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# Physical Match Running Performance Indicators in Professional Greek Footballers Competing in a National League: A Two-Consecutive-Period Survey (2021/22 and 2022/23)

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Abstract: Modern football demands a series of dynamic and unpredictable movements. This study aimed to assess changes in the physical performance of players across two consecutive periods (2021/22 and 2022/23) and evaluate their levels according to field position and match outcome. Fifty players from one team of the National Greek League-2, a new institution in Greek football, participated in this study. Data from 672 measurements of physical performance were collected using Global Positioning System (GPS) during 58 matches. The measurements included Total Distance (TD), High-Speed Running (HSR), Very High-Intensity Speed Running (VHS), Maximal Sprining (MS), Distance/Time (D/T), High Metabolic Load Distance (HMLD), sprints and accelerations-decelerations. Nonparametric tests were used for evaluation. The players had a mean age of 20.5±1.1yrs. Defenders and midfielders accounted for 44.0% of the study subjects, with the majority of the 672 measurements (23.8%; k=160) were recorded in April. Almost all measurements showed a decrease in 2022/23 compared to 2021/22 (p<0.05), or were lower when the match outcome was a defeat compared to a draw/win (p<0.05). Defenders covered a greater mean TD (8236meters) than midfielders/forwards (7426 & 7255meters) (p=0.006) and had higher mean participation time (p<0.001). Midfielders demonstrated greater mean measurements of VHS, MS, HMLD, and sprints compared to defenders/forwards (p<0.05). The findings indicate that the time period, filed position, and match outcome significantly impact GPS measurements. These factors should be considered when planning and preparing teams for the league season.

*Keywords:* Football; Global Positioning system (GPS); physical performance; match; total distance; High speed running.

# I. INTRODUCTION

Modern football is a complex sport characterized by dynamic and unpredictable movements, including high-speed actions like acceleration, jumping, and changing direction. The physical and technical demands of the sport have significantly increased in recent years (Smpokos et al., 2019). During official matches players are cumulatively exposed to high energetic

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load and heavy physical demands, which resulting regularly in severe musculoskeletal injuries (Smpokos et al., 2019). At the same time, the burden from multiple official competitions appears to lead to an increase risk of serious injuries and, consequently, to surgical operations (Eirale et al., 2013; Grassi et al., 2020; Walker et al., 2007; Wong & Hong, 2005).

Numerous studies have examined the running demands of official football matches over the past two decades (Asian Clemente et al., 2019; Mohr et al., 2003; Rampinini et al., 2007). These studies have explored various factors, like the total distance covered by players based on their positions (Di Salvo et al., 2009), match outcomes (Andrzejewski et al., 2016), and physical fitness (Redkva et al., 2018). Some researchers have also investigated the evolution of match performance in specific leagues. For example, Barnes and colleagues (Barnes et al., 2014) analyzed changes in physical parameters in the English Premier League over a span of seven years, observing an increase in high-intensity running and sprinting distance. Zhou and colleagues (Zhou et al., 2021) reported changes in technical and physical performance during official matches in the Chinese football Super League, including an increase in high-speed running and sprinting.

Match outcomes-whether a win, draw, or loss-may also influence players' physical performance. Elite international female football players were found to cover a greater total distance and perform more sprints when winning compared to when drawing or losing (Trewin et al., 2018). Other factors, such as the current score, player substitutions, fatigue, and weather conditions can also impact performance within each match. Over the course of a season, and from one season to another, factors like team ranking, changes in coaching staff, and player injuries can affect the technical and physical performance of the team (Morgans et al., 2023). However, there is limited scientific research on the physical performance of Greek Super League 2 teams across consecutive seasons, especially considering the introduction of B-teams.

Therefore, the aim of this study is to assess changes in the physical performance of football players over two consecutive periods (2021/22 and 2022/23) and evaluate their levels based on field position and match outcome, with a specific focus on the introduction of B-teams.

# **II. BODY OF ARTICLE**

### METHODS

### Participants

Fifty elite outfield professional football players competing in the National Greek Super League-2 over the two consecutive periods were selected. Players from various field positions were included to account for position-specific variations. height (cm), weight (kg) and Body Mass Index (BMI, kg/m<sup>2</sup>) were measured for each subject at the beginning of each period (table 1).

