality Program approval, which eases the optimal use of this technology by coaches, researchers, etc. [18, 19]. Every tracking system was calibrated on WIMUNET (RealTrack Systems, Almeria, Spain) before the data collection according to the manufacturer's instructions [20, 21]. Then, the devices were placed in the back pocket of a vest (Rasán, Valencia, Spain). Once the session had finished, the data were transferred to SPro (RealTrack Systems, Almeria, Spain) software in order to obtain the workload parameters.

Distance covered in meters (m), total number of high-intensity accelerations (ACC_{HIGH}, above 3 m/s^2), total number of high-intensity decelerations (DEC_{HIGH}, below -3 m/s^2), total number of high-speed running actions (HSRA, above 21 km/h), high-speed running distance (HSRD, above 21 km/h), player load (PL), and high metabolic load distance (distance covered when the metabolic power was above 25.5 W/kg) were downloaded from SPro (RealTrack Systems, Almeria, Spain). These variables, which were considered as representative of the workload of professional soccer players by previous studies (e.g., using principal components analysis), represented the volume (e.g., absolute distance covered in meters) and intensity (e.g., relative distance covered in meters, which is divided by the duration of the training session or match in minutes) [4, 12, 22, 23].

Statistical analysis

Firstly, a descriptive analysis was performed to show the intensity and volume workload demands as mean (M) and standard deviations (± SD). The Kolmogorov-Smirnov test was used to confirm the normality of the data set. Data were analysed using a mixed analysis of variance to compare the intensity and volume workload demands concerning the length of the microcycle, training, and match days. The pairwise comparisons were performed using the Bonferroni method. The magnitudes of the differences for all variables were analysed using the partial omega squared (ω_p^2). The ω_p^2 values were qualitatively interpreted using the following thresholds: < 0.01 small; < 0.06 medium and < 0.14 large. Alpha was set at $p < 0.05$. The data analysis was performed using SPSS (IBM, SPSS Statistics, V 22.0 Chicago, IL, USA) and graphs were designed using GraphPad Prism (GraphPad Software, release 8, La Jolla, CA, USA).

TABLE 1. Characteristics of short, regular, and long microcycles.

Length	Day	Description
Short microcycles	MD+1	Regeneration exercises and low-impact activities for the group of players who played more than 45 minutes in the match while the rest of the players had to compensate with rondos, possession drills, high-intensity circuits, and small-sided games.
	MD-4	Similar to MD+1 with an increase in intensity through positional games.
	MD-3	MD-3 (for five-day microcycles) were similar to MD+1 with an increase in intensity through positional games while MD-3 (for six-day microcycles) were characterized by transition drills, positional games, and 11 vs. 11 matches.
	MD-2	Light strength training, pressing tasks, and small-sided games.
	MD-1	Review of tactical elements regarding the match, play small-sided games, and perform activation drills.
	MD	Match day.
Regular microcycles	MD+1	Regeneration exercises and low-impact activities for the group of players who played more than 45 minutes in the match while the rest of the players had to compensate with rondos, possession drills, high-intensity circuits, and small-sided games.
	MD+2	Resting days.
	MD-4	Strength training, pressing tasks, and small-sided games.
	MD-3	Strength training, pressing tasks, small-sided, and medium-sided games.
	MD-2	Preventive strength training, rondos, control, and passing tasks, tactical drills.
	MD-1	MD-1 included activation drills, small-sided games, and review of the tactical keys regarding the match.
	MD	Match day.
Long microcycles	MD+1	Regeneration exercises and low-impact activities for the group of players who played more than 45 minutes in the match while the rest of the players had to compensate with rondos, possession drills, high-intensity circuits, and small-sided games.
	MD+2	Resting days
	MD-5	Activation drills, rondos, and 11 vs 11 games (half pitch).
	MD-4	Strength training, pressing tasks, and small-sided games.
	MD-3	Moderate-intensity positional games, transition drills, and 11 vs 11 matches.
	MD-2	Preventive strength training, rondos, tactical drills, control and passing tasks.
	MD-1	Activation drills, 6x6+6 small-sided games, and review of tactical keys regarding the match.
	MD	Match day.

MD: match day; MD-1: 1 day before the match; MD-2: 2 days before the match; MD-3: 3 days before the match; MD-4: 4 days before the match; MD-5: 5 days before the match; MD+1: 1 day after the match; MD+2: 2 days after the match.

