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# Evolution of technical activity in various playing positions, in relation to match outcomes in professional soccer

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**ABSTRACT:** The study presented below aimed to examine the position-specific evolution of technical activity among soccer players and how it is related to match outcomes over three consecutive domestic seasons in Germany's *Bundesliga*. The research was based on a sample of 13,032 individual match observations of 556 soccer players during the 2014/2015, 2015/2016 and 2016/2017 seasons. These players were classified into five positional roles: central defenders (CD), full-backs (FB), central midfielders (CM), wide midfielders (WM) and forwards (F). The activity of the players was analysed using the Impire AG motion analysis system. Our study indicates that over the course of the three seasons: 1) the total numbers of shots by CMs decreased in the case of won or drawn matches; 2) the number of passes by CD players increased in matches won, and by CM and WM players in matches won, drawn and lost, whereas percentage pass accuracy increased at the CM position in won and drawn matches; 3) players at each position engaged in a substantially smaller number of duels, no matter what the match outcome, while the percentage of encounters won in subsequent seasons decreased among CD, and increased among WM in matches won and at F positions in both won and drawn matches. This research clearly shows that the evolution of technique among professional soccer players is heading in the direction of increased accuracy, with a simultaneous stabilisation of, or even a decline in, the number of activities engaged in.

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## INTRODUCTION

Notational analysis provides a factual record of phenomena and offers objective data, providing important feedback for soccer players and coaches alike [1, 2]. This analysis is much used by elite teams, and can in fact play a major role in improving match strategy [3]. Detailed match analysis is now made possible through modern, technologically advanced motion analysis systems [4-6]. These systems have many applications in scientific research on professional match play in soccer, above all in connection with the evaluation of player activity in relation to technique [7], motor skills [8] and tactical play [9], as well as match modelling [10]. To seek out closer links between player activity and the real game, analyses are carried out to take account of different contextual variables [11, 12]. The most important situational variables for a team's activities during a match are: match location, quality of the opposition, location (country) of competition and match outcome [12, 13, 14].

Analysis related to match outcomes is particularly relevant to coaches and players, given the possibilities offered for differences in contextual variables that can be accounted for [13, 15]. It is in this context that we find a large number of papers detailing the physical [16], or technical nature [17] of players' activities, with other publications also investigating players' activity in relation to various playing positions [18]. However, in the match context, technical activity is defined as more important than physical activity [5, 19, 20, 21, 22]. Lago-Penas et al. [23], Castellano et al. [22] and Liu et al. [11] all state that the technical activities that are linked most readily with match outcome are either the number of shots taken or numbers of shots on target. For their part, Lago-Penas and Lago-Ballesteros [24], Shafizadeh et al. [25] and Liu et al. [11] also add that match outcome may be linked with the number of passes and passing effectiveness. Central midfielders have been found to

be responsible for both the most passes and the highest percentage of successful passes [7]. Elsewhere, Link and de Lorenzo [26] state that the key technical activity engaged in by German soccer players involves duels (a game action is defined as a duel if two players from opposing teams are in competition for the ball; a duel is always assigned to both participant players). While analysis based on match outcome is certainly very interesting, it is clear that a further analytical dimension might be possible were information from the analyses of several seasons to be considered, with a view to presenting not only the circumstances in a given game, but also the way in which the game itself may be evolving.

An understanding of how match play has evolved in the case of a given league may prove useful because consideration is given to the further modification of team preparation from the physical, technical and tactical points of view [27]. Interestingly, analysis of the World Cup Finals between 1966 and 2010 clearly indicates that, while every single considered variable changed significantly over time, the largest change related to passing rate [28]. Similarly, Bush et al. [29] reported that the overall numbers of passes increased by 40% across just seven consecutive seasons of the English Premier League.

This research notwithstanding, the rather limited number of studies describing soccer activity in successive seasons has so far failed to account for evolutionary trends where positions were concerned [30, 31]. When account was taken of positional roles it was found that the most marked increases in total numbers of passes came from central defenders and midfielders, as compared with full-backs, wide midfielders and attackers, for whom the increases were smaller more limited. Although wide players showed small increases in the number of pass attempts over seven seasons, increases in pass success rate were similar to those noted for central players [32].