The weight was measured on calibrated digital scales (Seca 861; Seca, Hamburg, Germany) to the nearest 0.1kg; the height was measured to the nearest 0.5 cm with a wall mounted stadiometer (Seca 225; Seca), all subjects were barefooted. BMI was calculated by each subject's weight over its height squared (kg/m<sup>2</sup>). For subjects participating in more than one period, the mean value of their weight and age was used. The player's nationality, field position, monthly measurements from global positioning system (GPS) were also recorded.

Locomotor data from the official matches in both periods (58 matches) were collected using manufacturer software (STATSport APEX or Sonra 2.1.4) with a sampling frequency of 10 Hz. The validity and accuracy of this tracking system have been previously presented (Smpokos-Sbokos et al., 2018a, 2018b). Match-data collection carried out at the football club's stadium and both home and away respectively (Smpokos et al., 2019). Each player wore a special adjustable neoprene harness which enables this device to be fitted to the upper part of his back (i.e. between the left and right scapula). All devices were activated 30 minutes before data collection to allow acquisition of satellite signals and synchronize the GPS clock with the satellite's atomic clock (Maddison & Ni Mhurchu, 2009).

### Procedures

This research analyzed data from a cross-sectional analysis conducted between the 2021/22 and 2022/23 periods. This study was conducted under non-experimental conditions, with the research problem embedded in the natural setting (Brito et al., 2016). The physical match running performance of players was quantified during matches in the 2021/22 and 2022/23 periods of the Greek National 2nd Division League. The study included players who were part of the team's pre-period preparation phase, as well as players who joined the team during the regular period due to transition, transfer, or loan.

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The Super League 2 Greece consists of 34 teams divided into two groups (Northern and Southern teams). In the 2021/22 season, the top-ranked clubs of the Greek first division League created B-teams which competed in this new league. The schedule of the first competitive season, 2021/22, was initially disrupted but eventually played out with more matches in the second half of the season. In the 2022/23 season, the participating teams remained split into two groups, with a total of 27 clubs competing.

The present study analyzed the 2021/22 and 2022/23 periods, with the team examined ranking fifth in the league table in the first period (n=32 matches; n=335 individual observations) and ninth in the second period (n=26 matches; n=337 measurements, Table 1). All procedures performed in studies involving human participants were in accordance with the ethical standards of the Ethics Committee of the University Hospital of Heraklion (PN 113/30-03-2013), Crete, Greece and with 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study as described in initial project of this effort (Smpokos et al., 2017; Smpokos-Sbokos et al., 2018a).

### Physical performance variables

The players' match running performance was analyzed using various measurements, including total distance covered (TD; km) & relative total distance (meters/minutes) (D/T). Total number of sprints and the high intensity speed zones was in line with Di Salvo and colleagues (Di Salvo et al., 2007) and Jennings and colleagues (Jennings et al., 2010) and categorized as follow: Very High-Speed running (VHS; 19.8 -25.2Km/h), Maximal Speed-Sprint (MS;>25.2Km/h) and High-Speed Running at zones 5 and 6 (HSR;>19.8-25-1 Km/h). A sprint was defined as a running exercise lasting at least 1 sec at the speed of at least 25.2Km/h (>7 m/s).

Acceleration activity was measured through alterations in GPS speed data and was defined as a change in speed for a minimum period of 0.5 s with a maximum acceleration in the period at least 0.5m/s. The acceleration was considered finished when the player stopped accelerating. The classification of accelerations by zone is based on the maximum acceleration reached in the acceleration period. The same approach was used regarding deceleration.

The load and intensity measures were identified as total number of accelerations or decelerations (>2 m/s<sup>2</sup>) and accelerations/min or decelerations/min, respectively. The HML distance measure combined the energy cost of constant velocity running above  $5.5m/s^2$  and acceleration-deceleration activity in  $2m/s^2$  during intermittent running (Coutts et al., 2015; Osgnach et al., 2010).

The players' match running performance was analyzed included the following measurements: total distance covered. Players who didn't enter HSR zones because they covered short, sharp distances were given credit in their HML score because the intensity of the work could be just great.

