Straight sprinting is the most frequent action in goal situations in professional football

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Straight sprinting is the most frequent action in goal situations in professional football

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Abstract
The present study aimed to analyse the influence of speed and power abilities in goal situations in professional football. During the second half of the season 2007/08, videos of 360 goals in the first German national league were analysed by visual inspection. For the assisting and the scoring player the situations immediately preceding the goal were evaluated. The observed actions were categorised as: no powerful action, rotation (around the body's centre-line), straight sprint, change-in-direction sprint, jump, or a combination of those categories.

Two hundred and ninety-eight (83%) goals were preceded by at least one powerful action of the scoring or the assisting player. Most actions for the scoring player were straight sprints (n = 161, 45% of all analysed goals, \(P < 0.001\)) followed by jumps (n = 57, 16%), rotations and change-in-direction sprints (n = 22, 6% each). Most sprints were conducted without an opponent (n = 109, \(P < 0.001\)) and without the ball (n = 121, \(P < 0.001\)). Similarly, for the assisting player the most frequent action was a straight sprint (n = 137, \(P < 0.001\)) followed by rotations (n = 28), jumps (n = 22) and change-in-direction sprints (n = 18). The straight sprints were mostly conducted with the ball (n = 93, \(P < 0.001\)).

In conclusion, straight sprinting is the most frequent action in goal situations. Power and speed abilities are important within decisive situations in professional football and, thus, should be included in fitness testing and training.

Keywords: soccer, power, high-intensity running, video analysis, fitness training

Introduction
Professional football is characterised by high physical demands and frequent changes in exercise intensity (Di Salvo et al., 2007; Dupont, Akakpo, & Berthoin, 2004; Stolen, Chamari, Castagna, & Wisloff, 2005). Football players conduct 1000 to 1400 short-time actions with frequent changes every 4 to 6 s and high intensity actions about every 70 s (Stolen et al., 2005). Thus, power and speed abilities are generally believed to be relevant in decisive situations in football (Cometti, Maffiuleti, Pousson, Chatard, & Maffulli, 2001; Dupont et al., 2004; Meyer, 2006; Reilly, Bangsbo, & Franks, 2000; Wragg, Maxwell, & Doust, 2000). Surprisingly, there is only scarce scientific data substantiating the importance of power and speed in football.

The early findings of Jacobs, Westlin, Karlsson, Rasmussen, and Houghton (1982) that fast twitch muscle fibres were predominant (60% fast twitch fibres and 66% relative muscle area occupied in M. vastus lateralis) in top level Swedish football players might be regarded as an indication that power is an important discriminant factor in football. More recently, Cometti and colleagues (2001) reported that elite football players showed higher knee flexor strength and faster 10 m sprint times when compared to amateur players. Similarly, Coen, Urhausen, Coen, and Kindermann (1998) observed faster 10 and 30 m sprint times in higher level players. Furthermore, Arnason et al. (2004) compared team average physical fitness with team success (final league standing) in the two highest Icelandic football divisions and observed a significant relationship between average jumping height and team success. A recent study reported moderate negative correlations (\(r = -0.60\) and \(-0.65\)) between repeated sprint ability (average time of six 40 m (2 x 20 m) shuttle sprints) and the distances covered at very high intensities (> 19.8 km·h\(^{-1}\)) and while sprinting (> 25.2 km·h\(^{-1}\)) in elite football players (Rampinini et al., 2007a). Together, these findings might be interpreted as indirect evidence that speed...
and power abilities are of considerable importance in high level football. In particular, Cometti et al. (2001) concluded that short-sprinting performance could be an important determinant of match-winning actions in football. To date, however, this view is not substantiated by direct observational data.

In light of the lacking direct scientific data regarding the importance of speed and power in decisive situations in football, the present descriptive study aimed to assess the frequency of various powerful actions (straight sprints, change-in-direction sprints, jumps, rotations) in goal situations in professional football by video analyses. Goal situations were chosen, because they are the ultimate objective measures of success in football (Pollard & Reep, 1997; Tenga, Ronglan, & Bahr, 2010b).

