This is the accepted version of an article published in Int J Sports Med 2020; 41(10): 677-681, which has been published in final form at https://www.thieme-connect.com/products/ejournals/abstract/10.1055/a-1171-1865#info

Workload monitoring in top-level soccer players during congested fixture periods

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Abstract

The aim of this study was to assess the internal and external workload of starters and non-starters in a professional top-level soccer team during a congested fixture period. Twenty Serie A soccer players were monitored in this study during two mesocycles of 21 days each. Starters and non-starters were divided based on the match time played in each mesocycle. The following metrics were recorded: exposure time, total distance, relative total distance, high-speed running distance over 20 $km \cdot h^{-1}$, very high-speed running distance over 25 $km \cdot h^{-1}$, individual very high-speed distance over 80% of maximum peak speed. Players' internal workload was quantified using the rating of perceived exertion. Substantial differences between starters and non-starters were found for: exposure time (effect size = *large* to *very large*), rating of perceived exertion (*large* to *very large*), total distance (*large* to *very large*), and individual very high-speed distance over 80% of maximum peak speed (*moderate* to *large*). Furthermore, differences for relative total distance, high-speed running distance over 20 $km \cdot h^{-1}$ and very high-speed running distance over 25 $km \cdot h^{-1}$ were *small* to *moderate,* but not significant. This study reports that during congested fixture periods, starters had higher exposure time, rating of perceived exertion, total distance, and individual very high-speed distance over 80% of maximum peak speed than non-starters. Practitioners should compensate the non-starters for the missing workload derived from the soccer match.

Keywords: training, football, team sports, GPS, high speed running

Introduction

During a soccer game, players who start games (starters) typically cover distances between 10–13 km, performing a variety of intense activities such as sprints, accelerations, decelerations, and changes of direction [1]. Players who do not start games (non-starters) need to compensate for this lack of workload (WL) with additional training that can be planned at the end of a game or during the next training sessions to maintain an adequate fitness level throughout the season. The individual quantification of total WL, which is the combination of training and match load, has critical importance for professional soccer coaches and sports scientists aiming to obtain physical adaptations and reduce the risk of injury [2]. The most common technology utilized to quantify external WL parameters are global navigation satellite systems (GNSS) [3]. GNSS are used to monitor sport-specific metrics, such as total distance covered (TD) and high-speed running, during training sessions and matches [3,4]. Additionally, external WL can be integrated with internal load (*e.g.,* rating of perceived exertion [RPE]) that might guarantee a better comprehension of the players' WL in soccer [2–4].

Recent research, conducted over an entire season on English Premier League players, reported that non-starters have a similar total exposure time and TD (considering both match and training time), but lower high-speed running and very high-speed running than starters [1]. Therefore, in order to compensate for different WL between starters and non-starters, practitioners should implement additional WL during training - with a focus on high-speed activities. However, proposing higher WL, in particular high-speed running and very high-speed running, may be complicated during congested fixture periods due to uncertainty regarding player selection and availability. Sports scientists have to manage the WL with the dual purpose of training and ensuring players are available for selection. The rationale for this approach is supported by the fact that long-term inadequate or excessive WL may undermine the players' physical sport-specific capacities and increase injury likelihood [5].

To date, information related to in-season internal and external WL in professional top-level soccer players during congested fixture periods is very limited. Therefore, the aim of this study was to assess the internal and external WL of professional Serie A starters and non-starters during congested fixture periods in-season. The authors' hypothesis was that during congested fixture periods starters may have higher internal and external WL compared to non-starters.

Materials and Methods

Participants

Twenty professional Serie A soccer players were monitored in this study (age 28.4±4.3years; body mass 81.8±6.5kg; height 184.2±5.5cm; maximum speed 34.1±1.2km·h^{-1}; 80% of peak speed 27.3±0.9km·h^{-1}). Inclusive criteria were the absence during the whole monitoring period of any medical contraindication (injury or illness) and regular participation in all the team's training sessions. The study was conducted in accordance with the Declaration of Helsinki. The Institutional Ethics Board of the University [redacted] approved the study. Informed consent was obtained from the players involved in this study. Authors confirm that this study meets the ethical standards of the journal [6].

