Contextual Factors and Aerobic Fitness Influence Match Running Performance in Elite Soccer

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Headline

Overall indexes of players' match physical performance are total distance (TD) and high speed running distances (HSR; speed >19 km/h) covered during a match (1,2). An important factor that affects match running performance of elite soccer players is their aerobic fitness level, with v-VO_2max being correlated with TD and HSR in top level professional soccer players (3). Contextual factors, such as playing position, match location, match result, goal difference and opposition level are additional variables that influence the match running performance of elite soccer players (4,5). As such, it would be advantageous to develop a predictive model examining the independent influence of a match performance variable such as TD and HSR, while accounting for all other variables as fitness and contextual factors using a multiple regression analysis.

Aim

The purpose of the present study was to examine the influence of aerobic fitness and contextual factors on match running performance, including total distance covered, distances covered at various speeds and number of sprints, of an elite Greek soccer team during a competitive season.

Design

An observational design was used to examine the influence of three contextual factors (playing position, game result and opposition level) on match running activities – distances covered at various speeds, total distance, maximum speed, number of sprints - of elite male soccer players from the same team during a competitive season.

Participants

Twenty-one elite professional soccer players (age: 25.2 ± 5.8 yrs; body mass: 73.1 ± 16 kg; height: 181 ± 0.06 m) of a Greek team of the Super League (highest level) participated in the study. From a tactical point of view, the team has used a 4-3-3 formation during the competitive period. All players were informed of the purpose of the study and gave their informed consent according to the Declaration of Helsinki.

v-VO_2max Assessment

Participant's v-VO_2max was assessed at the beginning of the competitive season with a 20m multistage fitness test (MSFT) (6). MSFT involves running back and forth between two lines set 20 m apart in time to recorded beeps. Velocity was 8.5 km/h on the first minute, which increased by 0.5 km/h every minute thereafter. Participants who dropped behind the required pace on two successive occasions were pulled out of the test. v-VO_2max was calculated according to the next equation (6): v-VO_2max = Final MSFT velocity * 1.34 -2.86.

Match Running Activities

Match running activities data from twenty-eight (28) Greek Super League (highest level) matches played by a professional soccer team were collected during the 2018-2019 season using a Polar Team Pro tracking system (Polar Electro, Kempele, Finland) based on GPS technology. A total of 157 data items from 21 players who completed entire matches were used in the study. The following match running activities were assessed: total distance (TD), high speed running distances (HSR; distance covered with more than 19 km/h), medium speed running distances (MSR; distance covered with 15-18.99 km/h), low speed running distances (LSR; distance covered with 11-14.99 km/h), very low speed running distances (VLSR; distance covered with 7-10.99 km/h), walking distances (WS; 3-6.9 km/h), maximum speed (MS) and the number of sprints (NrSP; distance covered with more than 25 km/h). Maximum speed represents the maximal run speed a player reached during a game.

Contextual Factors

Players were assigned to one of four outfield positions according to their activity on the pitch: Central defenders (CD; n=3; match observations =41), full backs (FB; n=5; match observations = 36), central midfielders (CM; n= 5; match observations = 32) and attackers (AT; n= 7; match observations = 48) to determine the influence of playing position on between-match variation in match activities. Additionally, match location (home / away) was recorded.

Statistical Analysis

All data were expressed as mean values and standard deviation (SD). Multiple linear regression analyses were performed in order to identify potential predictors of TD, HSR, MSR, LSR and VLSR using the enter method. TD, HSR, MSR, LSR and VLSR were considered as dependent variables. Independent variables were playing position, (Central Defenders=1, Full backs = 2, Central Midfielders = 3 and Attackers = 4), match location (home = 1 and away = 2), and players' v-VO_2max. Validity of the regression model was established by checking essential assumptions. Collinearity tests were performed using tolerance and variance inflation factor (VIF) for each level for each of the independent variables. Level of significance was set at $p<.05$.

Results

v-VO_2max values were 19.7 + 0.7 km/h. Also, distances covered at various speed zones and number of sprints of elite players during the competition period, according to their playing position and match location, are shown in Table 1.

Multiple hierarchical linear regression analyses were calculated to predict TD, HSR, MSR, LSR, VLSR, WS and NrSP based on players' v-VO_2max, playing position and match location. Normality, collinearity and homoscedasticity of residuals

Table 1. Covered distances (mean + SD) at various speeds according to playing position and match location of an elite soccer team throughout the championship.

