Match Running Performance on Three Different Competitive Standards in Norwegian Soccer

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Authors

Atle Sæterbakken[1], Vebjorn Haug[1], Dan Fransson[2], Halvard Nikolai Grendstad[3], Hilde Stokvold Gundersen[3], Vegard Fusche Moe[1], Einar Ylvisaker[1], Matthew Shaw[1], Amund Riiser[1], Vidar Andersen[1]

Affiliations

1 Department of Sport, Food and Natural Sciences, Hogskulen pa Vestlandet - Campus Sogndal, Sogndal, Norway
2 Departement of Food, and Nutrition and Sport Science, Center of health and Performance, Gothenburg, Sweden
3 Department of Food, and Nutrition and Sport Science, Hogskulen pa Vestlandet, Bergen, Norway

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Correspondence

Dr. Atle Sæterbakken
Department of Sport, Food and Natural Sciences
Hogskulen pa Vestlandet – Campus Sogndal,
PB133
6856 Sogndal
Norway
Tel: + 47/566/7 000
atle.saeterbakken@hvl.no

ABSTRACT

The aim of the study was to compare running performance of three competitive standards and to examine the effects of being promoted to a higher league in Norwegian football. One club's first and second team were included. The first team consisted of professional soccer players playing at Level 2 (2015 season) and Level 1 (2016 season). The second team consisted of amateurs playing at Level 4. A fully automatic tracking system was used to examine running performance, divided into different running-speed categories and playing position. Forty-one matches were included containing 278 observations. Level 1 performed 61 and 51 % sprinting compared to Level 2 and Level 4 but similar high-speed running. Similar high-speed running distances were observed only for the different playing positions at Level 1 compared to Level 2 and 4. The sprinting distance was greater for the central defender and attacker, and the number of accelerations was greater for central midfielders and wide midfielders' playing at Level 1 compared to lower competitive standards. In conclusion, better competitive standards resulted in greater high-intensity actions than lower leagues in Norwegian soccer. Furthermore, only central defenders and attackers increased their high-intensity locomotions when the team was promoted.

Introduction

Time-motion analysis techniques (i. e., video, GPS or radio signal systems) used to quantify match running performance in soccer have increased in the last decade [5, 8, 9]. Sport science has enabled the identification of physical capacities of different playing positions, leagues, and performance levels with the information used to improve training and testing protocols [4, 7, 16]. Although the majority of these studies have included professional soccer players in the top European leagues, little is known concerning running performance in lower-ranked leagues or changes in running performance for a team that is promoted to a higher competitive standard.

In general, similar total running distances (10–13 km) have been observed between different competitive standards and leagues [8, 26]. It has been argued that total distance is not a critical measurement of running performance in soccer. However, high-speed running (typical > 19.8 km/h) separates higher standards of players and leagues from lower standards [15, 21]. High-speed running distances correspond to approximately 8–10 % of the total distance [7, 11]. Mohr et al. [21] demonstrated 28 % and 58 % more high-intensity running (> 14.4 km/h) and sprinting in Italian elite league players compared to sub-elite Danish League players. Similarly, a greater distance covered in high-speed running has been observed in top versus middle- and bottom-ranked teams in the Danish league [15]. However, Bradley et al. [5] compared high-intensity activity patterns between domestic players from elite European teams with elite international players from the top 10 teams from the FIFA world ranking list. No differences were observed between the players regarding high-speed running distance, mean recovery time, or maximal running speed.

Different playing positions have different running performances [5, 7, 11]. The majority of the studies reports greater high-speed running distances (19.8–25.2 km/h) for wide midfielders and fullbacks compared to other positions, with central defenders performing the lowest high-speed running distance among professional players [7, 11, 16]. In sprinting (> 25.2 km/h), the distances reported are 123–346 m depending on playing position [7, 16]. Examining the progression of match performance across seven seasons in the English Premier League, Bush et al. [8] displayed increased high-intensity running by 24–35 % and sprinting by 36–63 % across different playing positions. The findings demonstrate an evolution in physical demands among professional soccer players.

