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ORIGINAL RESEARCH

Physical match performance and creatine kinase levels in elite football players

Gökmen Yapalı [1], Galip Bilen Kürklü [2]

[1] *Department of Physiotherapy and Rehabilitation, Faculty of Health Science, Necmettin Erbakan University, Konya, Türkiye.* [2] *Department of Coaching Education, Faculty of Sports Sciences, Istanbul Galata University, Istanbul, Türkiye.*

Abstract. Many studies have shown that creatine kinase (CK) concentration increases following an elite-level football competition. However, the relationship between match performance and CK levels at 72 hours after the match is still unclear. The aim of this study was to determine the relationship between physical match performance data and blood CK levels 72 hours post-match in elite football players. The study included 11 male elite football players (age=26.36±3.29 years, height=181.60±6.1 cm, weight=75.41±5.96 kg). Capillary blood samples were collected from the participants approximately 72 hours post-match and examined by reflectance photometry. Physical match performance data from 2 consecutive matches of a Turkish Super League team (while competing in the UEFA Europa League) were collected by a computerized video tracking system. There was no significant correlation between the players' CK level and their total distance (p=0.6012), high-intensity (20-24 km/h) running distance (p=0.8837), or sprinting distance (p=0.235). CK level was also not correlated with the percentage of total distance covered in high-intensity running (r=-0.62, p=0.052). However, moderate to strong negative correlations were observed between CK level and percentage of total distance covered in sprinting (r=-0.67, p=0.032) and percentage of total distance covered in high-intensity running and sprinting (r=-0.70, p=0.022). The current study suggests the benefit of evaluating distances covered in the game and CK concentrations 72 hours post-match while planning recovery interventions.

Keywords. Creatine kinase, football, match analysis, recovery, tracking system.

Introduction

Elite football players can experience considerable physiological stress during the playing season. Monitoring match and training variables and their relationships with blood biomarkers in response to elite football can provide detailed information about players' physiological conditions (Liam, 2014). Creatine kinase (CK) is being increasingly used as a diagnostic biomarker for the assessment of fatigue and recovery in elite football (Scott et al., 2016; Lazarim et al., 2009). Many studies examining CK after exercise have indicated that the increase in serum CK is related to the intensity, duration, and type of exercise, and these studies also suggest that CK levels are elevated after playing a football match (Liam, 2014; Scott et al., 2016; Thorpe & Sunderland, 2012; Russell et al., 2016). In a review of the literature, it was noted that most studies focused on physical match performance and CK concentration immediately after the match or 24–48 hours post-match (Scott et al., 2016; Lazarim et al., 2009; Thorpe & Sunderland, 2012; Russell et al., 2016; Silva et al., 2018; Russell et al., 2015; Devrnja & Matković, 2018). There are few studies investigating the relationship between CK levels at 72 hours post-match and the impact of game performance (Wiewelhove et al., 2015; Hagstrom & Shorter, 2018; Lovell et al., 2018).

Computerized video tracking systems are the most widely used tools for the analysis of distances covered by players, and most data about elite football competitions available in previous studies were obtained by using this system (Barros et al., 2007). Rampinini et al. (2007) and Di Salvo et al. (2007) published validity studies for various tracking systems with large player samples.

✉ G. Yapalı, e-mail: gyapali@gmail.com
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During an elite-level football match, players (depending on their positions) typically cover total distances of 9–14 km, including 2–3 km of high-intensity running and 250–500-meter sprints (Wiewelhove et al., 2015; Andrzejewski et al., 2013; Bloomfield et al., 2007). However, players cover the majority of the total distance and spend the most time per match in low-intensity movements such as standing, walking, and jogging per match (Rampinini et al., 2007).

Although many studies have shown that creatine kinase (CK) concentration increases following an elite-level football competition. CK concentration is an important indicator to show physical stress following training or a match. To our knowledge, before studies usually investigated acute (24-48 hours) CK concentration and physical performance. In addition to these studies, there may need to be studies that investigated prolonged elevated CK concentration and physical performance. However, the relationship between match performance and CK levels 72 hours after the match is still unclear. The aim of this study was to determine the relationship between physical match performance data and blood CK levels 72 hours post-match in elite football players.