### Data analysis

Data were analyzed using the SPSS software (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). Frequencies and mean levels of descriptive characteristics of the 50 football players were estimated according to the two time periods, using binomial,  $\chi^2$  and Mann-Whitney tests for comparing any difference (between 2021/22 & 2022/23). Differences in physical performance levels were evaluated also between the two consecutive periods using Mann-Whitney method. The effect size ( $\eta^2$ ) was also estimated according to Cohen's d method as d=( $\bar{x}_{2021/22}$ -  $\bar{x}_{2022/23}$ )/s<sub>Total</sub>, where  $\bar{x}$  is the mean value, *s* is the total standard deviation and values d>0.30 showing a difference d mediocre or high (decrease or increase of physical performance) in the second period. Using Kruskal-Wallis method the differences in physical performance levels were also evaluated according to matches' outcome and players' position.

### RESULTS

A comprehensive overview of the studied population and their measured characteristics is presented in Table 1. The players' mean age was  $20.5\pm1.1$  years, and their mean body mass index was  $23.3\pm1.4$  kg/m<sup>2</sup>. 44.0% of the studied subjects were defenders or midfielders, and the majority of the total measurements (23.8%; k=160) were recorded in April. Notably, the BMI remained relatively stable, but a significant difference was observed in age between the two periods (p<0.05).

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Table I. Characteristics of 50 Greek team's football players according to their participation in 58 matches at two
different consecutive periods (2021/22 and 2022/23).

		<b>T</b> / <b>1</b>	Two consecutive periods		
		Total	2021/22	2022/23	
		n (%)			
Matches		58	32	26	
Players		50 <sup>a</sup>	21	29	
common players			18 <sup>a</sup>		
Age, years	mean±stand. dev.	20.5±1.1	20.0±1.2*	20.9±1.1	
Body weight, kg	mean±stand. dev.	75.0±8.8	75.5±9.1	75.1±8.7	
Body height, cm	mean±stand. dev.	179.2±7.0	179.2±6.4	179.3±7.5	
<b>Body Mass Index,</b> kg m <sup>-2</sup>	mean±stand. dev.	23.3±1.4	23.4±1.8	23.2±1.7	
Nationality	Greek	37 (74.0)	17 (81.0)	20 (69.0)	
	other	13 (26.0)	4 (19.0)	9 (31.0)	
Position	defenders	22 (44.0)	10 (47.6)	12 (41.4)	
	midfielders	22 (44.0)	9 (42.9)	13 (44.8)	
	forwards	6 (12.0)	2 (9.5)	4 (13.8)	
Total measurements from GPS		672	335	337	
	November	71 (10.6)	32 (9.6)*	39 (11.6)	
Monthly measurements from GPS	December	125 (18.6)	64 (19.1)	61 (18.1)	
	January	105 (15.6)	50 (14.9)	55 (16.3)	
	February	91 (13.5)	62 (18.5)	29 (8.6)	
	March	34 (5.1)	34 (10.1)	-	
	April	160 (23.8)	84 (25.1)	76 (22.6)	
	May	61 (9.1)	9 (2.7)	52 (15.4)	
	June	25 (3.7)	-	25 (7.4)	

GPS, Global Positioning System.

<sup>a</sup> Total players in both seasons and 32 were the different players; 18 were the common (same) players between the two seasons.

Binomial,  $\chi^2$  and Mann-Whitney methods were performed: \*Significant difference between the two seasons at p<0.05.

**Table II** presents the differences in physical performance variables between the two periods. The results of the study revealed that across the two consecutive periods, almost all the physical performance variables decreased significantly in the second year (2022/23). The average TD covered in 2021/22 was 1001 m longer than during 2022/23 (8261 *vs.* 7260m, p<0.001). Moreover, further analysis between 2021/22 and 2022/23 demonstrated a significant increase in HMLD (1543 *vs.* 1310m, p<0.001), HSR (541.4 *vs.* 486.4m, p<0.003), VHS (424.3 *vs.* 378.9m, p<0.001), and total number of sprints (34.7 *vs.* 31.1, p<0.001).

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# Table II. Differences in physical performance levels of football players between the two consecutive periods,2021/22 and 2022/23.