RESULTS

Training and match days' workload

Figures 1 and 2 show the workload (volume and intensity) from training sessions and MD. Regarding training sessions, the greatest intensity and volume were found on MD-4, MD-3, and MD+1 in all variables. However, the lowest demands were found on MD-1 and MD-2. In addition, statistically significant differences ($p < 0.05$) between the workload from training and MD were found at all intensity and volume variables, the workload from MD being the most demanding. Specifically, the magnitude of the differences was large for all intensity and volume workload variables ($F = 36.35–753.94$; $p < 0.01$; $w_p^2 = 0.21–0.85$).

Effect of the length of the microcycle on the workload from training and match days

The length of the microcycle had a significant effect on the workload (volume and intensity variables) with a low to moderate effect size ($F = 4.84–14.19$; $p < 0.01$; $w_p^2 = 0.03–0.09$), except in relative ACC_{HIGH}, DEC_{HIGH}, and HMLD ($F < 2.51$; $p > 0.08$). Regarding volume-related variables, significant differences were found (Table 2) in training load when considering the length of the microcycle: (a) distance on all training days; (b) ACC_{HIGH} on MD+1 and MD-3; (c) DEC_{HIGH} on all training days except MD-4 and MD-2; (d) HSRA on all training days except MD+1; (e) HSRD, PL and HMLD on all training days except MD+1. In addition, the workload from MD in long microcycles was always greater than regular and short microcycles even though HSRA and total distance covered were the only variables without significant differences ($F = 2.29–2.95$; $p > 0.05$).

Regarding the intensity variables (Table 3), differences in training load were found in: (a) distance on all training days except MD-2; (b) ACC_{HIGH} on MD+1 and MD-3; (c) DEC_{HIGH} on all training days except MD-2; (d) HSRA and HMLD on MD-4, MD-3 and MD-2; (e) HSRD on all training days except MD+1 and MD-1; and (f) PL on MD-1. Furthermore, the intensity from MD in long microcycles was always greater than regular and short microcycles even though the total distance covered, HSRA, and HMLD were the only variables without significant differences ($F = 1.65–2.66$; $p > 0.05$).