Methods

Subjects

Eleven professional players on an elite football team (Turkish Super League, First Division) were included in this study. Data collected from different players in two competitions who completed the match (90 minutes) without any injury or complaints were analyzed. The goalkeeper of the team was excluded due to the different training styles and match activities.

The demographic and anthropometric characteristics of the players are shown in Table 1. All players on the team trained at high volume and intensity every week, usually with 1–2 days off.

Ethical Approval

The study was approved by the ethics committee of the Meram Medical Faculty of Necmettin Erbakan University (2018/1489) and performed according to the Declaration of Helsinki. Informed consent was obtained from all individual participants included in the study. The doctor of the relevant team conducted this study and the authors also received written consent from the authorities of the team.

Procedures

Data from 2 consecutive games (on September 18 and 23, 2017) were obtained using SentioStats® (Istanbul, Türkiye). The validity study of the Sentio demonstrated the effectiveness of the system compared with other multiple-object tracking methods (Sermetcan & Pınar, 2016). Total distance, high-intensity (20–24 km/h) running distance, and sprinting (>24 km/h) distance (in meters) were collected using this system. The distances covered in the matches and 72-hour post-match CK concentrations are shown in Table 2.

Table 1
Demographic and anthropometric data of the 11 players.

Age (years)	Height (cm)	Weight (kg)	BMI (kg/m²)	Body Fat (%)	Muscle Mass (kg)
26.36 ± 3.29	181.60 ± 6.1	75.41 ± 5.96	22.70 ± 1.29	11.80 ± 3.15	65.34 ± 3.72

Data were given as mean ± SD

Table 2
Distances covered in meters and CK levels 72 hours after matches in µ.mol.l-1.

Total (meters)	High-intensity (meters)	Sprint (meters)	72-hr CK (µ.mol.l-1)
9774 ± 668	1471 ± 397	247 ± 98	489.4 ± 374.30

Data were given as mean ± SD

Finger capillary blood samples were collected from the players by the team doctor. After cleaning the fingertip with ethyl alcohol, a lancet was used to prick the finger and the blood was collected into a heparinized capillary tube (Cat No. 955053202 Reflotron®). The blood was transferred onto a CK test strip (Cat No. 1126695 Reflotron®) as soon as possible and assessed by reflectance photometry using the Reflotron Analyzer Plus® (Boehringer Mannheim, Germany).

A hand-to-foot, multifrequency 8-electrode bioelectric impedance analysis device (MC-980MA, Tanita Corporation®, Japan) was used to measure body fat (%) and muscle mass (kg). General instructions were given to players including not consuming any medications, alcohol, or caffeine, and not eating or drinking to maintain good hydration before the 24 hours prior to measurement. Any metallic object was removed from players, skin cleared with alcohol then the subject asked stood with their barefoot on Tanita with good erect posture and grasped the hand grips of it (Kyle et al., 2004; Suarez-Arrones et al., 2018).

All tests were performed at the team performance laboratory, which was maintained at a temperature of 22.5°C during the procedures.

Statistical Analysis

The normality of the data was checked with histograms and Shapiro–Wilk test. The CK levels of the players showed a non-normal distribution. Correlation analysis was performed with Spearman rank-order test. The correlation coefficient (r) was interpreted as follows: 0.00 to 0.29: negligible, 0.30 to 0.49: weak, 0.50 to 0.69: moderate, 0.70 to 0.89 strong, 0.90 to 1.00 very strong. A *p-value* <0.05 was considered statistically significant. Statistical analyses were performed using R version 3.6.2 software.

Results

No significant correlations were observed between all distances covered and CK concentrations at 72 hours post-match (total distance: p=0.6012, high intensity running distance: p=0.8837, sprinting distance: p=0.235).

