PHYSICAL EDUCATION OF STUDENTS

ORIGINAL ARTICLE

The relationship of player load and anaerobic performance in different football playing strategies

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim The purpose of the present study is to determine the effect of player load on the anaerobic performance of soccer players.

Material and Methods Eighty Turkish Super League U21 players (age:19.56±1.3 years, height: 180.3±2.1cm, weight: 75.9±3.7kg) were involved in this study. The players completed eight different 11v11 training games. While one team practiced the ball possession and "defense as a team" strategy, the other team implemented the counterattacking strategy. The formation was kept as "4-4-2". The games were played as 2x20-min training matches. Maximum heart rate, player load, ratings of perceived exertion, high running speed, and sprint performances were analyzed. Pearson's correlation analysis was used in determining the level of correlation between quantitative variables. Linear regression analyses were carried out to examine the effect of player load on anaerobic performance components in different strategies and positions.

Results Compared to tactical strategy, player load values were found to be different from all positions (P<0.05). It was observed that maximum hearth rate, ratings of perceived exertion, high running speed, and sprint data were correlated with player load data (p<0.05). Given the results achieved from the regression analysis, it was determined that an increase in player load data caused an increment in these data.

Conclusions In conclusion, it was observed that player load data affect position-specific anaerobic performance in football. It is thought that the use of the data related to player load, acceleration, and deceleration in the training planning in accordance with the positions of players and the team strategies will increase the performance of the athlete.

Keywords: soccer, training, performance analysis, player load, time-motion.

Introduction

Soccer is a game, in which players have freedom of motion. Thus, it should incorporate tactics and strategic plans covering the team or specific to players individually or regionally. In soccer, strategy is a general plan regarding what to do when the ball is possessed by the team (attack) or the opponent (defense) [1]. The tactic, however, is responses among players and coaches to sudden defense or attacks [2]. Strategy is set only for the whole team, whereas tactics can be set individually and regionally. The 2nd region defense and fast attacks making use of the balls won can be given as an example of defense and attack strategies of teams, whereas fullbacks supporting the attack or determining the direction of passes in the game can be given as examples of tactics [3]. In addition, it is known that teams use different tactics for the set play formations. The system, however, is a general game plan prepared depending on the positions that players would take in the field (alignment in the field) [4]. Systems and strategies are determined before the game. But they might vary due to the events such as the team or opponent with dismissed player(s) or falling behind in the score [5]. The varying structure of the soccer and the coaches making difference by adding from their own game philosophy increase the importance of accurately setting the strategies. Strategy is related to the coach's game philosophy and this philosophy should overlap with the player group in the team. In addition, strategies and tactics may differ depending on the weather conditions and the opponent's condition. In the light of all this knowledge, it was thought that strategies and tactics might directly affect the player's performance.

The performance during a game can be considered as a combination of players' physical, physiological, and technical outcomes and mental productivity. In other words, it can be seen as the physiological and technical outcome of a physical action. However, in literature, only specific outcomes such as running distance at different speeds among the physical factors influencing the player performance and ball possession time and passes among the technical data were focused on [6, 7, 8]. From physiological aspect,

doi:10.15561/20755279.2023.0406

the difficulty of lactate and max VO_2 measurements during the game led coaches to measure heart rate by using a GPS system [9]. It was revealed that heart rate data was an important indicator in determining the aerobic performance of soccer players [10]. However, it might cause some variables to be ignored since they would not cause a sufficient level of increase in sudden movements, in which anaerobic metabolism is active in energy production [11]. Although elite soccer players have a higher level of high-intensity running distances and perform more anaerobic activity than the players in local leagues, no difference was observed between their heart rate values [12]. In addition, no statistically significant difference was found between VO2max levels of amateur and professional players in treadmill tests [12, 13]. In the light of this knowledge, it was thought that heart rate data and VO2max levels were not sufficient criteria for measuring the anaerobic performance of players and they did not fully reflect the quality differences between soccer players. Furthermore, the detailed analysis of anaerobic activities thought to affect the score and the decision moment gains importance [14].

In this parallel, it can be thought that analyzing the anaerobic factors influencing the performance of soccer players would be better. Although the soccer is a sport that is aerobic by 70%, it is also a sports branch that is directly related with the anaerobic system and includes high-intensity and sudden activities such as high-intensity runs, direction changes, jumps, accelerations and decelerations, and kicking the ball [15]. In studies carried out in recent years, it was found that the metabolic effect of acceleration was higher than that of high-intensity running and, although a player moves at low intensity, the metabolic effect increased depending on the change in speed [6, 15,]. In those studies, it was revealed that acceleration-based activities were related with anaerobic energy consumption. Since acceleration and deceleration can directly affect the repetitive sprinting skill that is very important for game performance in soccer, they are important for analyzing the reasons for fatigue and planning the trainings [16, 17].

