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Training load quantification in women's elite football: A season long prospective cohort study

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Abstract

The aim of this study was to investigate: 1) if there are differences in training load and intensity between the different training days within a microcycle, and 2) if training load and intensity within the different training days are stable over the course of a season. Data were collected over a full season from a team in women's premier division in Norway. External load (Total distance, High-Speed Running Distance (HSR), sprint distance, and the combined number of accelerations and decelerations (ACCDEC)) was assessed using a 10 Hz GPS system with a built-in accelerometer. Internal load was assessed through session Rating of Perceived Exertion (sRPE), which was multiplied with session duration (sRPE-Load). Training days were classified in relation to their proximity to the upcoming match day (MD); MD-4, MD-3, MD-2, and MD-1. Contents on these days were standardized according to a weekly periodization model followed by the coaching staff. Differences between training days were analyzed using a linear mixed effects model. All training days were significantly different from each other across multiple variables. ACCDEC values were highest on MD-4 (147.5 ± 13.0 ACCDEC count) and all distance variables were highest on MD-3. All measures of training load were significantly reduced from MD-3 to MD-2 (ES = 1.0-4.1) and from MD-2 to MD-1 (ES = 1.6-4.3). A significant negative effect across the season was observed for sRPE-load and ACCDEC (ES = 0.8-2.1). These results provide evidence that elite female football teams can be successful in differentiating training load between training days when implementing a weekly periodization approach.

Keywords: team sports, tactical periodization, seasonal change, female athlete, soccer

INTRODUCTION

The competitive season in football lasts several months, with matches being played almost every week, and sometimes twice a week. During a week cycle from one game to the next (*microcycle)*, teams need to train at a level that allows them to maintain their physical performance over the course of the season and at the same time be recovered for the upcoming match [1]. Consequently, training load during the microcycle has become a topic of interest for practitioners and researchers, and in recent years a growing body of studies has investigated training load within the microcycle of male football players [2]. The interest and popularity of women's football has also grown significantly in recent years [3–5]. This increase in popularity has led to several advancements in the professionalism of women's football. More players now have access to full-time training environments, improved training facilities and medical support, but players are also exposed to greater training and competition demands than ever before [3,5]. However, despite an increased scientific attention on women's football [4], little is known about microcycle training load in elite women's football [2,6]. Such information is of importance to better inform training and monitoring practices in this population [2,7].

The microcycle structure and training load distribution can be organised in several ways, as observed through different studies investigating microcycle training load [8–10]. One approach that has gained a lot of attention in recent years is the concept of *tactical periodization* [11]. The tactical periodization model aims to incorporate the tactical, technical, and psychological components of performance in addition to the physical [11–13]. To integrate the physical component, the model uses what is referred to as *horizontal alternation* of physical qualities on a microcycle level. Assuming a standard weekly cycle with six training days between games, the model allocates two days for recovery which are followed by three *acquisition days* and one taper day. The three acquisition days are often labelled as strength, endurance, and speed, in that order, despite these labels not necessarily being accurate from a physiological standpoint. Contents will vary between different coaches, but the first two acquisition days are intended as sessions with the highest training load, and there are some inherent features to the different acquisition days that are central to the concept. Strength session aims to include a high number of accelerations, decelerations, and changes of direction through training drills with few players and tight space (high player to area ratio). The endurance sessions will typically include longer sequences of play in larger space with more players, whereas speed sessions will include medium/large spaces with lower work/rest ratios to allow for high intensity actions [13–15]. The goal is to vary the physical stimuluses between days in order to allow for adequate recovery and minimal interferences while maximizing adaptions [13–15]. These days are followed by a taper day, where training volume is reduced to allow for recovery and supercompensation on the following match day. This weekly plan is then maintained as a standard with little variation across the season, with the goal of attaining *performance stabilization* throughout the season rather than having peaks and drops in performance [11,12,15].

Despite tactical periodization being a widely deployed model in professional football, a recent systematic review concluded that scientific support for the model is lacking, and descriptive studies conducted among teams that deploy a tactical periodization model was proposed as a good starting point [11]. Consequently, the aim of this study was not only to investigate microcycle training load in elite women's football, but also in the context of a tactical periodization model. More specifically we want to investigate: 1) if there are differences in training load and intensity between the different session-types within a tactical periodization microcycle, and 2) if training load and intensity within the different session-types are stable over the course of a season.

METHODS

Design

The current study was conducted as a prospective cohort study. To investigate training load within the microcycle, the internal and external load from training sessions and matches were collected over a period of 20 weeks for the entire duration of the 2020 competitive season lasting from July 5th to November 15th. The season would normally have started late March, but due to the Covid-19 pandemic the season start was delayed until July. Teams were given a five-week pre-season before the commencement of the season, but due to these alterations, the season was played more congested and without the usual summer break.