CK was not significantly correlated with the percentage of total distance covered in high-intensity running (r=-0.62, p=0.052). There was a moderate negative correlation between CK level and the percentage of total distance covered in sprinting (r=-0.67, p=0.032) (Figure 1). There was also a strong negative correlation between CK level and the percentage of total distance covered in combined high-intensity running and sprinting (r=-0.70, p=0.022; Figure 2).

Discussion

This study aimed to investigate the relationship between physical match performance data and blood CK levels 72 hours post-match in elite football players. There were negative correlations between CK concentrations at 72 hours post-match and both the percentage of total distance covered in sprinting and the percentage of total distance covered in combined high-intensity running and sprinting.

It has been suggested that CK provides a potential biochemical marker for use in elite football teams (Lazarim et al., 2009; Russell et al., 2016). However, an English Premier League (EPL) study failed to demonstrate a relationship between any indicators of the physical match performance and post-match CK values in football players (Scott et al., 2016).

The most common injury in elite football is muscle strain (31%) (Mueller-Wohlfahrt et al., 2013). CK is a good indicator used in athlete recovery monitoring, and CK elevations reveal a muscle damage response following a football game (Silva et al., 2018). Several studies have shown that CK concentrations can remain high for hours and even several days after an intense competition or prolonged training session (Russell et al., 2015; Devrnja & Matković, 2018; Hagstorm et al., 2018; Coelho et al., 2011). It has been suggested that CK provides a potential biochemical marker for use in elite football teams (Lazarim et al., 2009; Russell et al., 2016). However, an English Premier League (EPL) study failed to demonstrate a relationship between any indicators of physical match performance and post-match CK values in football players (Scott et al., 2016). That study was the first to examine the relationship between post-match CK and physical indicators of the match performance in elite football players using a video tracking system and was based on 48-hour post-match CK levels.

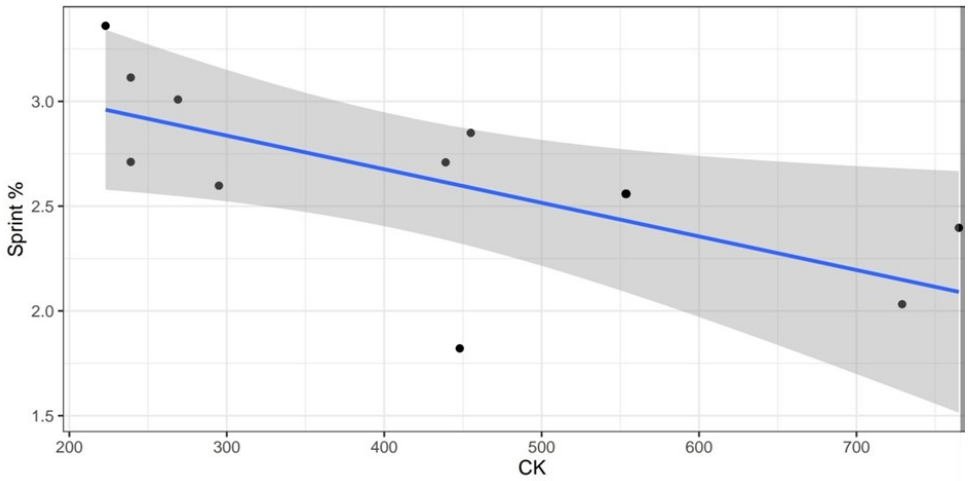

Figure 1. The relationship between the percentage (%) of sprint/total distances covered and CK (µ.mol.l-1).

