A COMPARISON OF SPRINT TECHNIQUE BETWEEN PROFESSIONAL FOOTBALL PLAYERS AND ELITE SPRINTERS

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This study compared sprint technique between professional footballer players and elite sprinters. Professional football players sprint technique was assessed using 2D video analysis and compared to publicly available data of elite sprinters from the IAAF biomechanical reports. Results showed sprinters had higher step frequencies and contacted the ground further back, with lower touchdown and higher toe-off distances.

KEYWORDS: kinematics, acceleration, maximum velocity, sprinting.

INTRODUCTION: Sprint performance has become increasingly important within association football, with an increase of up to 50% in the average number of sprints in a game and an increase of 8% in the total distance covered in a sprint (Campos Vázquez et al., 2023), leading to an increase in game speed of 15%, which is projected to reach approximately 9.8 m/s by 2030 (Barnes et al., 2014). In addition, performance analysis within professional football matches has shown that linear sprinting to be the most frequent powerful action preceding a goal (Faude et al., 2012). Consequently, sprinting ability has become of the utmost importance to both young and professional football players.
Sprint acceleration is a typical feature of football, characterised by shorter distances of high intensity requiring the ability to generate large amounts of horizontal force to accelerate the individual's mass (Morin et al., 2012). Typically, elite footballers will cover relatively short sprint distances of 10-20 m (Andrzejewski et al., 2013), highlighting the importance of sprint acceleration. However, sprint distances beyond 20 m usually reflect periods of peak intensity, often associated with worse case scenarios which can be decisive to the outcome of the game, such as emergency defending (Oliva-Lozano et al., 2020; Schulze et al., 2021). While sprint acceleration over relatively short distances is of great importance to elite football players, longer sprints and maximal velocity sprinting should not be overlooked.
A variety of research has attempted to examine characteristics of sprint performance using forward dynamics computer simulation (Miller et al., 2012), 3D motion analysis (Yu et al., 2008) or simplified force-velocity profiling (Samozino et al., 2016). Often such studies will aim to examine either general populations (such as physical education students: Samozino et al., 2016) or sprint specialists (Morin et al., 2012). In a few cases, sprinting characteristics of elite sports teams has been examined, but usually only via simplified data analysis methods, such as split times in elite Australian rules footballers (Young et al., 2008). To date no study has examine the differences in sprint characteristics between elite sprinters and professional football players. The aim of the present study was to compare sprint technique between professional footballer players and elite sprinters.

METHODS: Eleven male outfield professional footballers (mean ± SD: age 23.4 ± 3.78 years; stature 1.83 ± 0.07 m; body mass 79.4 ± 7.8 kg) competing for the same English Premier League team volunteered to participate in this study. All individuals completed a pre-screening health questionnaire and provided written informed consent, which was approved by the University ethics committee. An exclusion criterion was created for goalkeepers due to an insignificant exposure to linear sprinting. Comparisons to elite sprinters were made possible by utilising the Biomechanical reports from the 100 m final of the 2017 IAAF World Championships (Bissas et al., 2018) and the 60 m final of the 2018 IAAF World Indoor Championships (Walker et al., 2019).

Sprint testing of the football players was carried out in a single day in a familiar indoor venue with a 3G artificial turf pitch. Each player wore their usual football boots and club training attire typical for training. All players undertook their regular standardised warm-up supervised by the club's Head of Performance, followed by three sub-maximal effort 30-metre sprints at 60, 70, and 80% of their self-perceived maximum for familiarisation. Players then rested for 4 minutes while visible markers were affixed to the anterior superior iliac spine, posterior superior iliac spine, and greater trochanter. Sprint testing consisted of three maximal effort 30 m sprints from a standing start position (preferred foot forward) with a self-selected start time. Each sprint was separated by at least 4 minutes of passive recovery.
Data were collected using three 2D high-frequency cameras (1 x iPhone 12 Pro, 2 x iPhone 12, 240 Hz, resolution 1080p, Apple Inc., USA) positioned 15 m from, and perpendicular to, the centre of the running lane at 5 m, 15 m, and 25 m (Figure 1). Each camera was placed on a tripod at 104 cm above the ground, to capture sagittal plane images across the run with a 14 m wide field of view. Measurements were only taken from each central 10 m to reduce parallax error. Brower photocell timing gates (BRO001; Brower, Draper, UT, USA) were placed at 0 m, 5 m, 10 m, 20 m and 30 m along the track, timing to the nearest 0.001s (Figure 1).

