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## Relationships between technical and physical match performance in elite soccer

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## Abstract

**Introduction:** The purpose of this study was to investigate the potential associations between physical and technical match performance and to compare these activities in relation to the match outcome. **Materials and methods:** The research was based on an analysis of 622 matches of the Polish Ekstraklasa during three consecutive seasons. Such variables as total distance, distance covered in different speed zones, effective playing time, ball possession, number of passes and passing accuracy were taken into account. **Results:** Effective playing time ( $E_t$ ) was significantly and fairly correlated with total distance ( $r = 0.39, p < 0.001$ ), ball possession ( $r = 0.50, p < 0.001$ ), number of passes ( $r = 0.40, p < 0.001$ ), number of accurate passes ( $r = 0.43, p < 0.001$ ) and passing accuracy ( $r = 0.42, p < 0.001$ ). The comparison of the match performance according to the game outcome indicated that the total and sprinting distance covered by winning teams were significantly ( $p < 0.01$ ) longer than in losing teams (113.3 vs 112.7 km). In turn, the defeated teams had significantly greater ball possession (28.3 vs 26.4 mins) and performed a larger number of passes (470 vs 428) than the winning teams. **Conclusions:**  $E_t$  is one of the factors influencing the physical and technical match performance. Coaches should be aware that their team will have to cover a longer distance when playing against teams that prefer to keep the ball.

## Keywords

soccer, time-motion analysis, effective playing time

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## Article

## Relationships between technical and physical match performance in elite soccer

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**Abstract:** Introduction: The purpose of this study was to investigate the potential associations between physical and technical match performance and to compare these activities in relation to the match outcome. Materials and methods: The research was based on an analysis of 622 matches of the Polish Ekstraklasa during three consecutive seasons. Such variables as total distance, distance covered in different speed zones, effective playing time, ball possession, number of passes and passing accuracy were taken into account. Results: Effective playing time ( $E_t$ ) was significantly and fairly correlated with total distance ( $r = 0.39$ ,  $p < 0.001$ ), ball possession ( $r = 0.50$ ,  $p < 0.001$ ), number of passes ( $r = 0.40$ ,  $p < 0.001$ ), number of accurate passes ( $r = 0.43$ ,  $p < 0.001$ ) and passing accuracy ( $r = 0.42$ ,  $p < 0.001$ ). The comparison of the match performance according to the game outcome indicated that the total and sprinting distance covered by winning teams were significantly ( $p < 0.01$ ) longer than in losing teams (113.3 vs 112.7 km). In turn, the defeated teams had significantly greater ball possession (28.3 vs 26.4 mins) and performed a larger number of passes (470 vs 428) than the winning teams. Conclusions:  $E_t$  is one of the factors influencing the physical and technical match performance. Coaches should be aware that their team will have to cover a longer distance when playing against teams that prefer to keep the ball.

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**Keywords:** soccer, time-motion analysis, effective playing time.

### 1. Introduction

Analysis of match performance is one of the basic instruments commonly used by coaches at every level of sport competence. Currently available technologies, such as Global Positioning System (GPS) devices or video tracking systems, allow for accurate evaluation of both physical and technical-tactical performance. In the last two decades numerous authors have investigated the topics concerning match performance analysis [1–3]. Each research contributes to a better understanding of the game and indicates the directions of potential soccer evolution.

Numerous former studies have examined the time-motion performance during soccer matches. Some of these papers have analyzed the kinematic changes during the match [4–8]. Results presented in these papers concordantly indicated that due to increasing fatigue distance covered in the second half is significantly shorter in comparison with the first half. Moreover, numerous authors reported match performance according to playing position [1, 7], where significant differences were stated as well.