Together with the advancing technology, Player Load (PL) was introduced to literature and analysis of teams' performance analysis in order to assess the effect of acceleration on performance. In literature, the Player Load is known as a measurement method for the physical loads including all activities of players such as acceleration and deceleration, direction changes, sliding tackle, and jumping [18]. However, nowadays, it is a term that is calculated by dividing the sudden changes in acceleration of athletes in three different axes (anterior-posterior, vertical, and medial-lateral) by a scale by making use of a GPS system developed by Catapult Team Sport 5.0 [19]. PL is a method measuring the change in acceleration rather than the acceleration itself. Since soccer is not a sport played on a single plane and at a constant speed, accelerations and decelerations including the direction changes increase the metabolic load on players. The fact that running at a constant speed of 14 km/h and running at the speed of 5km/h with 2.5 m/s acceleration have the same metabolic load supports this conclusion [15]. For this reason, making use of PL data in analyzing the physical data of players makes it easier to understand the position-specific characteristics of acceleration and PL data.

Nowadays, because of the change in game speed, teams prefer different strategies to maximize the performance of their players and, in this parallel, differences are observed in the performance outputs of players [7]. Together with the effect of changing game structure on strategies, it is known that players might exhibit different performances depending on their positions [6]. In the light of all this knowledge, considering the acceleration-based PL data, the present study aims to measure the effect of player load on the anaerobic performance of elite soccer players in counterattack and ball possession strategies within the frame of 11v11 constant tactic formation (4-4-2). Multidimensional performance analyses to be performed in this parallel would be very useful for coaches to plan the training of players in harmony with their positions and accurately select the players before the game. Hence, by maximizing the capacities of players, their game performance might be increased.

Materials and Methods

Participants

Within the scope of this study, 120 volunteer players (age:19.56 ± 1.3 years, height: 180.3 ± 2.1 cm, weight: 75.9 ± 3.7 kg; M ± SD) playing in Turkish Super League clubs' soccer academy in U21-U17 age group in the 2018-2019 season were involved. The study group consisted of soccer players training 5 days a week (2 hours/day) and playing in at least 1 game every week. The inclusion criteria were the minimum years of training of 5 years and being in the same competitive level. The players were divided into center-back (CB), wingback (WNB), midfield center (MC), wing (WNG), and center-forward (ST). Goalkeepers were excluded from the scope of this study. All the soccer players and coaches were informed about the study procedure, requirements, benefits, and risks in written. For players aged younger than 18 years, consent forms were obtained from the families. The health conditions of the players were approved by club physician and physiotherapist by examining them before the training. The study protocol followed the guidelines stated in the Declaration of Helsinki and was approved by the Ethics Committee of the Faculty of Sport of Marmara University.

Experimental Design

The procedures were performed in 4 different periods (August, November, March, and May) throughout the competition period of the season 2018-2019. In parallel with the study plan, two different strategies were implemented by 12 different teams in 12 training games. Before each game, a 25-min goal-directed warmup exercise (5 minutes jogging, 10 minutes upper and lower extremity dynamic stretching, 10 minutes 3v2 passing drill) was performed as a beginning and then followed by 11v11 training game on a 90*68mt synthetic turf field for 2*20-min. The formation was kept at 4-4-2, which is used in UEFA coaching courses implemented by all the national federations affiliating with the UEFA JIRA convention in order to ensure both numerical and positional equality. Strategies were set to be "Depth in Defense and Counterattack (CA)" and "Ball Possession and Defense as a Team (BP)". In the CA strategy, teams were asked to draw back to their own half, which is called the pressure zone of a team, put pressure in this zone, and perform counterattack with the ball they won. In BP strategy, however, they were asked to attack by possessing the ball and put pressure and win the ball again when they lost it. To ensure the continuity of the game, the same balls (Nike Turkish Super League Ball) were placed on each edge of the field and any stop was prevented. Athletes were not subjected to intense exercise until 24 hours before the game and no game was played within 72-hour interval.

