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Relationships between match activities and peak power output and Creatine Kinase responses to professional reserve team soccer match-play

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ABSTRACT

The specific movement demands of soccer that are linked to post-match recovery and readiness to train are unclear. Therefore, we examined the relationship between Global Positioning System (GPS) variables and the change (Δ; from baseline) in Creatine Kinase (CK) concentrations and peak power output (PPO; during the countermovement jump) at 24 h and 48 h post-match. Fifteen English Premier League reserve team players were examined over 1–4 matches. Measurements of CK and PPO were taken before (24 h prior to match-play) and after (+24 h and +48 h) each game during which movement demands were quantified using 10 Hz GPS data. High intensity distance covered ($r = 0.386$, $p = 0.029$; $r = -0.349$; $p = 0.050$), high intensity distance covered·min^{-1} ($r = 0.365$, $p = 0.040$; $r = -0.364$, $p = 0.040$), high speed running distance ($r = 0.363$, $p = 0.041$; $r = -0.360$, $p = 0.043$) and the number of sprints·min^{-1} ($r = 0.410$, $p = 0.020$; $r = -0.368$, $p = 0.038$) were significantly related to ΔCK and ΔPPO at +24 h post-match, respectively. No relationships were observed between any match variables and ΔCK and ΔPPO after +48 h of recovery. These findings highlight that high intensity match activities are related to ΔCK and ΔPPO in the 24 h, but not 48 h, following soccer match-play. Such information is likely of interest to those responsible for the design of soccer player's training schedules in the days following a match.

1. Introduction

Soccer typically requires distances of 9–14 km to be covered per match (Bangsbo, 1994; Carling & Dupont, 2011). While low-intensity activities are dominant (Bangsbo, 1994; Carling & Dupont, 2011), ~300 changes in movement that exceed 0.5 m s^{-2} (and thus are classified as acceleration/deceleration efforts) are performed per half in 90 min of match-play (Russell, Sparkes, Northeast, Cook, et al., in press). Eccentric contributions to these muscle actions (Brancaccio, Lippi, & Maffulli, 2010; Clarkson, Nosaka, & Braun, 1992; Warren, Lowe, & Armstrong, 1999) likely explain the transient metabolic and physical performance disturbances attributed to exercise-induced muscle damage that are observed for up to 120 h

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post-match (Nedelec et al., 2012, 2014). Although unclear (McCall et al., 2015), insufficient recovery time has been associated with injury risk in European club competitions (Dupont et al., 2010) and international tournaments (Carling, Le Gall, & Dupont, 2012). Consequently, the ability to profile and/or predict post-match physiological and performance changes resulting from competitive involvement is desirable.

Indices of CMJ performance (e.g., peak power output; PPO) and Creatine Kinase (CK) concentrations are common markers used to assess the influence of prior exercise on subsequent performance (Nedelec et al., 2012, 2014; Russell, Sparkes, Northeast, & Kilduff, in press; Russell et al., 2015). Indeed, we recently reported that PPO during the CMJ was reduced (+24 h: −237 ± 170 W, +48 h: −98 ± 168 W) whereas CK was elevated (+24 h: +334.8 ± 107.2 μ L^{-1}, +48 h: +156.9 ± 121.0 μ L^{-1}) after 90 min of soccer match-play (Russell et al., 2015); responses which were consistent across four matches and a variety of playing positions. While such markers have provided worthwhile information regarding the time-course of changes following soccer-specific exercise, the time required for such changes to manifest (e.g., up to 120 h; Nedelec et al., 2012, 2014) likely precludes the sole use of these variables to inform training program design in the days soon after match-play. This problem is likely exacerbated by the between-match variability of CK and PPO responses to soccer match-play (Russell et al., 2015).

Previous authors have reported the use of match-play performance characteristics to predict individualized recovery kinetics in rugby union (Jones et al., 2014; Smart, Gill, Beaven, Cook, & Blazevich, 2008; Takarada, 2003), rugby league (McLellan & Lovell, 2012; McLellan, Lovell, & Gass, 2011) and Australian football (Young, Hepner, & Robbins, 2012) players. In one of the few studies to examine such relationships in soccer, Nedelec et al. (2014) reported significant correlations between the number of short sprints performed and the increase in muscle soreness at 48 and 72 h following competitive soccer match-play. However, an acknowledged limitation of this study was the use of video motion analyses when Global Positioning System (GPS) tracking data can report the intensity of match activities as opposed to just the amount (Nedelec et al., 2014). GPS tracking has demonstrated relationships between high speed running characteristics and changes in CK (Thorpe & Sunderland, 2012) and neuromuscular function (Duffield, Murphy, Snape, Minett, & Skein, 2012; Young et al., 2012) during the post-exercise recovery period.

In seven semi-professional soccer players, and using GPS analysis, significant correlations between indices of high intensity running (i.e., sprint number, sprint distance and high intensity distance covered) and immediate post-match increases in CK concentrations are reported (Thorpe & Sunderland, 2012). However, while acknowledging the small sample size used in this study, correlations between movement characteristics and physiological variables assessed immediately post-match may not reflect relationships between these indices after more prolonged durations of recovery (e.g., +24 and +48 h); especially, given the time-course of recovery of selected physiological variables and the fact that the days following match-play likely elicit reductions in a player's training volume. Typically, players will have a rest day or a recovery day in the 24 h following a match.

In summary, there is a paucity of literature that has examined the impact of soccer playing actions on post-match markers of recovery status. Such information would likely be of benefit to applied practitioners seeking methods of informing the modulation of training program design in the days following competitive encounters. Therefore, the aim of this study was to examine relationships between the movement demands of professional reserve team soccer match-play (determined by GPS) and post-match changes (from baseline) in CK concentrations and CMJ performance. We hypothesized that soccer-specific playing actions performed during match-play would be associated with changes in CK and PPO post-match.

2. Methods

2.1. Experimental design

This longitudinal and observational study investigated relationships between GPS variables collected during match-play and changes in CK concentrations and CMJ performance in the 48 h following soccer-specific exercise. The study presents data from a three month period whereby five consecutive matches were played during the 2013/2014 competitive season. The activity in the 48 h period before each game included a single training session on both days that lasted no longer than 60 min and started at ~10:30 h. These sessions typically required a channel warm-up (including dynamic stretches and short sprints), box drills (e.g., static keep ball, 6 vs 2) and tactical practices to be performed and were characterized by coaching staff as low volume and low intensity. Players were advised to rest in the afternoons following training. In agreement with previous studies, assessments of CK concentrations and CMJ performance were measured to monitor the impact of match-play during the 48 h following each game (Russell, Sparkes, Northeast, et al., in press; Russell et al., 2015) and GPS variables were collected during competitive encounters (Russell, Sparkes, Northeast, Cook, et al., in press; Russell, Sparkes, Northeast, et al., in press). The test–retest reliability of our variables (measured using coefficient of variation analyses) was 3.0% and 3.2% for CK and PPO, respectively.

2.2. Participants

Data are presented for 15 professional soccer players (age: 20 ± 1 years; stature: 1.80 ± 0.04 m; mass: 70.4 ± 5.4 kg) who play in outfield positions (centre back, centre midfield, full back, striker or wing) for a Premier League under-21 soccer team.