Only field-based team training sessions were considered for analyses. Training days were categorised according to their proximity to the upcoming match day (MD). The following days were included: MD-4, MD-3, MD-2, MD-1, and MD. The coaching staff followed a set microcycle structure where training contents were based on the tactical periodization model, with the goal of differentiating specific training loads between days, as described in the introduction. We refrain from labelling training days based on physical qualities, but MD-4, MD-3, and MD-2 contain the contents of a strength, endurance and speed session, respectively (Table 1). All training sessions included were from microcycles with seven, six, or five days between matches, as contents would sometimes change during shorter game-weeks. Three game-week cycles were excluded as a result. All microcycles started with two recovery days following the previous match day, of which one was a complete rest day. During the microcycles with seven days between matches, the coaching staff added an additional rest day in the middle of the week. As a result, there were two occasions that the MD-4 session was completed on MD-5 and one occasion that the MD-3 session was completed on MD-4. These sessions were, however, still classified as MD-4 and MD-3, respectively, as these are the days where the content of these sessions would normally belong. During microcycles with five days between matches, the MD-4 session was skipped by the coaching staff.

INSERT TABLE 1

Participants

Twenty-three outfield players from one team playing in the women's premier division in Norway participated in this study. Players were excluded if they did not play in at least one league match. Therefore, two players were excluded from further analyses, leaving 21 participants (mean ± SD: age 22.2 ± 3.7 years, body mass 64.1 ± 6.6 kg, height 168.6 ± 4.3 cm). For match load data, only observations where players played ≥85 min were included. Individual training load data was only included if the player participated in the entirety of the session. A total of 952 observations was included in the study. The number of observations varied between individuals and between the different days (Table 2). The study abided by the ethical principles of the Declaration of Helsinki, and accordingly players signed a letter of consent before the commencement of the study. The study was approved by the Norwegian

Centre for Research Data and the ethics committee at the Norwegian School of Sport Sciences.

Data collection and analyses

Players' external load was monitored using a 10 Hz GPS system with a built-in 200 Hz inertial measurement unit (Polar Team Pro Sensor, Polar Electro, Kempele, Finland). The Polar Team Pro system has been shown to have acceptable validity and reliability for measurements of total distances and distances covered above different velocity thresholds (Inter-unit reliability: ICC=0.63-0.99, TEM=1.06-5.05%. Comparison with 15Hz reference system: ICC=0.62-0.99, TEM=0.60-13.84%) [16,17]. Devices were mounted to a heart rate strap and each player wore the same device for all training sessions and matches. The real-time monitoring application (Polar Team Pro App, Polar Electro, Kempele, Finland; Version 2.0.4) was used to mark the exact start and end of each training session and halves during matches. After each training session and match, data from the devices were extracted. The following variables were selected for analyses: Total distance (m), High Speed Running (HSR) distance (>16 $km \cdot h^{-1}$) (m), sprint distance (>22.5 $km \cdot h^{-1}$) (m), and the combined number of accelerations (>2 $m \cdot s^{-2}$) and decelerations (<-2 $m \cdot s^{-2}$) (ACCDEC). The sprint threshold was based on recent recommendations [18], and is the same as used in a recent study on match load in elite women's football [5]. The high-speed running and ACCDEC thresholds are similar to those reported previously in women's football research [7,19] and were also standard thresholds for the Norwegian Premier League in the Polar Team Pro System used by several teams in the league. Variables were also divided by the session duration in minutes to investigate the average session intensity.

Internal training load was monitored by session Rating of Perceived Exertion (sRPE) using the modified CR10 RPE scale [20]. All players were familiarised with the scale and how to rate sRPE before the commencement of the study and registered sRPE within 30 minutes after each training session and match using a commercial phone application (AthleteMonitoring Pro, FITSTATS Technologies, Moncton, Canada; Version 1.1.6). sRPE was multiplied by the session duration in minutes to calculate sRPE-Load [20].

INSERT TABLE 2

Statistical analysis

Descriptive data are presented as mean with 95% confidence intervals (CI). Differences are presented as mean differences with 95% CI and effect sizes [21]. Each training load variable was modelled separately with a linear mixed effects model to deal with repeated measurements and an unbalanced design. The models were fit using the lmer function from the *lme4* package (lme4 version 1.1-27.1) in R version 4.1.2. Due to a large proportion of zeros and a non-normal distribution, the sprint distance data was fit with a negative binomial generalized linear mixed model using glmer function from the *lme4* package, with the negative binomial family function (with theta = 1.3) from the MASS package (MASS version 7.3-54). Sprint$\cdot min^{-1}$ was excluded from the analyses due to difficulties fitting an acceptable model to the data. For all models, fixed effects were training days (MD-4, MD-3, MD-2, MD-1 and MD), as factors, season (the dates of the sessions centred and rescaled from -0.5 to 0.5) and training days and season interacted. Random effects were specified as random intercepts for participants and random slopes for training days with a correlated variance-covariance structure, as well as random intercepts for each session and random intercepts for each microcycle. sRPE was fitted with uncorrelated variance-covariance structure due to convergence issues. Least squared means and differences in least squared means were extracted from the models using the *lmerTest* package (LmerTest version 3.1-3) for the linear mixed models and the *emmeans* package (emmeans version 1.7.1-1) for the generalized mixed model. Least squared means are estimated marginal means over a balanced population, where the standard errors are adjusted for the covariance parameters in the model, and hence represents the means and differences in means for a typical training session, for the typical player. Estimates of the season effect represents the change in training load, for each session-type, over a full season. Confidence intervals and p-values were derived using Kenward-Roger approximation for denominator degrees of freedom. Coefficients from the generalized mixed model were back-transformed to the original scale. Cohen's d effects sizes were calculated by standardizing on a combined between- and within-subject standard deviation (SD) for the given training day. For the differences between training days, the average of the two sessions' SD was utilized. Effect sizes were interpreted as: <0.2 = trivial, 0.2 to 0.6 = small, 0.6 to 1.2 = moderate, 1.2 to 2.0 = large, 2.0 to 4.0 = very large, and >4.0 = extremely large [22]. Null hypothesis testing was also included as complimentary analysis and is reported with $\alpha = \leq 0.05$ considered as significant [21].

