Three-, four- and five-day microcycles: the normality in professional football

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Antonio Gualtieri [1,2], Jordi Vicens-Bordas [3,4], Ermanno Rampinini [5,6], Duccio Ferrari Bravo [1], Marco Beato [2]

[1] Sport Science and R&D Department, Juventus FC, Turin, Italy
[2] School of Health and Sports Science, University of Suffolk, Ipswich, UK
[3] Sport Performance Analysis Research Group (SPARG), University of Vic-Central University of Catalonia, Vic, Barcelona, Spain
[4] UVic-UCC Sport and Physical Activity Studies Centre (CEEAF), University of Vic-Central University of Catalonia, Vic, Barcelona, Spain
[5] Human Performance Laboratory, MAPEI Sport Research Centre, Olgiate Olona, Varese, Italy
[6] Sport and Exercise Discipline Group, Human Performance Research Centre, Faculty of Health, University of Technology Sydney, Moore Park, New South Wales, Australia

Contact details for the corresponding author: Antonio Gualtieri, Juventus Football Club, antonio.gualtieri@juventus.com

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Abstract

Purpose: This study aimed to quantify training and match day (MD) load during three-, four- and five-day microcycles in professional adult football, as well as analyzing the effect of the microcycle length on training load produced the day after the match (MD+1) and the day before the match (MD-1).
Methods: The study involved 20 male professional football players whose external and internal load were monitored for a whole season. Training exposure (EXP), total distance covered (TD), high-speed running distance (HSR), sprint distance (SD), individual sprint distance above 80% of the individual maximum velocity (D>80%), number of accelerations (ACC) and decelerations (DEC) were quantified as well as rating of perceived exertion (RPE) and session training load (sRPE-TL).
Results: Microcycles length affected most of the variables of interest: HSR ($F = 9.04$, $p < 0.01$), SD ($F = 13.90$, $p < 0.01$), D>80% ($F = 20.25$, $p < 0.01$), accelerations ($F = 10.12$, $p < 0.01$) and decelerations ($F = 6.01$, $p < 0.01$). There was an interaction effect between training day and microcycle type for SD ($F = 5.46$, $p < 0.01$), D>80% ($F = 4.51$, $p < 0.01$), accelerations ($F = 2.24$, $p = 0.06$) and decelerations ($F = 3.91$, $p < 0.01$).
Conclusions: Coaches seem to be influenced by shorter microcycles in their training proposal, preferring sessions with a reduced muscle impact during shorter microcycles. Independently by the length of the congested fixture microcycle, the daily load seems to decrease when MD approaches.

Key words: Team Sports; Soccer; GPS; Monitoring; Congested fixture

Introduction

In nowadays football, the best teams from each championship (e.g., Serie A, Premier League) play frequently during the season to take part in international competitions or national cups. For instance, they do not play only during the weekend (1 match a week), but also during the week (e.g., 2-3 times in 7-8 days).[1] In these circumstances, the weekly number of training sessions is reduced to facilitate physical recovery (e.g., in the days immediately after the game) and so to promote performance.[2] Training load is affected by this strategy to the point that the weekly load, especially the distance run at high-speed, is mainly completed during the match itself.[3] This type of "*congested fixture season*" does not allow practitioners to plan training as during a standard microcycle (six training sessions a week with one match). Individual players may experience around 10 consecutive weeks of a congested calendar, including domestic and international matches.[4] In this context, teams' weekly schedules change during the season, so a standard nomenclature independent by the day of the week is adopted. More precisely, the training days (and their aims such as recovery, development or tapering) are defined on the basis of the distance from the previous or next match day (MD). In a traditional microcycle, it is common practice to define the days after the latest game as follow: match day plus 1 (MD+1) and MD+2, where usually the main aim is to promote physical and mental recovery, while MD-4, MD-3, MD-2 and MD-1 for the remaining days before the MD.[5] However, in congested fixture periods (as described above), the number of days between matches is reduced and therefore, the training week is shorter (e.g., for a four-day microcycle: MD+1, MD-2, MD-1, MD).