If, as previous research indicates, the number of passes, and their effectiveness, have undergone evolutionary change specific to different positions on the pitch, it is thus possible to hypothesise that similar changes might be noted, were other types of technical activity to be analysed. A potential way to gain an understanding of evolving patterns of play is to not only track longitudinal data trends, but also to quantify the progression/regression of selected types of technical activity, whilst accounting for match outcome [28]. To the best of our knowledge, no study has yet considered – in combination – the link between, on the one hand, the technical activity of professional soccer players playing in different positions over three successive seasons and, on the other hand, match outcome (i.e. win, draw, loss). In our study we used a large sample size to provide the most precise estimates of between-match error, and to detect real, systematic differences in the characteristics of technical activity [33]. In that light, the research described herein aimed to examine the position-specific evolution of technical activities relating to match outcomes in three consecutive domestic seasons of the German *Bundesliga*.

## MATERIALS AND METHODS

### *Players and match data*

The study sample consisted of 13,032 individual match observations of 556 soccer players competing in the *Bundesliga* during three consecutive domestic seasons (2014-2015, 2015-2016 and 2016-2017). Analysis was confined to outfield players (i.e. goalkeepers were excluded) completing entire matches (i.e. being present on the pitch for the whole 90 minutes). The players qualifying in this way were classified in terms of the five positional roles: central defenders (CD, match observations = 3590), full-backs (FB, match observations = 2792), central midfielders (CM, match observations = 3169), wide midfielders (WM, match observations = 1927), and forwards (F, match observations = 1554). The mean body height of the players studied was 183.92 ± 7.12 cm, while mean body mass was 78.57 ± 7.34 kg, and mean age 26.64 ± 4.03 years.

In the case of each of the abovementioned five positions on the pitch, the following numbers of observations were subjected to analysis with regard to match outcome – Win (W), Draw (D) and Loss (L) – over 3 consecutive seasons 2014-2015 (1), 2015-2016 (2), and 2016-2017 (3): W1 = 1606 (CD = 434; FB = 378; CM = 396; WM = 235; F = 163); W2 = 1643 (CD = 457; FB = 384; CM = 406; WM = 211; F = 185); W3 = 1629 (CD = 484; FB = 317; CM = 403; WM = 256; F = 169); D1 = 1201 (CD = 313; FB = 270; CM = 298; WM = 179; F = 141); D2 = 1024 (CD = 269; FB = 237; CM = 257; WM = 131; F = 130); D3 = 1053 (CD = 306; FB = 176; CM = 266; WM = 174; F = 131); L1 = 1586 (CD = 415; FB = 355; CM = 370; WM = 234; F = 212); L2 = 1666 (CD = 443; FB = 386; CM = 382; WM = 238; F = 217); L3 = 1624 (CD = 469; FB = 289; CM = 391; WM = 269; F = 206). The study was conducted in compliance with the Declaration of Helsinki, and was approved by the Local Ethics Committee (No. 20/2017).

### *Data collection and analyses*

The analysis was carried out using the Impire AG motion analysis system [34], with records of all the players' movements in all 918 matches, and with a sampling frequency of 25 Hz. Impire AG (Ismaning, Germany) and Cairos Technologies AG (Karlsbad, Germany) provide a ready-to-use, vision-based tracking system for team sports called VIS.TRACK. This consists of two cameras and the related software tracking of both players and the ball [35, 36]. The validity and reliability of this system for taking such measurements have been described in detail elsewhere [34, 35, 37, 38]. Liu et al. [39] have shown that team match events coded by independent operators using this system achieved very good agreement (weighted kappa values were 0.92 and 0.94), with an average difference of event time equal to 0.06±0.04 s. The types of technical activity recorded for players included: total number of shots, number of ball touches, number of passes, pass accuracy percentage, number of crosses, number of duels, and percentage of duels won. Complete

definitions of these kinds of technical activity are to be found at DFL, under *Definitionskatalog Offizielle Spieldaten*, or Definitions for Official Game Data [40].

### *Statistical analysis*

All variables were examined for normal distribution (using the Shapiro-Wilk test), and homogeneity of variance (Levene's test). Arithmetic means and standard deviations were also calculated, the means then being compared using two-way analysis of variance (MANOVA). The independent variables used were seasons and match outcome – and the interaction between them; while the dependent variables were selected kinds of technical activity described in this work. When a significant effect size was found, a post-hoc Fisher's least significant difference (LSD) test was performed. All statistical analyses were carried out using the STATISTICA ver. 13.1 (StatSoft. Inc., USA) software package.