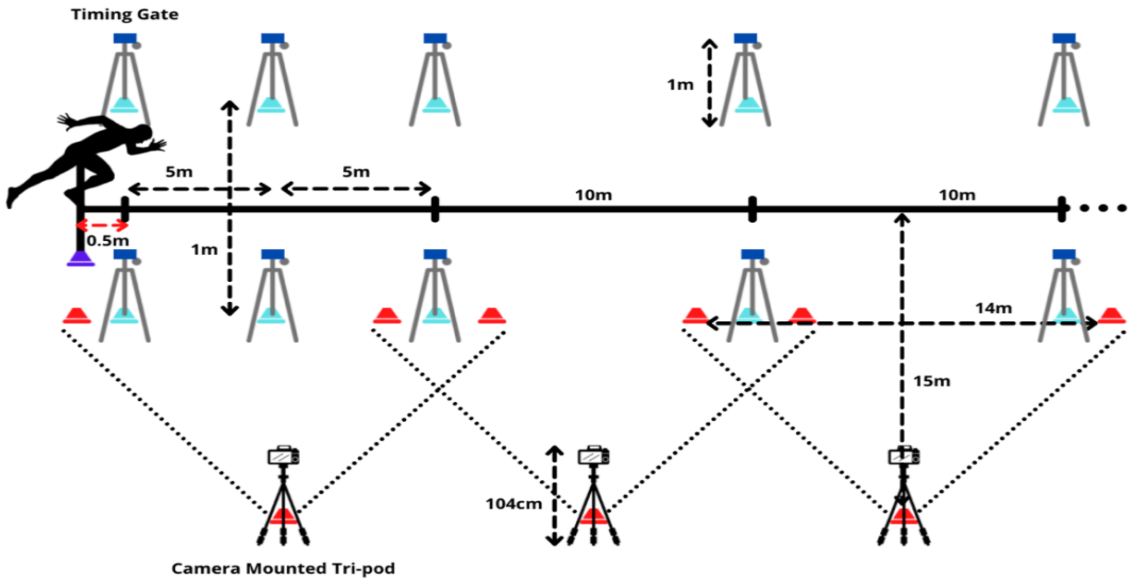

Figure 1: Data collection setup showing the locations of cameras and timing gates.

Each trial was manually digitised by a single investigator using Binary Video Analysis (Version 9.6.6; Sliac, Banská Bystrica, Slovakia). The human body was modelled at 5 points: left acromioclavicular joint, left greater trochanter, both knee and ankle joint centres, and at the toe of each boot. Instances of touchdown (first frame the foot was visibly in contact with the ground) and toe-off (first frame the foot had visibly left the ground) were identified and spatiotemporal (ground contact time [GCT], flight time [FT], step length [SL], step frequency [SF]) and kinematic (touchdown [TD_DCM] and toe-off [TO_DCM] distance to centre of mass, average trunk angle [ATA] (max velocity) or trunk angle range [TAR] (acceleration)) variables were calculated. All distances were normalised to body height.
Three participants selected at random from the testing sample were manually digitised by the same researcher on two separate occasions, 16-19 days apart. Test-retest reliability of manual digitisation was measured using an intraclass correlation coefficient (ICC 3,1) with 95% confidence intervals (CI) (Wild et al., 2018). ICC values were defined as poor (<0.5), moderate (0.5-0.75), good (0.76-0.90) and excellent reliability (>0.90) (37). Similar to the work of Wild et al. (2018), step characteristics and kinematic variables across the first three steps for each participant were averaged to represent acceleration. Maximum velocity characteristics were analysed using averaged step data over the 20-30 m split.
Normal distribution of data was assessed for all variables using the Shapiro-Wilk test ($p>0.05$). Independent samples t-tests and Cohen's d (Cohen, 1992) effect sizes (ES) were used to

compare variables between the two groups. The magnitude of effect size was evaluated using the following scale: trivial (≤ 0.19), small (0.20–0.59), moderate (0.60–1.19), large (1.20–1.99), very large (2.0–4.0) and extremely large (≥ 4.0) (39). between populations. All statistical analysis was performed using SPSS version 26 (IBM Corp., Armonk, NY, USA) with a significance level of p<0.05.