The periodization of loading across the weekly microcycle is commonly observed in adult players. Previous research reported that training volume gradually decreased during the week as match day approached.[6–9] Specifically, in an eight-day microcycle greatest distances and intensities were performed at MD-5 and MD-3, followed by a significant tapering phase at MD-2 and MD-1 in an attempt to reduce the residual fatigue accumulation during the previous days and to optimize MD performance.[9] A similar trend has been reported by Lopategui et al. 2021 in a seven-day microcycle, where a short tapering on MD-2 and MD-1 was planned before the game to recover from the previous loading days, essentials for maintaining or optimizing players' physical performance during the season.[10] Furthermore, Fleming et al. 2023 reported a similar organization of the training stimulus in six-day microcycles, where MD-4 was the most demanding training session of the week, MD-3 was a day-off and during MD-2 and MD-1 coaches decreased players' load to favor players' readiness.[11]

However, this weekly plan cannot be used during congested fixture periods: for example, in a four-day microcycle, the first session after the match (MD+1) is the only available training day where players who did not play the previous MD (non-starters, who are players that did not play or played only fraction of the match) can actually perform physical development (72 h before the next MD). On MD+2 (which is at less than 48 h from the previous MD and 48 h from the next MD), starters are still recovering from the workload of the previous MD and they cannot actually fully train, while non-starters needs to start tapering for the next MD. Finally, MD-1 (less than 72 h from the previous MD, and 24h from the next MD) is a tapering session for both starters and non-starters. A three-day microcycle (MD+1, MD-1 and MD) is also possible, and it represents at least the 30% of the microcycles of a team competing at the same time in the national championship and cup plus the international competitions.[12] In these conditions, MD+1 is the only available day to train non-starting players, but only contained load can be provided since about 48 h from the next MD are available. On the other hand, MD-1 (which is at less than 48 h from the previous MD and about 24 h from the next MD) could be the only day to prepare starting players and check their readiness before the following match, so the right balance between recovery from the previous game and getting ready for the next must be find.

The majority of the studies published in football described the load distribution during regular seven-day microcycles,[8,13–17] while some papers reported shorter microcycles with six to five days,[11,13,17–19] but limited information is currently available about shorter microcycles (i.e., four days), in particular for players militating in top-level teams (e.g., Italian Serie A).[20,21] Furthermore, to our knowledge, no studies have reported training load data specifically for scenarios of three-day microcycles (MD+1, MD-1 and MD). For this reason, this study aimed, firstly, to quantify training and MD load during three-, four- and five-day microcycles in Italian professional adult football, secondly, to compare the microcycle length on the training load during MD+1 and MD-1 and MD load. The authors' hypothesis was that the length of the microcycle do not affect the physical demand of the game (MD), but it influences the training load during MD+1 and MD-1.

Methods

Subjects

Twenty male professional Serie A football players were monitored in this study (age 28.1 ± 4.7 years; body mass 80.6 ± 5.9 kg; height 183.4 ± 5.1 cm; maximum speed 33.7 ± 1.5 $km.h^{-1}$; 80% of peak speed 27.1 ± 0.8 $km.h^{-1}$) for a whole season. The inclusion criteria comprised participation in the official competition. Goalkeepers were excluded from this study, therefore, only outfield players' match data were evaluated. The sample size estimation was calculated using G*power (Düsseldorf, Germany) for a one-way ANOVA fixed effect that indicated a total of 111 individual data points (single days) would be required to detect a *medium* effect (f = 0.3), three conditions (3 microcycles) with 80% power and an alpha of 5%. The actual sample size of this study was 1919 individual data points, with a real power of >95%, which reduced the likelihood of type 2 errors (false negative).[22] The Ethics Committee of the University of Suffolk (Ipswich, UK) approved this study (project code: RETH19/020). Informed consent to take part in this research was signed by the club. All procedures were conducted according to the Declaration of Helsinki for human studies.

