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Article

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Abstract

Purpose: Competitive match-play is a dominant component of the physical load completed by soccer players within a training micro-cycle. Characterising the temporal disruption in homeostasis that follows exercise may provide some insight into the potential for match-play to elicit an adaptive response. ***Methods:*** Countermovement jump (CMJ) performance was characterised 3 days post-match for 15 outfield players from an English Premier League soccer team (age: 25.8 ± 4.1 yrs; stature: 1.78 ± 0.08 m; mass: 71.7 ± 9.1 kg) across a season. These players were classified as either starters (n=9), or non-starters (n=6), according to the average individual playing time (higher/lower than 60 min/match). Linear mixed models were used to investigate the influence of indicators of match-activity (total distance covered (TD), and high-intensity running distance (HI)) on CMJ height and peak power (PP) values. ***Results:*** Starting players covered largely greater TD (ES=1.5) and HI (ES=1.4) than non-starters. Furthermore, there was a possible positive effect of HI on CMJ height and PP. This relationship suggests that an additional 0.6 km high-intensity distance covered would increase CMJ height and PP by slightly more than the smallest worthwhile change values of 0.6 cm and 1.0 W/kg, respectively. This small yet practically relevant increase in performance may suggest that match-play, more specifically the intense activities that are associated with the match, provides a physiological stimulus for neuromuscular adaptation. ***Conclusions:*** This data may have implications for the management of preparation of soccer squads, especially the training requirements of starting and non-starting players.

Keywords: jump test; high-intensity distance; performance; training adaptations

Introduction

Evidence of the systematic manipulation of training load in the build up to a competitive fixture illustrate the importance of the match to the overall planning and preparation strategies used within soccer.[1] The dominant role of the match in the weekly cycle of activity is also typified by it being associated with the highest physical load (both in terms of volume and intensity).[2] Longitudinal studies carried out on professional teams suggest that longer individual match playing time completed across the season favours the improvement and/or maintenance of the physical capacities relevant to soccer performance.[3] While playing time is an important contributor to the stimulus that may be presented by matches, other factors such as the match status[4] and the team's playing formation[5] will also impact the physical performance within matches. As a consequence the extent that match-play may lead to changes in fitness may not be identical for all players in all situations. Characterising the temporal disruption in homeostasis that follows an exercise bout can provide some insight into the potential for that stimulus to elicit an adaptive response. Improvements in jump performance may be indicative of the super-compensation that follows an exercise stimulus.[6] The quantification of jump performance at relevant time periods following matches may therefore provide a way to evidence the potential for match-play to act as a training stimulus for muscle power in soccer players.

Methods

Fifteen male professional outfield soccer players from an English Premier League (EPL) team were included in the study (age: 25.8 ± 4.1 yrs; stature: 1.78 ± 0.08 m; mass: 71.7 ± 9.1 kg). Written informed consent was obtained from all participants. The study was approved by the University Human Research Ethics Committee and the EPL club from which the participants volunteered. Data was collected and analysed for 12 domestic home matches for the team across an EPL season using a multi-camera computerised tracking system (Amisco Pro®, Sport-Universal Process, Nice, France). Physical parameters included the total distance covered (TD) (km) and the total distance covered at high-intensity (> 19.8 km/h) (HI) (km). Missing TD and HI data was attributed to players for non-played matches. According to the individual total playing time in the 12 matches (higher/lower than 720 min or, on average, 60 min/match) the players were classified as starters (n=9), or non-starters (n=6).

Countermovement jump without arm swing (CMJ) data were collected for all participants between 0900 and 1000, 3 days post-match. All participants were familiar with the jumping protocols, after completing jumps regularly as part of warm-up routines and participating in several practice testing sessions. All jump tests were conducted at an indoor facility to avoid any external variations in surface affecting results. In an attempt to standardise jump tests, participants were instructed to perform all attempts in accordance with the protocols outlined by Cormack et al.[7] Before each jump test, participants performed a two minute warm-up consisting of a variety of running patterns (e.g. jogging, high knees, and skipping). Participants then performed three practice jumps before the measurement trial. Participants were informed to self-select the jumping depth and to jump as high as possible. An Accupower force plate (AMTI; Watertown, MA; USA) was used for data collection. The CMJ height and peak power (PP) were taken as the outcomes of the CMJ test.

