The influence of soccer match play on physiological and physical performance measures in soccer referees and assistant referees

Running Head: Fatigue in soccer match officials

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Abstract

The aim of this study was to quantify the acute impact of soccer match officiating on selected physiological and physical performance measures. Twenty-four officials from the Spanish National 3rd Division participated in this study. External (global positioning system; GPS) and internal (heart rate) load data were collected for each match official during 8 official matches. Pre- and post-matches, referees were assessed for tympanic temperature, blood lactate, 15 and 30-m sprint speed and unilateral (dominant and non-dominant legs) and bilateral vertical jump performance. For referees, the acute physiological and physical performance effects of officiating (post-match value minus pre-match value) were large increases in blood lactate (1.7 $mmol.l^{-1}$; ±90% confidence limit 0.9 $mmol.l^{-1}$, effect size ES = 4.35), small increases in 15-m sprint (0.09; ±0.04 s, ES = 0.53) and 30-m sprint speed (0.14; ±0.08 s, ES = 0.39) and a small increase in non-dominant leg jump performance (2.1; ±1.4 cm, ES = 0.31). For assistant referees, there was a small decrease in tympanic temperature (-0.3°C; ±0.2°C, ES = -0.65), and small increases in blood lactate (0.4; ±0.3 $mmol.l^{-1}$, ES = 0.66), 15-m sprint (0.06; ±0.04 s, ES = 0.47), 30-m sprint (0.11; ±0.16 s, ES = 0.49) and bilateral countermovement jump height (3.4; ±1.5 cm, ES = 0.45). Taken together, these data demonstrate that the physical demands of soccer officiating are sufficient to elicit increases in blood lactate and small decrements in sprint performance and thereby provide some evidence for match-related fatigue.

Key words: match officials, field-testing, fatigue, sprinting, jumping.

Introduction

Soccer is an intermittent sport during which players have to be able to perform high-speed running actions during a match as an important prerequisite for successful participation (Reilly, Bangsbo, & Franks, 2000). While the physical (external load) and physiological (internal load) demands of soccer players have been extensively studied (Bangsbo, 1994; Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011; Impellizzeri et al., 2013; Stolen, Chamari, Castagna, & Wisloff, 2005; Weston, Batterham, et al., 2011; Weston, Drust, & Gregson, 2011) there are fewer studies focusing on soccer referees (Costa et al., 2013; Weston, Drust, Atkinson, & Gregson, 2011). Of the available literature, soccer referees cover approximately 10-12 km (Krustrup et al., 2009; Weston, Castagna, Helsen, & Impellizzeri, 2009) with a corresponding mean match heart rate of 85-90% of maximal heart rate (%HR_{max}) (D'Ottavio & Castagna, 2001; Weston, Castagna, Impellizzeri, Rampinini, & Breivik, 2010). Furthermore, the match referees match activity profiles appear to be driven by the activity profiles of the players (Weston, Drust, & Gregson, 2011). In contrast to the referees whose majority of movements are linear, assistant referees mostly perform activities of a multidirectional nature, limited to half of the length of the field; therefore, the total distance covered by assistants represents approximately half of the total distance covered by the referees (Mallo, Navarro, García-Aranda, & Helsen, 2009) with a substantially lower mean match heart rate (~77%HR_{max}) (Helsen & Bultynck, 2004).

Refereeing activity can be influenced by fatigue (Mallo, Navarro, Garcia-Aranda, Gilis, & Helsen, 2008), which is hardly surprising given the high physical and physiological match demand, and therefore the challenge to those involved in the physical preparation of soccer match officials is to ensure training programmes are devised to ensure that officials can cope with the high physical match demands by keeping up with play at all times to attain optimal positioning when making key decisions (Weston et al., 2012). As such, an understanding of match-related fatigue will help to inform match officials' physical training programs. Given that fatigue is difficult to discern from match analysis data (Weston et al., 2012), some authors have used match-induced changes in physiological measures (e.g. blood lactate) in an attempt to understand the fatigue implications of matches (Krustrup, Mohr, & Bangsbo, 2002; Krustrup et al., 2009). Moreover, even though body temperature plays an important role in physical performance (West, Cook, Beaven, & Kilduff, 2014), its influence in elite players seems to be unclear in team sports. Due to the lack of literature regarding this issue, it would be interesting to perform an assessment soccer match officials' match-induced change in temperature.