## RESULTS

Tables 1-5 present the analysis of variance models for the 5 considered pitch positions adopted by the players. The selected kinds of technical activity engaged in by German *Bundesliga* soccer players are shown in the context of the match outcome ultimately achieved, as well as in relation to the three consecutive domestic seasons. Analysis of the main results and interactions between them are presented below, in respect of the positions and the various types of technical activity.

### *Central defenders*

In the case of central defenders, two-factor analysis of variance revealed significant interactions between sub-groups involving match outcome and seasons, in the cases of number of ball touches and number of passes. Moreover, analysis of the different main effects showed that statistically significant differences with regard to seasons were to be noted for number of passes, pass accuracy percentage, number of crosses, number of duels, and percentage of duels won, while, with the factor of match outcome, significance was achieved with regard to the total number of shots, number of ball touches, number of passes, pass accuracy percentage, number of duels and percentage of duels won (Table 1).

**TABLE 1.** Differences in technical activity engaged in by central defenders in the *Bundesliga*, as related to Match Outcome (MO) and Seasons (S) (mean ± SD).

| Parameters | Match Outcome | Seasons | | | MO effect | S effect | MO x S effect | SSD ($p \leq 0.05$) |
|---|---|---|---|---|---|---|---|---|
| | | 2014/15 (1) | 2015/16 (2) | 2016/17 (3) | | F (Sig.) | | |
| Total shots [number] | Win | 0.57±0.85 | 0.61±0.88 | 0.62±0.87 | **4.52 (0.011)** | 0.02 (0.979) | 0.93 (0.446) | – |
| | Draw | 0.59 ±0.84 | 0.49±0.76 | 0.55±0.76 | | | | – |
| | Loss | 0.51±0.77 | 0.54±0.77 | 0.49±0.74 | | | | – |
| Ball touches [number] | Win | 62.58±23.52 | 65.85±25.67 | 65.73±23.95 | **5.72 (0.003)** | 2.89 (0.056) | **2.98 (0.018)** | **1<2,3** |
| | Draw | 62.85±21.54 | 61.10±23.37 | 64.98±27.15 | | | | – |
| | Loss | 63.36±23.44 | 59.08±22.51 | 62.41±23.63 | | | | **1>2<3** |
| Passes [number] | Win | 47.71±24.92 | 51.77±26.92 | 53.79±24.82 | **5.25 (0.005)** | **10.62 (0.001)** | **2.87 (0.022)** | **1<2,3** |
| | Draw | 47.63±22.37 | 46.77±23.93 | 52.44±27.59 | | | | **1,2<3** |
| | Loss | 48.86±23.18 | 45.49±22.78 | 49.98±23.49 | | | | **2<3** |
| Pass Accuracy (%) | Win | 79.59±10.91 | 80.03±13.02 | 80.83±11.55 | **9.00 (0.001)** | **5.50 (0.004)** | 0.50 (0.754) | – |
| | Draw | 77.67±12.10 | 78.52±12.52 | 80.00±12.18 | | | | **1<3** |
| | Loss | 78.08±11.63 | 77.65±12.25 | 79.10±10.75 | | | | – |
| Crosses [number] | Win | 0.06± 0.33 | 0.06± 0.32 | 0.08± 0.51 | 1.62 (0.198) | **8.61 (0.001)** | 2.27 (0.059) | – |
| | Draw | 0.08± 0.28 | 0.06± 0.29 | 0.12± 0.63 | | | | – |
| | Loss | 0.07± 0.32 | 0.05± 0.22 | 0.18± 0.76 | | | | **1,2<3** |
| Duels [number] | Win | 16.18±5.74 | 13.97±5.14 | 13.62±5.35 | **5.94 (0.003)** | **88.84 (0.001)** | 0.31 (0.873) | **1>2,3** |
| | Draw | 16.76±5.68 | 14.36±5.20 | 13.91±5.25 | | | | **1>2,3** |
| | Loss | 17.18±6.10 | 14.44±5.22 | 14.30±5.20 | | | | **1>2,3** |
| Duels won [%] | Win | 63.19±14.15 | 61.77±15.30 | 60.51±15.67 | **19.08 (0.001)** | **15.21 (0.001)** | 0.69 (0.597) | **1>3** |
| | Draw | 62.16±14.66 | 59.32±13.93 | 59.07±14.21 | | | | **1>2,3** |
| | Loss | 60.29±12.90 | 58.62±14.31 | 56.15±15.10 | | | | **1,2 >3** |

SSD – Statistically Significant Differences.