Searching for factors influencing match performance is another important scientific topic. Detecting potential determinants could greatly help in understanding the game demands. Andrzejewski et al. [9] indicated the importance of considering the match outcome in the assessment of physical aspects of soccer performance. Moreover, Castellano et al. [10] found that the distance covered by players is greater when playing at home, when the reference team is losing and when the level of the opposite team is higher. Another factor possibly influencing the physical performance is players' age. Rey et al. [11] demonstrated that running performance reduces with increasing age. Furthermore, Lorenzo-Martinez et al. [12] found that stability of physical performance is determined by players' age. Players' physical fitness was considered as a factor influencing the running performance during the game. Although some studies [5] suggested that match running performance does not depend on the maximal oxygen uptake ( $VO_{2max}$ ), other researchers [13, 14] showed that players' aerobic capacity is significantly correlated with high-intensity performance during official matches. Moreover, the significant relationship between the percentage of fat mass and high-speed running and sprinting distance was previously observed as well [13].

Technical performance assessment usually involves such variables as passes, headers, tackles, dribbling, shots and more general data such as ball possession or effective playing time [15, 16]. Most authors present results as activity (total number of actions) and accuracy (% of successful actions). Recent studies of Konefał et al. [17, 18] comprehensively analyzed the technical activity of the German Bundesliga players. Authors found that such activities as passes, duels, shots and crosses may differ according to the playing position even in one formation. Moreover, the significant influence of the match outcome on technical performance was exhibited as well. Analysis of three consecutive seasons demonstrated evolution of some technical parameters consisting in an increasing number of passes and a reduced number of duels. Modrić et al. [19] in their study identified associations between running performance and game performance in professional Croatian soccer players. They indicated that such variables as the number of accelerations or decelerations and the distance covered in different speed zones affect successful performance in soccer for some playing positions. All the above-mentioned studies proved that the topic of different forms of game analysis has been extensively investigated. Nevertheless, more research with a holistic approach is still needed to improve an understanding of the most important aspects of performance [20, 21].

In view of the above, the main purpose of this study was to investigate possible relationships between physical performance and selected technical variables like ball possession, number of passes and passing accuracy. Furthermore, the match performance of winning, drawing and losing teams was compared as well.

## 2. Materials and Methods

### 2.1. Design and Procedures

This observational retrospective study concerned the physical and technical performance of the Polish Ekstraklasa soccer teams across 3 consecutive seasons. 124 games from season 2017/2018, 290 matches from season 2018/2019 and 208 games from season 2019/2020 were analyzed. The matches played after the pandemic lockdown in season 2019/2020 were excluded from the analysis. This study was conducted in accordance with the Declaration of Helsinki and meets the ethical standards.

### 2.2. Data Collection

Data of the physical performance were obtained from the previously validated [22] TRACAB optical video tracking system (ChyronHego, NY, USA). Such physical performance parameters as the total distance (TD), low-intensity running (LIR,  $2-4 \text{ m}\cdot\text{s}^{-1}$ ), running ( $4-5.5 \text{ m}\cdot\text{s}^{-1}$ ), high-speed running (HSR,  $5.5-7 \text{ m}\cdot\text{s}^{-1}$ ) and sprinting ( $>7 \text{ m}\cdot\text{s}^{-1}$ ) were measured. Moreover, this system provided the data of effective playing time ( $E_t$ ), which was defined

as the duration of play after subtracting the time taken up by all stoppages – when the ball was out of play (injuries, substitutions, VAR interventions, etc.) [10]. Furthermore, such technical performance parameters as ball possession, the number of passes and passing accuracy data were received from the InStat video analysis system.

### 2.3. Statistical Analysis

All data sets were assessed using the Shapiro-Wilk test for normal distributions. Levene's test was used to evaluate the homogeneity of variances. One-way ANOVA was used to determine the significance of differences between the data of winning, drawing and losing teams. When ANOVA results were significant, post-hoc analyses using the Honest Significance Difference (HSD) Tukey test was performed to indicate eventual differences. In case of a lack of normality of distribution, the Kruskal-Wallis H test was applied. Moreover, to determine the possible relations between variables, Pearson's correlation was calculated. The level of correlation was fixed in the following categories: very strong ( $r \geq 0.80$ ), moderately strong ( $r = 0.60-0.79$ ), fair ( $r = 0.30-0.59$ ) and poor ( $r \leq 0.29$ ) [23]. The significance level was set at  $p < 0.05$ . All calculations were performed using Statistica 13.0 software (TIBCO Software Inc, 2017).