To provide direct evidence of development of fatigue during elite soccer games, it is necessary to combine motion analyses with physical performance tests performed before and after games (Krustrup, Zebis, Jensen, & Mohr, 2010). As such, some studies have compared the differences in post-match vs. pre-match values in certain key physical performance measures, namely sprinting speed and explosive leg power, as an indirect measurement of match-related fatigue (Andersson et al., 2008; Cortis et al., 2013; Krustrup et al., 2002; Krustrup et al., 2010; Nedelec et al., 2014; Tessitore, Cortis, Meeusen, & Capranica, 2007). Despite some authors observing substantially slower 30-m sprint times post-match compared to pre match values for assistant referees (Krustrup, Mohr, & Bangsbo, 2002), as yet there is no scientific evidence regarding the impact of a match on the referees' sprint speed. Some researchers have observed a significant decrease in explosive leg power, as determined by the vertical jump test, following a match in soccer players (Andersson et al., 2008; Nedelec et al., 2014; Tur & Gonzalez-Haro, 2011), and, due to the high physiological stress imposed upon match officials, the power performance of the lower limbs is no doubt of relevance to refereeing activity (Tessitore et al., 2007). The influence of match activities on the jump performance of referees is equivocal, however (Tessitore et al., 2007) and therefore further research is needed. Furthermore, many match activities require unilateral propulsion (e.g. rapid direction changes) and therefore an examination of lower limb functional strength asymmetry better represents the specific power requirements of match play movements (Maulder and Cronin, 2005).

Ultimately, a better understanding of match-related changes in referees' and assistant referees' physiology and speed/power performance can inform the development of specific training strategies aimed at maximizing on-field performance. Accordingly, the aim of this study was to quantify the acute impact of soccer match officiating on selected physiological and physical performance measures.

Methods

Participants

Twenty-four soccer match officials officiated on eight official soccer matches of the Spanish National 3rd Division across the 2014-15 soccer season. The match officials had at least ten years of officiating experience, with a minimum of six years at this particular level of competition. The 24 match officials constituted 8 field referees (25.6 ± 5.3 y; 182.8 ± 6.6 cm; 77.0 ± 8.9 kg; 22.4 ± 1.7 $kg \cdot m^{-2}$) and 16 assistant referees (32.3 ± 9.6 y; 175.4 ± 4.1 cm; 74.4 ± 8.3 kg; 23.8 ± 2.8 $kg \cdot m^{-2}$). All participants trained at least three times a week and were involved in refereeing on average twice per month. This investigation was performed in accordance to the Declaration of Helsinki and was approved by the Ethics Committee of University of the Basque Country (UPV/EHU) and met the ethical standards in Sport and Exercise Science Research (Harriss & Atkinson, 2013).

Design

The effects of soccer matches on jump and sprint performances and on physiological measures were evaluated (Figure 1). Pre-match, blood lactate concentration and tympanic temperature were measured and following these measurements all match officials undertook a 15-min standardized warm up, consisting of 7-min slow jogging and strolling locomotion followed by progressive sprints and static stretching. The time separating the end of the warm-up and the start of the match was 30 minutes, during which the physical performance measures were undertaken in the following order: bilateral countermovement jump, unilateral countermovement jump and sprint tests. Internal (heart rate [HR]) and external match loads (total distance covered, running mean speed) were collected for every match. All physiological and performance measures were then repeated immediately post-match (Figure 1) in the same order.