Experimental design

The external training load data was recorded as part of the regular monitoring routine of the club and was only analyzed *a posteriori*. All the data reported were collected during one season. The microcycle length was defined by the number of days available between two subsequent matches, inclusive of the match day itself. A day-off was included as well in the count of the days. In *figure 1* we reported the three microcycles analysed and the respective percentage of the total number of microcycles occurred during the season.

Please, insert here figure 1

The day following a match (MD+1), all the starting players did not train on the pitch, instead they performed indoor recovery activities (e.g., cycling, swimming, stretching). For each MD+1 (any microcycle), the training load data are exclusively related to the non-starting players. The physical demand of the game reported at MD is the average load produced by all the players involved in the game independently by their played time, therefore players were not excluded by the analysis on the basis of their played time. This decision was made in accordance with the five substitutions rule, which permits the replacement of up to 5 players during a match (compared to the previous rule allowing only 3 substitutions), aimed at minimizing the variability of MD load attributable to positional effects.

Methodology

During all the training sessions, Apex 10 Hz Global Navigation Satellite System (GNSS) (STATSports, Northern Ireland) units were used to collect data.[23] Apex units validity and reliability were previously reported both for team sports and peak speed monitoring.[23,24] The Apex units were turned on at least 15 minutes before the beginning of the data recording to guarantee synchronisation between the Apex units and GNSS.[23] GNSS data recorded by the units were downloaded and further analysed with STATSports Software (Apex version 3.0.02011). During matches, external load metrics were evaluated by a video tracking system (STATS, USA). Reliability of this type of apparatuses and its interchangeability with GNSS for measures of positional tracking metrics to monitoring of training and competitions were previously reported.[25]

External load metrics

In this study, GNSS recorded metrics were total distance covered (TD), high-speed running distance (HSR, between 20 and 25 $km \cdot h^{-1}$), sprint distance (SD, >25 $km \cdot h^{-1}$) and individual sprint distance (D>80% of the individual maximum velocity).[26,27] Individual sprint distance was calculated as 80% of the maximum peak velocity of each player previously recorded by the club using the same GNSS technology and video tracking system for training sessions and matches respectively. The number of high-intensity accelerations (ACC, >3 $m \cdot s^{-2}$), and decelerations (DEC, <-3 $m \cdot s^{-2}$) were quantified using GNSS technology.[28] The total football exposure (EXP) of each training session was quantified too and expressed in minutes (mins).

Internal load metrics

In this study, players' internal load was quantified in arbitrary units (AU) using the rating of perceived exertion (RPE, Borg's CR10-scale), which construct validity in soccer was previously reported.[29] Session training load (sRPE-TL, AU) was assessed multiplying the RPE value by training or match exposure.

Statistical Analyses

Data are presented as estimated marginal means (95% confidence intervals) for each dependent variable and were analyzed using linear mixed models to account for missing data and repeated measures. Normality of residuals was found for the linear mixed models (LMM). The primary analysis was a LMM, which used the Satterthwaite method (degrees of freedom estimation based on analytical results) to assess if significant differences exist between training days in the different microcycles (three-days, four-days or five-days microcycle as fixed effects) across several dependent variables.[30] During the secondary analysis, LMM were performed including as fixed effects the day of the week (MD+1, MD-1 and MD) and the type of microcycle (three-days, four-days or five-days), to test for differences and interaction effects. Players were considered as random effect grouping factors in all the analyses. When significant differences were found in the LMM, post-hoc tests were performed using Bonferroni corrections for multiple comparisons. Estimates of 95% confidence intervals (CIs) were calculated and reported in the figures. Effect sizes were calculated from the t and df of the contrast and interpreted using Cohen's d principle as follows *trivial* < 0.2, *small* 0.2 - 0.6, *moderate* 0.6 - 1.2, *large* 1.2 - 2.0, *very large* > 2.0.[31] Unless otherwise stated significance was set at $p < 0.05$ for all tests. Statistical analyses were performed in JAMOVI (The Jamovi project [2023], version 2.3, retrieved from https://www.jamovi.org).