RESULTS

Significant differences in training load were observed between all training days across all parameters except from sRPE-load between MD-4 and MD-3 and HSR between MD-4 and MD-2 (Table 3). ACCDEC values were highest on MD-4, whereas total distance, HSR and sprint distance values were highest on MD-3. All measures of training load were significantly reduced from MD-3 to MD-2 (ES = 1.0-4.1) and from MD-2 to MD-1 (ES = 1.6-4.3). MD-4 also showed significantly higher values of sRPE-Load, total distance, and ACCDEC compared to MD-2 (ES = 2.3-2.6) and MD-1 (ES = 4.8-7.0), but sprint was higher on MD-2 than on MD-4 (ES = 1.1). MD-1 showed the lowest values across all parameters. Significantly higher values were observed on MD compared to all training days across all measures of training load except from sprint distance compared to MD-3. MD was also significantly higher across all measures of intensity (Table 3). The highest average training session intensity for all distance variables (total distance covered (TDC)·min^{-1}, HSR·min^{-1} and sprint·min^{-1}) were observed on MD-3. ACCDEC·min^{-1} was slightly higher on MD-4 than on MD-3 (ES = 0.5) but was clearly higher than both MD-2 (ES = 1.5) and MD-1 (ES = 3.0). TDC·min^{-1} on MD-4 showed no difference compared to MD-2 (ES = 0.3), but HSR·min^{-1} was observed to be higher on MD-2 than on MD-4 (ES = 1.3). MD-1 showed the lowest training intensity values across all parameters.

INSERT TABLE 3

A significant negative effect across the season was observed for both sRPE-Load and sRPE (ES = 0.8-2.1) across all acquisition days (MD-4, MD-3 and MD-2). This was also observed for ACCDEC and sprint distance on MD-1 (ES = 0.2-2.5) and for both ACCDEC and ACCDEC·min^{-1} on MD-4 (ES = 1.4-1.7). A large effect size (ES = 1.7) was also observed for a negative effect across the season for total distance on MD-3, but this was non-significant (p=0.06) (Figure 1).

INSERT FIGURE 1

DISCUSSION

The main findings of this study show 1) differences in training load and intensity between all training days, indicating a successful differentiation in the training load, in accordance with the tactical periodization model. And 2) the results display significant reductions in sRPE, sRPE-Load and ACCDEC across the season, indicating that the team did not maintain a standard weekly cycle load.

No difference was observed in sRPE-Load between MD-4 and MD-3, which were the two training days with the highest sRPE-Load. The perceived load was, however, achieved through different stimuluses, as intended in the tactical periodization model; ACCDEC was higher on MD-4 than all other training days, and higher values of total distance, HSR and sprint distance was evident on MD-3 compared to all other training days.

More ACCDEC on MD-4 compared to MD-3 is in contrast to previous findings when investigating tactical periodization training load in adult [13] and youth male players [15]. It has been suggested that the lack of differences previously observed could be due to shortcomings of GPS systems in assessing change of direction tasks and that it may not have reflected the true demands of the session [15]. For instance, total distance has been observed to be strongly correlated to accelerations and decelerations variables [23], and considering that the highest total distances are typically reserved for MD-3, this can possibly hinder distinctions between these two days for acceleration/deceleration based variables. Supporting this, several studies have observed total distances to be higher on MD-3 than all other training days [13,15]. This is also observed in our study, and high values of total distance covered and TDC·min^{-1} seem to be distinct features of MD-3, in line with intended training load in the tactical periodization model [14,15]. Despite the total volume of ACCDEC counts not being higher on MD-4 in previous studies investigating tactical periodization training load [13,15], the intensity (i.e., actions per min) was reported to be higher in Buchheit et al. [15]. Lopategui et al. [13] did not report values relative to training duration but did report longer training durations on MD-3 than MD-4. These observations likely explain some of the observed discrepancies compared to our findings, as ACCDEC·min^{-1} not only was observed to be higher on MD-4 in our study, but training duration was also slightly longer on MD-4 compared to MD-3. Lastly, supporting the findings in our study, Moraleda et al. [9] observed total distances to be highest on MD-3 and acceleration counts to be highest on MD-4 in a team applying similar training content distinctions between these days.