Data collection

The body heights and weights of all players were measured at the beginning of the study. Each of the 12 training games was planned as 2*20-min and the games were recorded using a video camera (Sony CX625 Exmor R® CMOS Handycam G Lens) positioned in the way covering the entire field (15m from the field and at the top of tribune) to record all the movements of players. A GPS device recorded the spatial-temporal data at 10Hz sampling rate (Catapult Team Sport 5.0 GPS). The GPS device was used by placing on the backs of players by using a suitable belt. The reliability and validity of 10 Hz and higher GPS systems were reported in previous studies [1, 19]. Calibration was formed for each game format by making use of GPS devices located at four different corners of the field. Physiological, physical, and technical data of the players were collected at the end of the game and during half-time, and the average of those data was calculated.

Data analysis

The data in the present study were selected and collected in order to compare the player load to the physiological, physical, and technical components of the anaerobic performance of players during a game. The physiological, physical, and technical data involved in the present study were determined in accordance with the literature [6, 11, 20, 21].

Anaerobic performance criteria (APC) were determined to be max HR, HIR, sprint, game speed, and numbers of passing and winning the ball. RPE data was used in testing the effects of these data on the fatigue levels of players. It was reported in previous studies that kicking, passing, and wining the ball were among the anaerobic outputs [15].

Player Load (PL) is a term developed by Catapult Team Sport 5.0 and related with the change in acceleration of players. Player Load is calculated by dividing the sudden change in the acceleration of players in 3 different axes (anterior-posterior, vertical, and medial-lateral) by a specific scale [19]. Sudden change in acceleration is considered as a shock in physics (i.e., a derivative of acceleration). The formula is given below; ay refers to forward, ax to sideway (medial-lateral) and less vertical acceleration, whereas $\vec{a}$ is acceleration, $\vec{v}$ is velocity, $\vec{\gamma}$ is position, and *t* is time.

$$PL = \sqrt{\frac{\left(a_{y(t)} - a_{y(t-1)}\right)^2 + \left(a_{x(t)} - a_{x(t-1)}\right)^2 + \left(a_{z(t)} - a_{z(t-1)}\right)^2}{100}}$$

where *PL=PlayerLoad™*

PL has validity and reliability in accurately determining the change of load on player in a narrow field and short time [19].

Maximum Heart Rate (Max. HR): Heart rate data of players are proven to offer reliable physiological and physical information about players [4, 8]. The highest HR of players during the game was measured using a GPS system. Since the average HR data is mainly related with the aerobic performance, the max HR data was used in the present study.

Rate of perceived exertion (RPE): The modified 10-point RPE [22] was used in the present study. Players were asked to rate the intensity of load during the training between 1 and 10 points and the intensity of training was determined accordingly. It was specified that this value could be determined up to 30 minutes after the loading process [22]. Accordingly, the fatigue index was determined at the end of each half, when the resting HR is at the lowest level.

Physical data: They were determined as high-intensity running (HIR) (19-24km/h) distance, sprint (24 km/h or faster) distance, and maximum speed. All the data were measured using a GPS tracking system.

Technical data: pace (ball possession time/ number of ball touches), number of successful passes, and number of ball wins (tackle + interception). Technical data were analyzed using Posiscope game analysis program.

Statistical analysis

Statistical analyses were performed using the

Statistical Package for Social Science (SPSS, 2022) software. The data were expressed as minimum, maximum, mean, standard deviation, frequency, and percentage. Normality of the distribution of quantitative data was tested using Shapiro-Wilk test and diagrams. Paired group comparisons between normally distributed variables were performed using independent groups t-test. Comparisons between more than 2 normally distributed groups were performed by using One-Way variance analysis. The level of relationship between quantitative variables was determined using Pearson's correlation analysis. The effect of player load value on anaerobic performance values in different strategies and positions was examined using linear regression analyses. Statistical significance was set at $p<0.05$. Effect size (ES) was used in determining the size of effect of strategy on differences. Sizes were classified as unimportant (<0.2), small (>0.2-0.6), medium (>0.6-1.2), large (>1.2-2.0), and very large (2.0-4.0).

Results

PL data are presented in Table 1. In all the positions other than WNB, strategy was found to have a large effect size and there were statistically significant differences ($p<0.05$; ES: large). PL value was higher in CB position in BP strategy, whereas it was higher in CA strategy in other positions with a significant difference.

Independent from the positions of players in BP and CA strategies, the correlation of PL data with other variables affecting the APC was analyzed (Table 2). In BP strategy, it was determined that PL data had positive correlation with max HR, HIR, Borg, and number of passes (r=0.470, p<0.001; r=0.304, p=0.018; r=0.332, p=0.010; r=0.333, p=0.009; r=0.384, and p=0.002, respectively). On the other hand, it had correlation with max HR, HIR, sprint, max speed, and passes in CA strategy (Table 2).