Only a few studies have compared match running performance across different standards in a single country [4, 12]. Di Salvo et al. [12] compared the English Premier League and Championship (Levels 1 and 2) and demonstrated greater distances across all velocity categories (jogging, running, high-speed running, and sprinting) in the Championship than Premier League. In comparison, Bradley et al. [4] demonstrated greater high-speed running and sprinting in League 1 and Championship (Levels 3 and 2, respectively) than Premier League (Level 1). To the authors' knowledge, no previous studies have compared the running performance of players across three different competitive standards in lower-ranked leagues. Furthermore, little is known of the effects of promotion to a higher competitive standard on match running performance [22]. Therefore, the aim of the study was two-fold: 1) to compare running performance of three competitive standards, and 2) to examine the effects of being promoted.

Methods and Methods

Study design

An exploratory observational design was used to assess the aims. The data were collected during two seasons from a single professional football club in Norway and included matches played by both the first and second (reserve) team. During season 1 (2015), the first team played in the Norwegian first division (Level 2), the second highest league in the Norwegian football league system. During season 2 (2016), the first team played in the Norwegian Elite League (Level 1) following promotion in 2015. The locomotion data from the second team (playing at Level 4) were collected in the 2016 season. A total of 41 matches divided across the 3 competitive standards were included in the analyses (▶ **Table 1**). The matches were played in the home arena of the club using a fully automatic tracking system based on radio waves (ZXY Technology Ecosystem, Chyronhego, Trondheim, Norway). Running performance was divided into different running-speed categories and playing positions.

Subjects

Data from a total of 41 home matches were included (▶ **Table 1**). The data included 15 matches from Level 1, 14 matches from Level 2 and 12 matches from Level 4. Only locomotion from the players who started and completed a match were analyzed [17]. Goalkeepers were excluded from the study because they have different physical performance demands compared to outfield players [7, 17]. The total observations that fulfilled the inclusion criteria were 278 (▶ **Table 1**).

All teams played the same formation (4–4–2) with similar training philosophies and offensive match strategies (e. g., direct play). Further, some players from the Level 1 team played in Level 4 (n = 3) for match training or after recovery from injuries. Players playing in both Level 1 and Level 4 were defined as players belonging to only one team, i. e., in which they played the most matches. All players were informed orally and in writing of the procedures and provided their written consent before they were included [3] in the study. The study complied with the latest version of the Declaration of Helsinki, was conducted according to international standards [14] and approved by the Norwegian Centre for Research Data (47559/3/KH).

Measurements

The players wore small transponders (ZXY Sport System Transponder/IP grade, Chyronhego) monitoring their position at a frequency of 20 Hz. Before matches, the transponders (weighing 21 grams) were placed in belts and handed out to the players. The belts were worn around the hip with the transponders placed at the back. The data were transferred by microwaves to four receivers (ZXY RadioEyeTM Positioning Sensor, Chyronhego) mounted up in the light masts in each corner of the soccer field. By integrating position information from the four receivers in an advanced vector-based process, the player's position and movement could be determined

(for details; www.chyronhego.com). A beacon functioned as a control unit for the transponders and synchronized them to avoid interference in the signaling [25]. The reliability of the system was determined in a previous study reporting an interclass correlation (ICC) coefficient of 1.0, 0.999, and 0.999 (p = 0.001) for x- and y- and total distance, respectively [17].

Further, the data were compressed and filtered by a Linux server using Ubuntu 14.04 before they were stored in an SQL database. The data were transferred from the database to a software program (Excel 2013; Microsoft, Redmond, Washington, USA). All matches were monitored live by researchers using a software program (ZXY Sport Tracking, Chyronhego).

Criteria of data classification

Combining the positioning data and the time frame, the movements (distance covered) were divided into total distance of high-speed running (19.8 < 25.2 km/h) and sprinting (> 25.2 km/h) in accordance with previous and similar studies [17, 27]. The number of accelerations was also monitored. An acceleration was operationally defined as > 2 m·s^{-2} lasting more than 0.5 s and terminated once acceleration fell below 1 m·s^{-2}. Finally, when the acceleration fell below the minimum point, the acceleration was defined as ended.

Statistical analyses

All data was tested for normal distribution using the Kolmogorov-Smirnov test and the Levene's test for homogeneity. Linear mixed models were used to assess differences between the 3 competitive standards (fixed factor) including players and match as individual random intercept factors in the models. Differences in the locomotion categories for the 5 different playing positions were analyzed within the three competitive standards using the same model. All statistical analyses were conducted with SPSS version 25.0 (SPSS Inc., Chicago, IL, USA). All results are presented as means ± standard deviations and Cohen's d effect size (ES). An ES of 0.2 was considered small, 0.5 medium, and 0.8 large [10]. Statistical significance was accepted at p ≤ 0.05.