Linear mixed models were used for data analysis, with random intercepts for individual players. First, for all examined variables, the mean values (as measured across all examined matches) were compared for starters vs. non-starters. The standardised estimated difference between groups was used as the effect size (ES). The ES magnitude was evaluated as trivial (>0.2), small (>0.2 to 0.6), moderate (>0.6 to 1.2), large (>1.2 to 2.0), and very large (>2.0).[8] Subsequently, the effects of match TD and HI (fixed factors) on post-match CMJ height and PP (dependent variables) were evaluated in the whole sample of players (n=15). Since the average CMJ height and PP showed a curvilinear trend over time across the 12 matches, a third-degree polynomial effect of time (days) was also included among fixed effects. The effects of match physical performance variables on CMJ outcomes were assessed as the effects of two within-player standard deviations changes in the fixed factor.[8] Magnitude-based inferences were made on the true effects and evaluated with respect to the smallest worthwhile change (SWC) of dependent variables. 0.6 cm and 1.0 W/kg were used as SWC values for CMJ height and PP, respectively.[7] The following scale of qualitative probabilistic terms was used to make inference on the effects: 25-75%, possible; 75-95%, likely, 95-99%, very likely; > 99%, almost certain.[8] The analyses were performed using the software R, version 3.0.3.

Results

Table 1 illustrates the mean values of the examined variables for the sample. Starting players covered greater TD and HI than non-starters, with differences (90% CI) of, respectively, 3.192 (1.613 to 4.770) and 0.317 (0.119 to 0.515) km. The differences showed large effect sizes (1.5 and 1.4, respectively). Conversely, CMJ height and CMJ PP showed trivial differences (0.4 (-2.3 to 3.2) cm, ES = 0.16; 0.6 (-3.2 to 4.5) W/kg, ES = 0.13) between the two groups.

The within-player standard deviations, calculated from the residual variance of linear mixed models with random intercepts on individual players, were 2.442 and 0.291 km for TD and HI, respectively.

Linear mixed models revealed a possible trivial effect of TD on both CMJ height and PP measured 3-days post match. Conversely, there was a possible positive effect of HI on CMJ height and PP (Figure 1). This relationship suggests that an around 0.6 km additional distance covered would increase CMJ height and PP by slightly more than the SWCs of 0.6 cm and 1.0 W/kg. A previous study[9] showed that the average HI for different playing position ranged from

0.459 km (central defenders) to 0.856 km (wide midfielders). These HI values would respectively imply CMJ height and PP increases from 0.5 to 1.0 cm, and from 0.9 to 1.6 W/kg, as compared to a condition of not playing the match (HI = 0 km). Therefore, match-play may be regarded as having a practically meaningful impact on CMJ performance.

Discussion

The aim of this investigation was to evaluate the potential for match-play to act as a physiological stimulus for adaptation in professional soccer players. The analysis of our data demonstrated a short-term improvement in CMJ height and PP 3 days post-match. The improvements were proportional to the amount of HI completed in the match. Such relationships were slightly less evident between the TD covered and CMJ performance. This data suggests that the intensity of activity that is associated with an EPL match may act as an important stimulus for the neuromuscular system. It is not surprising that we have observed this relationship as the importance of exercise intensity for the adaptative process is well documented.[10] Moreover, these observations are not dissimilar to the data of Meister et al.[11] that illustrated trends for CMJ to increase in periods when fixtures were congested.

The small yet practically relevant increase in jump performance observed as a consequence of greater HI may represent evidence to support the notion that match-play, more specifically the intense activities that are associated with elite soccer competition, may provide a physiological stimulus for muscle power. As such it would seem that the match-play itself may represent an important component of the neuromuscular load completed by players during the week. This data may have implications for the management of appropriate training methods of elite soccer players. This could include a better understanding of the different training requirements for starting and non-starting players. The training needs for starting players can be adapted according to the HI distance they actually covered in the previous match as compared to trying to influence the training completed through the use of a team's or player's typical values. Indeed, the physical load during match-play can't be pre-arranged as that associated with training sessions, as this physical demand is a consequence of factors such as the teams and opponent tactics, match status, actual individual playing time (e.g. 75 vs. 95 minutes), playing position (e.g. in a match a player could play in a position different than his usual position), and other factors. Specifically, it would seem advisable to ensure some additional training to starting players who for any reason (e.g. low match intensity) have not reached the amount of HI deemed to provide an appropriate neuromuscular stimulus during match play. In this case, it seems logical to set the additional training proportionally to the difference between the actual and target match HI. Also, according to the present findings, a practical recommendation for coaches is to ensure additional high-intensity training to non-starting players. This training strategy was used in the management of the present team. This may explain why the overall CMJ performance was not lower in non-starters, despite them completing less amounts of total and high-intensity distance during matches (Table 1).

Some limitations of the present study are to be acknowledged. First, the assessment was focused on muscle power as a physical performance capacity, although match-play may also act as a stimulus for endurance or other soccer-specific physical capacities. Furthermore, the potential effects of power training performed by the team during the study period on CMJ performance was not examined. Finally, the study was carried out over approximately a 3-month long period in the middle of the season. Further studies need to address these points by examining, over an entire season, the interactive effects of training and match physical load stimuli on a wider set of physical performance variables. Furthermore, the impact of specifically designed additional training programs for non-starters deserves particular attention.