Given the correlation analysis performed by considering the positions of soccer players, PL data was found to have positive correlation with max HR, Borg, and pass values in CB position (r=0.532, p=0.008; r=0.645, p=0.001; r=0.614, and p=0.001, respectively). In WNB position, positive correlation was found only with HIR (r=0.475, p=0.019), whereas positive correlation was found only with Max HR data in ST position (r=0.461, p=0.023). In WNG position, correlation was found with HIR, sprint, and max HR data (Table 3).

Linear regression analyses were performed in order to examine the effect of player load on the APC in BP and CA strategies. As a result of the analyses not considering the positions of players, it was determined that 1 unit increase in PL value resulted in a 0.178 unit increase in max HR in BP strategy

Table 1. Distribution of player load data by positions and strategies

Position	Strategy		p	Effect size
	Ball Possession	**Counter Attack**		
Centre Back	224.13±32.73	195.42±24.96	0.024*	0.986
Wing Back	244.13±26.15	257.08±19.86	0.185	0.558
Midfieleder	250.46±19.39	267.63±11.95	0.016*	1.066
Winger	237.50±22.51	258.25±16.94	0.018*	1.041
Forward	230.75±34.87	256.83±25.30	0.048*	0.856
p	0.164	<0.001*		
Effect size	0.110	0.641		

*Statistically significant at p <0.05, RPE: Received Perceived Exertion

Table 2. Linear correlation analysis between player load and APC criteria

Parameters	BP		CA	
	r	**p**	**r**	**p**
Maximum Heart Rate	0.470	<0.001*	0.332	0.010*
High Intensity Running	0.304	0.018*	0.379	0.003*
Sprint	0.073	0.579	0.332	0.010*
Maximum Speed	0.049	0.712	0.447	<0.001*
RPE	0.333	0.009*	0.252	0.052
Pace	0.159	0.224	0.140	0.287
Pass	0.384	0.002*	0.520	<0.001*
Ball Wins	0.137	0.298	-0.238	0.067

*Statistically significant at p <0.05

and a 0.105 unit increase in CA strategy (p<0.001 and p=0.010, respectively). The model found as a result of the regression analysis performed in order to examine the effect of player load value on HIR distance in BP and CA strategies was determined to be statistically significant (p=0.018 and p=0.003, respectively). It was found that 1 unit increase in PL value caused a 0.685 unit increase in HR value in BP strategy and a 0.764 unit increase in CA strategy (Table 4). In addition, it was also determined that 1 unit increase in PL value caused a 0.813 unit increase in sprint value and a 0.044 unit increase in max

Table 3. Distribution of correlation analysis between player load and APC criteria by positions

Parameters	STP		WNB		MC		WNG		ST	
	r	p	r	p	r	p	r	p	r	p
Max HR	0.532	0.008*	0.137	0.525	-0.395	0.056	0.236	0.266	0.461	0.023*
HIR	0.239	0.261	0.475	0.019*	0.007	0.973	0.496	0.014*	0.071	0.742
Sprint	0.353	0.091	0.201	0.347	0.069	0.748	0.507	0.011*	-0.010	0.961
Max speed	0.240	0.259	0.147	0.494	0.042	0.845	0.453	0.026*	-0.273	0.196
RPE	0.645	0.001*	0.346	0.098	-0.182	0.395	0.270	0.202	-0.111	0.604
Pace	0.357	0.087	0.377	0.069	-0.319	0.129	0.119	0.580	-0.013	0.953
Pass	0.614	0.001*	0.236	0.266	0.018	0.932	-0.006	0.979	0.152	0.479
Ball Wins	-0.170	0.427	0.289	0.170	0.177	0.407	-0.135	0.529	-0.214	0.314

*Statistically significant at p <0.05, Max HR: Maximum Heart Rate, HIR: High Intensity Running, RPE: Received Perceived Exertion