		Two consecutive periods				
	Total -	2021/22	2022/23			
	Mean (Stand. Dev.)			Difference	<i>p</i> -value	$\eta^2$
Players, n	50	21	29			
Measurements, n	672	335	337			
Total Distance, TD (meters)	7759 (3000)	8261 (2839)	7260	-1001	< 0.001	0.33
<b>High Speed Running</b> , HSR (running speed > 19.8 Km/h, in meters)	513.8 (252.7)	541.4 (254.7)	486.4 (248.0)	-55.0	0.003	0.22
<b>Very high-intensity speed running distance</b> , VHS ( <i>sprinting or speed 19.8-25.2 Km/h, in meters</i> )	401.5 (189.6)	424.3 (191.5)	378.9 (185.2)	-45.4	0.001	0.24
<b>Maximal sprinting speed running distance</b> , MS ( <i>sprinting or speed</i> >25.2 <i>Km/h</i> , <i>in meters</i> )	112.6 (84.5)	118.8 (84.7)	106.4 (84.1)	-12.3	0.023	0.15
Participation Time, minutes/match	68.9 (27.3)	73.2 (25.8)	64.7 (28.1)	-8.4	< 0.001	0.31
<b>Distance/Time</b> , D/T ( <i>meters/minutes</i> )	115.7 (19.4)	116.4 (22.4)	114.9 (15.8)	-1.5	0.663	0.08
Sprints (number)	32.9 (15.0)	34.7 (15.2)	31.1 (14.5)	-3.7	0.001	0.24
<b>High Metabolic Load Distance</b> , HMLD ( <i>meters</i> )	1426 (607)	1543 (566)	1310 (625)	-233	< 0.001	0.38
Accelerations $>2m/s2(n)$	57.4 (23.8)	60.2 (22.8)	54.5 (24.5)	-5.7	0.003	0.24
<b>Decelerations</b> $>2m/s2(n)$	64.1 (28.4)	66.9 (28.8)	61.4 (27.7)	-5.5	0.009	0.19

 $\eta^2$  (effect size) was estimated according to Cohen's d method as d= $(\bar{x}_{2021/22} - \bar{x}_{2022/23})/s_{Total}$ , where  $\bar{x}$  is the mean value and s is the standard deviation.

Mann-Whitney tests.

**Table III** examines the physical performance levels based on match outcome (win, draw, defeat). A significantly greater mean TD was covered in matches where the outcome was a draw compared to wins or defeats (8322 vs. 7913 and 7154m, respectively, p<0.001). Moreover, significant increases in HSR, VHS, and the total number of sprints were demonstrated when the outcome result of the match was a win rather than a draw or defeat. A higher HMLD distance was covered when the outcome was a draw compared to wins or defeats (1551 vs. 1442 and 1316m, p=0.001).

# Table III. Differences in physical performance levels in the two study periods (2021/22 & 2022/23) and according to matches' outcome.

	Matches' o				
	win	draw	defeat		
	Mean (Stan	Mean (Stand. Dev.)			
Matches, n	25	14	19		
Measurements, n	296	156	220		
Total Distance, TD (meters)	7913	8322	7154	< 0.001	
	(2878)	(2984)	(3081)		
High Speed Running, HSR	544.3	531.6	460.2	< 0.001	
(running speed >19.8 Km/h, in meters)	(253.6)	(250.2)	(245.5)		
Very high-intensity speed running distance, VHS	424.5	414.9	361.0	0.001	
(sprinting or speed 19.8-25.2 Km/h, in meters)	(191.8)	(182.3)	(186.0)		

Maximal sprinting speed running distance, MS (sprinting or speed>25.2 Km/h, in meters)	120.2 (83.6)	121.3 (91.0)	96.1 (78.8)	0.001
Participation Time, minutes/match	70.1 (26.6)	73.1 (26.4)	64.4 (28.2)	0.005
<b>Distance/Time</b> , D/T ( <i>meters/minutes</i> )	116.8 (22.4)	116.1 (17.5)	113.8 (15.9)	0.086
Sprints (number)	34.4 (14.9)	34.0 (14.9)	30.1 (14.7)	0.003
High Metabolic Load Distance, HMLD (meters)	1442 (599)	1551 (568)	1316 (628)	0.001
Accelerations $>2m/s2(n)$	58.4 (22.8)	60.2 (23.4)	54.0 (25.0)	0.037
<b>Decelerations</b> $>2m/s2(n)$	63.6 (27.3)	68.4 (28.2)	61.7 (29.7)	0.061