******Figure 1 near here******

Procedures

Blood lactate and temperature

Capillary blood samples (Lactate Plus™, Nova Biomedical, USA) were collected from the earlobe to determine the blood lactate concentration, following the protocol of Boullosa, Abreu, Tuimil, and Leicht (2012). Tympanic temperature (ThermoScan™ 5 IRT 4520, Braun GmbH, Krongerg, Germany) was also measured (Hamilton, Marcos, & Secic, 2013).

Physical performance evaluation

Participants performed two countermovement jumps (CMJ) on a force platform sampling at 500 Hz (Quattro Jump™, Kistler, Switzerland) with two legs, two unilateral CMJ with the dominant leg and two unilateral jumps with the non-dominant leg (Newton et al., 2006). The highest jump was used to determine the dominance of the lower limbs (Newton et al., 2006). Dominant (D) and non-dominant (ND) leg were matched with strong and weak limb, respectively. Two maximal jumps of each test were recorded, interspersed with approximately 10 s rest between jumps and 90 s rest between tests. The highest jump was used for further analysis. Jump height was calculated from the flight time by means of the following formula: $h = gt^2/8$ (Young, 1995). Coefficient of variation (CV) for the jump tests was calculated (CMJ: 6.1 ± 5.7%, CMJD: 6.5 ± 7.2% and CMJND: 3.6 ± 3.6%). Following the jumps, 30-m sprint tests were performed (Figure 1) on grass and match officials wore their own soccer boots for this test. Participants' starting position was 0.5 m behind the first timing gate (Microgate™ Polifemo Radio Light, Bolzano, Italy). The time was automatically activated as participants passed the first gate, that is, at the 0-m line. Split times were recorded at 15 m and 30 m. Match officials were asked to run as fast as possible from the start line and to eliminate reaction time participants started when ready. Each match official performed two trials interspersed with a 90-s rest period. The best performance was then used for analysis. CV for the acceleration tests was calculated (15 m sprint: 1.3 ± 1.3%, 30 m sprint: 0.8 ± 0.6%).

Internal match loads

Match officials' heart rate was recorded continuously during the matches (Polar Team System™, Kempele, Finland) at 5-s intervals. Heart rate during the 15-min half-time period was excluded from the analysis. Intensities of effort were subsequently calculated and expressed as percentages of maximal heart rate (HR_{max}).

External match loads

All match officials were equipped with global positioning system (GPS) devices (MinimaxX v4.0, Catapult Innovations™, Melbourne, Australia) operating at the sampling frequency of 10 Hz. The data are presented for entire match where mean distances covered and mean speeds were monitored (Costa et al., 2013).

Statistical Analysis

Results are presented as means ± standard deviations (SD). The CV (Atkinson & Nevill, 1998) was used to assess the variability of the CMJs and the sprint tests. Dominant to non dominant ratio of the various measures were determined using the formula (dominant leg – non dominant leg) / dominant leg x 100 (Newton et al., 2006). Prior to analyses, plots of the residuals versus the predicted values of all variables revealed no clear evidence of non-uniformity of error. In athletic research, it has been argued that it is not whether an effect exists but how big the effect is that matters and that the use of the P value alone provides no information about the direction or size of the effect or the range of feasible values (Hopkins, Marshall, Batterham, & Hanin, 2009). Therefore, we elected to use effect sizes (ES), with uncertainty of the estimates shown as 90% confidence intervals, to quantify the magnitude of the difference between post-match and pre-match physiological and physical performance measures. ES were classified as trivial (<0.2), small (0.2 to 0.6), moderate (0.6 to 1.2), large (1.2 to 2.0), very large (2.0 to 4.0) and extremely large (>4.0) (Hopkins et al., 2009). A threshold value of 0.2 between-subject standard deviations was set as the smallest worthwhile change and inference was then based on the disposition of the confidence interval for the mean difference to this smallest worthwhile effect; the probability (percent chances) that the true difference between tests is substantial (beneficial / detrimental) or trivial was calculated as per the magnitude-based inference approach (Batterham & Hopkins, 2006). These percent chances were then qualified via probabilistic terms and assigned using the following scale: 25-75%, possibly; 75-95%, likely; 95-99.5%, very likely; >99.5%, most likely (Hopkins et al., 2009). Inference was classified as unclear if the 90% confidence limits overlapped the thresholds for the smallest worthwhile positive and negative effects (Hopkins et al., 2009). Mean differences, confidence intervals, effect sizes and magnitude-based inferences were calculated using a custom-made spreadsheet (Hopkins, 2006). Relationships between the relative change (Δ%) of the referees' physiological performances and the match demands were examined using correlation coefficients, with 90% confidence limits (CL). The following scale of magnitudes was used to interpret the magnitude of the correlation coefficients: <0.1, trivial; 0.1-0.3, small; 0.3-0.5, moderate; 0.5-0.7, large; 0.7-0.9, very large; >0.9, nearly perfect (Hopkins et al., 2009).