Table 4. Linear regression analysis between player load and APC criteria

Parameters	Strategy	r	F	R^2 (Effect size)	Beta (95% CI)	p
Max HR	BP	0.470	16.417	0.221	0.178 (0.090, 0.266)	<0.001*
	CA	0.332	7.172	0.110	0.105 (0.027, 0.183)	0.010*
HIR	BP	0.304	5.911	0.092	0.685 (0.121, 1.25)	0.018*
	CA	0.379	9.711	0.143	0.746 (0.267, 1.225)	0.003*
Sprint	BP	0.073	0.311	0.005	0.131 (-0.339, 0.601)	0.579
	CA	0.332	7.196	0.110	0.813 (0.206, 1.42)	0.010*
Maximum Speed	BP	0.049	0.137	0.002	0.004 (-0.018, 0.026)	0.712
	CA	0.447	14.495	0.200	0.044 (0.021, 0.067)	<0.001*
RPE	BP	0.333	7.247	0.111	0.008 (0.002, 0.014)	0.009*
	CA	0.252	3.928	0.063	0.007 (0, 0.013)	0.052
Pace	BP	0.159	1.511	0.025	0.003 (-0.002, 0.008)	0.224
	CA	0.140	1.157	0.020	0.002 (-0.002, 0.006)	0.287
Pass	BP	0.384	10.031	0.147	0.124 (0.046, 0.203)	0.002*
	CA	0.520	21.548	0.271	0.064 (0.037, 0.092)	<0.001*
Ball Wins	BP	0.137	1.105	0.019	0.006 (-0.006, 0.018)	0.298
	CA	-0.238	3.474	0.057	-0.012 (-0.025, 0.001)	0.067

*Statistically significant at p <0.05, Max HR: Maximum Heart Rate, HIR: High Intensity Running, RPE: Received Perceived Exertion speed in CA strategy (p=0.010). It was determined that 1 unit increase in PL value caused a 0.124 unit increase in the number of passes in BP strategy and 0.064 unit increase in CA strategy (p=0.002; p<0.001).

As a result of the linear regression analysis performed considering the positions of players, it was found that 1 unit increase in PL value caused a 0.124 unit increase in the number of passes in ST position in BP strategy (p=0.032). In WNB position, however, 1 unit increase in PL value caused a 1.536 units increase in HIR (p=0.032), and 0.014 and 0.152 units increase in pace and pass values, respectively (Table 5). In SP position, 1 unit increase in PL value

Table 5. Distribution of regression analysis between player load and APC criteria by positions

Parameters	Strategy	Position	r	F	R^2 (Effect size)	Beta (95% CI)	p
Max HR	BP	STP	0.489	3.149	0.239	0.182 (-0.047, 0.411)	0.106
		WNB	0.391	1.809	0.153	0.131 (-0.086, 0.347)	0.208
		MC	-0.063	0.040	0.004	-0.029 (-0.347, 0.29)	0.846
		WNG	0.544	4.213	0.296	0.138 (-0.012, 0.287)	0.067
		ST	0.619	6.213	0.383	0.124 (0.013, 0.235)	0.032*
	CA	STP	0.772	14.763	0.596	0.306 (0.128, 0.483)	0.003*
		WNB	0.017	0.003	0.001	0.008 (-0.323, 0.338)	0.959
		MC	-0.410	2.020	0.168	-0.334 (-0.858, 0.19)	0.186
		WNG	-0.091	0.083	0.008	-0.036 (-0.318, 0.245)	0.779
		ST	0.271	0.791	0.073	0.086 (-0.13, 0.302)	0.395
HIR	BP	STP	0.214	0.481	0.046	0.304 (-0.674, 1.283)	0.504
		WNB	0.619	6.208	0.383	1.536 (0.162, 2.91)	0.032*
		MC	0.213	0.476	0.045	0.434 (-0.968, 1.836)	0.506
		WNG	0.440	2.395	0.193	0.709 (-0.312, 1.73)	0.153
		ST	0.096	0.093	0.009	0.11 (-0.691, 0.91)	0.767
	CA	STP	0.031	0.010	0.001	0.036 (-0.766, 0.837)	0.923
		WNB	0.241	0.614	0.058	0.393 (-0.724, 1.509)	0.451
		MC	-0.260	0.726	0.068	-0.278 (-1.005, 0.449)	0.414
		WNG	0.136	0.188	0.018	0.214 (-0.887, 1.315)	0.674
		ST	-0.529	3.886	0.280	-0.938 (-1.999, 0.122)	0.077
Sprint	BP	STP	0.284	0.876	0.081	0.591 (-0.816, 1.997)	0.371
		WNB	-0.115	0.134	0.013	-0.206 (-1.462, 1.049)	0.722
		MC	0.251	0.672	0.063	0.505 (-0.867, 1.877)	0.431
		WNG	0.020	0.004	0.000	0.017 (-0.572, 0.606)	0.951
		ST	-0.525	3.813	0.276	-0.34 (-0.728, 0.048)	0.079
	CA	STP	-0.111	0.124	0.012	-0.069 (-0.504, 0.366)	0.732
		WNB	0.287	0.894	0.082	0.959 (-1.3, 3.217)	0.367
		MC	0.280	0.850	0.078	0.369 (-0.523, 1.26)	0.378
		WNG	0.369	1.578	0.136	0.911 (-0.705, 2.527)	0.238
		ST	-0.419	2.134	0.176	-0.833 (-2.103, 0.437)	0.175
Max Speed	BP	STP	0.172	0.304	0.029	0.014 (-0.041, 0.068)	0.594
		WNB	-0.007	0.001	0.000	0 (-0.048, 0.047)	0.982
		MC	0.317	1.116	0.100	0.023 (-0.025, 0.071)	0.316
		WNG	-0.057	0.033	0.003	-0.002 (-0.028, 0.024)	0.859
		ST	-0.572	4.856	0.327	-0.028 (-0.056, 0)	0.052
	CA	STP	-0.086	0.075	0.007	-0.005 (-0.049, 0.039)	0.790
		WNB	0.145	0.215	0.021	0.006 (-0.022, 0.034)	0.653
		MC	-0.272	0.797	0.074	-0.029 (-0.101, 0.043)	0.393
		WNG	0.350	1.392	0.122	0.027 (-0.024, 0.077)	0.265
		ST	-0.360	1.491	0.130	-0.028 (-0.078, 0.023)	0.250

