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**Title:** Technical demands of soccer match-play in the English Championship

**Running title:** Technical analysis of soccer

**ABSTRACT**

The aim of this study was to investigate the effect of match-play on the performance of technical actions in professional soccer players. Using computerized notational analysis, technical performance was quantified for the outfield players of one team during the 2010/2011 English Championship season. This retrospective study evaluated temporal patterns in the performance of players who completed more than 10 games ( $n=10$ ). Total possessions and number of ball distributions were lower in the second versus the first half of match-play ( $10 \pm 7\%$ ,  $P=0.010$  and  $11 \pm 8\%$ ,  $P=0.009$ , respectively). Analysis across 15-min intervals revealed reductions during the last 15-min of match-play in the total number of possessions (0:00-14:59 min:  $11.8 \pm 1.9$  vs. 75:00-89:59 min:  $9.5 \pm 1.7$ ,  $P<0.05$ ) and distributions (0:00-14:59 min:  $10.9 \pm 2.3$  vs. 75:00-89:59 min:  $8.7 \pm 2.1$ ,  $P<0.05$ ). The number of touches taken per possession, number of challenges, percentage of challenges won, length of forward distributions and percentage success of distributions were all similar between halves and across 15-min intervals. These results demonstrate that match-specific factors reduced total possessions and number of passes in the second half of match-play. Coaching staff could use this information to inform team tactics and technical training sessions.

**Key Words:** Fatigue, football, passing, skill, technique, possession

## INTRODUCTION

### *Paragraph 1.*

It is important to consider the demands of a particular sport when developing training programs (10). Many studies have described the physical demands of soccer match-play (for a review see: 18) and have reported average data about the distances covered at varying thresholds of intensity over the full duration of a game (3, 13, 21) or over smaller segments (i.e., over 15 or 45-min; 6, 11). Most authors have observed declining physical efforts as the match progresses, particularly in the second half (e.g., 6, 8, 12). Although match-related fatigue has been suggested to explain inter-half decrements in performance (12), other factors probably contribute to this phenomenon including self-pacing strategies (9) and tactical changes (19). Nevertheless, quantification of the physical demands of match-play assists conditioning staff to design soccer-specific training programs.

### *Paragraph 2.*

The primary aim of soccer is to score more goals than the opposition within the allotted time period. As the performance of technical actions (i.e., soccer skills) can determine success in soccer (8), it is surprising that limited descriptive data exists to characterize skill-related performances during competitive soccer match-play. Such data could be used by those responsible for the technical preparations of soccer players to increase the specificity of the practices employed before and during competitive encounters. Previous studies have demonstrated that passing, dribbling and shooting performance can reduce during and immediately following simulated soccer match-play (for a review see: 16). However, research that increases our understanding of the technical responses to actual soccer match-play are warranted (4).

*Paragraph 3.*

Inconclusive findings currently exist in the few studies that have sought to describe the technical responses of soccer players during competition; some authors have identified an effect (11) whereas others disagree (6). For example, reductions in short passing performance that have been attributed to the accumulated effects of match-related fatigue have been reported to exist between the first and second halves in players from the Italian Serie A (11). Conversely, separating the match into six 15-min periods negated the effects of soccer-specific exercise upon a range of technical actions performed by elite midfield players competing in the highest league in France (6). It is possible that these conflicting results are an artefact of different statistical analyses, varying demands of leagues in different countries and/or the effects of match-specific factors (e.g., current score, technical challenges and tactical strategies in the latter stages of the match). Consequently, the influence of soccer match-play on skilled performance is equivocal in professional soccer players.

*Paragraph 4.*

In summary, the performance of technical actions (soccer skills) is important in defining the outcome of soccer matches. The influence of competitive match-play on skilled performances is not well-characterized. Therefore, the aim of this study was to examine the influence of actual soccer match-play on markers of technical performance in soccer players competing in the English Championship. We hypothesized that the demands of match-play would influence the performance of technical actions during soccer games.