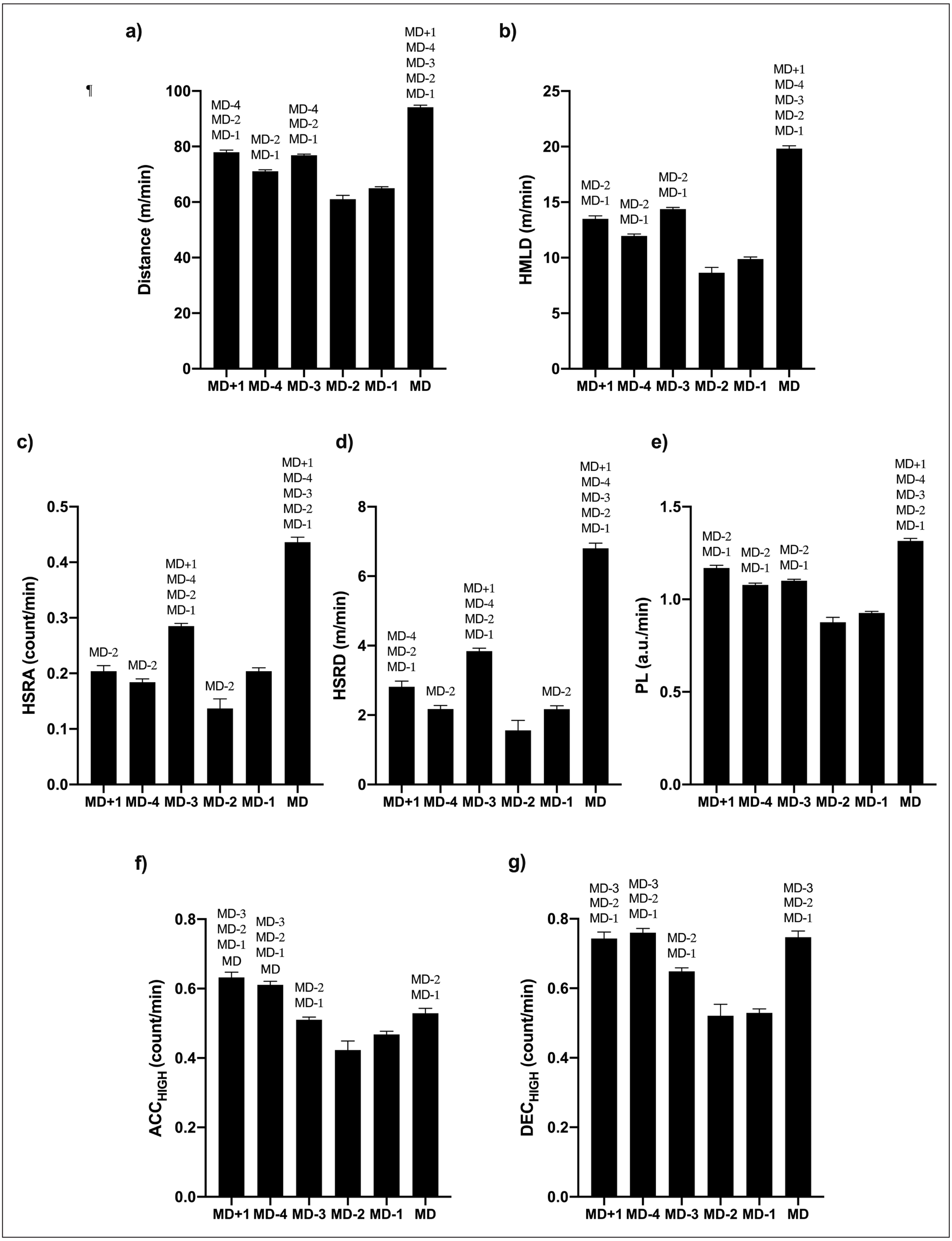

FIG. 1. Pairwise comparison between the workload from training and match days (MD) in volume of (a) distance, (b) HMLD, (c) HSRA, (d) HSRD, (e) PL, (f) ACC_{HIGH}, and (g) DEC_{HIGH}. $^{MD+1}$Significant difference compared to MD+1 ($p < 0.05$); $^{MD-4}$significant difference compared to MD-4 ($p < 0.05$); $^{MD-3}$significant difference compared to MD-3 ($p < 0.05$); $^{MD-2}$significant difference compared to MD-2 ($p < 0.05$); $^{MD-1}$significant difference compared to MD-1 ($p < 0.05$); ^{MD}significant difference compared to MD ($p < 0.05$).