Like Lopategui et al. [13], we observed the highest HSR and sprint values on MD-3, but contrary Buchheit et al. [15] observed the highest values on MD-2. Considering the labels given to the different training days, one might expect the largest sprint volumes on MD-2 (often labeled "speed day"). However, the shorter sequences played in medium to large spaces and lower work/rest ratios often applied for MD-2 might allow players to conduct sprints at a higher intensity relative to their max, which is an important stimuli to develop maximal sprinting ability [24,25]. In fact, Lopategui et al. [13] observed that there were more repeated high-intensity efforts and more accelerations above the highest threshold (3 m·s^{-2}) on MD-2 compared to MD-3, despite more HSR and sprint distance being observed on MD-3. Furthermore, despite MD-2 being referred to as one of the three acquisition days, it typically contains lower training load than MD-4 and MD-3 [12,14]. Lowering volume while maintaining intensity can therefore be considered in line with the concept of tactical periodization, and moreover follows the principles observed to be successful for tapering in other sports [24]. Evidence of a begun taper on MD-2 was evident in our study through the decrease in training load across all parameters from MD-3 to MD-2. Despite average session intensity values also decreasing between these days it is possible that the intensity within specific exercises and game-play sequences were maintained. Future studies should investigate the effect of work/rest ratios and durations on the intensity of different game formats. Irrespective, TDC·min^{-1} on MD-2 showed no difference compared to MD-4, and HSR·min^{-1} was observed to be higher on MD-2 than on MD-4, indicating that for at least these parameters the average sessions intensity on MD-2 was maintained or increased from MD-4. Allocating the highest training load to MD-4 and MD-3 before starting the tapering process on MD-2 is also in line with other studies reporting on training load in both elite women's [9] and men's football [10,26]. In summary, it seems that teams following a tactical periodization model are successful in differentiating training load between the different training days, which is further supported by the findings in this study. Observations by Buchheit et al. [15] indicate that different physiological responses could arise from these differences, but further studies are needed to establish this with certainty.

A key principle to the concept of tactical periodization is the aim of performance stabilization through maintenance of the standard weekly cycle, which should remain almost invariable over the course of the season [12]. However, we observed significant reductions in sRPE and sRPE-Load for all acquisition days across the season. Reductions were also observed for ACCDEC and sprint on MD-1 and for both ACCDEC and ACCDEC·min^{-1} on MD-4. Except from ACCDEC and ACCDEC·min^{-1} decreasing across the season on MD-4, external load variables on the different acquisition days showed no significant changes across the season. Despite this, both sRPE and sRPE-Load declined significantly on all acquisition days. Considering relationships between internal and external measures of training load, one might expect the players' exertion to remain similar across the season unless they increased their capacity to an extent that would allow them to work at a lower relative intensity [27]. However, such relationships are not perfect, and exact relationships between internal and external load were not investigated in this study. Duration of session could also affect (especially) sRPE-Load. However, in our data, there was a significant negative effect across the season for duration on MD-3 and MD-1, but not for the other days (data not shown). ACCDEC is central to the desired training stimuli on MD-4, and the same is true for total distance on MD-3, where a non-significant negative effect (ES = 1.7) across the season was observed. It is possible that these reductions in ACCDEC and total distance can explain some of the observed reductions in perceived exertion on these training days, as sRPE and sRPE-Load have previously shown strong relationship with total distance covered and accelerometer derived metrics [28–30].

Training load from different in-season periods or changes throughout the season have not been investigated in other teams utilizing a tactical periodization model. Lopategui et al. [13] did, however, report large variations in training load within specific acquisition days across the season, but whether this was due to periodic changes or weekly fluctuations was not elaborated. Our analyses in this study investigated the linear effect of seasonal changes in training load, and despite this analysis only showing that there is a significant linear effect across the season, one can visually observe that particularly the last few weeks show lower training load (Figure 1). Results from other studies that have quantified training load from different periods seem to indicate that reductions in training load are common towards the end of the season [8,31]. This is likely due to coaches being afraid of unnecessary injuries towards the end of the season, as well as fitness staff likely not fearing a decay in fitness with only a few weeks remaining.

The reductions in training load on MD-1 were likely of little importance to the physical adaptions of the players, as the load is relatively low on this day to allow for recovery. It should be mentioned that allowing for recovery is an important part of the process of physical adaptions [1], but the training load and intensities observed on MD-1 are likely not large enough to provide stimuluses for adaption alone. However, whether the observed training load on MD-1 is optimal to promote recovery and subsequent readiness on matchday was not investigated in this study. Optimal tapering training load for football players also remains an unanswered question in the literature [8]. The reduction of ACCDEC on MD-4 might be more concerning for the long-term adaptions of players. To what extent this variable affects the development of fitness in players is uncertain, however it is more likely that a reduction on acquisition days (versus MD-1) will influence the overall fitness. Lastly, there was not observed any reductions in any training load variables on MD, indicating that at least match intensity and load was maintained during the season.

As with several studies in elite football, this study only included one team and had few participants, thus we cannot exclude the possibility for type 2 errors and other biases. The low number of participants (n=21) results in failure to report positional differences in this study. Our inclusion criteria excluded weeks with more or less than 5-7 days between matches. This criterion was selected to reduce confounding factors. However, this limits the application of the findings to weeks that do not follow this schedule. Lastly, we were unable to find a study investigating the validity of acceleration and deceleration measurements from the polar team pro system or how these are calculated. Most GPS systems designed for team sport calculate these measurements from GPS data. However, if calculated from the embedded accelerometers, integrated accelerometers typically show good intra- and inter-unit reliability despite showing questionable validity, meaning that accelerometer data can be used to detect changes or differences, but measurements of absolute magnitudes of acceleration should be interpreted with caution [32].