Table 5 (continued).

Parameters	Strategy	Position	r	F	R^2 (Effect size)	Beta (95% CI)	p
RPE	BP	STP	0.555	4.451	0.308	0.008 (0, 0.017)	0.061
		WNB	0.587	5.245	0.344	0.019 (0.001, 0.038)	0.045*
		MC	0.256	0.699	0.065	0.01 (-0.016, 0.035)	0.423
		WNG	-0.064	0.041	0.004	-0.002 (-0.029, 0.024)	0.844
		ST	0.434	2.316	0.188	0.006 (-0.003, 0.014)	0.159
	CA	STP	0.472	2.866	0.223	0.009 (-0.003, 0.022)	0.121
		WNB	-0.290	0.921	0.084	-0.01 (-0.032, 0.013)	0.360
		MC	0.194	0.391	0.038	0.008 (-0.021, 0.038)	0.546
		WNG	0.229	0.553	0.052	0.011 (-0.021, 0.042)	0.474
		ST	-0.295	0.954	0.087	-0.006 (-0.019, 0.007)	0.352
Pace	BP	STP	0.253	0.681	0.064	0.005 (-0.009, 0.02)	0.428
		WNB	0.684	8.794	0.468	0.014 (0.004, 0.025)	0.014*
		MC	-0.151	0.234	0.023	-0.003 (-0.019, 0.012)	0.639
		WNG	-0.031	0.009	0.001	-0.001 (-0.018, 0.017)	0.925
		ST	-0.145	0.216	0.021	-0.002 (-0.012, 0.008)	0.652
	CA	STP	0.505	3.422	0.255	0.011 (-0.002, 0.024)	0.094
		WNB	-0.178	0.326	0.032	-0.004 (-0.018, 0.011)	0.581
		MC	-0.181	0.340	0.033	-0.004 (-0.021, 0.012)	0.573
		WNG	0.001	0.000	0.000	0 (-0.021, 0.021)	0.998
		ST	0.010	0.001	0.000	0 (-0.007, 0.008)	0.976
Pass	BP	STP	0.635	6.754	0.403	0.105 (0.015, 0.196)	0.027*
		WNB	0.624	6.381	0.390	0.152 (0.018, 0.286)	0.030*
		MC	0.534	3.982	0.285	0.334 (-0.039, 0.706)	0.074
		WNG	0.535	4.002	0.286	0.123 (-0.014, 0.259)	0.073
		ST	0.250	0.667	0.063	0.06 (-0.104, 0.225)	0.433
	CA	STP	0.210	0.461	0.044	0.014 (-0.031, 0.058)	0.513
		WNB	-0.052	0.027	0.003	-0.006 (-0.089, 0.077)	0.874
		MC	0.308	1.047	0.095	0.124 (-0.146, 0.393)	0.330
		WNG	0.349	1.389	0.122	0.029 (-0.026, 0.083)	0.266
		ST	0.875	32.704	0.766	0.185 (0.113, 0.257)	<0.001*
Ball Wins	BP	STP	-0.169	0.294	0.029	-0.006 (-0.032, 0.02)	0.599
		WNB	0.033	0.011	0.001	0.001 (-0.028, 0.03)	0.919
		MC	0.356	1.452	0.127	0.017 (-0.015, 0.049)	0.256
		WNG	0.381	1.701	0.145	0.025 (-0.018, 0.067)	0.221
		ST	-0.111	0.124	0.012	-0.004 (-0.026, 0.019)	0.732
	CA	STP	0.631	6.615	0.398	0.020 (0.003, 0.038)	0.028*
		WNB	0.487	3.113	0.237	0.023 (-0.006, 0.053)	0.108
		MC	0.518	3.668	0.268	0.055 (-0.009, 0.12)	0.084
		WNG	0.472	2.873	0.223	0.012 (-0.004, 0.028)	0.121