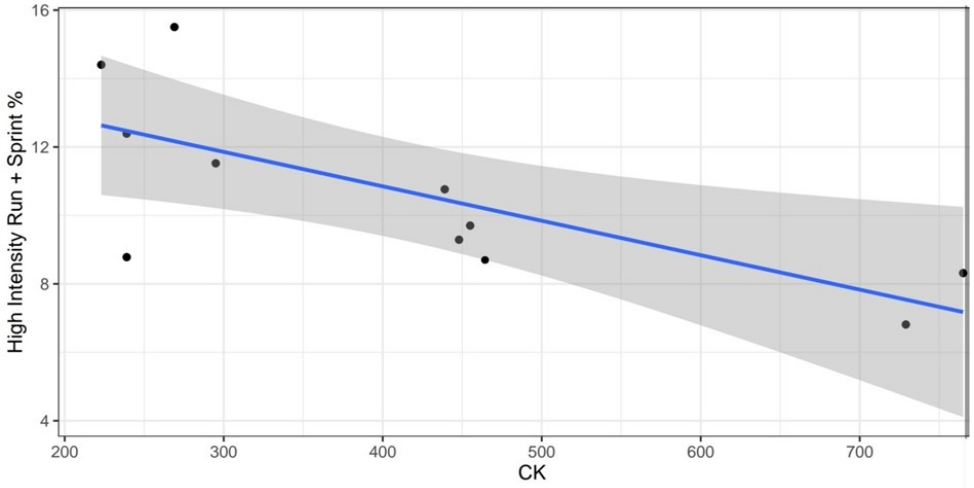

Figure 2. The relationship between the percentage (%) of sprint+high intensity/total distances covered and CK (µ.mol.l-1).

At present, there is very limited information regarding CK responses at 72 hours after a football match, and therefore little is known about the relationship between physical match performance data and CK measured at 72 hours post-match. Because elite football players are frequently required to play consecutive matches at intervals of 3 days, there may be not enough time for physical recovery and evaluation of recovery indicators such as CK (Nedelec et al., 2012). Nedelec et al. (2014) reported that playing in a football match resulted in significant neuromuscular fatigue for up to 72 hours post-match, depending on the number of sprints and sudden changes in direction performed during the competition.

According to our study, distances covered (especially total distance) in the Turkish Super League are not as high as those in the leading European leagues such as EPL, Seria A, and La Liga. Scott et al. revealed that EPL players regardless of position had overall total and sprint distances of 10574±854 m and 312±154.2 m These values were 9774±668 m and 247±98 m in the present study (Scott et al., 2016).

Conclusions

The aim of this study was to examine the relationship between the distances covered by elite football players during a match, measured using a computerized video tracking system, and their capillary blood CK concentrations obtained at 72 hours post-match. The main findings of our study were that: 1) There was a moderate negative correlation between the percentage of total distance covered in sprinting and 72-hour post-match CK levels, 2)- There was a strong negative correlation between the percentage of total distance covered in

high-intensity running and sprinting and 72-hour post-match CK levels.

There is still no consensus among coaches and sports scientists regarding the timing of recovery interventions after competitions for elite team sport athletes (Lovell et al., 2018). Different studies have reported that between 24 and 120 hours are required to normalize CK levels (Silva et al., 2018; Russell et al., 2015; Lovell et al., 2018). Therefore, efficient and individualized recovery strategies seem necessary for preventing non-contact injuries (especially muscle injury). In order to prevent muscle strains and plan recovery training during an intensive game schedule, our findings suggest that distances covered in the game and CK concentrations of players 3 days post-match should be evaluated as often as possible.

One of the limitations of our study is that the duration of the ball in play is unknown. The players appeared to spend excessive time in resting movements such as jogging and walking. This high rate of recovery time period in game may explain the negative correlations between the percentage of distances and CK levels. Another limitation was the small number of players in the sample.

Authors' Contribution

Study Design: GY, GBK; Data Collection: GY, GBK; Statistical Analysis: GY, GBK; Manuscript Preparation: GY, GBK.

Ethical Approval

The study was approved by the ethics committee of the Meram Medical Faculty of Necmettin Erbakan University (2018/1489) and performed according to the Declaration of Helsinki.

Funding

The authors report no involvement in the research by the sponsor that could have influenced the outcome of this work.

Conflict of interest

The authors declare that there was no conflict of interest in conducting this research.

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