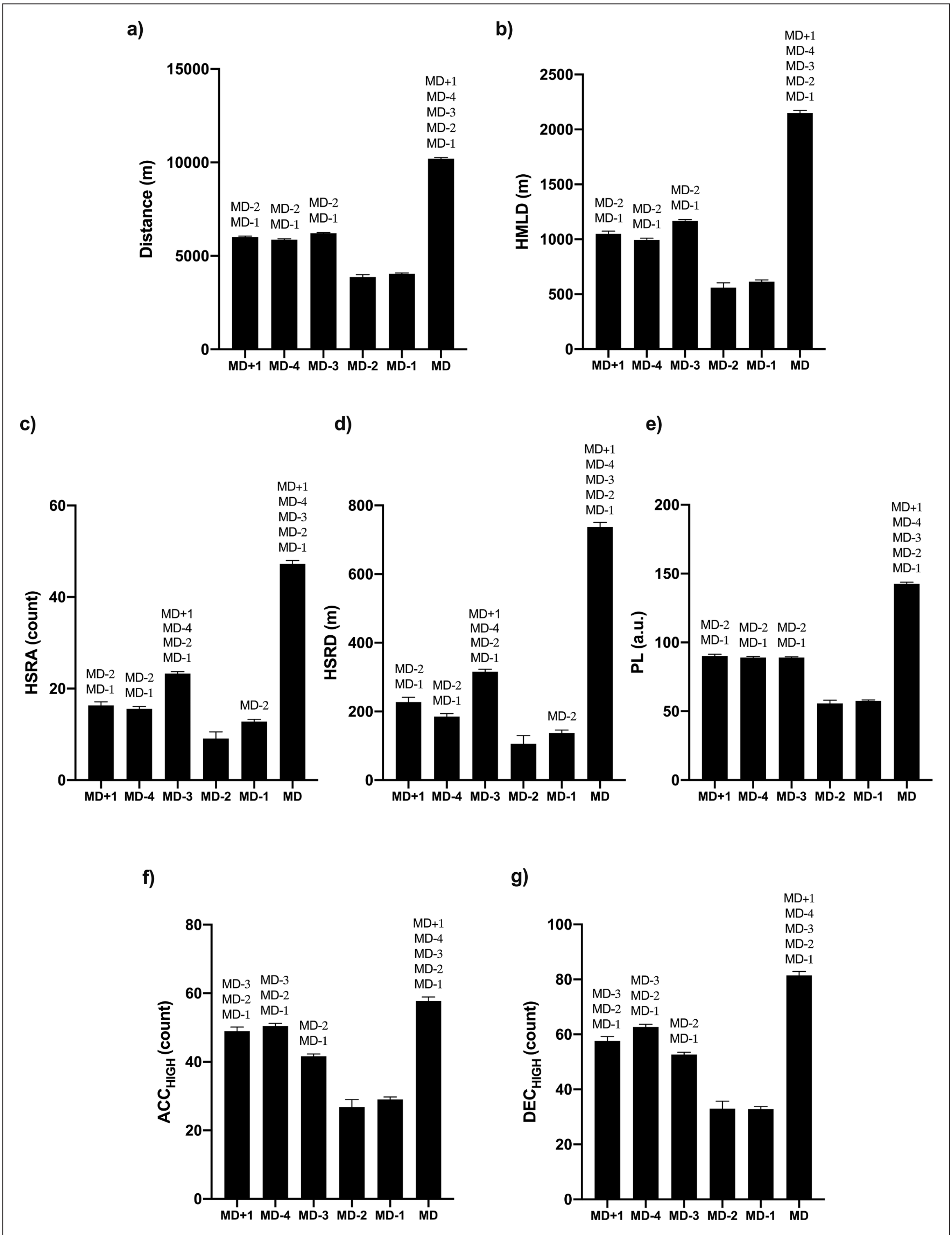

FIG. 2. Pairwise comparison between the workload from training and match days (MD) in intensity workload (a) distance, (b) HMLD, (c) HSRA, (d) HSRD, (e) PL, (f) ACC_{HIGH}, and (g) DEC_{HIGH}. $^{MD+1}$significant difference compared to MD+1 ($p < 0.05$); $^{MD-4}$significant difference compared to MD-4 ($p < 0.05$); $^{MD-3}$significant difference compared to MD-3 ($p < 0.05$); $^{MD-2}$significant difference compared to MD-2 ($p < 0.05$); $^{MD-1}$significant difference compared to MD-1 ($p < 0.05$); ^{MD}significant difference compared to MD ($p < 0.05$).

TABLE 2. Volume workload from training and match days and comparative analysis based on the length of the microcycle