▶ **Table 1** An overview of the number of valid observations, players' positions, and leagues in addition to the numbers of players (n) observed in each position and in total.

Position	Level 1	Level 2	Level 4
Central defenders	25 (n = 3)	24 (n = 3)	23 (n = 4)
Full-backs	29 (n = 3)	20 (n = 3)	13 (n = 8)
Central midfielders	16 (n = 4)	21 (n = 4)	15 (n = 8)
Wide midfielders	19 (n = 5)	18 (n = 6)	11 (n = 4)
Attackers	18 (n = 4)	12 (n = 4)	14 (n = 5)
Total observations	107 (n = 14)	95 (n = 17)	76 (n = 23)

Results

Locomotion and competitive standards

Analyses demonstrated 24 % and 20 % non-significant greater distance in high-speed running in the Level 1 compared to Level 2 players (p = 0.229; ES = 0.61) and Level 4 players (p = 0.243; ES = 0.48) with no differences between Level 2 and Level 4 (p = 0.919). In sprinting, the players in Level 1 matches performed 61 and 51 % greater sprint distances than players at Level 2 (p = 0.025; ES = 0.85) and Level 4 (p = 0.040; ES = 0.69), with no difference between Level 2 and Level 4 (p = 0.756). Players at Level 1 and Level 2 demonstrated 16 % (p = 0.080, ES = 0.60) and 24 % (p = 0.001; ES = 0.95) more accelerations than players at Level 4. Players at Level 1 and Level 2 demonstrated a similar number of accelerations (p = 0.175). There were no differences in total distance among the competitive standards (p = 0.640–0.982). All details are presented in ▶ **Table 2**.

Playing position and competitive standards

For the total distance, analyses demonstrated no differences in total distance between the competitive levels for any of the five playing positions (p = 0.197–0.962). For further details, ▶ **Table 3**.

For high-speed running, analyses demonstrated no differences among the competitive levels for any of the 5 playing positions (p = 0.079–0.990). Despite running 26.6 % and 30.0 % as central defenders in Level 1 compared to Level 2 and 4, no statistical differences were observed (p = 0.079–0.100; ES = 0.96 and 1.06). For the attackers, 31.2 % non-significant lower high-speed running distances were performed in Level 2 compared to Level 1 (p = 0.081; ES = 1.90). For further details, ▶ **Table 3**.

In sprinting, analyses demonstrated central defenders in Level 1 sprinted 82.9 % and 85.2 % longer than Level 2 (p = 0.042; ES = 0.96) and Level 4 (p = 0.044; ES = 1.06) with no differences between Level 2 and 4 (p = 0.873). For the full-backs, central defenders, and wide midfielders, no differences in sprinting distances were observed between competitive standards for the full-backs (p = 0.075–0.998). Despite sprinting 70.7 % longer in Level 1 than Level 4 for the central midfielders, no significant difference was observed between competitive standards (p = 0.077). Similarly, the wide midfielders sprinted 52.8 % and 61.2 % in Level 1 compared to Level 2 (p = 0.092; ES = 1.01) and Level 4 (p = 0.075; ES = 1.18). No statistical differences were observed. For the attackers, Level 1 sprinted 72.6 % (p = 0.020; ES = 1.72) longer distances than Level 2, but similar distances compared to Level 4 (p = 0.219). No differenc-

▶ **Table 2** The total distance, different speed categories, and number of accelerations among competitive standards Level 1, Level 2, and Level 4 in Norwegian soccer.

Categories	Level 1	Level 2	Level 4	Differences	ES
Total distance (m)	11 151 ± 812	11 037 ± 788	11 057 ± 953	–	0.02–0.14
High-speed running (m)	842 ± 278	679 ± 247	702 ± 309	–	0.48 and 0.61
Sprinting (m)	218 ± 112 *	135 ± 76	144 ± 103	Level 1 > Level 2 and Level 4	0.69 and 0.85
Acceleration (n)	149 ± 37#	159 ± 35 *	128 ± 33	Level 2 > level 4	0.60 and 0.95

* Significant difference (p < 0.05). # Statistical tendency (p < 0.100). ES = effect size.

