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Technical performance during soccer matches of the Italian Serie A league: Effect of fatigue and competitive level

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Summary The purpose of this study was to examine the changes in technical and physical performance between the first and second half during official matches of Italian Serie A league. Further aim was to compare the technical and physical performance of the players of the more successful teams (ranked in the first 5 positions) with the players of the less successful teams (ranked in the last 5 positions) from the same league. A total of 416 individual games from 186 soccer players (27 ± 4 years, 76 ± 5 kg, and 181 ± 5 cm) were analysed using a video match-analysis system. The match performance parameters analysed were: total distance covered (TD), high-intensity running distance (HIR), very high-intensity running distance (VHIR), total distance with the ball (TDB), high-intensity running distance with the ball (HIRB), and very high-intensity running distance with the ball (VHIRB). The number of skill involvements was also measured. The players from the more successful teams covered greater TDB and HIRB and also had more involvements with the ball, completed more short passes, successful short passes, tackles, dribbling, shots and shots on target compared to the less successful teams ($P < 0.01$). A significant decline ($P < 0.01$) between the first and second half was found for both physical performance and some technical scores (involvements with the ball, short passes and successful short passes). This study showed a decline in technical and physical performance between the first and second half, and that both physical performance and technical skills were different between players from more successful and less successful teams.

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Introduction

Technical and tactical abilities are considered important for success in soccer. However, while many studies have analysed physical soccer performance using manual or computerised video match-analysis systems,[1–11] very few studies have investigated the technical performance of professional soccer players.[12–14] Several studies have shown a decrement in physical performance during the match. In particular, some studies have shown that high-intensity running and sprinting decrease between the first and second half.[3,15] This decline in physical work has been linked to match-related physical fatigue.[3,10,16,17] A recent study examining English Premier League soccer players has also shown that only players who completed the greatest amount of physical activity in the first half experienced decreased physical performance in the second half.[18] Similar results have been also reported for English Premier League soccer referees.[19] However, while there is evidence that match-related fatigue may lead to a decline of physical performance within match, no studies have examined if there is also a decrease in technical (i.e. skill-related) involvements between the first and second half. A study by Helgerud et al.[20] have shown an increase in the involvements with the ball and a decrease in unsuccessful passes after 8 weeks of aerobic interval training. Their findings suggest a link between physical fitness and the fatigue-induced worsening of some technical skills.

It has been previously shown that physical match performance is different between professional soccer players of dissimilar competitive levels.[3] Mohr et al.,[3] reported that top-class soccer players from the Italian Serie A league covered more total distance, high-intensity running distance and sprinting distance compared to professional players competing in the Danish Professional League. While a previous study have investigated the differences in physical capacities between players of the best and worst team within the same league,[21] to the authors' knowledge, no studies have examined the relationships between physical performance during the match and team success amongst a homogenous group of professional soccer players competing within the same national league. Similarly, despite the common belief that technical abilities are important for soccer performance, no studies have examined whether skill-related measures collected during actual match play are different between the players of the more successful teams from their less successful counterparts.

Therefore, the aims of this study were: (1) to verify if a decrease in the technical scores other than physical performance can be detected between the first and second half, and (2) to examine the differences in physical and technical performance between players from the more successful teams (ranked in the first 5 positions of the league) and less successful (team ranked in the last 5 positions of the league) teams during the 2004–2005 Italian Serie A league.

Methods

Data were obtained from 416 individual matches from 186 soccer players (age: 27 ± 4 year, body mass: 75.9 ± 5.3 kg, and height: 1.81 ± 0.05 m) from 18 Serie A teams were collected. For this study the players were classified into three categories to assess each of the aims of the study. First of all, the player's data were divided in two subsets according to the final rank of their teams within the Serie A at the end of the season. Individual data of the players from the five highest ranked teams were classified as the 'More Successful' group ($n = 197$) and the individual data of the players from the five lowest ranked teams were classified as the 'Less Successful' group ($n = 166$). Assuming the decrement in physical performance as an indicator of match-related fatigue, each player's technical score data (skill-related involvements during each match) were also divided in two categories based on the fatigue condition and irrespective to the final rank of their teams: higher fatigue and lower fatigued on the basis of their change in HIR during the match. The criteria for determining these conditions was based upon the reliability of the video match-analysis system SICS® (Bassano del Grappa, Italy) for measuring HIR. We have previously shown that the typical error as a coefficient of variation (CV) for HIR using this system was 3.2% ($n = 5$; trials = 2; 95%CI = 1.9–9.2%).[22] Therefore, a value of 8.9% was set as the criteria for the fatigue condition. Given the small sample size of the pilot study, we calculated the the minimal detectable change using the more stringent 95% confidence interval (i.e. CV 2.77).[22] Specifically, the individual data of the players who demonstrated a decrement in HIR > 8.9% during the second half were included in the 'higher fatigue' category ($n = 187$), and the individual data of the players who were able to complete more HIR in the second half (increase in HIR above 8.9%) were included in the 'lower fatigue' category ($n = 97$). The study was approved by the Independent Institutional Review Board of MAPEI Sport Research Centre according to

the Guidelines and Recommendations for European Ethics Committees by the European Forum for Good Clinical Practice.