PRACTICAL APPLICATIONS

Considering the limited number of studies describing training load in elite women's football, this study has provided novel insights and reference values regarding training load at the elite level. This study has provided evidence to show that elite female football teams can be successful in differentiating training load between training days when implementing a tactical periodization approach. Despite providing a methodological framework, appropriate training load and intensity has not been proposed as part of the tactical periodization model for neither the male nor female population. This study has provided training load values that can serve as guidance for further investigations into women's football, both for teams applying the tactical periodization model, and for future studies.

CONCLUSIONS

This study demonstrated that an elite female football team utilizing a tactical periodization model were successful in differentiating specific training load between the different training days within a weekly microcycle, as per intentions. Similarly, the training load pattern across the week was observed to follow recommendations, and the lowest training load was observed on MD-1 for all parameters investigated. Significant negative effects across the season were observed for several parameters, which is contrary to the recommended mechanisms for attaining performance stabilization throughout the season using a tactical periodization model. Despite this, no effect was observed across the season for any variables on MD.

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Table 1. Training contents on the three different acquisition days.

MD-4	MD-3	MD-2
(1) General warm-up with dynamic stretching (5 min)	**(1)** General warm-up with dynamic stretching (5 min)	(1) General warm-up with dynamic stretching (5 min)
(2) Workstations (lateral jumps, accelerations and decelerations with resistance, stability) (5-10 min)	**(2)** Workstations (core, hamstring and hip-flexor work) (5-10 min)	(2) Progressive plyometric and power exercises (5-10 min)
(3) Intensified warm-up with extra focus on change of direction, accelerations, and decelerations (5 min)	**(3)** Intensified warm-up finished with progressions runs and/or sprints (5 min)	(3) Intensified warm-up with running drills, progressions runs and/or sprints (5 min)
(4) Technical warmup/passing drill (10 min)	**(4)** Large possession or shadow play (20 min)	(4) Technical warm-up/passing drill (10 min)
(5) Small possession (15 min)	**(5)** Situational drills (20-30 min)	(5) Pressing drills with short work periods and sufficient rest (15 min)
(6) Position specific 1v1s (15 min)	**(6)** 11v11 games (full pitch, 3-4 games of 8-12 min, r=2-4 min)	(6) Transitions & counterattacks (2-4 vs 1-3 players) (15 min)
(7) SSGs 4v4/5v5 (length x width: 25-40m x 20-25m, 6-10 games of 90- 120s, rest = 60-120s)	**(7)*** Conditioning on either a group or individual level (10s on/20s off runs, 30m sprints)	(7) 7v7/8v8 games (70-80m x 40-45m, 2-4 games of 3-5 min, rest = 3 min)

MD = match day, SSG = small-sided games, *** =** *Did not feature in each session.*

Table 2: Number of players, observations, and observations per player for external and internal load observations within each session-type for the entire duration of the season.

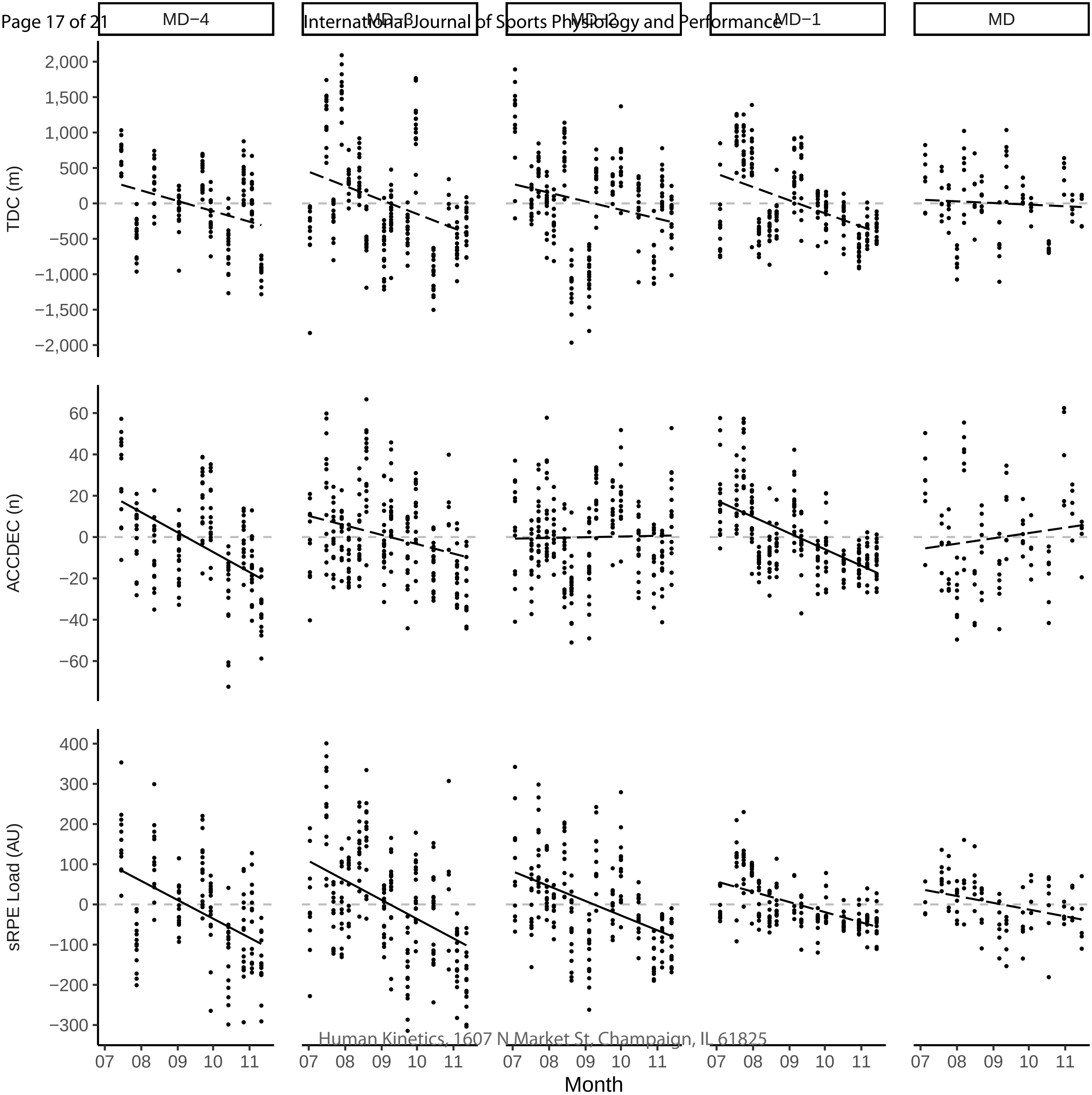
	External load observations					Internal load observations				
	n	**Total**	**Mean**	**Min**	**Max**	**n**	**Total**	**Mean**	**Min**	**Max**
MD-4	21	159	7.6	3	10	19	151	7.9	3	10
MD-3	21	227	10.8	5	14	19	224	11.8	5	15
MD-2	21	231	11.0	4	15	19	217	11.4	4	15
MD-1	21	235	11.2	4	15	19	198	10.4	4	15
MD	15	100	6.7	1	18	13	88	6.8	1	18