*Full-backs*

In the case of the analysed technical activity engaged in by players in full-back positions, no statistically significant differences between sub-groups were observed with regard to the interaction between match outcome and seasons. However, significant differences were noted for the factor of seasons, with significant linkage noted in the cases of number of crosses, number of duels and match outcome, as well as total number of shots, number of passes, pass accuracy percentage, number of crosses and percentage of duels won (Table 2).

*Central midfielders*

Analysis of the technical activity engaged in by central midfielders revealed no significant differences in the case of the interaction with match outcome and seasons. However, significant differences were recorded for the factor of seasons with regard to the total numbers of shots, number of passes, pass accuracy percentage, number of crosses and number of duels won, as well as for the factor of match outcome, when it came to the number of ball touches, number of passes, pass accuracy percentage, number of crosses and percentage of duels won (Table 3).

*Wide midfielders*

Where wide midfielders were concerned, analysis of technical activity again showed no significant differences in the interaction between match outcome and seasons. On the other hand, when it came to main-effects analysis, the parameters were found to be significantly influenced by the factor of season, differentiating significantly in the total number of shots, number of ball touches, number of passes, number of crosses, number of duels and percentage of duels won. In turn, there were significant differences for the relationship with match outcome, in the case of total number of shots, number of ball touches, number of passes, pass accuracy percentage, number of crosses and percentage of duels won (Table 4).

*Forwards*

Among forwards, significant differences in the technical activity under analysis were confined to the main effects. The factor of season exerted a significant differentiating effect on number of crosses, number of duels and percentage of duels won, while the factor of match outcome was found to be related significantly to total number of shots taken, number of ball touches, number of passes, percentage pass accuracy and percentage of duels won (Table 5).

**TABLE 2.** Differences in technical activity engaged in by full-backs playing in the *Bundesliga*, as related to Match Outcome (MO) and Seasons (S) (mean ± SD).

| Parameters | Match Outcome | Seasons | | | MO effect | S effect | MO x S effect | SSD ($p \leq 0.05$) |
|---|---|---|---|---|---|---|---|---|
| | | 2014/15 (1) | 2015/16 (2) | 2016/17 (3) | | F (Sig.) | | |
| Total shots [number] | Win | 0.54±0.83 | 0.58±0.81 | 0.69±0.87 | **6.06 (0.002)** | 2.46 (0.086) | 1.13 (0.339) | – |
| | Draw | 0.54±0.81 | 0.49±0.73 | 0.63±0.93 | | | | – |
| | Loss | 0.48±0.77 | 0.48±0.76 | 0.47±0.78 | | | | – |
| Ball touches [number] | Win | 66.89±17.18 | 67.08±19.73 | 66.22±18.09 | 2.80 (0.061) | 2.19 (0.112) | 0.83 (0.507) | – |
| | Draw | 65.82±16.00 | 64.88±16.96 | 64.20±18.67 | | | | – |
| | Loss | 67.13±16.35 | 64.09±18.26 | 64.43±15.79 | | | | – |
| Passes [number] | Win | 40.54±17.40 | 42.07±20.23 | 42.11±17.66 | **6.75 (0.001)** | 0.87 (0.419) | 1.04 (0.385) | – |
| | Draw | 38.90±14.26 | 37.95±14.77 | 39.56±17.53 | | | | – |
| | Loss | 40.31±14.21 | 38.52±15.72 | 40.06±13.66 | | | | – |
| Pass Accuracy (%) | Win | 71.43±12.68 | 73.89±12.73 | 74.22±12.51 | **7.90 (0.001)** | 2.30 (0.100) | 1.63 (0.165) | – |
| | Draw | 70.90±11.96 | 70.32±12.49 | 71.38±12.76 | | | | – |
| | Loss | 71.49±11.65 | 71.98±11.81 | 71.93±10.97 | | | | – |
| Crosses [number] | Win | 1.62± 1.57 | 1.64± 1.57 | 2.15± 2.23 | **3.93 (0.020)** | **12.24 (0.001)** | 1.26 (0.285) | **1,2<3** |
| | Draw | 1.81± 1.77 | 1.92± 1.78 | 2.31± 2.26 | | | | **1,2<3** |
| | Loss | 2.02± 1.90 | 1.84± 1.77 | 2.15± 1.88 | | | | **2<3** |
| Duels [number] | Win | 19.84±6.49 | 16.29±5.39 | 15.84±5.36 | 2.40 (0.091) | **106.89 (0.001)** | 0.24 (0.918) | **1>2,3** |
| | Draw | 19.71±6.20 | 16.74±5.59 | 16.30±5.89 | | | | **1>2,3** |
| | Loss | 20.24±6.25 | 16.95±5.87 | 16.50±6.21 | | | | **1>2,3** |
| Duels won [%] | Win | 56.29±12.17 | 55.52±13.12 | 55.22±13.27 | **5.58 (0.004)** | 0.05 (0.948) | 0.38 (0.820) | – |
| | Draw | 55.41±12.84 | 56.09±13.27 | 55.70±12.92 | | | | – |
| | Loss | 53.99±11.99 | 53.82±13.72 | 54.15±13.34 | | | | – |