Each match was monitored using a computerised, semi-automatic video match-analysis system [data were supplied by SICS® (Bassano del Grappa) with formal permission]. This method uses six cameras (three for each side of the pitch) and allows collection of the match-analysis data of all the players involved in the game. The objective measures of match performance used for the analysis were: (1) total distance covered (TD); (2) high-intensity running distance (running speed > 14 km h^{-1}, HIR); (3) very high-intensity running distance (running speed > 19 km h^{-1}, VHIR); (4) total distance with the ball (TDB); (5) high-intensity running distance with the ball (running speed > 14 km h^{-1} with the ball, HIRB); (6) very high-intensity running distance with the ball (running speed > 19 km h^{-1} with the ball, VHIRB). In a pilot study the accuracy expressed as typical error of this video match-analysis system was 3.6% for HIR ($n = 5$; 95%CI = 2.6—10.3%) and 1.0% for TD ($n = 5$; 95%CI = 0.6—2.9%).

Technical data from each match was also supplied by the SICS System (SICS®, Bassano del Grappa). The frequency of involvements for the following skills was collected during each match:

1. Involvements with the ball: number of situations where the player is in contact with the ball; if the player touched the ball more than once before releasing or losing it then this was recorded as one involvement with the ball.
2. Short passes: number of short foot passes (length < 37 m) performed by a player.
3. Successful short passes: number of short foot passes (length < 37 m) performed by a player and successfully received by another player of the same team.
4. Long passes: number of long foot passes (length > 37 m) performed by a player.
5. Successful long passes: number of long foot passes (length > 37 m) performed by a player and successfully received by another player of the same team.
6. Crosses: number of long foot passes performed by a player from an offensive zone (last 40 m of pitch between the short side of the penalty area and the lateral side of the field) and direct to the penalty area.
7. Headers: number of times where a player is in contact with the ball with his head.
8. Tackles: number of situations where a player contests the ball with an opponent player and involved physical contact.
9. Dribbling: number of situations where a player tries to overcome another player with the ball possession.
10. Shots: number of attempts to score.
11. Shots on target: number of attempts to score within the goal.

Statistical analyses

Data are presented as the mean ± standard deviation (s). Before using parametric statistical test procedures, the assumptions of normality and sphericity were verified. Differences between the players from the more successful and less successful teams were determined using unpaired *t*-tests. Differences between the first and second half were determined using Student's paired *t*-test. A two-way (2×2 design) analysis of variance (ANOVA) was used on each dependent variable (technical parameters) to examine the effect of 'fatigue' condition on technical indices (dependent variables). The independent variables included one between-subject factor (fatigue condition) with two levels (higher fatigue and lower fatigue), and one within-subjects factor (time) with two levels (first and second half). A mixed two-way ANOVA was also used to examine the effect of level on fatigue. The independent variable included one between-subject factor (competitive level), with two level (more successful and less successful), and one within-subject factor (half), with two levels (first half and second half). To control for type I error a pseudo-Bonferroni adjustment was applied dividing the *P* level by the number of dependent variables families[23]: (1) physical performance without the ball (TD, HIR, VHIR), (2) physical performance with the ball (TDB, HIRB, VHIRB), (3) interactions with the ball (involvements, tackles and dribbling), (4) ball transmissions (short and long passes, crosses and headers) and (5) attempts on goal (shots). Thus, an operational α level of 0.01 ($P < 0.05/5$) was used for *F* values. When a significant *F* value was found, Bonferroni's post hoc tests were applied. The level of statistical significance was set at $P < 0.05$.