**Methods**

During the second half of the season 2007/08 videos of 409 goals (out of a total of 429, missing recordings from 5% (7 out of 153) of all matches) in the first German national league were recorded on DVD from public television broadcast. Three percent of these goals were own goals, 8% directly resulted from a standard situation (free kicks, penalties) and 1% could not be evaluated due to insufficient video sequences. Thus, 360 goals (89% of recorded and 84% of all goals) were analysed for the scoring player. Eleven percent of those goals were assisted by a standard situation (corners, free kicks) and, consequently, 322 goals were analysed for the assisting player (Figure 1).

Public sport programmes show all goals of the highest German leagues with multiple replays in real time as well as slow motion from various perspectives. This enabled a comprehensive evaluation of most goal situations. For the assisting as well as the scoring player the situations directly preceding the goals (time from action while receiving the ball to the assisting pass or to the shot on goal, respectively) were evaluated by visual video analysis. For this purpose, the observer was free to watch each situation as often as was necessary to categorise the observed activities into one of the following main categories: rotation, straight sprint, change-in-direction sprint, jump, a combination of those categories or absence of the above mentioned actions (no powerful action). Each goal was visually analysed by one investigator. Inter-observer-reliability was assessed by two investigators independently analysing 30 randomly selected goals. One investigator analysed 24 goals twice 4 weeks apart to estimate intra-observer-reliability. Kappa coefficients for inter- and intra-observer reliability for the overall assessment were $\kappa = 0.75$ and $\kappa = 0.84$. This corresponded to 87% and 92% agreement, respectively.

**Main categories**

**Rotation.** This category comprised rotations of a player around his body's vertical centre-line. A rotation of at least $90^\circ$ had to be completed with the whole body. A rotation only of the upper body was not rated as a complete rotation. Kappa coefficients for inter- and intra-observer reliability were $\kappa = 0.70$ and $\kappa = 0.84$, respectively, corresponding to 97% and 96% agreement.

**Straight (linear) sprint.** This sprint was defined as a very high intensity run with (near) maximal velocity in a straight direction after a distinct acceleration. Kappa coefficients for inter- and intra-observer reliability were $\kappa = 0.63$ and $\kappa = 0.67$, respectively, corresponding to 83% agreement each.

**Change-in-direction sprint.** A change-in-direction sprint was defined as a very high-intensity run with two distinct and identifiable accelerations in different directions (more than $50^\circ$ from the initial sprint line) (Young, McDowell, & Scarlett, 2001). Slightly curved runs without a second acceleration phase were not assessed as change-in-direction sprints but instead as linear sprints. Kappa coefficients were:
inter-observer reliability $\kappa = 1.00$ (100% agreement), intra-observer reliability $\kappa = 0.84$ (96% agreement).

**Jump.** A jump was defined as a primary vertical movement with only partial horizontal direction (e.g. headers or tacklings in the air) and with clearly identifiable take-off and flight phase. Kappa coefficients were: inter-observer reliability $\kappa = 1.00$ (100% agreement), intra-observer reliability $\kappa = 0.84$ (96% agreement).

For all main categories, it was additionally evaluated whether those actions were completed under the pressure of an opponent, i.e., a defending player trying to conquer the ball or to impede the offensive action. In addition, for the straight sprint and change-in-direction sprint categories it was assessed whether the activity was performed with or without the ball. Ball possession was defined as the player having at least two contacts with the ball. Without ball possession was assumed when there was only one final contact before scoring or assisting a goal (direct play). Furthermore, the players were categorised according to their playing position (defender, midfielder, striker) as published on the official club homepages.

**Statistics**

In the present descriptive study data are given as absolute and relative frequencies and frequency tables were used to present data. Ninety-five percent confidence intervals for relative frequencies were calculated. Differences between categories with regard to the absolute and relative frequency of occurrence were analysed by means of chi-square testing.

An $\alpha$-level of $P < 0.05$ was accepted as statistically significant.

**Results**

In 298 out of 360 goals (83%) at least one powerful action of either the scoring or the assisting player was observed. In 62% (222 out of 360 goals) there was at least one powerful action of the scoring player resulting in a total of 262 powerful actions (Table I). The assisting player conducted at least one powerful action in 55% (176 of 322) of the goals. This resulted in a total of 205 powerful actions for the assisting player (Table I).