SSD – Statistically Significant Differences.

**TABLE 3.** Differences in technical activity engaged in by central midfielders playing in the *Bundesliga*, as related to Match Outcome (MO) and Seasons (S) (mean ± SD).

| Parameters | Match Outcome | Seasons | | | MO effect | S effect | MO x S effect | SSD ($p \leq 0.05$) |
|---|---|---|---|---|---|---|---|---|
| | | 2014/15 (1) | 2015/16 (2) | 2016/17 (3) | | F (Sig.) | | |
| Total shots [number] | Win | 1.31±1.37 | 1.19±1.36 | 1.09±1.37 | 0.69 (0.500) | **6.47 (0.002)** | 1.17 (0.323) | **1>3** |
| | Draw | 1.30±1.38 | 1.19±1.23 | 1.00±1.16 | | | | **1>3** |
| | Loss | 1.12±1.24 | 1.23±1.36 | 1.05±1.15 | | | | – |
| Ball touches [number] | Win | 63.98±23.84 | 67.25±26.57 | 67.05±24.21 | **11.91 (0.001)** | 1.01 (0.363) | 0.97 (0.425) | – |
| | Draw | 61.76±17.99 | 62.84±22.46 | 62.85±21.44 | | | | – |
| | Loss | 62.36±20.33 | 61.77±20.86 | 61.64±19.18 | | | | – |
| Passes [number] | Win | 48.14±23.55 | 51.62±26.23 | 52.78±24.17 | **13.06 (0.001)** | **5.10 (0.006)** | 1.06 (0.373) | **1<2,3** |
| | Draw | 45.36±16.90 | 47.67±22.08 | 48.62±21.31 | | | | – |
| | Loss | 46.39±19.54 | 45.72±19.19 | 47.57±18.55 | | | | – |
| Pass Accuracy (%) | Win | 76.86±11.22 | 78.86±11.91 | 79.00±10.48 | **7.90 (0.001)** | **5.00 (0.006)** | 1.80 (0.118) | **1<2,3** |
| | Draw | 76.01±10.43 | 75.84±11.35 | 78.08±11.23 | | | | **1,2<3** |
| | Loss | 76.49±9.80 | 76.70±10.89 | 76.82±10.39 | | | | – |
| Crosses [number] | Win | 0.38± 0.74 | 0.39± 0.76 | 0.99± 1.70 | **5.14 (0.006)** | **76.65 (0.001)** | 0.07 (0.991) | **1,2<3** |
| | Draw | 0.54± 0.95 | 0.48± 0.90 | 1.13± 1.88 | | | | **1,2<3** |
| | Loss | 0.56± 0.93 | 0.54± 0.95 | 1.16± 1.99 | | | | **1,2<3** |
| Duels [number] | Win | 23.86±7.96 | 20.29±6.32 | 20.83±6.83 | 0.13 (0.882) | **74.11 (0.001)** | 0.81 (0.515) | **1>2,3** |
| | Draw | 23.85±7.99 | 20.49±6.37 | 20.61±6.90 | | | | **1>2,3** |
| | Loss | 23.96±8.19 | 21.07±6.72 | 20.33±6.31 | | | | **1>2,3** |
| Duels won [%] | Win | 51.28±12.49 | 51.83±12.42 | 52.29±11.90 | **9.03 (0.001)** | 1.77 (0.170) | 0.30 (0.880) | – |
| | Draw | 50.28±11.80 | 50.35±12.84 | 51.50±11.85 | | | | – |
| | Loss | 49.03±11.97 | 50.12±12.23 | 49.82±12.34 | | | | – |

SSD – Statistically Significant Differences.