Results

The players from less successful teams completed more physical work compared to the players from the more successful teams players (Table 1, $P < 0.01$). Specifically, the players from the less successful teams covered more TD (+4%), HIR (+11%) and VHIR (+9%). In contrast, players in the more successful group covered more TDB (+18%) and

Table 1 Differences in physical and technical performance during official matches among top-level soccer players of the most successful (1—5 in the final ranking) and the less successful teams (15—20 in the final ranking)

Variables	Most successful teams (individual data, $n = 197$)	Less successful teams (individual data, $n = 130$)	Difference mean value	Difference 95%CI
Physical data (*m*)				
Total distance	11647	12190	543	285 to 801
High-intensity running	3787	4263	476	228 to 722
Very high-intensity running	1196	1309	113	14 to 210
Total distance with the ball	540	443	−97	−135 to −8
High-intensity running with the ball	299	251	−48	−74 to −21
Very high-intensity running with the ball	127	109	−18	0 to −35
Technical data (*n*)				
Involvement with the ball	44.7	34.5	−10.2	−13.3 to −7.0
Short passes	27.7	19.1	−8.6	−11.3 to −5.9
Short successful passes	25.7	17.8	−7.9	−10.5 to −5.4
Percentage of successful short passes	92.5	92.6	0.1	−1.9 to 1.7
Long passes	4.4	3.7	−0.7	−1.6 to 0.2
Successful long passes	3.0	2.5	−0.5	−1.2 to 0.3
Crosses	1.4	1.0	−0.4	−6.9 to 10.3
Headers	2.5	2.2	−0.3	−0.7 to 0.4
Tackles	1.6	1.0	−0.6	−0.8 to 0.3
Dribbling	1.0	0.5	−0.5	−0.9 to −0.3
Shots	1.8	1.2	−0.6	−0.9 to −0.2
Shots on target	0.9	0.5	−0.4	−1.1 to −0.2

HIRB (+16%) compared to the less successful group ($P < 0.01$). The VHIRB distance covered by the players of the most successful teams was greater ($P = 0.04$) than the players of the less successful teams but was not lower than the adjusted alpha level after Bonferroni's correction ($P < 0.01$). Involvements with the ball, short passes, successful short passes, tackles, dribbling, shots and shots on target were higher in the more successful group than in the less successful group. No difference was also found in percentage of successful short passes. No significant differences were found for VHIRB and for the other technical scores ($P > 0.16$).

Players, irrespective to the final rank of their teams, covered more TD, HIR and VHIR in the first half compared to the second half (+2%, +7% and +7%, respectively) (Table 2, $P < 0.01$). Similarly, TDB and HIRB were higher in the first than in the second half (+5% and +9% respectively). VHIRB did not change from the first to the second half ($P > 0.05$). Only three technical measures decreased from the first to the second half (Table 3, $P < 0.01$): involvements with the ball (−9%), short passes (−11%) and successful short passes (−11%). All the other technical parameters remained similar ($P > 0.05$). The percentage of successful short passes did not decrease in the second half.

Significant fatigue condition × time interactions were found for involvement with the ball ($P = 0.004$), short passes ($P = 0.005$) and successful short passes ($P = 0.003$). In the higher fatigue group the number of involvement with the ball, short passes and successful short passes decreased from the first to second half [from 20.7 ± 8.5 (CI = 12.9 to 30.1) to 18.2 ± 7.9 (CI = 11.0 to 26.9), from 12.4 ± 7.4 (CI = 5.7 to 20.6) to 10.5 ± 6.7 (CI = 4.4 to 17.9) and from 11.5 ± 7.0 (CI = 5.1 to 19.2) to 9.7 ± 6.4 (CI = 3.9 to 16.8), respectively]. However, the same technical parameters did not change between the first and second half in the lower fatigue group: 18.8 ± 7.1 (CI = 12.6 to 27.0) to 18.6 ± 6.7 (CI = 12.7 to 26.4) for involvement with the ball; 10.3 ± 6.1 (CI = 4.9 to 17.4) to 10.2 ± 5.6 (CI = 5.3 to 16.7) for short passes; and 9.5 ± 5.7 (CI = 4.5 to 16.1) to 9.5 ± 5.5 (CI = 4.7 to 15.9) for successful short passes. No significant interactions were found in the other dependent variables ($P > 0.16$). The percent of successful short passes did not change between the first and second half in the higher fatigue group (92.7% and 92.4%, respectively). Similarly, no changes were found in the percent of successful short passes between the first and second half in the lower fatigue group (92.2% and 93.1%, respectively).