Experimental Design

External and internal WL data were recorded as part of the daily monitoring routine. Two mesocycles of 21 days (MC1 and MC2), each with 6 matches, were analysed in this study. The two mesocycles were divided by 2 weeks of the international break, during which players were involved with their national teams: during the last days of the second week, WL was partially individualized after players returned to the club after the international break. In both mesocycles the training, match, and total WL (sum of training and match load) were calculated. Starters and non-starters were defined according to the match time played with the club during each mesocycle using a median-split approach.

Procedures

During all the training sessions, Apex 10 Hz GNSS (STATSports, Northern Ireland) units were used to collect data [4]. Apex units validity and reliability were previously reported both for team sports and peak speed monitoring [4]. The Apex units were turned on 15 minutes before the beginning of the data recording to guarantee synchronisation between the Apex units and GNSS [4]. GNSS data recorded by the units were downloaded and further analysed with STATSports Software (Apex version 3.0.02011). During matches, external WL 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 [7].

The external load variables considered in this study were: Exposure time, TD measured in metres, relative total distance (RD) calculated as the ratio between TD and the total time of the session, distance covered above 20 $km\cdot h^{-1}$ (D>20) and distance covered above 25 $km\cdot h^{-1}$ (D>25) [8]. Individual very high-speed distance (D>80% Vmax) was calculated as 80% of the maximum peak speed of each player previously recorded by the club using the same GNSS technology and video tracking system for training sessions and matches respectively. 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 [9]. Session training load (sRPE-TL) was assessed multiplying the RPE value by training or match duration.

Statistical analysis

Data were presented as mean ± standard deviation (SD). Shapiro-Wilk test was used for checking the normality (assumption). Independent t-test comparing starters and non-starters was used to detect between-groups differences. Statistical significance was set at $p<0.05$. Estimates of 95% confidence interval (CI) were also calculated. Threshold values for meaningful benefit effects were evaluated based on the smallest worthwhile change (SWC) calculated as 0.2 multiplied by the between-subjects SD. Effect size calculated as Hedges' *g* was interpreted as *trivial* < 0.2, *small* 0.2-0.6, *moderate* 0.6-1.2, *large* 1.2-2.0, *very large* > 2.0 [10]. Statistical analyses were performed by JASP software version 0.10.2 (Amsterdam, Netherland) for MAC.

Results

The total WL (sum of training and match load) recorded during MC1 and MC2 for starters and non-starters are reported in Table 1.

*****Table 1 here, please*****

Figure 1 reports the WL subdivision between training sessions and matches for both starters and non-starters. Considering only training sessions, WL values were higher for non-starters, but during MC1 the differences were not meaningful for RPE (3.3 vs 3.0 AU, p=0.08), D>20 (2697 vs 1788 m, p=0.08), D>25 (498 vs 213 m, p=0.120) and D>80% Vmax (151 vs 59 m, p=0.175), while in MC2 all the differences were significant apart for the RD (72 vs 69 m/min, p=0.270).

Conversely, considering only WL performed during matches, significantly higher load was found for starters except for RD (MC1: 118 vs 121 m/min, p=0.525; MC2: 114 vs 115 m/min, p=0.810) and RPE in MC2 (7.7 vs 6.8 AU, p=0.109).

*****Figure 1 here, please*****

Discussion

This study supports the authors' hypothesis that starters have higher internal and external WL compared to non-starters during congested fixture periods when both training and match load were included.

Contrary to previously published data about a seasonal-long analysis [1], starters produced higher total exposure and TD, but non-significant between groups differences were found for D>20 in MC2 and D>25 in both MC. A definitive explanation for these findings is not possible, however, the training strategies implemented by the club may have partially compensated the differences in WL between starters and non-starters. Furthermore, these conflicting results may suggest the existence of data variability from team to team, which should not be generalized as Serie A vs. Premier League [1]. Future studies involving larger sample size (*e.g.,* more than one team) could further investigate the existing differences between soccer leagues. However, when D>80% Vmax was analysed, the differences between the two groups were *moderate* to *large* in MC1 and in MC2, respectively. This finding underlines the importance of individualising very high-speed running thresholds to optimise soccer WL analysis. These findings have high relevance in soccer because of the growing evidence on the importance of very high-speed running for performance and injuries prevention purposes [1,11]. Therefore, further attention should be paid, in congested fixture periods, to this training metric for starter and non-starters.