Results

The referees' and assistant referees' external and internal match loads are presented in Table 1. For the referees (Table 2), the physiological and physical performances effects of match play were a possibly extremely large increase in blood lactate, a very likely small increase in 15 m sprint time, a likely small increase in 30 m sprint time and a likely small increase in non-dominant leg countermovement jump height. For the assistant referees (Table 3), the effects of match play were likely small increases in tympanic temperature, blood lactate and 15 m sprint time and very likely small increases in 30 m sprint time and bilateral countermovement jump height. For both referees, the effects for all remaining measures were unclear.

******Table 1 near here******

******Table 2 near here******

******Table 3 near here******

Relationships between match loads and the change in physiological and performance measures for the referees and assistant referees are presented in Table 4. Relationships between the post-match change in physiological with performance measures were unclear to large for total match distance, mean match speed and mean match heart rate.

******Table 4 near here******

Discussion

The aim of our study was to quantify the acute effects of soccer match officiating on selected physiological and performance measures. In spite of the fact that internal and external match loads and the changes on the physiological and performance variables have been researched in team sports players (Cortis et al., 2013; Cortis et al., 2011; Nedelec et al., 2014; Povoas et al., 2014; Tur & Gonzalez-Haro, 2011), no clear scientific evidence has been found of their influence on soccer match officials. As such, this is the first study to quantify the acute effects of match play on physiological and physical performance measures in soccer referees and assistant referees. Our main findings were that match play induced some physiological perturbations and a small decrement in sprint performance, both in referees and assistant referees, although this performance decrement did not extend to jump performance.

Quantifying the match performance of referees and assistant referees during competitive match play enables an assessment of whether or not match officials are able to meet the physical and physiological demands of the matches and also provides specific information for training program design (Weston, 2014). In our study we observed that soccer referees covered a distance of almost twice that of assistant referees. Accordingly, other studies reported a total distance of 10270 ± 900 m and 6760 ± 830 m in international matches (Krustrup et al., 2009) and a total distance of 10197 ± 952 m and 5819 ± 381 m during the America's Cup (Barbero-Alvarez, et al., 2012) for referees and assistant referees, respectively; 10218±643 m for the Confederation Cup Germany in referees (Mallo, Navarro, Garcia-Aranda, & Helsen, 2009); 11770±808 m in the Premier League for referees (Weston, Drust & Gregson, 2009); and 6137±539 m in Under 17 World Cup Finland in assistant referees (Mallo et al., 2008). Furthermore, Costa et al. (2013) reported similar mean speed value for referees as was observed in the present study (6.5±0.9 $km \cdot h^{-1}$). With regard to internal match loads, our results concurred with the majority of studies reporting a mean heart rate response equivalent to the 85-90% of HR_{max} (Barbero-Alvarez et al., 2012; Helsen & Bultynck, 2004; Krustrup et al., 2009; Weston & Brewer, 2002).