Playing Position	Match Location	TD (M + SD)	NrSP (M + SD)	WS (M + SD)	VLSR (M + SD)	LSR (M + SD)	MSR (M + SD)	HSR (M + SD)
Central Defenders	Home (n = 24)	10167 ± 436	8 ± 4	3327 ± 242	2783 ± 202	1988 ± 191	873 ± 153	519 ± 122
	Away (n = 17)	9957 ± 442	6 ± 2	3265 ± 214	2831 ± 274	1981 ± 173	843 ± 116	424 ± 83
	Total (n = 41)	1080 ± 445	7 ± 3	3301 ± 230	2803 ± 233	1985 ± 181	860 ± 138	480 ± 116
Fullbacks	Home (n = 18)	10734 ± 452	17 ± 7	3573 ± 457	2248 ± 460	2175 ± 228	1199 ± 232	953 ± 292
	Away (n = 18)	10427 ± 529	13 ± 6	3475 ± 280	2402 ± 340	2115 ± 226	1058 ± 214	786 ± 239
	Total (n = 36)	10581 ± 509	15 ± 7	3524 ± 377	2325 ± 406	2145 ± 226	1128 ± 231	869 ± 277
Midfielders	Home (n = 15)	10870 ± 534	11 ± 4	3889 ± 554	2084 ± 235	2311 ± 287	1326 ± 213	759 ± 199
	Away (n = 17)	11029 ± 783	9 ± 3	3731 ± 444	2272 ± 421	2569 ± 521	1342 ± 334	651 ± 167
	Total (n = 32)	10954 ± 672	10 ± 4	3805 ± 497	2184 ± 354	2448 ± 441	1335 ± 279	720 ± 188
Attackers	Home (n = 27)	10841 ± 658	21 ± 6	3779 ± 357	2168 ± 439	2074 ± 278	1139 ± 187	1087 ± 227
	Away (n = 21)	10602 ± 638	19 ± 6	3605 ± 242	2406 ± 477	2016 ± 315	1096 ± 215	976 ± 172
	Total (n = 48)	10737 ± 653	20 ± 6	3703 ± 321	2272 ± 466	2049 ± 293	1120 ± 199	1039 ± 210
Total	Home (n = 84)	10631 ± 606	15 ± 8	3626 ± 444	2346 ± 452	2113 ± 268	1109 ± 251	838 ± 313
	Away (n = 73)	10508 ± 706	12 ± 7	3523 ± 342	2473 ± 435	2161 ± 400	1085 ± 285	725 ± 267
	Total (n = 157)	10574 ± 655	13 ± 7	3578 ± 402	2405 ± 447	2135 ± 336	1098 ± 266	785 ± 297

Total distance (TD); High Speed Running Distances (HSR); Medium Speed Running Distances (MSR); Low Speed Running Distances (LSR); Very Low Speed Running Distances (VLSR); Walking Speed Distances (WS); Maximum Speed (MS) and the Number of Sprints (NrSP).

Table 2. Summary of multiple regression models for variables predicting the covered distances at various speeds, total distance and number of sprints performed by an elite soccer team during championship.

	WS	VLRS	LRS	MSR	HSR	TD	NrSP
$F_{3,156}$	13.3**	17.2**	1.4	15.3**	54.0**	15.1**	38.8**
r^2	20.7%	25.2%	2.7%	23.0%	51.4%	22.8%	43.2%
SEE	361.35	601.9	334.35	236.04	209.15	581.27	5.51
B Constant	1824.1*	5119.3**	-1224.6	-1137.7*	-1928.5**	5600.7**	-49.6**
CI (95%)	155.7 to 3492.4	3317.1 to 6921.4	-319.1 to 2768.3	-2227.5 to -47.9	-2894.1 to -962.8	2917.0 to 8284.7	-75.3 to -24.0
B Home/Away	-97.4	116.7**	51.5	-13.6	-101.9**	-100.0	-2.1*
CI (95%)	-212.2 to 17.4	-7.3 to 240.7	-54.7 to 157.7	-88.5 to 61.4	-168.4 to 35.5	-284.7 to 84.7	-3.9 to -0.4
B Playing Position	122.1**	-135.7**	26.1	63.6**	126.7**	163.5**	2.8*
CI (95%)	69.1 to 175.0	-192.9 to -78.5	-22.9 to 75.1	29.0 to 98.2	96.0 to 157.3	78.3 to 248.7	2.0 to 3.6
B v-VO_2max	80.7	-129.3**	39.1	106.6**	129.3**	239.4**	3.0**
CI (95%)	-5.5 to 166.9	-222.3 to -36.1	-40.6 to 118.9	50.3 to 162.9	79.4 to 179.2	100.8 to 378.0	1.7 to 4.3

Total distance (TD); High Speed Running Distances (HSR); Medium Speed Running Distances (MSR); Low Speed Running Distances (LSR); Very Low Speed Running Distances (VLSR); Walking Speed Distances (WS); Maximum Speed (MS) and the Number of Sprints (NrSP).** $p < 0.01$; * $p < 0.05$.

assumptions were satisfied in all predictive models. Multiple regression models for the estimation of HSR and NrSP with all three predictors (players' v-VO_2max, players' positional role and whether the match location is at home or away) produced R^2 values of 51.4% and 43.2% of the variation in HSR and NrSP, respectively (Table 2). On the other hand, multiple regression models with two predictors (players' v-VO_2max and players' positional role) produced lower R2 values (20.7% - 25.2%) of the variation in TD, MSR, VLSR and WS (Table 3). Match location did not contribute to the multiple regression models for the estimation of TD, MSR, VLSR and WS.