RESULTS: Manual digitisation test-retest reliability was excellent (ICC = 0.996). Independent samples *t*-tests showed significant mean differences between footballers and sprinters in spatiotemporal and kinematic variables for both acceleration and maximum velocity sprinting (Tables 1 & 2). During acceleration sprinting (Table 1) there were large differences for FT (p<0.01, ES: 1.60) and SF (p<0.01, ES: -1.71), a very large difference for TD_DCM (p<0.001, ES: 3.95), and an extremely large difference for TO_DCM (p<0.001, ES: -7.03). Similarly, during maximum velocity sprinting (Table 2) there were large differences for SF (p<0.01, ES: -1.63) and TD_DCM (p<0.01, ES: 1.95), very large differences for GCT (p<0.001, ES: 2.56), TO_DCM (p<0.001, ES: -2.19), and an extremely large difference for SL (p<0.001, ES: -4.27).

Table 1: Comparison of sprint characteristics during acceleration phase.

	Footballers (mean ± std)	Sprinters (mean ± std)	Effect Size (Cohen's d)
Ground contact time (ms)	164 ± 12	161 ± 12	0.19
Flight time (ms)	**71 ± 9**	**55 ± 11**	**1.60****
Normalised step length	0.70 ± 0.03	0.72 ± 0.04	-0.30
Step Frequency (Hz)	**4.30 ± 0.25**	**4.66 ± 0.16**	**-1.71****
Trunk Angle Range (°)	8.6 ± 12.7	9.3 ± 4.8	-0.07
Normalised touchdown distance	**0.12 ± 0.03**	**0.01 ± 0.03**	**3.95*****
Normalised toe-off distance	**0.32 ± 0.02**	**0.47 ± 0.02**	**-7.03******

NOTE: variables calculated during the first 3 steps; elite sprinter data = 60 m final from 2018 IAAF World Indoor Championships; p < 0.05*, p < 0.01**, p < 0.001***

Table 2: Comparison of sprint characteristics during maximum velocity phase.

	Footballers (mean ± std)	Sprinters (mean ± std)	Effect Size (Cohen's D)
Ground contact time (ms)	**109 ± 8**	**93 ± 5**	**2.56*****
Flight time (ms)	115 ± 7	116 ± 7	-0.18
Normalised step length	**1.12 ± 0.06**	**1.32 ± 0.03**	**-4.27*****
Step Frequency (Hz)	**4.49 ± 0.16**	**4.80 ± 0.22**	**-1.63****
Average Trunk Angle (°)	78.6 ± 3.1	78.1 ± 2.9	0.17
Normalised touchdown distance	**0.24 ± 0.03**	**0.21 ± 0.02**	**1.95****
Normalised toe-off distance	**0.30 ± 0.02**	**0.34 ± 0.01**	**-2.19*****

NOTE: variables calculated during 20-30 m split for football players; elite sprinter = 100 m final from 2017 IAAF World Championships; p < 0.05*, p < 0.01**, p < 0.001***

DISCUSSION:

The aim of the present study was to compare sprint technique between professional footballer players and elite sprinters. Common across both phases of sprinting, elite sprinters consistently contacted the ground further back, with significantly lower TD_DCM and significantly larger TO_DCM. Differences in foot contact locations are indicative of more anteriorly orientated ground reaction force vectors (Wild et al., 2018), showing that elite sprinters are better able to project their centre of mass forwards, whilst also reducing breaking forces, during both acceleration and maximum velocity sprinting. Furthermore, during both phases of sprinting, elite sprinters had significantly higher SF, showing a higher leg turnover speed compared to footballers. However, it is unclear if this difference is due to technical differences or other neuromuscular factors not assessed here. During maximal velocity sprinting elite sprinters displayed significantly shorter GCT with no significant difference in FT compared to footballers. Lower GCT is likely a result of higher sprint speeds but coupled with similar FT the results show that elite sprinters are still capable of producing sufficient vertical impulse during this reduced GCT. During acceleration sprinting elite sprinters displayed significantly shorter flight times with no significant difference in ground contact time, suggesting sprinters produce less vertical impulse during this phase compared to footballers, but during similar GCT. It is possible that sprinters have a more anteriorly orientated ground reaction force vector, as indicated by foot contact distances, suggesting sprinters place more emphasis on propulsion during this phase than footballers do. Coupled with more anteriorly positioned foot contacts for footballers these findings suggest that footballers may be overstriding during acceleration, resulting in higher braking forces and longer GCT.

CONCLUSION:

The current study provides insight into the elite population of professional football players, highlighting lower SF and possible overstriding during both acceleration and maximum velocity sprinting when compared to elite sprinters. Future training interventions may wish to focus on increasing leg turnover and more optimal foot ground contacts during both phases of running to help improve sprinting performance in perspective football players and gain a competitive advantage over their opponents.

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