This study confirms that soccer matches are a critical training component of the week, where players can perform more very high-speed running and soccer-specific activities, which can be difficulty recreated during a congested fixture micro-cycle [1,12]. During the training sessions, coaches may find difficult to replicate the equivalent match running intensity demands, as well as to compensate for the missing match-load for non-starters. This is particularly true during congested fixture periods since the available training time may be limited (*e.g.,* at the end of the game or the day after the game). Moreover, the current research has added evidence of a higher sRPE-TL for starters, which is not only explained by the higher exposure time, but also by the impact of the high RPE values recorded during matches that are hardly replicable during training sessions.

The non-significant differences in RD is explained by the fact that non-starters usually perform additional shorter duration high-intensity aerobic training with no very high-speed running at the end of the game or during the first available training session, raising average values of RD for non-starters in comparison to starters. Moreover, two days after the match, training prescription was differentiated for starters and non-starters, with the objective of reducing high intensity training for starters and properly conditioning non-starters, in line with team objectives and literature recommendations [12]. In the described mesocycles, the most common strategy utilized to reduce the gap between starters and non-starters occurred between the end of the game and the second day after the match. After the game, low-volume high-intensity aerobic training with no very high-speed running was proposed for non-starters, while the day after the game these players performed a combination of small-sided games and power training in the gym. Two days after the game, following a first part of the session in which low-intensity tactical drills were performed for all the team players, non-starters continued their additional training with low-intensity technical-tactical drills. Practitioners should take advantage of all the windows of opportunity to train non-starters in the 48 hours following a game. This is particularly important during congested fixture periods to avoid the presence of long de-training periods for non-starters.

A limitation related to this study is the sample utilized, which is relatively small and limited to just one team. Ideally, the sample size enrolment should be based on an *a priori* estimation, however this option was not feasible due to the limited number of top-level soccer players available, which represents an ecological condition in team sports such as soccer. As reported by Harriss et al. [6], studies involving a very specific population (such as in this investigation) can have a very high impact on real-world practise, even with a small sample size. A further limitation that should be considered was the utilisation of GNSS and video tracking system for the monitoring of training sessions and matches, respectively [7].

In conclusion, this study has reported that starters and non-starters were exposed to significantly different volumes of internal and external load during congested fixture periods. This difference was mainly ascribable to the different total exposure time of the two groups and to the unique WL demands of the match. Players' individualised thresholds for very high-speed running distance (D>80% Vmax) may help to identify the WL needs of non-starters during congested fixture periods. This external load metric might be necessary for sport scientists and coaches to optimally prepare players for the most demanding phases of the match and to avoid de-training for non-starters. For all the reasons reported, the monitoring of external and internal WL metrics should be utilized to manage the training sessions and to plan compensation drills between starters and non-starters.

Acknowledgements

No acknowledgements exist for this investigation

Conflict of interests

[redacted] was employed at the time of the study by Juventus FC. All other authors declare no competing interests.

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Figure 1. Summary of training and match workload for starters and non-starters during two 21 days-congested fixture mesocycles. Data are presented in mean ± standard deviation (SD). S_MC1 and S_MC2 = starters during 1st and 2nd mesocycle respectively; NS_MC1 and NS_MC2 = non-starters during 1st and 2nd mesocycle respectively; sRPE-TL = session Rate of Perceived Exertion Training Load; AU = Arbitrary Units; m = meters; Distance >80% Vmax = Total distance above 80% of maximum peak speed; *training load significantly higher than starters ($p<.05$); #match load significantly lower than starters ($p<0.05$); †total workload lower than starters.