## **METHODS**

Experimental approach to the problem

*Paragraph 5.*

A semi-automatic computerized player tracking system was used to code the technical actions of professional soccer players during every home match (23 matches) played in the 2010/2011 competitive season of the English Championship. A within-subjects design was used to compare passing, possession and tackling performances between playing halves and transiently over 15-min intervals. This approach is congruent with previous studies in the field (6), and has been shown to demonstrate sensitivity in detecting performance changes over the duration of a match (12).

Subjects

*Paragraph 6.*

A professional soccer squad competing in the English Championship (second tier of professional soccer in the UK) was recruited for this study. Skill-related performances were analyzed during competitive matches and congruent with the experimental design employed by previous authors in this field (6), this study was performed retrospectively on existing data. As these data arose as a condition of employment in which player performance was routinely measured over the course of the competitive season, usual appropriate ethics committee clearance was not required (20). Nevertheless, all performance data was anonymized to ensure player confidentiality and approval for the study was obtained from the club involved prior to data analysis procedures being undertaken.

## Procedures

### *Paragraph 7.*

All matches were played at the home venue of the team under investigation and a total of 23 Championship games throughout the 2010/2011 season were analyzed. Before starting the playing season all players had completed a pre-season period of physical and technical preparation that included approximately 10 friendly matches. Following the start of the season, two competitive fixtures were played per week (i.e., Kick-off at 20:00 h Tuesday evenings and 15:00 h Saturday afternoons) and the players training strategy focused upon recovery and maintenance of physiological adaptations and accounted for approximately 10 hours per week. Given the retrospective nature of the study no attempts were made to influence the player's responses. However, all players performed standardized preparations before each match in agreement with the performance strategy of the club involved. To minimize the effects of variation, only outfield players who completed the full duration of 10 or more games throughout the season were included. Altogether, 151 individual observations of match performance were obtained with  $15 \pm 4$  games being played per player.

## Measures of technical performance

### *Paragraph 8.*

Match activity profiles were characterized using a semi-automatic computerized player tracking system (AMISCO Pro, Sport-Universal Process, Nice, France). This multiple-camera system tracks the movements and game-specific events of each player at a sampling rate of 10.0 Hz over the duration of the matches (7). The accuracy of the AMISCO Pro system in measuring player movements and game-

specific events in elite soccer competition have been described in detail elsewhere (5, 8, 12).

*Paragraph 9.*

Measures of technical performance were defined in the AMISCO Pro system and were coded by trained company match analysts. Variables examined related to individual possessions (i.e., total number and number of touches taken), tackling (i.e., number of challenges attempted and percentage success of challenges won), and passing (i.e., number of distributions, length of forward distribution [m] and percentage success of distributions). All variables were calculated for each half and across six 14:59 min intervals of match-play (i.e., 0:00-14:59 [INT<sub>1</sub>], 15:00-29:59 [INT<sub>2</sub>], 30:00-44:59 [INT<sub>3</sub>], 45:00-59:59 [INT<sub>4</sub>], 60:00-74:59 [INT<sub>5</sub>], 75:00-89:59 [INT<sub>6</sub>]). Data collected in extra time were not included in the analyses in order to facilitate comparison between matches.

Statistical analyses

*Paragraph 10.*

All statistical analyses were conducted using SPSS (Version 19.0; SPSS Inc., Chicago, IL, USA). Results are reported as means and standard deviation (mean  $\pm$  SD). Paired sampled t-tests were used to examine the effect of each half of exercise on indices of technical performance whereas one way repeated measures (within-participants factor: time period) analyses of variance (ANOVA) were used to examine the influence of timing on technical performance where there were more than two time-points (i.e., every 15-min). Mauchly's test was consulted and Greenhouse–Geisser corrections were applied where the assumption of sphericity was violated. Where appropriate, follow-up analyses were performed using Tukey



pairwise multiple comparison procedures. Statistical significance was set at  $P < 0.05$  and partial- $\eta^2$  was calculated retrospectively using commercially available software (G\*Power version 3.0.10, Universitat Kiel, Germany).