n = number of players, Total = total number of observations, mean = average number of observations per player, min = minimum number of observations per player, max = maximum number of observations per player, MD = match day.

Table 3: Training load comparison between the different session-types within the microcycle. An extended table with differences between session-types can be found in the appendix.

	MD-4		MD-3		MD-2		MD-1		MD
	Mean ± CI (95 %)	ES	Mean ± CI (95 %)	ES	Mean ± CI (95 %)	ES	Mean ± CI (95 %)	ES	Mean ± CI (95 %)
Number of sessions (N)	10		15		15		15		18
Duration (min)	110.9 ± 5.8		107.4 ± 5.6		90.3 ± 7.0		75.0 ± 6.8		95.0 ± 0.9
External load variables									
TDC (m)	5862.9 ± 392.8 **#**	2.1-7.8	6862.0 ± 334.4 **#**	2.1-8.6	4848.9 ± 316.1 **#**	2.3-9.4	3062.9 ± 302.2 **#**	4.3-13.5	10220.5 ± 449.6 **#**
TDC·min^{-1}	52.5 ± 3.5 ***** ˟ ¤	0.3-9.8	64.4 ± 3.0 **#**	2.1-7.2	54.0 ± 3.0 ***** ˟ ¤	0.3-8.6	41.1 ± 2.9 **#**	2.6-10.8	108.2 ± 4.6 **#**
HSR distance (m)	342.5 ± 99.3 ***** ˟ ¤	0.6-4.4	746.7 ± 95.5 **#**	2.0-5.8	426.2 ± 82.6 ***** ˟ ¤	0.6-3.8	74.7 ± 74.8 **#**	3.3-6.8	1279.1 ± 149.7 **#**
HSR·min^{-1}	3.1 ± 1.0 **#**	1.3-4.8	7.0 ± 0.9 **#**	1.4-5.2	4.7 ± 0.8 **#**	1.3-3.7	1.0 ± 0.8 **#**	2.6-6.5	13.6 ± 1.6 **#**
Sprint distance (m)	9.4 (5.0 to 17.8) **#**	0.7-2.9	90.5 (57.4 to 142.6) ~ ° ˟	0.7-2.6	40.0 (14.8 to 64.6) **#**	1.0-1.7	0.6 (0.3 to 1.1) **#**	0.7-3.3	136.5 (85.1 to 219.1) ~ ° ˟
ACCDEC (n)	147.5 ± 13.0 **#**	0.7-4.8	129.2 ± 11.8 **#**	0.7-3.8	90.5 ± 9.3 **#**	1.7-3.8	53.8 ± 8.6 **#**	2.2-5.6	193.1 ± 15.7 **#**
ACCDEC·min^{-1}	1.3 ± 0.1 **#**	0.5-3.0	1.2 ± 0.1 **#**	0.5-2.7	1.0 ± 0.1 **#**	0.9-3.5	0.7 ± 0.1 **#**	1.5-4.7	2.0 ± 0.2 **#**
Internal load variables									
sRPE-Load (AU)	650.7 ± 59.6 ° ˟ ¤	0.3-5.6	612.8 ± 50.9 ° ˟ ¤	0.3-5.1	378.4 ± 44.6 **#**	2.2-4.3	168.3 ± 39.5 **#**	2.9-8.4	770.9 ± 56.1 **#**
sRPE (AU)	5.8 ± 0.4 ° ˟ ¤	0.1-4.1	5.7 ± 0.4 ° ˟ ¤	0.1-3.8	4.2 ± 0.4 **#**	1.4-4.1	2.2 ± 0.4 **#**	2.3-7.2	8.2 ± 0.5 **#**