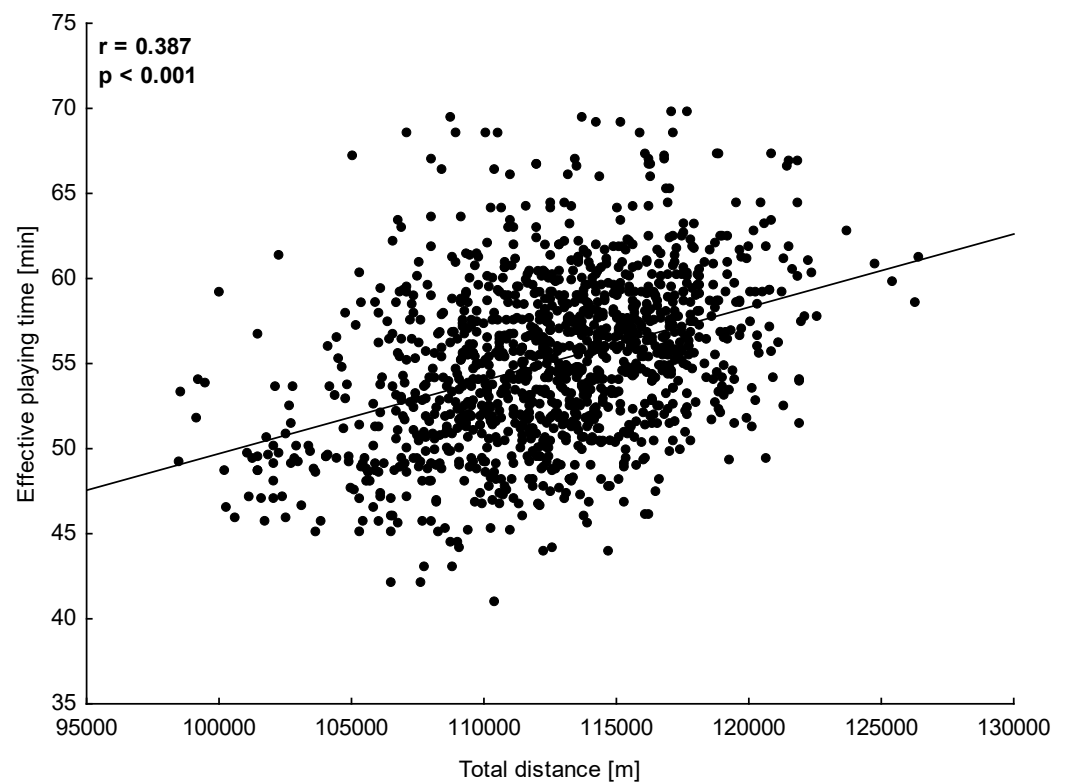
### 3. Results

The average effective playing time during the analyzed seasons was  $55.1 \pm 4.94$  minutes, which corresponds to 56.96% of the total match duration. Calculation of Pearson's correlation indicated that  $E_t$  was fairly and significantly related with such physical variables as TD ( $r = 0.39, p < 0.001$ ) and LIR ( $r = 0.45, p < 0.001$ ). Interestingly, the total time of the game was not significantly correlated with  $E_t$ , ball possession or the number of passes. HSR and sprinting distance were not significantly correlated with any of the technical performance variables. Further analysis exhibited that  $E_t$  was significantly and fairly related with the ball possession ( $r = 0.50, p < 0.001$ ), number of passes ( $r = 0.40, p < 0.001$ ), number of accurate passes ( $r = 0.43, p < 0.001$ ) and passing accuracy ( $r = 0.42, p < 0.001$ ) (Tab. 1). Moreover, the comparison of the match performance according to the game outcome showed that the total and sprinting distance covered by winning teams was significantly ( $p < 0.01$ ) longer than in losing teams. In contrast, the defeated teams had significantly greater ball possession and performed more passes than the winning and drawing teams (Tab. 2).