## RESULTS

Variations in technical performance between halves

*Paragraph 11.*

Match-play influenced indices of technical performance; specifically, the total number of possessions per player were reduced by  $10 \pm 7\%$  between the first and second halves ( $P=0.010$ ,  $\text{partial-}\eta^2 = 1.01$ , Table 1). Similarly, the number of distributions per player were reduced by  $11 \pm 8\%$  in the second half of match-play ( $P=0.009$ ,  $\text{partial-}\eta^2 = 1.03$ , Table 1). All other indices of technical performance remained unchanged between halves ( $P>0.05$ , Table 1).

\*\*\*\*\* INSERT TABLE 1 NEAR HERE \*\*\*\*\*

Transient changes in technical performance

*Paragraph 12.*

The number of possessions that occurred during INT<sub>6</sub> were  $20 \pm 9\%$  lower than INT<sub>1</sub> ( $P=0.020$ ,  $\text{partial-}\eta^2 = 0.330$ , Table 2). Although pass distance was consistent throughout match-play, exercise influenced passing with  $20 \pm 10\%$  fewer distributions made in INT<sub>6</sub> when compared to INT<sub>1</sub> ( $P=0.040$ ,  $\text{partial-}\eta^2 = 0.312$ , Table 2). The performance of all remaining technical actions that were analyzed were unchanged during match-play ( $P>0.05$ , Table 2).

\*\*\*\*\* INSERT TABLE 2 NEAR HERE \*\*\*\*\*

## DISCUSSION

### *Paragraph 13.*

The primary focus of this within-subjects descriptive study was to evaluate the influence of actual match-play on the technical performances of soccer players competing in the English Championship. In agreement with our hypothesis, match-play influenced the performance of some technical actions. More specifically, possession and passing performances were reduced in the second half of match-play while transient changes in indices of passing and individual possession occurred throughout exercise. This is the first study to report the influence of actual match-play on markers of technical performance in English Championship soccer players. This data is likely to be of interest to coaches and conditioning staff who are responsible for the technical preparation of soccer players.

### *Paragraph 14.*

Data from laboratory-based studies that have incorporated simulations of soccer match-play and measures of soccer skill have consistently identified that the effects of match-related fatigue manifest in the latter stages or following exercise (1, 2, 16). However, the evidence is less clear when technical actions have been evaluated during actual match-play. In the current study, the total number of individual possessions and the number of distributions performed were reduced between halves. Moreover, these measures were also reduced in the final 15 min of match-play when compared to the initial stage of the match. Consequently, in the English Championship, it appears that the demands of actual match-play influence selected soccer skills.

### *Paragraph 15.*

In variables where transient changes occurred over time (i.e., total number of individual possessions and number of distributions), the highest values were observed in INT<sub>1</sub>; a finding which is in agreement with previous authors (19). Because this was a descriptive study, the reasons for these observations are unclear; however, it has been proposed that a desire to enforce tactical superiority can result in an elevated pace of play during the initial stages of a game (19). Moreover, certain physiological changes that are associated with the warm-up that preceded INT<sub>1</sub> may have smoothed the transition from a state of rest to commencing exercise. Consequently, elevated VO<sub>2</sub> kinetics, post-activation potentiation, increased muscular temperature and the priming of neural pathways (for a review see: 4) may have afforded an ergogenic effect in the initial stages of the matches observed.