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### Kruskal-Wallis tests

**Figure I** presents the physical performance levels in the two study periods according to playing position. Defenders were found to cover a greater mean TD (8236 m) than midfielders/forwards (7426 & 7255 m) (p=0.006) or with higher mean participation time (p<0.001). Midfielders, compared to defenders and forwards, showed greater mean VHS (437 *vs.* 358 and 424 m, respectively, p<0.001), mean number of sprints (35.6 *vs.* 29.7 and 34.5, p<0.001), HSR (563 *vs.* 462 and 513 m, p<0.001), MS (124.7 *vs.* 105.4 and 88.3 m, p=0.001), and mean HMLD (1488 vs. 1368 and 1392, p=0.015). Forwards performed a greater mean D/T than defenders and midfielders (124.5 *vs.* 111 and 118 m/minutes, p<0.001).

### → Figure I



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The study is the first to examine changes in physical performance, considering field position and match result, in Greek professional football players across two consecutive seasons. The main findings of the study were as follows: i) all physical performance variables significantly decreased in the second year of the study (2022/23), ii) based on match outcome, draws showed significantly greater TD and HMLD, while wins recorded significant increases in HSR, VHS, and the number of sprints, iii) positional differences were detected in TD, with defenders covering a greater distance than midfielders and forwards. Additionally, midfielders scored significantly higher in high-intensity game activities such as HSR, VHS, MS, and HMLD compared to their counterparts. Finally, forwards scored higher D/T values than their counterparts.

Running performance in the game has been previously studied in several countries. In general, players covered an average of 9 to 11 km in matches across different leagues, including Italy's Serie A (Rampinini et al., 2007), France's (Carling et al., 2016), Spain's La Liga (Castellano et al., 2011), England's Premier League (Bradley & Noakes, 2013), and Greece's Super League 1 (Smpokos-Sbokos et al., 2018a, 2018b). To our knowledge, this is the first study to report a decrease in physical performance in the second season of a professional team. This finding contrasts with previous studies in European leagues (Chmura et al., 2019; Mohr et al., 2003; Rampinini et al., 2007).

The TD covered in football matches has been extensively studied as an indicator of overall physical demands in elite competitions (Rey et al., 2022). The current results show that players exhibited a decrease in TD by approximately 1000m in the second year. It is worth noting that this decrease is not consistent with previous studies (Barnes et al., 2014), which reported a greater increase in the English Premier League between the 2006/07 and 2013/14 periods. The results of these studies show that TD and HSR increased by 30-55% and 29-33% respectively. A similar comparison (Zhou et al., 2021) provided data on physical and technical indicators of the Chinese Soccer Super League over six periods, showing a significant increase of 9.9% in TD and HSR between the 2021 and 2017 periods. The unexpected 8-week off-period and the transfer of four key players in the second year may have had a negative impact on the players' physical match performance. Additionally, four starting players from the team moved to other teams in the second year. Each of these players covered approximately 10,500-11,500 meters in total distance (TD) and tactically pressured for 70-80% of the total playing time, so the team's dynamics changed without these players.

Furthermore, the analysis of the match results revealed that the soccer players covered the longest TD and high-speed running distance (HMLD) in draws. This is consistent with Aquino and colleagues' findings, which showed that TD was higher in draws and wins compared to defeats (Aquino et al., 2019). Our research results align with those of Lago and colleagues (Lago et al., 2010) and Moalla and colleagues (Moalla et al., 2018), who emphasized that the most intense phase of the game occurs in losses or draws. In this context, Oliva-Lozano and colleagues (Oliva-Lozano, Barbier, et al., 2023; Oliva-Lozano, Fortes, et al., 2023) reported that the highest TD and HMLD were achieved at the beginning of the first half. All of this information could explain the high level of physical performance in the later stages of draws, suggesting that soccer players increase their maximum physical performance to improve the final score of the match (Castellano et al., 2011).