**TABLE 4.** Differences in technical activity engaged in by wide midfielders playing in the *Bundesliga*, as related to Match Outcome (MO) and Seasons (S) (mean ± SD).

| Parameters | Match Outcome | Seasons | | | MO effect | S effect | MO x S effect | SSD ($p \leq 0.05$) |
|---|---|---|---|---|---|---|---|---|
| | | 2014/15 (1) | 2015/16 (2) | 2016/17 (3) | | F (Sig.) | | |
| Total shots [number] | Win | 2.28±1.81 | 2.11±1.66 | 1.74±1.60 | **10.86 (0.001)** | **9.54 (0.001)** | 0.66 (0.622) | **1,2 >3** |
| | Draw | 1.88±1.48 | 1.73±1.44 | 1.65±1.44 | | | | – |
| | Loss | 1.85±1.70 | 1.66±1.45 | 1.48±1.46 | | | | **1 >3** |
| Ball touches [number] | Win | 54.10±17.97 | 55.00±17.90 | 57.65±15.61 | **19.61 (0.001)** | **16.24 (0.001)** | 0.61 (0.653) | **1<3** |
| | Draw | 50.08±14.33 | 48.66±13.37 | 54.82±16.76 | | | | **1,2 <3** |
| | Loss | 49.65±12.32 | 49.13±14.45 | 53.68±15.57 | | | | **1,2 <3** |
| Passes [number] | Win | 34.33±16.04 | 36.25±16.20 | 36.82±13.04 | **28.84 (0.001)** | **7.88 (0.001)** | 0.68 (0.606) | **1<3** |
| | Draw | 30.45±11.54 | 29.98±10.66 | 32.97±13.22 | | | | **2 <3** |
| | Loss | 29.89±9.12 | 30.24±12.08 | 33.07±12.97 | | | | **1,2 <3** |
| Pass Accuracy (%) | Win | 71.09±12.78 | 73.24±12.40 | 71.89±11.94 | **8.40 (0.001)** | 1.01 (0.363) | 0.81 (0.521) | – |
| | Draw | 69.79±11.53 | 70.66±12.18 | 71.30±11.62 | | | | – |
| | Loss | 69.58±11.61 | 69.26±11.95 | 69.59±12.00 | | | | – |
| Crosses [number] | Win | 1.43± 1.68 | 1.47± 1.64 | 2.75± 2.36 | **4.01 (0.018)** | **78.35 (0.001)** | 0.86 (0.491) | **1,2<3** |
| | Draw | 1.69± 1.65 | 1.72± 1.66 | 3.18± 2.76 | | | | **1,2<3** |
| | Loss | 1.77± 1.87 | 1.84± 2.09 | 2.83± 2.62 | | | | **1,2<3** |
| Duels [number] | Win | 25.49±7.58 | 23.02±7.70 | 19.46±6.78 | 0.54 (0.581) | **80.81 (0.001)** | 1.13 (0.341) | **1>2>3** |
| | Draw | 25.02±8.07 | 21.62±7.63 | 19.96±7.57 | | | | **1>2>3** |
| | Loss | 25.07±7.77 | 22.23±7.19 | 20.34±7.55 | | | | **1>2>3** |
| Duels won [%] | Win | 47.32±11.14 | 49.11±11.50 | 50.21±12.55 | **11.83 (0.001)** | **4.19 (0.015)** | 0.49 (0.741) | **1<3** |
| | Draw | 46.22±12.12 | 46.92±12.27 | 48.22±13.05 | | | | – |
| | Loss | 45.44±11.72 | 45.66±12.21 | 46.31±11.64 | | | | – |

SSD – Statistically Significant Differences.

**TABLE 5.** Differences in technical activity engaged in by forwards playing in the *Bundesliga*, as related to Match Outcome (MO) and Seasons (S) (mean ± SD).