		Short microcycles (M ± SD)	Regular microcycles (M ± SD)	Long microcycles (M ± SD)	*F (p-value)*	w_p^2 *(magnitude)*	*Post-hoc*
Distance (m)	MD+1	6153.75 ± 968.74	5665.65 ± 1081.67	5442.36 ± 1024.35	8.51 (< 0.01)	0.05 (low)	a b
	MD-4	4941.30 ± 1463.36	6065.38 ± 787.41	6228.05 ± 865.20	59.23 (< 0.01)	0.32 (large)	a b
	MD-3	6089.56 ± 1151.19	6515.95 ± 926.92	6523.01 ± 1074.75	11.82 (< 0.01)	0.08 (moderate)	a b
	MD-2	4780.22 ± 903.98	3190.32 ± 486.56	4848.41 ± 386.57	17.83 (< 0.01)	0.12 (moderate)	b c
	MD-1	4091.04 ± 553.57	3945.54 ± 463.58	4376.14 ± 591.36	24.96 (< 0.01)	0.16 (large)	a b c
	MD	10183.93 ± 879.41	10183.01 ± 801.97	10467.40 ± 781.98	2.29 (0.06)		
ACC_{HIGH} (count)	MD+1	38.24 ± 9.56	56.83 ± 18.58	51.67 ± 17.02	11.20 (< 0.01)	0.08 (moderate)	a b
	MD-4	49.32 ± 15.56	51.12 ± 15.27	50.89 ± 14.36	0.36 (0.69)		
	MD-3	44.18 ± 15.56	39.46 ± 12.01	41.24 ± 14.99	4.24 (0.02)	0.02 (low)	
	MD-2	30.63 ± 14.86	27.91 ± 8.88	29.23 ± 10.10	2.87 (0.09)		
	MD-1	29.09 ± 10.46	27.52 ± 9.39	30.44 ± 7.33	2.54 (0.08)		
	MD	51.18 ± 24.62	60.40 ± 11.65	61.65 ± 12.63	5.44 (< 0.01)	0.03 (low)	a b
DEC_{HIGH} (count) (count)	MD+1	44.16 ± 9.11	68.54 ± 22.41	60.15 ± 19.31	14.31 (< 0.01)	0.10 (moderate)	a b
	MD-4	64.23 ± 23.16	60.78 ± 17.77	63.05 ± 17.41	1.06 (0.35)		
	MD-3	56.23 ± 21.05	51.41 ± 15.25	50.41 ± 15.37	4.30 (0.01)	0.02 (low)	a
	MD-2	37.69 ± 18.51	33.27 ± 12.48	34.31 ± 13.33	2.73 (0.10)		
	MD-1	33.49 ± 14.84	29.76 ± 10.06	35.15 ± 10.19	5.82 (< 0.01)	0.03 (low)	b
	MD	72.23 ± 35.08	82.82 ± 14.78	89.37 ± 16.73	6.27 (0.02)	0.04 (low)	a b
HSRA (count)	MD+1	15.51 ± 10.28	17.48 ± 10.78	15.08 ± 9.96	1.29 (0.28)		
	MD-4	6.71 ± 5.96	21.37 ± 10.74	19.37 ± 10.36	71.50 (< 0.01)	0.37 (large)	a b
	MD-3	18.74 ± 9.73	24.54 ± 9.17	23.95 ± 9.50	24.18 (< 0.01)	0.16 (large)	b
	MD-2	12.96 ± 7.12	5.55 ± 3.24	10.76 ± 5.61	6.59 (< 0.01)	0.05 (low)	a
	MD-1	12.42 ± 7.12	11.36 ± 6.19	14.26 ± 5.88	7.46 (< 0.01)	0.05 (low)	b c