Since the match physiological and physical demands are disparate for referees and assistant referees, we therefore recommend that referees and assistant referees do not undergo similar specific programs to improve their physical conditioning. Specifically, greater external and internal match loads imposed upon soccer referees, when compared to assistant referees, necessitate an increased reliance upon aerobic energy provision during matches and this should be trained for accordingly. The detailed breakdown of an elite referee's training activity over an 8-year period presented by Weston et al. (2011) provides a template for the design of match officials' training given that this programme helped an elite soccer referee progress to the pinnacle of his sport by refereeing the FIFA World Cup and UEFA (Union of European Football Associations) Champions League finals. Whereas, for assistant referees focus should be upon improving sprint and repeated-sprint ability, and also the efficiency of sideways movements as they perform as much sprinting and more sideways running than their referee counterparts (Krustrup et al., 2009).

In the present study blood lactate increased substantially post-match when compared to pre-match and this was observed both for referees and assistant referees. This finding suggests that anaerobic system is stimulated during matches (Krustrup et al., 2009). The higher blood lactate increase observed for the referees in comparison to the increase observed in assistant referees, no doubt reflects the higher physical and physiological match demands imposed on referees. In the present study, post-match lactate values were lower than the values obtained by Krustrup et al. (2009) (referees: 4.6 ± 3.3 mmol.l^{-1}, assistant referees 2.8 ± 2.6 mmol.l^{-1}) following international matches. These differences could well reflect the marked difference in standard of matches officiated in the respective studies as in the present study national-level match officials referees participated, whilst in the Krustrup et al. (2009) study participants were international standard match officials. Although some authors have observed that the body temperature increased in the fourth bout of a small-sided game in team sports (West et al., 2014; Yanci, Iturricastillo, & Granados, 2014), in the present study we found no match-induced increases in body temperature.

A reduced physical capacity at the end of a soccer match can be considered an indirect measurement of match-related fatigue (Cortis et al., 2013). For example, sprint tests performed before and after elite male and female soccer matches games have demonstrated that peak running speed and repeated sprint performance deteriorate considerably during games (Krustrup et al., 2006; Krustrup, Zebis, Jensen, & Mohr, 2010). Our findings demonstrated small post-match decrements in the sprint performance of soccer referees and assistant referees, suggesting that in this particular cohort the physical demands of match play were sufficient to induce fatigue. While this is a novel finding for soccer referees, Krustrup, Mohr, and Bangsbo (2002) also reported a reduction in post-match sprint performance of similar magnitude (2.7%) in assistant referees. We did not, however, observe any match-induced impairments in our measures of jump performance, this finding is consistent with the work of other researchers when examining the match-induced changes in vertical jump performance in regional soccer referees (Tessitore et al., 2007), male and female soccer players (Cortis et al., 2013; Krustrup et al., 2010).

Our data therefore suggest that the referees and assistant referees were indeed able to cope the physical match demands that are most closely aligned to explosive vertical jump performance. This is not surprising given that match officials perform relatively few match-related actions in the vertical plane. Match officials may, however, experience higher levels of fatigue on the horizontal axis given that their match-related movements actions constitute forward, backward and also sideways running; thus suggesting that horizontal jump tests could provide further insight into match-related fatigue. Ultimately, our findings of impaired sprint performance yet no change in jump performance are consistent with previous work and provide further evidence that fatigue development in soccer is a highly specific phenomenon (Krustrup et al., 2010).

Examining the associations between external and internal loads provides can provide insight into the underlying causes of match-related fatigue. In the present study, we found large associations between total match distance, mean match speed and also mean match heart rate with the match-induced change in blood lactate, yet unclear to moderate associations between match running variables with the changes in sprint and countermovement jump performance. As such, it is likely that the sprint and countermovement jump variations are more related to short-term actions involving the neuromuscular system as opposed to global match loads. Therefore it would be interesting to quantify the short-term and high-intensity actions in match officials. Surprisingly, the correlation between the internal and external match load was higher with non-dominant leg countermovement jump height, suggesting that external match loads have a differential effect on bilateral and unilateral jump performance.