| Parameters | Match Outcome | Seasons | | | MO effect | S effect | MO x S effect | SSD ($p \leq 0.05$) |
|---|---|---|---|---|---|---|---|---|
| | | 2014/15 (1) | 2015/16 (2) | 2016/17 (3) | | F (Sig.) | | |
| Total shots [number] | Win | 2.98±1.76 | 3.35±2.01 | 3.09±1.99 | **48.60 (0.001)** | 2.79 (0.062) | 0.44 (0.782) | – |
| | Draw | 2.43±1.72 | 2.57±1.60 | 2.27±1.68 | | | | – |
| | Loss | 2.16±1.55 | 2.25±1.54 | 2.09±1.42 | | | | – |
| Ball touches [number] | Win | 44.87±14.44 | 44.23±13.08 | 43.43±12.20 | **11.96 (0.001)** | 0.14 (0.867) | 0.74 (0.566) | – |
| | Draw | 40.87±11.44 | 41.38±12.61 | 42.34±12.60 | | | | – |
| | Loss | 40.17±11.10 | 41.46±11.45 | 40.33±12.65 | | | | – |
| Passes [number] | Win | 28.82±11.89 | 27.76±11.01 | 27.92±10.86 | **8.54 (0.001)** | 0.59 (0.556) | 1.54 (0.189) | – |
| | Draw | 25.30±9.18 | 25.32±10.32 | 27.71±10.93 | | | | – |
| | Loss | 25.38±9.03 | 26.29±9.37 | 25.64±9.93 | | | | – |
| Pass Accuracy (%) | Win | 68.58±11.93 | 69.50±13.19 | 70.12±11.36 | **6.41 (0.002)** | 2.76 (0.064) | 0.07 (0.991) | – |
| | Draw | 65.95±11.52 | 66.48±13.71 | 67.71±11.67 | | | | – |
| | Loss | 66.06±12.10 | 67.35±13.21 | 68.33±12.76 | | | | – |
| Crosses [number] | Win | 0.87± 1.35 | 0.88± 1.47 | 0.92± 1.26 | 0.27 (0.763) | **5.16 (0.006)** | 1.16 (0.325) | – |
| | Draw | 0.70± 1.01 | 0.78± 1.00 | 1.03± 1.78 | | | | **1<3** |
| | Loss | 0.72± 1.12 | 0.67± 1.08 | 1.10± 1.94 | | | | **1,2<3** |
| Duels [number] | Win | 28.12±9.94 | 24.09±8.94 | 22.57±7.91 | 1.05 (0.352) | **43.72 (0.001)** | 0.81 (0.517) | **1>2,3** |
| | Draw | 28.04±8.48 | 23.63±8.56 | 23.07±8.38 | | | | **1>2,3** |
| | Loss | 26.46±7.57 | 23.54±7.79 | 22.88±8.32 | | | | **1>2,3** |
| Duels won [%] | Win | 43.13±10.24 | 44.96±11.78 | 45.73±10.23 | **10.01 (0.001)** | **7.79 (0.001)** | 0.58 (0.677) | **1<3** |
| | Draw | 42.26±11.20 | 44.12±10.85 | 46.26±11.08 | | | | **1<3** |
| | Loss | 40.82±10.89 | 42.44±10.90 | 42.42±12.13 | | | | – |

SSD – Statistically Significant Differences.

## DISCUSSION

The work detailed in this paper sought to investigate the position-specific evolution of different kinds of players' technical activity in connection with the outcomes achieved by teams in matches in Germany's *Bundesliga*. The study is the first to map such an evolution of technical parameters in the context of match outcome, and from the point of various player positions.

Given the aim of soccer, the differences between matches won and lost by professional teams are mainly manifested in the number of shots on goal, as well as the effectiveness of the shots [11, 22, 23]. Our research confirms the findings to date in this respect, while also making it clear that in *Bundesliga* matches it is mainly wide midfielders and forwards who take shots. It would seem that, as is the case for other kinds of technical activity, the key role of taking shots should go hand in hand with an evolutionary increase in the numbers of shots taken in consecutive seasons [29]. However, our results show that the total number of shots did not change among forwards, and it even decreased in the play engaged in by wide midfielders in matches that were ultimately won. Furthermore, there is no sign of an increase in the number of shots taken among players assigned other positions on the pitch. Shafizadeh et al. [25] have shown that during the 2012 UEFA European Championships, the Spanish and Italian national teams (who were the two finalists) took an average of 16.33 shots per match. Compared with those findings, our work shows that over the three monitored seasons in the Bundesliga, the winning team averaged just 7.58 shots, which is 54% fewer. This far lower number of shots may reflect the way in which the modern game of soccer sees teams producing significantly more shots after longer passing sequences [41]. Furthermore, Sarmento et al. [12] stated that an increase of 1 second in the offensive sequence duration resulted in a 2% decrease in the probability of its success and an extra pass resulted in a decrease of 7%. As Rampinini et al. [42] suggest, the decline in numbers of shots could also be a result of poor decision making requiring players to correct their mistakes.