The assisting player conducted at least one powerful action in 55% (176 of 322) of the goals. This resulted in a total of 262 powerful actions (Table I). In 298 out of 360 goals (83%) at least one powerful action of the scoring player was observed. In 62% (222 out of 360 goals) there was at least one powerful action of the scoring player compared to midfielders ($P = 0.06$) and defenders ($P < 0.001$, Figure 3). Whereas defenders scored mostly after a jump (58%), strikers and midfielders scored more often after a straight sprint (62 and 70%, respectively, Table III). When strikers assisted a goal this was more often conducted after a powerful action compared to defenders ($P = 0.006$) and midfielders ($P < 0.001$, Figure 3). The most frequent powerful action while assisting a goal was a straight sprint (65 to 69% of all powerful actions) for all playing positions (Table III).

**Discussion**

The present study aimed to describe the frequency of powerful actions when scoring or assisting a goal in professional football. In 83% of all goals during the second half of the season 2007/08 in the German Bundesliga at least one powerful action of the scoring or assisting player was observed. The present results show that straight sprints are the most dominant powerful action in decisive offensive situations in elite football. Change-in-direction sprints, jumps and rotations seem to be of less importance when scoring a goal. Whereas most powerful actions of the scoring player (81%) were conducted without the ball (i.e. one-touch actions), this was equally distributed for the assisting player (50% direct play and 50% dribbling).

The main result of this study is that most goals were preceded by a powerful action. In particular, this was predominantly a straight sprint by either the
Figure 2. The frequency of powerful actions with and without ball possession in goal situations for the scoring (top) and the assisting player (bottom). Data as absolute and relative frequencies (with 95% confidence intervals). * = significantly different to all other categories. CinD = change-in-direction.

Table II. Absolute and relative frequencies of powerful actions with and without an opponent.

<table>
<thead>
<tr>
<th></th>
<th>straight sprint</th>
<th>CinD sprint</th>
<th>jump</th>
<th>rotation</th>
<th>sum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>scoring player</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with opponent</td>
<td>52*</td>
<td>19.8</td>
<td>15</td>
<td>5.7</td>
<td>33</td>
</tr>
<tr>
<td>without opponent</td>
<td>109*</td>
<td>41.6</td>
<td>7</td>
<td>2.7</td>
<td>24</td>
</tr>
<tr>
<td>assisting player</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with opponent</td>
<td>54*</td>
<td>26.3</td>
<td>15*</td>
<td>7.3</td>
<td>13</td>
</tr>
<tr>
<td>without opponent</td>
<td>83*</td>
<td>40.5</td>
<td>3*</td>
<td>1.5</td>
<td>9</td>
</tr>
</tbody>
</table>

* = values with and without opponent significantly different. CinD = change-in-direction.
scoring or the assisting player. Straight sprinting enables a player to escape from his opponent and/or to reach a free zone to shoot on the goal or to give a decisive pass. The straight line is the shortest possible connection between two points and, thus, it seems plausible that straight sprinting enables the attacker to arrive at an anticipated promising position in the shortest possible time. Thus, the time to accurately defend the situation might be too short for the opposing player.

Goals were mostly scored by strikers after a straight sprint without the ball. Sprinting with the ball may slow down the movement and, thus, the striker does not have the advantage described above. This is not surprising when considering that only 1.2 to 2.4% of the running distance in match play is covered with the ball (Di Salvo et al., 2007). Similarly, fighting against an opponent may also slow down velocity and, thus, it is also plausible that most successful explosive actions of the scorer were conducted without an opponent. In contrast, midfielders assisted most goals while sprinting with the ball. This finding corresponds to the observation that midfielders cover a higher running distance with the ball compared to other playing positions (Di Salvo et al., 2007). It might be speculated that it is necessary to perform a short sprint with the ball to reach an appropriate position to pass the ball to the best positioned teammate.