The primary limitation of our study is the low sample size of matches, especially given the high variability of referees' match running performances previously reported (Weston, Gregson, et al., 2011). We did, however, find small match-induced changes in physical performance despite this low sample size. As a result, we have provided the first piece of evidence for match-related fatigue in soccer referees and such data are valuable to scientists and coaches alike as the data help to inform the specifics of match-related conditioning. Further limitations of our work are that it remains to be seen whether these findings extend to match officials at the highest levels of the game and also that a more elongated profiling of the response to match play was not performed. Finally, we were unable to quantify the impact of the match-related impairment in sprint performance on match running capacity. As such, we encourage future work to provide more detailed analyses of match running performance (e.g. 5

or 15-min segments) when evaluating the acute effects of soccer match officiating on selected physiological and performance measures.

Practical Applications

In the present study, referees and assistant referees recorded impaired sprint performance following matches suggesting that physical training to offset the match-related decline in this specific aspect of physical performance is advised. Repeated-sprint training therefore has obvious appeal for those involved in the training of soccer match officials as such training is a time-efficient method for enhancing several components of match-related fitness, namely speed, power and the ability to perform repeated bouts of high-intensity running and sprinting (Taylor, Macpherson, Spears, & Weston, 2015; Weston et al., 2015). We have recommended that referees and assistant referee undertake different training regimes given the substantial disparity in their match external and internal loads and that this difference should relate not only to the prescription training activities but also to overall training volume.

Conclusion

Soccer referees cover more distance and record a higher mean running speed than assistant referees, suggesting a necessity for the planning specific training programs for referees and assistant referees to improve their physical performance. We observed a small decrement in post-match 15 and 30-m sprint performance when compared to pre-match, both in referees and assistant referees, yet no negative changes were found for the bilateral and unilateral jump capacity. The decrease in the sprint performance could be considered as an indicator of match-related fatigue. Finally, a horizontal jump test assessed pre- and post-match would be interesting to further assess match-related fatigue in soccer referees and assistant referees.

References

Appendices

Tables

Table 1 Internal and external soccer match load of referees and assistant referees

	Referees	Assistant referees
Total distance covered (m)	10053±1165	5305±497
Mean speed ($km \cdot h^{-1}$)	6.1±0.9	3.2±0.3
HR_{max} (bmp)	185±9	169±14
HR_{mean} (bmp)	161±11	133±17
$\%HR_{mean}$	86.8±3.2	78.8±5.0

HR_{max}: maximum heart rate value; HR_{mean}: mean heart rate;

Table 2 Descriptive statistics and mean differences (post-match value minus pre-match value) in the referees' physiological and physical performance measures, along with effect sizes and qualitative inferences

	Pre-match mean ± SD	Post-match mean ± SD	Mean difference ±90% CL	Effect size ±90% CL	Qualitative inference
Physiological measures					
Tympanic temp (ºC)	36.9 ± 0.5	36.8 ± 0.5	-0.1; ±0.7	-0.17; ±0.41	Unclear
Blood lactate (mmol.l^{-1})	1.4 ± 0.3	3.0 ± 1.5	1.7; ±0.9	4.35; ±2.22	Possibly extremely large
Performance measures					
15 m sprint (s)	2.43 ± 0.15	2.52 ± 0.16	0.09; ±0.04	0.53; ±0.26	Very likely small
30 m sprint (s)	4.34 ± 0.31	4.47 ± 0.33	0.14; ±0.08	0.39; ±0.24	Likely small
CMJ (cm)	30.6 ± 6.5	30.5 ± 7.7	-0.1; ±1.9	-0.02; ±0.26	Unclear
CMJd (cm)	18.7 ± 5.5	19.4 ± 6.2	0.7; ±1.3	0.12; ±0.21	Trivial
CMJnd (cm)	17.1 ± 6.0	19.2 ± 6.8	2.1; ±1.4	0.31; ±0.21	Likely small
Imbalance (%)	9.1 ± 10.4	6.1 ± 6.1	-3.0; ±7.1	-0.26; ±0.60	Unclear