**Table 1.** Correlations between effective playing time and selected physical and technical performance variables.

	LIR	Ball possession [min]	Number of passes	Number of accurate passes	Passing accuracy [%]
$E_t$ [min]	$r = 0.45$ $p = 0.000$	$r = 0.50$ $p = 0.000$	$r = 0.40$ $p = 0.000$	$r = 0.43$ $p = 0.000$	$r = 0.42$ $p = 0.000$

*LIR – low-intensity running ( $2-4 \text{ m}\cdot\text{s}^{-1}$ ),  $E_t$  – effective playing time*



**Fig. 1.** Correlation between effective playing time and the total distance covered by teams from the Polish Ekstraklasa.

**Table 2.** Physical and technical match performance with reference to the match outcome.

	W	D	L
Total distance [m]	113307 ± 4213**	112719 ± 4042*	111880 ± 4643
LIR [m]	44577 ± 3049	44360 ± 3014	44115 ± 3285
Running [m]	17998 ± 1680	18064 ± 1694	18134 ± 1799
HSR [m]	7121.3 ± 770.6	6995.6 ± 758.1	6986.1 ± 812.5
Sprinting [m]	1798.7 ± 371.2**	1739.0 ± 336.0	1695.4 ± 360.7
Number of HIR	602.6 ± 57.9*	596.4 ± 55.4	592.2 ± 61.3
Ball possession [min]	26.39 ± 4.78 <sup>††</sup>	26.88 ± 4.72 <sup>††</sup>	28.25 ± 4.96
Number of passes	428.35 ± 78.07 <sup>††</sup>	444.5 ± 83.2 <sup>††</sup>	466.7 ± 80.0
Passing accuracy [%]	79.0 ± 4.5	78.8 ± 4.5 <sup>††</sup>	80.1 ± 4.0

W – winning team, D – drawing team, L – losing team, LIR – low-intensity running ( $2\text{--}4\text{ m}\cdot\text{s}^{-1}$ ); HSR – high-speed running ( $5.5\text{--}7\text{ m}\cdot\text{s}^{-1}$ ), HIR – high-intensity runs

\*significantly higher than L at  $p < 0.05$ ; \*\* significantly higher than L at  $p < 0.01$ ;

<sup>††</sup> significantly lower than L at  $p < 0.01$ ;

#### 4. Discussion

The current study investigated relationships between physical and technical performance in professional soccer and compared match activity according to the game result. The significant positive correlation between  $E_t$  and physical performance (TD and LIR) reported in this paper suggests that the “ball in play” time is one of the crucial determinants of the running volume during a soccer match. Moreover, a comparison the data with reference to the game outcome indicated greater physical performance in winning teams, while the level of technical activity was higher in losing teams.

Paul et al. [21] in their commentary paper suggested that match running performance is dependent on such factors as fatigue, pacing, contextual and tactical variables. Furthermore, Lago-Peñas et al. [24] previously emphasized that  $E_t$  should be taken into account when analyzing physical performance in elite soccer. The results of the current study suggest that  $E_t$  could be another factor influencing the distance covered during the game. Longer periods of the time when the ball is in play (without any game interruptions) require continuous movement from the players. Moreover,  $E_t$  was positively related with ball possession and other technical activities. Therefore, it can be stated that if teams perform a large number of accurate passes during the game and  $E_t$  is relatively long, the distance covered by the players will be greater. Recently, Zhao and Zhang [25] indicated that occurrence of such interruptions as goals, corner kicks, fouls, yellow and red cards negatively affects the  $E_t$ , and consequently, the physical match performance might be reduced as well.