▶ **Table 3** An overview of the locomotion of the different speed categories among the different competitive standards.

Playing position	Level 1	Level 2	Level 4	Significant differences ($p < 0.05$)	Effect size
Central defenders					
Total distance (m)	10 513 ± 389	10 403 ± 522	10 106 ± 457		
High-speed running (m)	580 ± 133#	458 ± 123	444 ± 127		0.96 and 1.06
Sprint (m)	150 ± 62 *	82 ± 45	81 ± 54	Level 1 > Level 2 and Level 4	1.25 and 1.18
Accelerations (n)	109 ± 14	129 ± 16 *	99 ± 16	Level 2 > Level 1 and Level 4	1.33 and 0.60
Full-backs					
Total distance (m)	10 885 ± 521	10 729 ± 564	10 972 ± 1001		
High-speed running (m)	865 ± 223	759 ± 113	849 ± 167		
Sprint (m)	242 ± 117	177 ± 77	217 ± 123		
Accelerations (n)	146 ± 31	167 ± 26	135 ± 23		0.73 and 1.30
Central midfielders					
Total distance (m)	11 834 ± 687	11 586 ± 606	11 843 ± 708		
High-speed running (m)	669 ± 223	586 ± 264	556 ± 165		
Sprint (m)	140 ± 84	97 ± 64	82 ± 59		
Accelerations (n)	147 ± 34 *	154 ± 29	118 ± 13	Level 1 > Level 4	1.15
Wide midfielders					
Total distance (m)	11 603 ± 831	11 745 ± 688	11 768 ± 529		
High-speed running (m)	1094 ± 199	968 ± 183	934 ± 343		
Sprint (m)	295 ± 125	193 ± 70	183 ± 103		1.01 and 0.96
Accelerations (n)	178 ± 24	196 ± 33	145 ± 25 *	Level 1 and Level 2 > Level 4	1.35 and 1.72
Attackers					
Total distance (m)	11 384 ± 927	10 798 ± 526	11 296 ± 630		
High-speed running (m)	1056 ± 203#	721 ± 125	963 ± 312		1.90 and 0.36
Sprint (m)	259 ± 71 *	150 ± 51	214 ± 87	Level 1 > Level 2	1.72
Accelerations (n)	180 ± 29	162 ± 35	166 ± 33		

Statistical tendency ($p < 0.100$). * Statistical differences among competition standards.

es were observed between Level 1 and Level 2 (p = 0.125). For further details, ▶ **Table 3**.

For the number of accelerations, analyses demonstrated 18.3 % and 30.5 % more accelerations for the central defenders in Level 2 compared with Level 1 (p = 0.026; ES = 0.60) and Level 4 (p = 0.003; ES = 1.33). No difference was observed between Level 1 and 4 (p = 0.204). For the central midfielders, Level 2 resulted in 30.5 % more accelerations than Level 4 (p = 0.011; ES = 1.15). There was no significant difference between Level 1 and 4, but the central midfielders demonstrated 24.5 % more acceleration than Level 4 (p = 0.079; ES = 1.61). No difference was observed between Level 1 and 2 (p = 0.463). Level 1 and Level 2 demonstrated 22.7 and 35.1 % more accelerations than Level 4 (p = 0.001–0.019; ES = 1.35–1.72) with no difference between Level 1 and 2 (p = 0.105). A similar number of accelerations was observed among the competitive levels for the full-backs and the attackers (p = 0.121–0.881). For further details, ▶ **Table 3**.

Discussion

The aim of the study was to compare the running performance among the competitive standards and to examine the effects of being promoted to a higher league. The main finding was an increase in high-intensity performance (sprinting and number of accelerations) for the two top divisions (Level 1 and Level 2) compared to Level 4 in Norwegian soccer. Being promoted to a higher league resulted in greater sprinting distances. However, when the different playing positions were analyzed, greater sprinting distances and a higher number of accelerations were observed for the central defenders, wide midfielders, and attackers in Level 1 compared to Level 2 and 4 in Norway.