Match-play is typically associated with the highest amount of HI running experienced by players within a training micro-cycle.[12] It is therefore un-surprising that this activity may then act as a stimulus for adaptation for individual players. Periodising the physical load so the competition represents the highest physiological requirement during a micro-cycle is logical in one sense (i.e. players may not be over-reached going into matches and are protected from the risk of injury). It could also be suggested that the failure to adequately recreate the intensity associated with match play in training may also have the potential to be maladaptive, making difficult the improvement or maintenance of muscle power across the season. The limited data that is available to scientifically support these approaches would indicate a need for more comprehensive training studies at an elite professional level.

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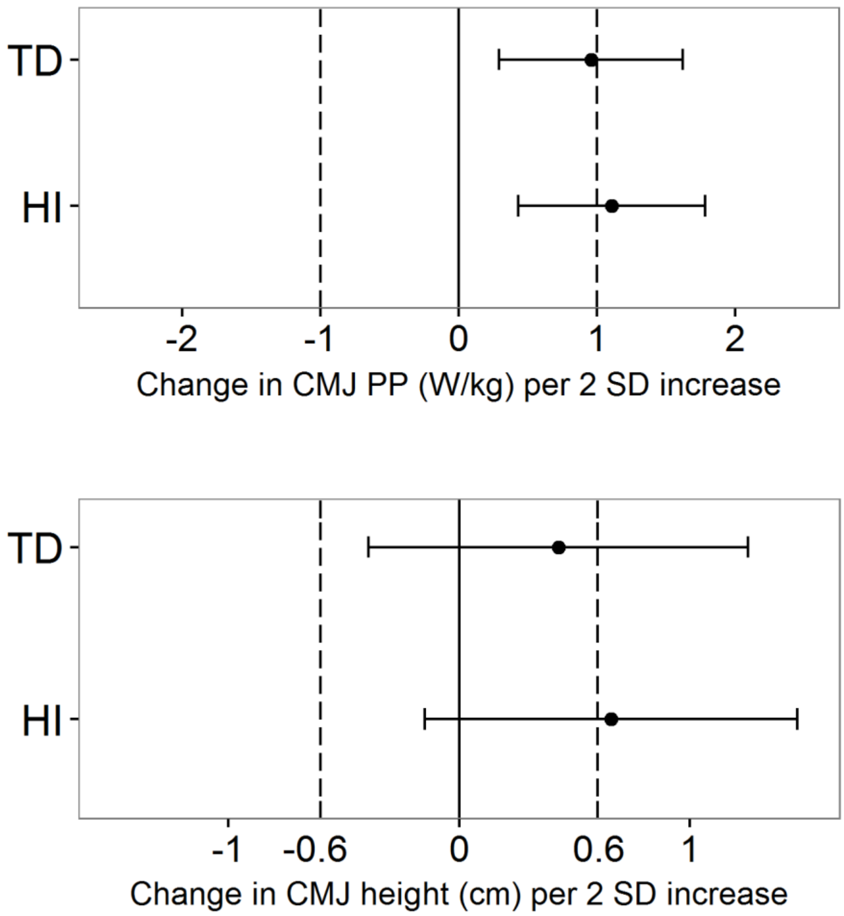

Figure 1: Effects of two standard deviations of within-player changes of total distance covered (TD), and total distance covered at high-intensity (HD) on CMJ PP (upper panel) and CMJ height (lower panel) measured 3 days after the match. Horizontal bars represent the 90% confidence intervals. Vertical dashed lines represent the smallest worthwhile change.

TABLE 1. Linear-mixed models estimates of the mean with between-player SD (in brackets) and 90% CI for the examined match physical performance and CMJ performance variables

	Overall (n = 15)	Starters (n = 9)	Non Starters (n = 6)
CMJ height (cm)	34.9 (2.7) 33.7 to 36.2	34.8 (2.8) 33.1 to 36.4	35.2 (2.9) 33.2 to 37.2
CMJ PP (W/kg)	47.5 (3.9) 45.8 to 49.2	47.7 (3.5) 45.8 to 49.7	47.1 (4.8) 43.8 to 50.5
TD (km)	9.394 (2.068) 8.426 to 10.361	10.551 (0.974) 9.905 to 11.197	7.361 (1.906) 2.683 to 4.260
HI (km)	0.713 (0.226) 0.605 to 0.820	0.828 (0.180) 0.715 to 0.940	0.510 (0.177) 0.366 to 0.653