Data are presented as mean ± CI (95%). Symbols indicate significant ($p < 0.05$) difference from: # = all other days, ~ = MD-4, * = MD-3, ° = MD-2, ˟ = MD-1, ¤ = MD. ***TDC = total distance covered, HSR = high-speed running distance, sprint = sprint distance, ACCDEC = combined number of accelerations and decelerations, sRPE = session rating of perceived exertion, MD = match day.***


MD−4
MD−3
MD−2
MD−1
MD
TDC (m)
ACCDEC (n)
sRPE Load (AU)
2,000
1,500
1,000
500
0
−500
−1,000
−1,500
−2,000
60
40
20
0
−20
−40
−60
400
300
200
100
0
−100
−200
−300
07
08
09
10
11
Month

Appendix 1

Table 1, appendix 1: Between-session comparison of training load variables.

	Mean ± CI (95%)		Mean difference	Confidence interval (95%)	Effect size	P-value
TDC						
MD	10221 ± 450					
		vs MD-1	7158	6658 to 7657	13.5	<0.01
		vs MD-2	5372	4904 to 5839	9.4	<0.01
		vs MD-3	3358	2912 to 3805	5.6	<0.01
		vs MD-4	4358	3826 to 4889	7.8	<0.01
MD-1	3063 ± 302					
		vs MD-2	-1786	-2190 to -1382	4.3	<0.01
		vs MD-3	-3799	-4216 to -3383	8.6	<0.01
		vs MD-4	-2800	-3267 to -2333	7.0	<0.01
MD-2	4849 ± 316					
		vs MD-3	-2013	-2417 to -1609	4.1	<0.01
		vs MD-4	-1014	-1478 to -550	2.3	<0.01
MD-3	6862 ± 334					
		vs MD-4	999	532 to 1466	2.1	<0.01
MD-4	5863 ± 393					
HSR						
MD	1279 ± 150					
		vs MD-1	1204	1050 to 1359	6.8	<0.01
		vs MD-2	853	712 to 994	3.8	<0.01
		vs MD-3	532	407 to 657	2.2	<0.01
		vs MD-4	937	786 to 1087	4.4	<0.01
MD-1	75 ± 75					
		vs MD-2	-352	-448 to -255	3.8	<0.01
		vs MD-3	-672	-779 to -565	5.8	<0.01
		vs MD-4	-268	-380 to -256	3.3	<0.01
MD-2	426 ± 83					
		vs MD-3	-320	-419 to -222	2.0	<0.01
		vs MD-4	84	-26 to 193	0.6	0.13
MD-3	747 ± 96					
		vs MD-4	404	289 to 519	2.6	<0.01
MD-4	343 ± 99					
Sprint						
MD	137 (85 to 219)					
		vs MD-1	136	71 to 200	3.3	<0.01
		vs MD-2	96	34 to 159	1.7	<0.01
		vs MD-3	46	-21 to 114	0.7	0.18
		vs MD-4	127	64 to 190	2.9	<0.01
MD-1	1 (0 to 1)					
		vs MD-2	-39	-58 to -20	1.6	<0.01
		vs MD-3	-90	-131 to -49	2.6	<0.01
		vs MD-4	-9	-15 to -3	0.7	<0.01
MD-2	40 (15 to 65)					
		vs MD-3	-50	-90 to -11	1.0	0.01

		vs MD-4	31	12 to 50	1.1	<0.01
MD-3	91 (57 to 143)					
		vs MD-4	81	41 to 121	2.1	<0.01
MD-4	9 (5 to 18)					
ACCDEC						
MD	193 ± 16					
		vs MD-1	139	123 to 156	5.6	<0.01
		vs MD-2	103	89 to 117	3.8	<0.01
		vs MD-3	64	50 to 80	2.1	<0.01
		vs MD-4	46	28 to 63	1.5	<0.01
MD-1	54 ± 9					
		vs MD-2	-37	-48 to -25	2.2	<0.01
		vs MD-3	-75	-89 to -62	3.8	<0.01
		vs MD-4	-94	-108 to -79	4.8	<0.01
MD-2	91 ± 9					
		vs MD-3	-39	-51 to -27	1.7	<0.01
		vs MD-4	-57	-71 to -43	2.6	<0.01
MD-3	129 ± 12					
		vs MD-4	-18	-31 to -5	0.7	<0.01
MD-4	148 ± 13					
sRPE-Load						
MD	771 ± 56					
		vs MD-1	603	537 to 669	8.4	<0.01
		vs MD-2	401	331 to 471	4.3	<0.01
		vs MD-3	158	94 to 222	1.5	<0.01
		vs MD-4	136	46 to 226	1.2	<0.01
MD-1	168 ± 40					
		vs MD-2	-216	-248 to -185	2.9	<0.01
		vs MD-3	-445	-500 to -389	5.1	<0.01
		vs MD-4	-471	-521 to -422	5.6	<0.01
MD-2	378 ± 45					
		vs MD-3	-235	-289 to -180	2.2	<0.01
		vs MD-4	-255	-297 to -213	2.6	<0.01
MD-3	613 ± 51					
		vs MD-4	-38	-97 to 21	0.3	0.20
MD-4	651 ± 60					

Data are presented as mean ± CI (95%). TDC = total distance covered, HSR = high-MD-2 running distance, sprint = sprint distance, ACCDEC = combined number of accelerations and decelerations, sRPE-load = session rating of perceived exertion-load, MD = match day.