Results

The results are summarized in Figures 2-5; and Tables S1-S18 (Supplementary material).

Microcycle type

A total number of 18, 12 and 10 of three-, four- and five-day microcycles respectively were analyzed, corresponding to 34%, 23% and 19%, respectively, of the total number of microcycles of the competitive season.

The daily mean value was analyzed (Tables S1-S6 and Figures 2-3). Three-, four- or five-day microcycles affected most of the variables of interest: HSR ($F = 9.04$, $p = 0.00012$), sprint ($F = 13.90$, $p < 0.00001$), individualized sprint >80% ($F = 20.25$, $p < 0.0001$), accelerations ($F = 10.12$, $p < 0.0001$) and decelerations ($F = 6.01$, $p = 0.0025$). Exposure was found significant ($F = 3.60$, $p = 0.02748$), but the difference between microcycles (*post-hoc*) was trivial. Instead, total distance ($F = 0.691$, $p = 0.501$) and sRPE-TL ($F = 1.03$, $p = 0.358$) were not affected by microcycle type.

Contrasts showed that three- and four-day microcycles had greater daily average HSR demands than the five-day microcycle ($p < 0.05$).

Three-day microcycle showed greater sprint and individualized sprint daily demands ($p < 0.001$), but lower accelerations and decelerations ($p < 0.01$), than the four- and five-day microcycles.

Please, insert here figures 2 and 3

Training day and microcycle type

The training days (MD+1, MD-1) and match day presented differences for all the variables of interest ($p < 0.0001$, Tables S7-S14 and Figures 4-5). There was an interaction effect between training day and microcycle type for sprint ($F = 5.46$, $p = 0.00023$), individualized sprint ($F = 4.51$, $p = 0.00128$), accelerations ($F = 2.24$, $p = 0.06318$) and decelerations ($F = 3.91$, $p = 0.00369$, Tables S15-S18).

Contrasts showed, for individualized sprint distance, trivial differences (29 m, $p = 0.018$, $d = 0.18$) at MD+1 in favor to the three-day microcycle compared to the five-day microcycle. Four-day microcycle presented the greater number of accelerations at MD-1, compared to three-day microcycle (-8.5, $p < 0.00001$, $d = -0.29$); and at MD compared to three- (-11.6, $p < 0.00001$, $d = -0.36$) and five-day microcycles (-9.3, $p = 0.00009$, $d = 0.25$). Four-day microcycle presented the greater number of decelerations at MD-1, compared to three-day microcycle (-7.9, $p = 0.00039$, $d = -0.23$); and at MD compared to three- (-16.4, $p < 0.00001$, $d = -0.43$) and five-day microcycles (14.2, $p < 0.00001$, $d = 0.33$).

Please, insert here figures 4 and 5

Discussion

This study aimed, firstly, to quantify training and MD load during three-, four- and five-day microcycles in Italian professional adult football and secondly to compare the microcycle length on the training load during MD+1 and MD-1 and MD load. We found that the microcycle length affected the average daily values of most of the variables of interest like high-speed, sprint and individualized sprint distances, as such the number of accelerations and decelerations. Moreover, the microcycle type affected individualized sprint distance at MD+1, and accelerations and decelerations at MD-1 and MD.

The management of recovery and training in a specific congested fixture microcycles plays a key role for the long-term players health, physical development and fitness maintenance.[2] From the point of view of a starting player, the workload performed during the MD becomes critical since there is not much time for training.[3,27] On the other hand, from a non-starting player perspective the physical training compensation during the first two sessions of the microcycle is critical, achievable during a seven-day microcycle,[32] but almost impossible in a four- or three-day microcycle scenario described above. In a previous study, non-starters typically had a lower total load than starters during weeks with two matches, with less time spent above 90% of maximum heart rate and covering a shorter high-speed running distance throughout the week, which fell short of the workload equivalent to a full match.[7] For these reasons, managing the load for both starting and non-starting players during a congested fixture period (which for some clubs can last some months or a whole season) becomes an arduous challenge for practitioners, especially for the most impacting aspects of the physical dimension of training such as high-speed and sprint running.[27]