Table 3 Descriptive statistics and mean differences (post-match value minus pre-match value) in the assistant referees' physiological and physical performance measures, along with effect sizes and qualitative inferences

	Pre-match mean ± SD	Post-match mean ± SD	Mean difference; ±90% CL	Effect size; ±90% CL	Qualitative inference
Physiological measures					
Tympanic temp (ºC)	36.8 ± 0.4	36.5 ± 0.7	-0.3; ±0.2	-0.65; ±0.46	Likely small
Blood lactate (mmol.l^{-1})	1.4 ± 0.6	1.8 ± 0.6	0.4; ±0.3	0.66; ±0.53	Likely small
Performance measures					
15 m sprint (s)	2.58 ± 0.12	2.64 ± 0.13	0.06; ±0.04	0.47; ±0.29	Likely small
30 m sprint (s)	4.58 ± 0.21	4.69 ± 0.24	0.11; ±0.16	0.49; ±0.23	Very likely small
CMJ (cm)	29.5 ± 7.2	32.9 ± 8.9	3.4; ±1.5	0.45; ±0.19	Very likely small
CMJd (cm)	15.8 ± 3.1	15.8 ± 2.9	0.1; ±0.9	0.02; ±0.27	Unclear
CMJnd (cm)	14.5 ± 2.9	14.8 ± 4.0	0.3; ±1.1	0.10; ±0.35	Unclear
Imbalance (%)	8.5 ± 8.1	10.5 ± 8.8	1.9; ±5.5	0.23; ±0.64	Unclear

Table 4 Correlations (±90% confidence limits) for total match distance, mean match speed and mean match heart rate (expressed as a % of maximal heart rate) with the Δ% match change (post-match value minus pre-match value) in physiological and physical performance measures.

	Total distance covered (m)	Mean speed ($km.h^{-1}$)	$\%HR_{max}$
Δ% Tympanic Temperature	0.21; ±0.33 Unclear	0.21; ±0.33 Unclear	-0.03; ±0.34 Unclear
Δ% Blood lactate	0.62; ±0.22 Likely large	0.64; ±0.21 Likely large	0.60; ±0.23 Likely large
Δ% 15 m sprint	0.26; ±0.32 Likely small	0.25; ±0.33 Unclear	0.32; ±0.31 Possibly moderate
Δ% 30 m sprint	0.25; ±0.33 Unclear	0.25; ±0.33 Unclear	0.32; ±0.31 Possibly moderate
Δ% CMJ	-0.49; ±0.27 Likely moderate	-0.47; ±0.27 Likely moderate	-0.34; ±0.31 Possibly moderate
Δ% CMJd	0.12; ±0.34 Unclear	0.11; ±0.34 Unclear	0.11; ±0.34 Unclear
Δ% CMJNnd	0.33; ±0.31 Possibly moderate	0.33; ±0.31 Possibly moderate	-0.07; ±0.34 Unclear
Δ% Imbalance	-0.20; ±0.33 Unclear	-0.20; ±0.33 Unclear	0.10; ±0.34 Unclear

CMJ: countermovement jump; CMJd: dominant leg countermovement jump; CMJnd: non-dominant leg countermovement jump; HR_{max}: maximum heart rate value

Figures

Figure 1 Temporal sequence of the fitness performances and measures obtained during each soccer match.

LA: blood lactate; CMJ: countermovement jump; CMJD: unilateral countermovement jump with the dominant leg; CMJND: unilateral countermovement jump with the non-dominant leg.