Similar distances in high-speed running (19.8–25.2 km/h) but greater sprinting (> 25.2 km/h) were observed in the highest competitive levels in Norway compared to competitive Level 2 and Level 4. However, no differences were observed between Level 2 and Level 4; ▶ **Table 2**). These results were partly as hypothesized, but we hypothesized greater high-speed running performance between these two competition standards. Level 1 and Level 2 contained professional players whereas Level 4 players were amateurs. Different training volumes, time to recovery, training background, and nutrition may have influenced running performance, but these factors were not included in the study. Still, all data measurements were conducted in the same arena on artificial turf, which reduced the bias when interpreting the results. Moreover, Level 4 contained talents or players aiming to become professional players in the top levels. The Level 4 players may therefore not be representative of the league.

Being promoted from Level 2 to Level 1 resulted in 24 % non-significant and 61 % greater distance in high-speed running and sprinting, but with a similar total distance and number of accelerations

when total performance was analyzed. Several plausible explanations could be used to interpret the results. First, playing at a higher performance level may result in better ball-handling technique, which may increase the number of successful passes, movements, and involvements for each player [8]. Further, playing against better-organized teams may result in improved running performance with a lesser margin of error. If mistakes were made, it has been shown that more explosive locomotion occurred to correct the errors [5, 6, 8, 21]. For example, Mohr et al. [21] demonstrated greater high-intensity running in elite Italian League players compared to sub-elite Danish League players. However, not all previous studies have supported these findings [5, 8, 22]. Secondly, the team playing in Level 2 won their league. In 18 of 30 matches, they were victorious with half of them by more than two goals. Having the lead or leading comfortably in a match may have resulted in changing to a more defensive formation/tactic and thereby less high-speed running. Playing at Level 1, the team won 8 of 30 matches and only 2 of those were with more than two goals. Rampinini et al. [23] demonstrated greater high-speed running distance when teams play against the higher-placed teams compared to the teams positioned at the bottom of the league. These findings may support the speculation that playing at higher competitive levels resulted in more high-speed running. Thirdly, changes in playing squad between the two seasons may have resulted in new players with a specific physical capacity (i. e., ability to perform high-speed running) or experience playing soccer at a greater intensity [1, 19, 20]. New players with a different physical capacity may have affected the results. However, 7 players played in both Level 1 and Level 2, which represent 41 and 50 % of the players included in the two competitive levels. An analysis of the running performance of these players demonstrates an increase in high-intensity running and sprinting by 32 and 89 %. Improved training status among these players, or being promoted to a higher competitive level, may have resulted in the increased high-intensity performance. Still, this inference is not supported by Morgans et al. [22], who compared the two highest leagues in England and demonstrated no differences in high-intensity running and sprint distances. In Brazilian football, the 3rd and 4th competitive standards produced greater total distances, mean speed, and frequency of high-intensity activities than the 1st level [2].

There were no overall differences between the two highest competitive standards when examining team performance. However, when different playing positions were analyzed, differences among competitive standards were observed. The different playing positions produced similar total distances among the competitive standards. The results were as hypothesized and supported by previous findings [8]. For example, Bush et al. [8] reported a 2 % reduction in total distance in the Premier League between the 2006/2007 and 2011/2012 seasons. The central defenders playing at Level 1 demonstrated non-significant greater total distances in high-speed running (19.8–25.2 km/h) but greater sprinting distances (> 25.2 km/h) compared to Level 2 and Level 4. Despite a 27 and 30 % greater high-speed running distance in Level 1 compared to Level 2 and 4, only statistical tendencies ($p < 0.100$) were observed. Importantly, the effect sizes of the greater high-speed running distance in Level 1 were 0.96 and 1.06, which are considered a large effect [10]. The results for the central defenders were partly as hypothesized, because we also expected greater high-intensity performance in Level 2 compared to Level 4 [22]. Greater sprint performance may be a result of technical mistakes (for example, an incomplete pass) at Level 1, whereby the central defenders had to compensate for the errors with high-intensity defensive running to a greater extent than in the lower levels.