Microcycle type

We found that microcycle type did not affect significantly the mean volume of the training intended as total distance, exposure time and sRPE training load, but different performance indicators of the intensity were affected by it (Figure 2 and 3). The average high-speed running and sprinting distance was reduced by longer microcycles, in particular by five-day microcycles which caused a reduction of 14-19% and 16-32% respectively. This can be explained by the impact of the non-starting players load at MD+1, the main session for non-starting players to produce HSR and sprinting distances in all the microcycles analyzed, with very low demands for the other days. The number of accelerations were lower when only two days were available to prepare the following match (in three-day microcycles). This can be explained because coaching staff were more conservative during three-day microcycles, with non-starting players at MD+1 and with the whole team at MD-1. In that scenario the training drills programmed were more focused on organizing the team tactics for the following match, rather than physical conditioning, using larger pitches with reduced acceleration demands.[33] These data exacerbate the problem of the under-training for non-starting players during congested fixture periods with only two days between games as previously reported.[27] The different trend between the microcycles in terms of accelerations and decelerations could be explained by the different type of drills proposed. In fact, it seems that match and game-based exercises tend to keep an acceleration-deceleration ratio around 1, while more analytical drills like technical development exercises tend to reduce the decelerative demand.[34] In our case, in five-day microcycles part of the sessions was dedicated to the technical development of the players, keeping the accelerative load high with a low decelerative demand.

Training day and microcycle type

As reported in other studies the daily load seems to decrease when MD approaches, with the lower load at MD-1.[3,7] The length of the microcycle did not show significant differences in the load at MD-1, apart for accelerations and decelerations that was lower in a three-day microcycle compared to a four-day microcycle. On the other side, in all the microcycles MD+1 was the session with the highest training load (produced by non-starting players). In terms of accelerations, the MD+1 training session was more demanding than the match itself, and this can be explained by the low number of players involved during training (starters focused on recovery, while non-starters did a compensatory session) and, consequently, because of characteristics of the drills, which preferentially used reduced pitch dimensions.[33,35] At MD+1 deceleration demand was lower compared to acceleration demand, which is a different stimulus considering the greater deceleration number compared to acceleration recorded during games.[28] Instead, the distance completed at HSR and sprinting was largely completed in the game itself, similarly to what previously reported in English Premier League players.[3] In particular, D>80% resulted to be really low in all the training days of a five-day microcycle. This counterintuitive result can be explained considering the whole season during which longer microcycles could have been used to favor recovery. In fact, the fatigue accumulated during chains of three- and four-day microcycles could have been mitigated avoiding single high-load training sessions during five-day microcycles. However, looking at the total volume of HSR and sprinting accumulated during the microcycles it becomes clear that the daily average was affected by the number of training days and that a higher absolute HSR and sprinting volume was produced when more days were available.

Four-day microcycles were the most demanding scenario in terms of accelerations and decelerations both at MD-1 and MD. These results are not in line with previous studies showing a higher performance at MD when reducing load at MD-1.[36] We did not compare the demand of MD-2 between a four- and five-day microcycle, which may have told us that a five-day microcycle was more demanding at MD-2 than a four-day microcycle in terms of accelerations. Such fatiguing demands may have influenced the reduced number of accelerations and decelerations during the game at the end of a five-day microcycle compared to a four-day microcycle.[36] Apart for the number of accelerations and decelerations, the game physical demand was not affected by the microcycle length, but we want to highlight that we compared only different types of congested periods. In fact, comparing congested and non-congested periods, lower accelerative and decelerative load was reported at MD when more matches were played and less training sessions were available.[20]