	MD	45.21 ± 14.09	44.40 ± 13.18	49.29 ± 12.74	2.95 (0.07)		
HSRD (m)	MD+1	224.73 ± 195.93	245.77 ± 214.95	197.82 ± 162.84	1.17 (0.31)		
	MD-4	63.72 ± 63.15	258.59 ± 167.44	238.19 ± 142.93	58.62 (< 0.01)	0.33 (large)	a b
	MD-3	234.19 ± 157.13	338.50 ± 168.57	334.19 ± 174.65	25.84 (< 0.01)	0.17 (large)	a b
	MD-2	156.91 ± 98.85	51.30 ± 36.89	127.24 ± 66.67	6.96 (< 0.01)	0.05 (low)	a
	MD-1	131.04 ± 83.55	127.43 ± 94.74	162.69 ± 80.63	6.81 (< 0.01)	0.05 (low)	b c
	MD	696.42 ± 256.79	684.60 ± 251.03	789.16 ± 235.23	4.19 (0.01)	0.02 (low)	b c
PL (a.u.)	MD+1	88.42 ± 21.16	88.90 ± 18.88	86.77 ± 17.76	0.24 (0.78)		
	MD-4	75.90 ± 24.01	90.62 ± 14.33	93.14 ± 15.58	34.07 (< 0.01)	0.22 (large)	a b
	MD-3	89.13 ± 19.77	93.10 ± 16.10	90.94 ± 15.91	3.22 (0.04)	0.02 (low)	a
	MD-2	68.90 ± 15.23	45.16 ± 9.40	70.61 ± 8.25	13.97 (< 0.01)	0.10 (moderate)	a c
	MD-1	58.06 ± 9.24	56.29 ± 8.24	62.11 ± 8.71	16.74 (< 0.01)	0.12 (moderate)	b c
	MD	140.73 ± 20.52	143.01 ± 18.42	150.92 ± 19.57	5.91 (< 0.01)	0.04 (low)	b c
HMLD (m)	MD+1	1039.25 ± 306.21	1032.75 ± 302.92	942.36 ± 315.45	2.14 (0.12)		
	MD-4	675.20 ± 383.76	1106.52 ± 260.09	1083.25 ± 299.71	75.03 (< 0.01)	0.39 (large)	a b
	MD-3	1059.47 ± 336.32	1215.41 ± 288.72	1186.12 ± 287.40	16.24 (< 0.01)	0.11 (moderate)	a b
	MD-2	760.38 ± 278.30	403.85 ± 121.38	713.42 ± 140.77	9.45 (< 0.01)	0.07 (moderate)	a c
	MD-1	611.64 ± 161.30	580.97 ± 153.39	661.50 ± 137.85	10.39 (< 0.01)	0.08 (moderate)	b c
	MD	2100.77 ± 382.51	2103.99 ± 273.22	2242.09 ± 363.24	3.64 (0.03)	0.02 (low)	b c

M: mean; SD: standard deviation; F: F-value of ANOVA; p: significance; w_p^2: partial omega squared. [a]Differences between short microcycles and regular length microcycles ($p < 0.05$); [b]differences between short microcycles and long microcycles ($p < 0.05$); [c]differences between long microcycles and regular length microcycles ($p < 0.05$).