For the full-backs, central midfielders, and wide midfielders, similar high-speed running and sprinting among competitive levels were demonstrated that were not as hypothesized. Irrespective of this finding, the wide midfielders demonstrated 71 % non-significant greater sprint distance in Level 1 compared to Level 4. The only difference observed for these 3 playing positions was the number of accelerations. In general, both Level 1 and 2 demonstrated a greater number of accelerations than Level 4 with a large effect size (ES = 0.73–1.72). The attackers in Level 1 tended towards greater high-speed running distances but demonstrated greater sprinting than Level 2. Different attackers, playing formation, or a change in tactics may explain the differences. For example, different playing formations been used to explain different locomotion in Brazilian football [2]. An interesting observation is the lack of statistical differences between Level 2 and Level 4 in high-intensity and sprint distances, with exception of the central defenders. Regardless, differences in the number of accelerations among competitive standards were observed for central defenders and midfielders (central and wide), but no differences between Level 1 and 2 with the exception of the central defenders. This partly supports our speculation that better competitive levels result in more explosive running performance. Low statistical power due to low observation for each position is most likely the reason why no statistically significant differences in high-speed running distance and sprinting were observed among the different playing positions. The sprinting distance and number of accelerations in the present study could indicate that the number of high-intensity actions is greater at a higher performance level due to a higher standard. For example, Bush et al. [8] demonstrated an increase in the number of passes by 25–70 % from the 2006/2007 season in Premier League to the 2012/2013 season. Further, Bradley et al. [4] compared the three highest competition standards in England and demonstrated 4–39 % higher numbers of passes, successful passes, balls received, and average touches in the Premier League compared to the lower standards.

In contrast to the present findings, players in the English Premier League had a 7–29 % shorter high-speed running distance than the Championship (Level 2) and League 1 (Level 3) [4, 12]. However, England has several professional leagues while in Norway only the two best leagues are defined as professional. Most likely, the gaps between competitive standards in England are greater than in Norway. Further, previous studies comparing the locomotion within a competitive level have demonstrated that the highest-ranked teams performed less high-speed running than lower-ranked teams [11, 24]. This may explain the difference in running performance between Level 1 and Level 2.

To the author's knowledge, no previous studies have compared lower-ranked European leagues similar to the performance standards in Norway. Only one previous study has examined locomotion at Norwegian Level 1 [17]. Ingebrigtsen et al. [17] examined the best team in Norway that qualified for the UEFA Europe League the same year. Compared to the present results, Ingebrigtsen et al. [17]

reported lower and higher distances in high-speed running and sprinting depending on the different playing positions. Previous studies comparing different competitive standards from higher-ranked leagues have also demonstrated non-conclusive results [1, 4, 9, 20–22]. All these studies were performed in countries with several professional competitive levels and in leagues better ranked than the Norwegian leagues. Previous studies have also demonstrated that high-speed running is strongly correlated with training status [8, 18, 19], which may explain the results of the present study compared to better ranked leagues.

Only home matches for a single football club were included in the present study, with 41 matches analyzed across three teams where two were professional and one amateur. The results may therefore not be generalized to other leagues or competitive standards. However, this is the first study to include locomotion in several competition standards in Norway. Further, low statistical power may increase the chances of performing type II errors, which may be the case especially for comparisons of the locomotions for the different playing positions. However, the ZXY tracking system was not portable like GPS systems, which made it impossible to include more players or matches within the two years of data collection. In addition, the locomotion (i. e., sprinting, accelerations, and high-intensity running) was summed from an entire match. Dividing the analyses into peak periods or periods of 5–15 min might reveal differences between competitive standards in high-intensity actions. Finally, we did not include anthropometric data (i. e., age) in the data collection.

In conclusion, higher competitive levels demonstrated greater sprint distances but similar high-speed distances compared to lower leagues in Norwegian soccer. No differences in locomotion were observed between Level 2 and Level 4. Being promoted to higher competitive level increased only the sprint distance at a team performance level, and high-intensity actions increased for the central defender, wide midfielder, and attacker playing positions.

Practical applications

Physical capacity in soccer is one of several factors that explains team success in soccer [13]. Still, no differences were observed between Level 2 compared to Level 4, which may reflect the standards in Norwegian soccer or the physically demanding tactics used in Norwegian soccer. Further, being promoted to a higher competitive level only increased sprint distances when team performance was analyzed. However, when the different playing positions were analyzed, more intensive and explosive locomotion was observed. One interesting observation was that players returning from injuries or who needed match training from the Level 1 team played matches in Level 4. The physical load may not be enough compared to the requirements in Level 1, which is important for coaches to recognize. Finally, young players aiming to play football in Level 1 need to focus on explosive movements like sprinting and acceleration to reach the physical level required.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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