Appendix 2

Table 1, appendix 2: Between-session comparison of intensity variables.

	Mean ± SD		Mean difference	Confidence interval (95%)	Effect size	P-value
TDC·min^{-1}						
MD	108.2 ± 4.6					
		vs MD-1	67.1	62.2 to 71.9	10.8	<0.01
		vs MD-2	54.2	49.7 to 58.6	8.6	<0.01
		vs MD-3	43.8	37.3 to 47.5	7.2	<0.01
		vs MD-4	55.6	50.6 to 60.7	9.8	<0.01
MD-1	41.1 ± 2.9					
		vs MD-2	-12.9	-16.5 to -9.4	2.6	<0.01
		vs MD-3	-23.3	-26.9 to -19.6	4.9	<0.01
		vs MD-4	-11.4	-15.5 to -7.3	2.6	<0.01
MD-2	54.0 ± 3.0					
		vs MD-3	-10.4	-13.9 to -6.9	2.1	<0.01
		vs MD-4	1.5	-2.6 to 5.5	0.3	0.46
MD-3	64.4 ± 3.0					
		vs MD-4	11.8	7.8 to 15.9	2.8	<0.01
MD-4	52.5 ± 3.5					
HSR·min^{-1}						
MD	13.6 ± 1.6					
		vs MD-1	12.6	11.1 to 14.2	6.5	<0.01
		vs MD-2	8.9	7.4 to 10.3	3.7	<0.01
		vs MD-3	6.6	5.3 to 7.9	2.6	<0.01
		vs MD-4	10.5	9.0 to 12.1	4.8	<0.01
MD-1	1.0 ± 0.8					
		vs MD-2	-1.7	-4.7 to -2.9	3.6	<0.01
		vs MD-3	-6.1	-7.0 to -5.1	5.2	<0.01
		vs MD-4	-2.1	-3.2 to -1.1	2.6	<0.01
MD-2	4.7 ± 0.8					
		vs MD-3	-2.3	-3.2 to -1.4	1.4	<0.01
		vs MD-4	1.6	0.6 to 2.7	1.3	<0.01
MD-3	7.0 ± 0.9					
		vs MD-4	3.9	2.8 to 5.0	2.8	<0.01
MD-4	3.1 ± 1.0					
ACCDEC·min^{-1}						
MD	2.0 ± 0.2					
		vs MD-1	1.3	1.2 to 1.5	4.7	<0.01
		vs MD-2	1.0	0.9 to 1.2	3.5	<0.01
		vs MD-3	0.8	0.7 to 1.0	2.7	<0.01
		vs MD-4	0.7	0.5 to 0.9	2.4	<0.01
MD-1	0.7 ± 0.1					
		vs MD-2	-0.3	-0.4 to -0.2	1.5	<0.01
		vs MD-3	-0.5	-0.6 to -0.4	2.4	<0.01
		vs MD-4	-0.6	-0.7 to -0.5	3.0	<0.01
MD-2	1.0 ± 0.1					
		vs MD-3	-0.2	-0.3 to -0.1	0.9	<0.01
		vs MD-4	-0.3	-0.4 to -0.2	1.5	<0.01
MD-3	1.2 ± 0.1					

		vs MD-4	-0.1	-0.2 to -0.0	0.5	0.04
MD-4	1.3 ± 0.1					
sRPE						
MD	8.1 ± 0.8					
		vs MD-1	6.0	5.4 to 6.5	7.2	<0.01
		vs MD-2	4.0	3.5 to 4.5	4.1	<0.01
		vs MD-3	2.5	2.0 to 3.0	2.4	<0.01
		vs MD-4	2.4	1.8 to 2.9	2.3	<0.01
MD-1	2.2 ± 0.5					
		vs MD-2	-1.9	-2.3 to -1.6	2.3	<0.01
		vs MD-3	-3.5	-3.8 to -3.1	3.8	<0.01
		vs MD-4	-3.6	-4.0 to -3.2	4.1	<0.01
MD-2	4.2 ± 0.7					
		vs MD-3	-1.5	-1.9 to -1.2	1.4	<0.01
		vs MD-4	-1.6	-2.0 to -1.2	1.6	<0.01
MD-3	5.6 ± 0.8					
		vs MD-4	-0.1	-0.5 to 0.3	0.1	0.51
MD-4	5.7 ± 0.8					

Data are presented as mean ± CI (95%). TDC = total distance covered, HSR = high-MD-2 running distance, sprint = sprint distance, ACCDEC = combined number of accelerations and decelerations, sRPE = session rating of perceived exertion, MD = match day.