TABLE 3. Intensity workload from training and match days and comparative analysis based on the length of the microcycle

		Short microcycles (M ± SD)	Regular microcycles (M ± SD)	Long microcycles (M ± SD)	*F* (*p-value*)	w_p^2 (*magnitude*)	*Post-hoc*
Distance (m/min)	MD+1	78.68 ± 14.84	71.54 ± 7.01	70.77 ± 9.16	12.53 (< 0.01)	0.08 (moderate)	a b
	MD-4	65.38 ± 12.93	71.52 ± 7.69	72.01 ± 9.63	19.27 (< 0.01)	0.12 (moderate)	a b
	MD-3	74.65 ± 10.32	78.10 ± 11.60	76.85 ± 13.24	4.96 (< 0.01)	0.03 (low)	a
	MD-2	67.21 ± 12.61	60.12 ± 9.17	62.16 ± 4.96	2.69 (0.07)		
	MD-1	65.49 ± 8.50	66.20 ± 8.15	63.32 ± 7.56	4.75 (< 0.01)	0.03 (low)	c
	MD	94.04 ± 7.97	93.12 ± 7.48	95.22 ± 7.12	1.65 (0.19)		
ACC_{HIGH} (count/min)	MD+1	0.53 ± 0.14	0.68 ± 0.23	0.68 ± 0.20	5.26 (< 0.01)	0.03 (low)	a b
	MD-4	0.62 ± 0.20	0.61 ± 0.18	0.60 ± 0.15	0.47 (0.62)		
	MD-3	0.54 ± 0.17	0.48 ± 0.15	0.51 ± 0.16	5.38 (< 0.01)	0.03 (low)	a
	MD-2	0.41 ± 0.19	0.43 ± 0.17	0.44 ± 0.15	0.09 (0.76)		
	MD-1	0.48 ± 0.18	0.46 ± 0.15	0.46 ± 0.12	1.03 (0.36)		
	MD	0.47 ± 0.23	0.55 ± 0.11	0.56 ± 0.11	4.74 (0.01)	0.02 (low)	a b
DEC_{HIGH} (count/min)	MD+1	0.61 ± 0.12	0.82 ± 0.27	0.79 ± 0.22	7.44 (< 0.01)	0.05 (low)	a b
	MD-4	0.81 ± 0.28	0.73 ± 0.21	0.74 ± 0.19	3.59 (0.03)	0.02 (low)	a
	MD-3	0.70 ± 0.25	0.62 ± 0.18	0.63 ± 0.18	5.36 (< 0.01)	0.03 (low)	a b
	MD-2	0.51 ± 0.23	0.53 ± 0.24	0.56 ± 0.27	0.10 (0.75)		
	MD-1	0.56 ± 0.26	0.50 ± 0.16	0.53 ± 0.16	3.53 (0.03)	0.01 (low)	a
	MD	0.67 ± 0.32	0.76 ± 0.14	0.81 ± 0.15	5.32 (< 0.01)	0.03 (low)	b
HSRA (count/min)	MD+1	0.19 ± 0.13	0.22 ± 0.13	0.19 ± 0.12	1.42 (0.24)		
	MD-4	0.09 ± 0.07	0.25 ± 0.12	0.22 ± 0.11	69.81 (< 0.01)	0.35 (large)	a b c
	MD-3	0.23 ± 0.11	0.29 ± 0.11	0.28 ± 0.11	23.26 (< 0.01)	0.15 (large)	a b
	MD-2	0.18 ± 0.10	0.10 ± 0.06	0.14 ± 0.07	4.65 (0.01)	0.02 (low)	a
	MD-1	0.20 ± 0.11	0.19 ± 0.10	0.21 ± 0.10	1.27 (0.28)		
	MD	0.42 ± 0.13	0.41 ± 0.12	0.45 ± 0.12	2.55 (0.08)		
HSRD (m/min)	MD+1	2.80 ± 2.42	3.09 ± 2.75	2.46 ± 1.99	1.28 (0.27)		
	MD-4	0.84 ± 1.80	3.03 ± 1.93	2.75 ± 1.62	55.67 (< 0.01)	0.30 (large)	a b c
	MD-3	2.81 ± 1.71	4.05 ± 1.95	3.91 ± 2.06	26.52 (< 0.01)	0.16 (high)	a b
	MD-2	2.19 ± 1.40	0.97 ± 0.70	1.63 ± 0.85	5.43 (< 0.01)	0.03 (low)	a
	MD-1	2.05 ± 1.26	2.13 ± 1.56	2.35 ± 1.14	1.83 (0.16)		
	MD	6.44 ± 2.38	6.26 ± 2.31	7.18 ± 2.14	3.59 (0.03)	0.02 (low)	c
PL (a.u./min)	MD+1	1.13 ± 0.28	1.12 ± 0.14	1.13 ± 0.18	0.56 (0.95)		
	MD-4	1.00 ± 0.22	1.07 ± 0.14	1.09 ± 0.17	2.51 (0.08)		a b
	MD-3	1.09 ± 0.19	1.12 ± 0.20	1.08 ± 0.22	2.22 (0.10)		
	MD-2	0.97 ± 0.21	0.85 ± 0.18	0.91 ± 0.11	2.40 (0.09)		
	MD-1	0.93 ± 0.16	0.95 ± 0.15	0.90 ± 0.14	3.15 (0.04)	0.02 (moderate)	c
	MD	1.30 ± 0.19	1.31 ± 0.17	1.37 ± 0.18	3.96 (0.02)	0.02 (low)	b c
HMLD (m/min)	MD+1	13.25 ± 4.13	13.02 ± 3.05	12.10 ± 3.19	2.14 (0.12)		
	MD-4	8.69 ± 4.33	13.06 ± 2.99	12.58 ± 3.25	59.36 (< 0.01)	0.31 (large)	a b
	MD-3	12.91 ± 3.47	14.58 ± 3.50	14.01 ± 3.70	12.77 (< 0.01)	0.08 (moderate)	a b
	MD-2	10.65 ± 3.75	7.61 ± 2.29	9.15 ± 1.80	4.86 (< 0.01)	0.03 (low)	a
	MD-1	9.77 ± 2.52	9.80 ± 2.77	9.67 ± 2.39	0.11 (0.90)		
	MD	19.39 ± 3.48	19.24 ± 3.45	20.40 ± 3.32	2.66 (0.07)		