*Statistically significant at p <0.05, Max HR: Maximum Heart Rate, HIR: High Intensity Running, RPE: Received Perceived Exertion.

caused a 0.124-unit increase only in max HR value (p=0.032). No significant difference depending on a variable was found in MC and WNG positions in linear regression analyses (p>0.05).

In CA strategy, it was determined that 1 unit increase in PL values of players playing in CB position caused 0.306 unit increase in max HR value and 0.020 unit increase in number of ball wins. In ST position, however, 1 unit increase in PL value was found to cause a 0.185 unit increase in number of passes (Table 5). No significant difference depending on a variable was found in WNB, MC, and WNG positions in linear regression analyses (p>0.05).

Discussion

In the present study, PL and APC variables were separately discussed and their interactions were analyzed for the whole team and for players playing in different positions within the scope of 11v11 formation and in accordance with the soccer rules. Several studies were carried out considering teams' ball possession ratios and formations [21, 23]. However, in the present study, strategies implemented by teams were considered and position-specific characteristics were also analyzed. The novelty of the present study increases since it was carried out with 11v11 formation and within the scope of PL and APC.

The main finding of this study; it was determined that there were differences between position-specific PL values of players in the same formation (4-4-2) but different strategies (BP and CA), these values were in correlation with APC criteria, and the linear regression model that was established was significant. The change in PL values of players affected the APC parameters in the same way. In other words, an increase in PL value caused an increase in APC criteria. Thus, the null hypothesis of the present study was accepted.

Player load

It was observed that position-specific PL data significantly changed when strategies of teams changed (Table1). In CA strategy, PL values of players playing in MC, WNG, and ST positions increased by 6-11% (ES: Large). In particular, players in MC position, who play at central positions, contribute to the team in both defense and attack. It can be thought that their acceleration and deceleration values changed since they have to perform defense and attack in a larger area in CA strategy. ST players also play in the center. The fact that players have to accelerate suddenly in a large area while starting an attack, especially in CA strategy, supports the findings achieved in this study. WNG players, however, play in the center but their tasks in beginning defense and attack are similar to those of ST players and it is supported by the PL data (WNG: 258.25±16.94; ST: 256.83±25.30). It is known that CB players have lower acceleration and deceleration values in comparison to the other positions [24, 25]. PL value of CB players was found to be 15% higher in BP strategy (BP: 224.13±32.73; CA: 195.42±24.96). This is because BP strategy is based on pass and support, they play an active role in playmaking by moving forward, backward, and sideward. Furthermore, since they have to defend a larger area in case of a pressure when ball was lost, they have to accelerate and decelerate constantly in order to fulfill their duty.

In BP strategy, the fact that there was no difference in PL values between the positions suggests the importance of accurately using the distance between blocks in this strategy (p=0.164). Players from different zones have to play close to each other in defense and attack because BP strategy is based on passing the ball, supporting, and defense as a team. In sum, since they keep the area narrow and perform defense and attack in a confined area, the difference between position-specific acceleration and deceleration decreases.

Differing from BP strategy, CA strategy is based on defense and attack on a large area; it incorporates position-specific attack and defense duties and it causes differences between PL values (p>0.001; ES: Large). As it can be understood from the effect size, especially in this strategy, sudden speed changes are observed among players in large areas during the transitioning games. It causes changes in acceleration and deceleration rates of players. While players playing in MC position have the highest PL value, the values for WNG, WNB, and ST positions were similar to each other (Table 2). It was stated that MC players have high PL values since they have responsibilities requiring maneuvering skills [26]. In addition, it was also emphasized in a similar study that fullback and wing players have a higher number of accelerations in comparison to the other positions [27]. The reason for STP position to be lower than the other positions can be explained by the assignment of these players to relatively narrower areas when compared to the players in other positions. Furthermore, the fact that they have a lower number of ball touches in comparison to other strategies also supports this conclusion. In addition, it can be stated that center-backs have less responsibility and their area remains relatively limited since it is preferred to expand the game by using the wings, in CA strategy especially while beginning an attack. This hypothesis is supported by the fact that players playing in central positions generally had higher acceleration values in the axis Z (vertical) [25].