Table 2 Differences between first and second half in physical and technical performance during official soccer matches of the Italian Serie A ($n = 416$)

Variables	First half	Second half	Difference mean value	Difference 95% CI
Physical data (*m*)				
Total distance	5966	5862	−104	−145 to −61
High-intensity running	2038	1909	−129	−176 to −83
Very high-intensity running	633	591	−42	−66 to −18
Total distance with the ball	250	237	−13	−22 to −3
High-intensity running with the ball	142	130	−12	−19 to −5
Very high-intensity running with the ball	60	55	−5	−9 to 1
Technical data (number)				
Involvement with the ball	20.4	18.7	−1.7	−2.4 to −1.0
Short passes	12.0	10.8	−1.2	−1.8 to −0.7
Successful short passes	11.1	10.0	−1.1	−1.6 to −0.5
Percentage of successful short passes	91.6	91.3	0.3	−2.2 to 1.5
Long passes	2.2	1.9	−0.3	−0.5 to 0.1
Successful long passes	1.4	1.3	0	−0.3 to 0.1
Crosses	41.8	42.8	1.0	−3.9 to 5.9
Headers	0.6	0.6	−0.1	−0.1 to 0.1
Tackles	1.3	1.2	0	−0.3 to 0.1
Dribbling	0.7	0.7	−0.1	−0.1 to 0.2
Shots	0.4	0.3	−0.1	−0.1 to 0.1
Shots on target	0.7	0.7	0	−0.1 to 0.1

No influence of competitive level on the decrement in technical scores between the first and second half were found (interactions, $P > 0.05$). This indicated that the decline in technical scores was not different between the players of the most successful and the players of the less successful teams.

Discussion

Technical and tactical abilities are widely considered to be important determinants of soccer performance. While high physical fitness allows the player to remain involved with the play and to perform more high-intensity activities,[16,20,24,25] the overall performance in soccer matches is usually determined by the technical or skill-related abilities of the players. Despite this, most previous match-analysis studies have only investigated the physical performance of soccer. It is well known that fatigue reduces the ability to perform physical work during a soccer match. Indeed, recent studies have shown both that the amount of high-intensity running and sprinting decline as a soccer match progresses.[3,15,18] In agreement with these studies, the present findings demonstrated that the distances performed with and without the ball (except VHIRB) decrease during the match. A new important finding of this study, however, is that there was also a decrease in several measures of technical skills during a match.

The decline in high-intensity activity between the first and second half is probably related to match-related fatigue.[3,10,16,17] Indeed, a recent study has shown that players of the English Premier League that covered less distance at high-intensity in the first half were able to cover more distance in the second half.[18] In the present study, the players in the higher fatigue group had a decrease in their involvements with the ball as well as a decrease in the total number of short passes and number of successful short passes. However we also observed that the lower fatigue group did not suffer a decline in these same technical scores. Combined, these results suggest that match-related fatigue may influence a player's technical ability for completing short passes during a match. However, the percentage of successful short passes remained unchanged across halves also splitting the data in lower and higher fatigue groups. Therefore, when taken collectively, the present results suggest that match-related fatigue has a greater influence on a player's ability to get involved with the ball than it does on player's skill proficiency.

The present results show that the players from the more successful teams covered less distances at all speed range categories compared to the players from the less successful counterparts. Most notably, the players from the more successful teams com-

pleted more physical work when in possession of the ball (TDB and HIRB) than the players from the less successful teams. These results are in contrast with previous research that reported that top level Italian players performed more high-intensity activity than lower level professional players participating in the Danish League.[3] The major difference between these two studies is that all players that were involved in the present study competed in the same national league in the same season. On the contrary, Mohr et al.,[3] compared the match-related physical performance measures between teams from separate leagues. Nonetheless, the present results further extend the previous research[3] and show that not only the ability to compete at high-intensity during a match, but also the ability to have greater involvements with the ball and complete more skill-related activities is important to be successful in top level professional soccer. Interestingly, the specific technical skills (involvements with the ball and short passes) that decreased in the second half were also the skills that resulted different between the players from the more successful and from the less successful teams. Although potential influences of team tactics should be taken into account, our results suggest that the more relevant technical skill parameters for success in top level professional soccer are: involvements with the ball, short passes, successful short passes, tackles, dribbling, shots and shots on target.

Not only player technical abilities but also decision-making, game intelligence and team tactics are important factors that might influence the execution of technical tasks.[26] In this study we are unable to determine whether the observed changes in technical measures were due to changes in factors such as cognitive function, local muscular fatigue, strength or endurance capacity. Furthermore, as the analyses were completed on players during actual match play, the results reflect the interaction between all the players involved in the games. Therefore, we suggest that more controlled studies should examine the effect of soccer-match related fatigue on specific technical skills, physical fitness and cognitive functions in isolation.

In conclusion, this study demonstrates for the first time that some technical skills decrease between the first and second half of official matches probably as a consequence of physical fatigue. Furthermore, some technical skill measures taken during match play (involvements with the ball, short passes, successful short passes, tackles, dribbling, shots and shots on target) are different between the players from more successful top level professional soccer teams compared to less successful teams competing in the same league.

Practical applications

- It is useful to identify the most relevant technical skills for soccer players and to identify the specific drills that might be more effective for the success during matches.

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