*Paragraph 16.*

Interestingly, not all of the technical actions examined in this study demonstrated a uniform response to exercise when match-play was separated into 15-min periods. These findings support those of Rampinini et al. (11) who identified that a quarter of the technical measures examined decreased from the first to the second half in Serie A players who experienced physical fatigue decrements: namely, involvements with the ball (-9%), short passes (-11%) and successful short passes (-11%). In the current study, differences between halves were identified in 2 of the 9 indices of technical performance examined. Although physical performance measures were not examined in this study, the differences observed in technical measures were of a similar magnitude (~10%) to that identified by Rampinini et al. (11). It is therefore possible that different technical actions performed in soccer vary in their susceptibility to influence from exercise. This finding supports previous work from

our laboratories whereby academy soccer players who participated in the Soccer Match Simulation (17) demonstrated reductions in measures of passing and shooting performance in the second half of exercise while the performance of dribbling remained unchanged (15). Nevertheless, the possibility that such changes were a function of the tactics employed throughout actual match-play cannot be discounted.

*Paragraph 17.*

Our findings contradict those of Carling and Dupont (6) who used a similar study design and identified that actual match-play did not influence any indices of technical performance either between halves or across six 15-min periods in French league 1 players. The precise mechanisms regulating performance throughout soccer-specific exercise remain to be established and are likely to be multifaceted in nature. Notwithstanding the influence of previously mentioned factors, such as team tactics (19) and self-pacing strategies (9), it is also plausible that the lack of agreement between studies is explained by the greater degree of variation observed in technical performance measures when compared to physical indices of performance (2, 14).

*Paragraph 18.*

It has previously been proposed that a lack of sensitivity exists in the gross measures derived from computerized time-motion analysis studies could contribute to the lack of differences previously identified over the course of a match in the skilled performance of midfield soccer players (6). However, we observed differences in the average responses of soccer players regarding their technical performances throughout actual match-play using notational analysis. It is plausible that variation in the number of games that players were involved in contributed to these contradictory findings. For example, in the current study, data is presented for players who completed the full duration of at least 10 matches throughout the 23

matches played at the home venue whereas the range of games played by the players analyzed by Carling and Dupont (6) was considerably greater (i.e., between 2 and 24 games per player).

*Paragraph 19.*

When interpreting the current findings, a number of limitations should be considered. Firstly, the physical demands of elite match-play are known to be position-specific (8) and it is plausible that such observations might also exist for technical actions. Unfortunately, because this within-subject study design was limited to one team the sample size did not permit differentiation of position-specific technical demands; nevertheless, our data supports previously published findings, especially in relation to the half-to-half variations observed (11). Secondly, data from laboratory-based studies that have investigated the effects of exercise on the performance of soccer skills have identified that the susceptibility to modification by exercise varies according to the skill being executed (15). Owing to the methods employed, the full array of technical actions performed during soccer match-play was not able to be examined. Consequently, future research opportunities exist to profile the effects of soccer-specific exercise on other technical performances. Lastly, this study was a descriptive study; therefore, it was not possible to determine the cause of temporal changes in the performance of technical actions.

## **PRACTICAL APPLICATIONS**

### *Paragraph 20.*

This study presents novel findings describing temporal patterns in the performance of technical actions of players competing in the English Championship league. Our data demonstrated that transient changes occurred in selected measures of technical performance during actual match-play; specifically, the number of individual possessions and passes performed were reduced in the second half of a game, particularly in the last 15-min. Although the current study was descriptive in nature and therefore unable to elucidate the specific reasons for these findings, these data support laboratory-based studies that have demonstrated an effect of exercise-induced fatigue on the performance of some soccer skills. Therefore, coaches and conditioning staff could use this information to inform team tactics and technical training sessions by implementing strategies that aim to minimize such occurrences (e.g., substitutions, aerobic and anaerobic conditioning programs and nutritional supplementation protocols etc.); however, the efficacy of such strategies remains to be confirmed when actual match-play is the mode of exercise used.

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## FIGURE LEGENDS

**Table 1:** Technical performance variables (Mean  $\pm$  SD) between first and second halves of match-play averaged over 23 home matches (n=10)

**Table 2:** Technical performance variables (Mean  $\pm$  SD) as a function of timing throughout matches averaged over 23 home matches (n=10)