Pearson's Correlation and Linear Regression Analysis

One of the most interesting results achieved in the present study is that PL data had positive correlation with Max HR, HIR, RPE, and number of passes in both strategies and the linear regression model established here was statistically significant (Table 2 and 4). From this aspect, the present study is consistent with the literature [27, 28]. In the light of this knowledge, it can be seen that PL data was in parallel with the anaerobic performance indicators. Moreover, it was also stated in previous studies that the changes in acceleration were related with the anaerobic metabolism [15, 29]. It was determined that 1 unit increase in PL data caused increases in high-intensity activities related with anaerobic performance such as max HR and HIR of the player.

It is known that deceleration, re-acceleration, and direction change are related with anaerobic metabolism [9]. Thus, it can be said that PL data affect anaerobic performance in soccer, regardless of the strategy.

In addition, the relationship between high-intensity running distances, PL, and expanded-area game in this strategy is further supported by the finding that, in CA strategy, sprint and maximum speed data had a correlation with PL (p=0.010) and the linear regression model was significant. The differences in maximum speeds correspond to the full acceleration and long-distance high-intensity running [20]. Besides that, the fact that PL data is related not only with the acceleration but also with the change in acceleration shows the importance of the changes related to the acceleration in a large area in CA strategy. It should be considered significantly PL values cause metabolic fatigue [30].

In the position-specific correlation analysis, the positive correlation found in HIR, sprint, and max speed values of wing players (playing in WNG and WNB positions) emphasizes the position-specific characteristics of those players. Regardless of the strategy, the players playing in this area have to cover a large area at the highest speed in the shortest time. It might cause the players to take action and accelerate in accordance with the position. For this reason, an increase in PL value might cause an increase in high-intensity activities of players. The correlation between max HR and PL data of STP and ST players, who play at the headmost and backmost positions at the center, is an example for anaerobic performance of center players. Despite the positive correlation with PL, different strategies also have effect in these two player groups. A 1-unit increase in PL was found to cause a 0.125 unit increase in ST position in CA strategy and a 0.3 unit increase in STP position in BP strategy. The common point of these two positions is that they have responsibility in the center, regardless of the strategies. However, since STP players are required to defend a larger area in BP strategy, acceleration and deceleration activities might increase. It might consequently cause PL data to have a positive correlation and max HR to increase. In this parallel, it can be thought that CA strategy requiring maximum effort in a large area increased the high-intensity and acceleration-related physical load on ST players.

It should be considered that PL data might vary depending on the studies and methods applied. While acceleration and deceleration values of players were higher in comparison to the other positions [24]. Another study reported values similar to or lower than the average [27].

Conclusions

In the present study, it was determined that PL data varied depending on the positions and strategies and it had positive correlation with APC criteria. As a result of the regression analysis, it was found that 1 unit increase in PL data caused increase in APC criteria. The main practical applications for coaches and strength-conditioning professionals to be drawn from this study is that, considering the requirements arising from the differences in strategies, PL data directly affected the anaerobic performance of soccer players and it is necessary to plan the trainings within the scope of specialization principle by using PL and similar components in condition training in soccer and considering the position-specific differences.

Considering the fact that, depending on the acceleration and deceleration, the speed changes of players during the game increase the metabolic load on the player and reduce the repetitive sprint skills, it would be accurate to plan especially the repetitive sprint trainings in parallel with direction changes depending on the changes in acceleration and deceleration.

Position-specific differences between the players should be paid importance, especially in speed trainings. It is known that fullback players sprint longer distances in comparison to the players in other positions. Planning the speed, strength, and agility trainings specifically to positions by considering the differences arising from strategy and acceleration would increase the game performances of players.

In conclusion, the data obtained in the present study revealed that PL data of players might vary depending on the strategies and, consequently, on the positions of players. It would allow coaches to maximize the trainings in harmony with the planned strategy and to accurately select the players in accordance with the determined strategies and tactics.

Acknowledgements

The authors have no conflicts of interests to declare.

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Cite this article as:
Erol M, Kapelman AE, Kızılet A. The relationship of player load and anaerobic performance in different football playing strategies. *Physical Education of Students,* 2023;27(4):190–200.
https://doi.org/10.15561/20755279.2023.0406

Received: 20.06.2023

Accepted: 21.07.2023; **Published**: 30.08.2023