Interestingly, Tenga, Holme, Ronglan, and Bahr (2010a) observed in 163 matches of the male Norwegian professional league that success (scoring a goal) was higher when teams conducted counter-attacks compared to elaborate attacks. Therefore, the importance of very high-intensity running and sprinting, which might be assumed more relevant in counterattack situations, seems plausible from a tactical point of view. Another interesting finding in this regard is that less successful teams (bottom five of the final league standing) covered more high-intensity running distance compared to successful teams (top five) (Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009). This difference was mainly due to more high-intensity running without ball possession and, thus, probably due to the attempts to regain the ball. However, the number of leading sprints (sprints of more than 0.5 s duration) was significantly higher in successful teams. Effect sizes were small and, thus, the practical relevance

Figure 3. The frequency of goals or assists which were accompanied by powerful actions as related to playing positions. The bars represent relative frequencies (with 95% confidence intervals). The absolute number of goals and assists preceded by a powerful action related to the total number of goals and assists are embedded within the bars. * = significantly different to both other categories; # = significantly different to defenders.

Table III. Absolute and relative frequencies of powerful actions as related to playing position

<table>
<thead>
<tr>
<th>Playing Position</th>
<th>Straight Sprint</th>
<th>CinD Sprint</th>
<th>Jump</th>
<th>Rotation</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Scoring Player</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defender</td>
<td>12 (4.6)</td>
<td>1 (0.4)</td>
<td>19 (7.3)</td>
<td>1 (0.4)</td>
<td>33 (12.6)</td>
</tr>
<tr>
<td>Midfielder</td>
<td>62 (23.7)</td>
<td>6 (2.3)</td>
<td>12 (4.6)</td>
<td>9 (3.4)</td>
<td>89 (34.0)</td>
</tr>
<tr>
<td>Striker</td>
<td>87 (33.2)</td>
<td>15 (5.7)</td>
<td>26 (9.9)</td>
<td>12 (4.6)</td>
<td>140 (53.4)</td>
</tr>
<tr>
<td>Assisting Player</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defender</td>
<td>21 (10.2)</td>
<td>2 (1.0)</td>
<td>7 (3.4)</td>
<td>2 (1.0)</td>
<td>32 (15.6)</td>
</tr>
<tr>
<td>Midfielder</td>
<td>63 (30.7)</td>
<td>11 (5.4)</td>
<td>7 (3.4)</td>
<td>10 (4.9)</td>
<td>91 (44.4)</td>
</tr>
<tr>
<td>Striker</td>
<td>53 (25.9)</td>
<td>5 (2.4)</td>
<td>8 (3.9)</td>
<td>16 (7.8)</td>
<td>82 (40.0)</td>
</tr>
</tbody>
</table>

CinD = change-in-direction.
of this finding should be further substantiated. Nevertheless, the relationship between tactical behaviour, physical abilities of players and team success might represent an interesting topic for future research.

The present findings are also in line with observations that, in particular, strikers together with wing midfielders and fullbacks are the playing positions showing the greatest running distances while sprinting during match play (Di Salvo et al., 2007; Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007b). Sprinting activities vary considerably (3 to 40 bursts of high intensity activity, >23 km·h⁻¹, per match) with the above mentioned positions conducting more bursts compared to central defenders and central midfielders (Di Salvo et al., 2007). Considering the importance of straight sprints in successful match situations, a high number of sprints of strikers may enhance their chance of scoring a goal. Moreover, it might be speculated that wing midfielders are frequently involved in sprint duels with the opposing fullbacks prior to assisting a goal. However, from the present results no conclusive statement in this regard is possible as we did not distinguish between central and external midfield positions.

The importance of straight sprinting in goal situations can have implications for training and competition. With respect to tactical decision making the present findings may influence the selection of players or the preferred playing strategy. Furthermore, it has been shown that sprint times can be improved by specific training regimens (Stolen et al., 2005) with different effects of straight and change-in-direction sprint training on the respective sprint ability (Young et al., 2001). Considering the relevance of straight sprinting in decisive situations, it is recommended that fitness training and testing should include such sprints.