Discussion

The findings of the present study have shown that TD and HSR distances are influenced from both contextual factors and aerobic fitness characteristics. Specifically, covered HSR distances and NrSP performed by an elite soccer team are dependent on individual v-VO_2max characteristics, playing position and match location during competition. These three variables can explain 51% and 42% of the total variance of HSR and NrSP.

The present study supports that v-VO_2max is a determinant factor influencing the number of sprints performed, high speed covered and moderate distances, as well as, distance covered with lower speed during competition. The findings of the present study suggest that for each one km/h increase in v-VO_2max, there is an increase in HSR by an average of 129 meters. These data verify the significant influence of cardiovascular fitness in match running performance in elite soccer players. Similarly, previous studies (7,8) have reported a strong relationship between v-VO_2max and HSR, TD distance covered during a game in elite soccer and rugby players.

Match activities of elite professional soccer players have been well analyzed in relation to playing position (9,10). The present study has similarly found a significant influence of playing position on match running performance. A one unit difference in the playing position value was associated with a 126m and 163m increase in covered HSR distance and TD, respectively. Buchheit et al. (9) have reported that match running performance was position-dependent in highly trained young soccer players. Also, it is well known that match location impacts the physical performance of soccer players (4). Similarly, the present study reports that if the elite soccer player plays at home, his average HSR increases by 100 meters, whereas he performs 2 more sprints in comparison to playing away. Lagos et al. (4) have found that match location is a significant determinant for TD prediction but not for HSR, showing that when the team played away, TD covered was reduced by 262 m compared with playing at home.

From the findings of the present study, it is interesting to note that the regression model for the HSR prediction presents higher R2 and includes three variables (v-VO_2max, playing position and match location) as significant predictors in comparison to the regression model for the prediction of TD which includes only v-VO_2max and playing position as significant determinants. This means that HSR may be a more sensitive variable to the changes of v-VO_2max and contextual factors, such as playing position and match location compared to TD. For this reason an additional statistical analysis was conducted in order to indicate if there are differences on distances covered at various speeds between home and away matches. Although

significant differences were found for both HSR and TD with large effect sizes, this difference on TD was not reflected in the multiple regression models for estimation of TD. Ryan et al. (7) have reported that individual aerobic fitness and contextual factors significantly influence running performance during Australian football matches.

Practical Applications

- Broaden our knowledge on the influence of individual aerobic fitness, playing position and match location upon the match running performance of an elite soccer team throughout a season.
- Assist the coaches to plan and organize their team adequately.
- Improve the understanding and the analysis of players' match running performance during a soccer match.
- Improve the interpretation of players' physical performance behavior during a season upon specific fitness and situational variables.

Limitations

- The population studied is characterized by high individual cardiovascular fitness (v-VO_2max and VO_2max values) and certain psychological and cultural characteristics, technical skills, team formation, defensive and offensive tactical functions.
- Our predictive models for the distances covered at various speeds and the number of sprints performed of elite soccer players during competition may have limited generalizability because of the specific population used in the present study, although previous studies have shown a variety of influence of physical and contextual factors on match running activities.

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References

1.Krustrup P, Mohr M, Ellingsgaard H, Bangsbo J. Physical demands during an elite female soccer game: importance of training status. Med Sci Sports Exerc. 2005;37(7):1242-8.
2.Reilly T, Gilbourne D. Science and football: a review of applied research in the football codes. J Sports Sci. 2004;21(9):693-705.
3.Rampinini E, Bishop DJ, Marcora S, Bravo D, Sassi R, Impellizzeri F. Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. Int J Sports Med. 2007;28(3):228-35.
4.Lago C, Casais L, Dominguez E, Sampaio J. The effects of situational variables on distance covered at various speeds in elite soccer. Eur J Sport Sci. 2010;10(2):103–9.
5.Buchheit M, Modunotti M, Stafford K, Gregson W, Di Salvo V. Match running performance in professional soccer players: effect of match status and goal difference. Sport Perform Sci Rep. 2018;March 21:1-3.
6.Berthoin S, Gerbeaux, M, Geurruin F, Lensel-Corbeil G, Vandendorpe F. Estimation of maximal aerobic speed. Sci Sport. 1992;7(2):85-91.
7.Ryan S, Coutts AJ, Hocking J, Kempton T. Factors Affecting Match Running Performance in Professional Australian Football. Int J Sports Physiol Perform. 2017;12(9):1199-204.
8.Swaby R, Jones PA, Comfort P. Relationship between maximum aerobic speed performance and distance covered in rugby union games. J Strength Cond Res. 2016;30(10):2788-93.
9.Buchheit M, Mendez-Villanueva A, Simpson B, Bourdon P. Match running performance and fitness in youth soccer. Int J Sports Med. 2010;31(11):818-25.
10. Di Salvo V, Baron R, Tschan H, Calderon Montero FJ, Bachl N, Pigozzi F. Performance characteristics according to playing position in elite soccer. Int J Sports Med. 2007;28(3):222–7.

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