Analyzing data according to the game result showed that the distance covered in HSR, sprinting and in general was significantly longer in winning than in losing teams. Previous studies investigating the associations between the match outcome and physical performance reported ambiguous results. Clemente et al. [26] analyzed the time-motion characteristics of Spanish teams according to their competitive level. They found that there were no large differences in match running performance between successful and unsuccessful teams. Similarly, Hoppe et al. [27] established that the distance covered at different speeds alone is not an important factor for achieving success in German Bundesliga soccer teams. However, a significant positive correlation between match running with ball possession and the final number of accumulated points was revealed in this study. Contrary to the studies mentioned above, our results suggest that in the Polish Ekstraklasa winning teams cover longer TD, sprinting distance and a larger number of high-intensity runs in comparison with losing teams. These differences could probably be caused by a different level of soccer specific skills in the analyzed leagues. It seems to be justified that teams with lower technical and tactical potential need to perform more physical work to be successful. In line with our research, Zhou et al. [28] showed that, among others, the total distance, high-speed distance and sprinting distance could exert a significant effect on winning the game in the Chinese Soccer Super League. Andrzejewski et al. [9] reported that these relations may differ according to the playing position. Furthermore, Chmura et al. [29] found that wide midfielders and forward players cover a significantly longer distance at higher intensities in winning games when compared with drawn or lost matches. Interestingly, in the same study, full-backs, central defenders and central midfielders were running less in winning games. Analysis of the match activity profile of goalkeepers indicated that a larger number of running and sprinting actions was registered during won games [30].

There is no agreement between researchers about the influence of technical variables on the match outcome. In our study, the detailed analysis of technical performance emphasized that losing teams executed significantly more passes and had higher ball possession when compared with drawing and winning teams. The data presented above are in line with previous research of Lago and Martin [30] and may indicate that teams after scoring a goal and obtaining an advantage could be more concentrated on defensive play and allow losing teams to keep the ball. In this situation defensive players of winning teams are less involved in offensive actions while offensive players are running more to

disrupt the opposite team during building their actions. Bradley et al. [32] analyzed the physical and technical performance of English Premier League players regarding the high or low percentage of ball possession. In contrast to our results, they established that there were no significant differences in total and high-intensity running distance between teams with higher and lower ball possession. This might indicate that higher ball possession by itself does not determine the running performance during the game. Zhou et al. [28] found that a larger percentage of ball possession is related with winning the match in the Chinese Soccer Super League. The opposite conclusions were presented by Kubayi and Toriola [33], who found that in the South African Premier Soccer League defeated teams had higher ball possession (53.35%) in comparison with winning teams (47.65%). These results were confirmed in the current analysis of the Polish Ekstraklasa, where losing teams had significantly longer ball possession in comparison with drawing and winning teams (28.3, 26.9 and 26.4 mins, respectively). The differences between the leagues could be explained by various styles of play typical of each national league. In some countries, teams prefer to keep the ball when winning, while elsewhere the tactic based on giving the ball to the opponent and waiting for counterattack may be more common. All the cited above papers clearly indicate that future research is essential for a better understanding of the potential influence of the technical performance on the match outcome in professional soccer.

Despite novel data, this study contains some limitations. Analyzing a larger number of technical variables (e.g. scored goals, shots, duels etc.) could provide interesting and practical findings. Moreover, due to the holistic approach presented in the current research, the data was not reported according to the playing position. Such analysis could demonstrate potential differences between players from different formations.

## 5. Conclusions

This study examined the potential relationships between physical and technical match performance in elite soccer teams with reference to the game result. The main finding of the current research is that physical match performance in professional soccer players is significantly associated with effective playing time. Furthermore, the comparison of the data according to the match outcome indicated that winning teams covered significantly longer total distance and longer sprinting distance than losing teams. Interestingly, the highest ball possession, passing accuracy and the greatest number of passes were reported for the unsuccessful teams.

Coaches should be aware, that their team will have to cover a longer distance when playing against teams that prefer to keep the ball and perform a large number of passes. Moreover, the level of physical fitness that allows covering longer total distances and longer distances at highest intensities could be an important factor increasing a chance to obtain the positive result of the game.

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