Moreover, in a draw, the balanced score during the match increases the need for more sprinting or higher HMLD to create scoring opportunities, which in turn puts pressure on the opponent's defense (Faude et al., 2012). Finally, another study reported that maximum speed (MS) and high-speed running (HSR) were greater when winning than when losing (Aquino et al., 2017). Our study's results suggest that the winning teams in the Greek League 2 covered a longer high-speed running distance, very high-speed running distance, and number of sprints. These differences could be attributed to the varying levels of soccer-specific skills required among the analyzed leagues. Specifically, teams with lower technical and tactical potentials are forced to exert more physical effort to succeed (Radzimiński et al., 2022). Ultimately, TD, high-speed distance, sprint distance, and others have a significant impact on winning, as shown in a study on the Chinese Soccer Super League (Zhou et al., 2021).

In conclusion, wins and losses are primarily associated with distance-related variables (TD, HSR), while draws tend to require less physical performance (Oliva-Lozano et al., 2021). However, there is no consistency among studies as the relationship between match outcome and external load profile depends heavily on additional variables such as the opponent's competitive level (Aquino et al., 2017; Castellano et al., 2011), effective playing time (Castellano et al., 2011), team playing style (Aquino et al., 2017), or match status.

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To investigate whether players maintained or adjusted their performance across different playing positions, we analyzed the study's sample data and compared it to normative data. Our findings revealed that defenders covered more total distances (TDs) than midfielders and forwards. This contradicts previous studies which reported that midfielders, followed by forwards and defenders, covered greater TDs during soccer matches (Di Salvo et al., 2009; Mohr et al., 2003; Vescovi & Favero, 2014). It also contradicts previous data from the Australian A-League, where wingers traveled greater peak high-speed distances in the game compared to central defenders, defensive midfielders, and strikers (Thoseby et al., 2023).

Conflicting results have also been reported regarding relative peak high-speed running (HSR) demands. Our study found that midfielders had the highest high-intensity speed running demands, whereas previous data reported that forwards and wingers had the highest demands or that there were no position-specific differences (Delaney et al., 2018; Fereday et al., 2020). These inconsistencies may be explained by the specific playing formation, competitive level of opponents, tactics, and players' physical fitness within each team (Aquino et al., 2017; Arjol-Serrano et al., 2021). Therefore, it appears that practitioners, coaches, and fitness trainers should implement position-specific training programs for their players.

The study demonstrates significant differences in physical performance metrics between the 2021/22 and 2022/23 periods, with the latter generally showing a decline in performance. These changes can be attributed to various factors, including player fatigue, changes in tactical strategies, or overall team dynamics. Additionally, the outcome of the match influences physical performance, as winning and drawing teams tend to have better performance metrics compared to the losing teams. These results emphasize the importance of physical preparation and performance analysis in the context of football.

### Limitations

Sample size was limited to professional soccer players of a single club. Future studies should take this into account along with other contextual variables (e.g. opponent's competitional level, effective playing time and the exact way these TD were covered, i.e. with or without the ball). They should also analyze the relationship between training and external load profile of the game.

It is unclear to what extent our results are specific to the time and club in which the study was conducted, or if they can be generalized to all football players in the Greek Super League-2. In order to understand the characteristics of leagues in a more general sense and to interpret data from individual clubs within a broader context, it would be beneficial for clubs to provide high-quality data on physical and technical aspects, as well as team playing systems. Furthermore, sport scientists should employ a "universal" methodology and data processing approach (Ammann et al., 2022). This would assist football clubs in tailoring load monitoring to individual players, thereby improving short- and long-term performance and reducing the risk of injuries.

### **III. CONCLUSION**

This study provides valuable insights into the physical match running performance indicators in professional Greek footballers competing in the National Greek League-2. The findings indicate that time-period, player position, and match outcome are significant factors in changes in GPS measurements. Coaches and trainers can utilize these findings to develop targeted training programs and optimize the players' performance in future seasons. Further research can explore additional factors that may influence physical performance in footballers and investigate long-term trends in performance indicators.

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