Our work confirms earlier findings that the number of passes and pass accuracy are both factors that relate directly to match outcome [7, 43, 44], while at the same time showing that it is in matches won that players in all the studied positions produce the largest number of passes, and achieve the highest percentage pass accuracy. Moreover, Konefał et al. [10] reported that an increase in the number of passes increases the chances of the team winning.

Furthermore, over the three successive seasons under study, in the *Bundesliga* there was an increase in the number of passes. These increases were largest in central defenders (13%) and central midfielders (16%) playing in matches their teams went on to win. The upward trend for the number of passes echoes the findings of Bush et al. [29], who reported that in English Premier League seasons 2006/7 to 2012/13, central defenders and central midfielders increased their number of passes by 70% and 50% respectively.

While central defender remains a position from which many passes are delivered, our work shows that the most pronounced upward trend for this variable was found for central midfielders. The ever-greater significance that players in this position are assuming in the shaping of matches and their outcomes is emphasised by the 3% increase in the effectiveness of passing in matches won or drawn; as well as the 7% increase noted over seven seasons in the English Premier League [29]. The key role that modern soccer seems to be giving to central midfielders arises from the fact that, on average, passes delivered from the midfield into the attacking area prove to be most effective [43, 45]. Moreover, Konefał et al. [10] indicate that even one more pass by a side defender during the match results in a 3% increase in the chance of winning. Additionally, in our study only forwards failed to achieve a pass success rate of >70%, which is now deemed a minimum requirement for elite soccer [46]. Barnes et al. [27] confirm the trend towards increased effectiveness of passing, stating that the percentage occurrence of players with a passing success rate <70% decreased from 26% in 2006–07 to 9% in 2012–13 in the English Premier League.

One very interesting result of our work is the discovery of an inversely proportional relationship between the number of duels and the percentage of duels won. Indeed, it is rather surprising that the three most-recent *Bundesliga* seasons witnessed a steady decline in the number of duels, irrespective of players' positions on the field or match outcome. At the same time, the percentage of duels won increased in line with ever-more offensive positions. For their part, Barnes et al. [27] found that between the 2006-7 and 2012-13 seasons in the English Premier League, the number of duels rose significantly. Furthermore, whilst Link and de Lorenzo [26] revealed a 16% increase in the number of duels in the final phase of the *Bundesliga* season, our most up-to-date research, presented here, shows a reversal of that upward trend in the numbers of duels. The decline in the number of duels, along with a simultaneous increase in their level of effectiveness, may also reflect better player decision-making and a greater awareness of choice of technical activity that has a better chance of being effective [47].

The manner in which teams play can thus be said to be evolving in the direction of play with larger numbers of passes and a simultaneous decline in numbers of duels, albeit with the level of effectiveness of these duels being maintained. This further implies that soccer is heading further in the direction of joint action, as opposed to individual play. It may further be suggested that this phenomenon reflects a better understanding of roles, tactics and team organisation in an attempt to further perfect collective action, seeking to reduce energy expenditure in the course of a given game, and with a view to high-level performance being maintained more effectively through the season as a whole [20]. These findings might allow coaches to design training exercises similar to real, 'in-game' competition, with the style of game relevant to players in the different positions being adapted in the interests of improved match outcomes. The association between seasons, match outcomes, and the type of technical activity (classified according to position) should be useful and of practical assistance to coaches seeking to evaluate both the long- and short-term efficacy of strategic periodisation plans in team sports.

A limitation of the present study is that it is based on domestic seasons and in only one specific league (the German *Bundesliga*), and thus the obtained data may need to be treated with a degree of caution. In light of the results of the present study, further research is necessary into the relationship between soccer players' technical activities, a greater number of contextual variables, match outcomes over a greater number of seasons, and k-means clustering.

## CONCLUSIONS

From the above findings, it can reasonably be concluded that over three recent seasons technical activity in the *Bundesliga* evolved at all player positions and in relation to all match outcomes, albeit at different rates. The research clearly indicates that the evolution of technical activity among professional players of the game is evolving in the direction of greater accuracy, with a simultaneous absence of change or even decline in the amounts or levels of activity. This effect would seem to be connected with an ever-greater awareness on the part of professional soccer players as to the ways in which optimised technical activity can be applied during a match in order to encourage or secure the achievement of the most favourable match outcome. This highlights the way in which the most important characteristics of play at elite levels revolve around quality, and not quantity.

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