Limitations and future directions

This study is not without limitations, firstly, the sample utilized is limited to just one team during a single season. Ideally, the sample size enrolment should be based on an a priori estimation, however, this option was not feasible due to the specificity of the top-level soccer players monitored in this study. Therefore we used a convenience sampling and repeated the observations during a whole season gathering a large dataset.[37] Contrariwise, a strength of this study is its high ecological validity; data coming from a very specific population have a very high impact on real-world practice, even with a small sample size.[38] A second limitation that should be acknowledged is related to the utilization of GNSS and video tracking system for the monitoring of training sessions and matches, respectively,[25] therefore, some variability between the data could be related to the different monitoring systems used. A third limitation of this study is the lack of training load quantification for the post-match activities performed by non-starting players immediately at the end of the match when running based training was completed. A dedicated analysis of training load of starters and non-starters during different types of congested fixture periods could let emerge interesting highlights for practitioners. Further studies could also investigate the impact of positions on training load distribution during different microcycles.

Conclusions

In conclusion, coaches seem to be influenced by shorter microcycles in their training proposal, preferring sessions with a reduced muscle impact when less days are available. This adaptation is managed by reducing the number of drills not focusing on the tactical preparation of the following match such as small-sided games and technical development drills, but not reducing the total exposure of every single session. Independently by the length of the congested fixture microcycle, the daily load seems to decrease when MD approaches, with the lower load at MD-1. A five-day microcycle seems the shortest period allowing for the alternation of training and recovery days, necessary condition for players health and performance improvement, in turn useful for a safe and high-quality sports show.

Practical applications

Practitioners can use our findings to re-think on their training plan during three-, four- and five-day microcycles and to look for any feasible improvement, in particular managing the technical and tactical drills selection. A lower number of accelerations and decelerations can be useful when few days are available to let starting players recover from the previous match and to be as ready as possible for the following one. Similarly, a "longer" five-day microcycle during a congested fixture period can be seen as a recovery opportunity for starting players rather than a week to train. On the other side, for non-starting players MD+1 can be a window of opportunity to reach high velocities since they may not have this stimulus the other training days of the week, especially if not exposed to this immediately after the game ends as some form of compensatory training. Finally, football governing bodies should consider increasing the minimum number of days allowed between two official games to let players recover further and, in turn, provide higher-quality football events.

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Figures and Tables

Figure 1. Competitive microcycles analysed and their prevalence during the season. MD, Match Day. For each training day (circles) the distance in terms of days from both the preceding and succeeding match days has been reported using respectively positive (+) and negative (-) count.

Figure 2. Microcycle type and total distance (a), high-speed running distance (b), sprint distance (c) and individualised sprint distance, i.e. >80% of the individual maximum speed (d). Statistically significant differences ($p < 0.05$) across microcycles length are reported as follows: § significantly higher than three-day microcycles; * significantly higher than four-day microcycles; # significantly higher than five-day microcycles.

Figure 3. Microcycle type and accelerations (a), decelerations (b), sRPE, session Rating of Perceived Exertion (c) and exposure (d). Statistically significant differences ($p < 0.05$) across microcycles length are reported as follows: § significantly higher than three-day microcycles; * significantly higher than four-day microcycles; # significantly higher than five-day microcycles.

Figure 4. Microcycle type and training day type: total distance (a), high-speed running distance (b), sprint distance (c) and individualised sprint distance, i.e. >80% of the individual maximum speed (d). The load at MD+1 has been produced by non-starting players. Statistically significant differences ($p < 0.05$) across microcycles length are reported as follows: § significantly higher than three-day microcycles; * significantly higher than four-day microcycles; # significantly higher than five-day microcycles. Three-day microcycles data are represented in blue, four-day in grey and five-day in yellow.

Figure 5. Microcycle type and training day type: accelerations (a), decelerations (b), sRPE, session Rating of Perceived Exertion (c) and exposure (d). The load at MD+1 has been produced by non-starting players. Statistically significant differences ($p < 0.05$) across microcycles length are reported as follows: § significantly higher than three-day microcycles; * significantly higher than four-day microcycles; # significantly higher than five-day microcycles. Three-day microcycles data are represented in blue, four-day in grey and five-day in yellow.