M: mean; SD: standard deviation; F: F-value of ANOVA; p: significance; w_p^2: partial omega squared. [a]Differences between short microcycles and regular length microcycles ($p < 0.05$); [b]differences between short microcycles and long microcycles ($p < 0.05$); [c]differences between long microcycles and regular length microcycles ($p < 0.05$).

DISCUSSION

This study aimed to describe the volume and intensity from the workload of professional soccer players, compare the workload between training and MD, and analyse the effect that the length of the microcycle had on the workload. The greatest intensity and volume from training sessions were found on MD-4, MD-3, and MD+1 in all variables. However, there were significant differences between the workload from training and MD at all intensity and volume variables, the workload from MD being the most demanding. In addition, a novel finding of this study was that the length of the microcycle had a significant effect on the workload not only in the volume but also in the intensity, except for relative ACC_{HIGH}, DEC_{HIGH}, and HMLD.

This study showed that the training load decreased in the sessions before a competition, which is consistent with previous studies [5, 24, 25]. Specifically, these studies also showed that the workload was greater on MD-4 and MD-3 than MD-2 and MD-1 [5, 24, 25]. This confirms the tapering strategy which is adopted by strength and conditioning coaches as an attempt to decrease the stress of training and maximize performance on the competitive day [26]. In this regard, various investigations also suggested that MD-4 and MD-3 were the most suitable days for loading the players through repeated high-intensity actions, drills undertaken on larger pitch sizes or reducing the number of players in the playing area [5, 10, 24]. In addition, the results from this study indicated that another demanding training day was MD+1. However, caution should be taken with this interpretation of the results. The team was divided into two groups of players in order to compensate those players who could not participate in the match or played less than 45 minutes, and therefore these players had to complete additional tasks on MD+1 in order to replicate competition loads [5]. Moreover, various studies showed that the workload was greater on the match days in comparison with the training days [8–10]. However, this study revealed that the workload from MD was the most demanding not only in volume but also in intensity. This is one of the main findings of this study since to date, data have usually been reported in relation to the volume of the sessions. For instance, these professional soccer players covered ~5744 m at an intensity of ~70 m/min on MD-4 while they covered ~10278 m at an intensity of ~94 m/min on MD. This implies that the players may not replicate the volume of the match in training sessions, but strength and conditioning coaches may design training drills that prepare the players for the intensity of match play. Furthermore, recent investigations suggested that the players should be trained for the most intense periods of the match, which are also known as worst case scenarios or most demanding passages of play [23, 27, 28], since the players may get to cover ~191 m/min in distance covered, ~38 m/min in HSRD, ~66 m/min in HMLD, ~3 ACC_{HIGH}/min, and ~4 DEC_{HIGH}/min during these passages of play [23].

Regarding the effect of the length of the microcycle on the workload, this study found a significant effect not only on the volume but also on the intensity, except for relative ACC_{HIGH}, DEC_{HIGH}, and HMLD. Previous investigations also found that the length of the microcycle had a significant impact on the workload from soccer players [4, 9, 13, 14]. For example, a recent study showed that the training load increased with longer microcycles [14]. This is controversial since we did not systematically observe this tendency in our training load data, which might be explained by differences in training methodologies adopted by the coaches [29]. However, our study found that the workload from MD in long microcycles was greater than regular and short microcycles. Different investigations on professional soccer players also concluded that the length of the microcycle had an impact on some variables related to match running performance (e.g., distance covered) [4, 30], which may be a consequence of a longer recovery period or better preparation for the match. Nevertheless, there are other investigations that showed how distance covered, for instance, remained unaffected over short microcycles [31, 32]. In addition, a recent study, which investigated the intensity required during the worst-case scenarios, found that the length of the microcycle had a significant effect on the intensity from training days, but not from MD [12]. However, although there is a lack of research on the effect of the length of the microcycle on the workload from training and MD, similar periodization strategies (e.g., unloading the players on MD-2 and MD-1 as MD approaches) may be observed regardless of the length of the microcycle [24, 33, 34].

This study has some general limitations that may also guide future investigations. For example, only one professional soccer team was analysed, and it would be of interest to carry out a multi-club study. Moreover, future studies may include additional external load variables (e.g., explosive distance, and acceleration or deceleration distance) or internal load variables (e.g., mean heart rate), which were not considered in this study. Also, this study used absolute thresholds for the collected variables (e.g., 19.8 km/h for HSRD or 3 m/s^2 for ACC_{HIGH}). However, recent studies suggested the addition of individualized thresholds (e.g., considering the player's maximal sprinting speed or acceleration) [35–37]. In addition, this study did not consider the influence that contextual variables such as MD participation had on the training load from the upcoming week (e.g., performance on MD+1).

Practical applications

This study showed significant differences between the workload from training and MD at all intensity and volume variables, the workload from MD being the most demanding. Also, the greatest intensity and volume from training sessions were found on MD-4, MD-3, and MD+1 in all variables. Specifically, data from Tables 2 and 3 may be used as a useful reference for sport scientists and strength and conditioning coaches, who are responsible for the workload periodization and make daily decisions to find the right balance between loading the players for positive adaptations and reducing the injury risk. Understanding this workload from both training and MD, coaches may include specific training drills to replicate the competition demands by considering not only the average demands but also the most demanding passages of play. Although MD-4 and MD-3 were the most suitable days for loading the players through repeated high-intensity actions, drills undertaken on larger pitch sizes or reducing the number of players in the playing area, the results showed that MD seems to elicit a unique stimulus in terms of volume and intensity. Therefore, caution should be taken on MD+1 with the recovery strategies for those who played the match while the players who could not participate in the match need to be overloaded on MD+1 considering the workload from MD. In addition, a novel finding of this study was that the length of the microcycle had a significant effect on the workload not only in the volume but also in the intensity, except for relative ACC_{HIGH}, DEC_{HIGH}, and HMLD. Thus, special focus should be placed on MD from short and regular microcycles since declines in physical performance were observed in comparison with long microcycles.

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Conflict of Interest Disclosure

None of the authors has a conflict of interest to declare, and all authors were involved in the study design, data collection and interpretation, and contributed to the writing of the manuscript.

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