Other powerful actions seem to be of minor importance for scoring a goal in high level football. Jumping seems relevant when goals are scored through headers after crosses or standards. This is particularly relevant for defenders when scoring a goal. Change-in-direction sprints seldom precede a goal. It might be speculated that changing direction needs time and, thus, defenders are able to arrive at an appropriate defending position and have more time left to successfully interfere.

Possibly, change-in-direction sprints, jumps and rotations are of greater importance in decisive defensive situations when players must react to the attacking players' behaviour. However, the analysis of defensive situations was not addressed in the present study and such an approach might be limited because objective assessment of definitely decisive defensive situations seems complicated.

Nevertheless, this may be an interesting topic for future research, too.

Study limitations

Obviously, the main limitation of the present study is the use of visual video inspection to assess different powerful actions when scoring a goal. This approach might be prone to subjective bias and, thus, critical evaluation of inter-observer consistency using kappa statistics has been recently proposed (Barris & Button, 2008; Drust, Atkinson, & Reilly, 2007). Kappa coefficients for inter- and intra-observer reliability in the present study indicated substantial to almost perfect agreement for all analysed categories (Landis & Koch, 1977). There was only a low number of goals which were preceded by combined actions (about 9% of all goals) and selected for reliability analyses. Thus, we refrained from calculating kappa coefficients for those combined actions. However, it is unlikely that this affected the overall results and conclusions of the present study.

Alternatively, the use of modern video tracking systems might have allowed more objective evaluation of running distances and velocities (Carling, Bloomfield, Nelsen, & Reilly, 2008; Drust et al., 2007). Such an approach, however, would have reduced the number of goals remaining for analyses because only a few stadiums in Germany are equipped with such systems. In addition, available systems show considerable variability when assessing running distances (Randers et al., 2010) and, thus, it would be necessary to use the same system in all stadiums to allow valid comparisons. Furthermore, despite recent technical advances, automated player tracking and the analyses of single actions like jumps, rotations and change-in-direction sprints still need manual correction and analysis (Barris & Button, 2008) and, thus, altogether it seems questionable whether such an approach might have been really advantageous.

In the present study, scored goals have been used as the ultimate objective measure of success in football. Such an approach has been criticised as goals only account for about 1% of all ball possessions in high level football (Pollard & Reep, 1997; Tenga et al., 2010b). Thus, when using goals as criterion measures for decisive situations in football large samples are required for meaningful analyses. Alternatively, broader measures such as scoring opportunities, shots on goal, or entry in the last third of the pitch have been proposed (Tenga et al., 2010b). However, such an approach may complicate an objective assessment of decisive situations in football. For instance, it might be speculated that most of those situations were not successful because the conducted physical activities were not
appropriate to score a goal and, thus, these situations are not representative for decisive situations in football. Therefore, the use of goals as ultimate measures of decisive situations seems justified.

Furthermore, it should be considered that the present data were obtained during one half of a season in a male professional league of one European country. Although the analysed league is among the best in the world, a transfer of the results to other leagues or levels of play (e.g. with other cultural backgrounds or to female or junior football) should be done with care. Such analyses might be regarded as interesting areas for future studies.

Conclusion and future perspectives

The results of the present study show that power and speed abilities are important in decisive situations in professional football. In particular, straight sprinting is the most dominant action when scoring goals. Thus, straight sprinting should be considered in fitness testing and training.

Other power abilities which have been shown to be of minor importance when scoring goals (rotations, change-of-direction sprints or jumps) may be more important in defensive situations where players must react to the opponents’ behaviour. However, this issue is an interesting content for future research.

In addition, the relationship of physical activities and tactical behaviour remains a promising topic for further studies. Moreover, a comparison between successful and unsuccessful shots, an analysis with regard to the zones where shots were taken as well as the influence of the time of the match (with special regard to fatigue) or the league standing (particularly with respect to the zones where shots were taken as well as the influence of the time of the match (with special regard to fatigue) or the league standing (particularly with respect to the zones where shots were taken as well as the influence of the time of the match (with special regard to fatigue) or the league standing (particularly with respect to the zones where shots were taken as well as the influence of the time of the match (with special regard to fatigue) or the league standing (particularly

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