# VARIATION OF MATCH STATISTICS AND FOOTBALL TEAMS' MATCH PERFORMANCE IN THE GROUP STAGE OF THE UEFA CHAMPIONS LEAGUE FROM 2010 TO 2017

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**Abstract:**

The aim of this study was to identify the relationships between the variation of match variables and teams' match performance. Data from all 768 matches played at the group stage of the UEFA Champions League from season 2009/2010 to 2016/2017 were analysed. The non-clinical magnitude-based inferences were used to identify the differences of technical variation between the teams. Autocorrelation function, correlation analysis and generalised linear model were used to examine the relationships between the variation of match variables and teams' match performance. Results showed that the qualified teams demonstrated a more stable match performance on the variables related to goal scoring, attacking and passing, while the non-qualified teams displayed a more stable match performance on the variables related to defending. The coefficients of variation (CV) of all the variables related to goal scoring and the variables related to attacking and passing showed negative relationships with the teams' match performance, while the CVs of the variables related to defending showed positive relationships with the teams' match performance. Findings of this study can provide useful information about the fluctuation of match variables, contributing to the development of specific training interventions to enhance teams' performance in key indicators.

***Key words:*** *match analysis, coefficient of variation, performance indicators, football, soccer*

## Introduction

Football is a complex and dynamic team sport (Garganta, 2009; Liu, Yi, Giménez, Gómez, & Lago-Peñas, 2015) where teams' performances combine interactions of technical, tactical, physical and mental factors (Carling, Reilly, & Williams, 2008; Drust, Atkinson, & Reilly, 2007; Liu, Yi, et al., 2015). In this unpredictable context, it is difficult for coaches and researchers to identify which factors contribute mostly to team's success and how these factors interact (Higham, Hopkins, Pyne, & Anson, 2014). Nevertheless, over the past years, a large amount of match statistics could be obtained due to the advancements in video analysis systems (e.g., AMISCO, OPTA, and ProZone), which could help us to objectively interpret the played matches (Liu, Hopkins, & Gómez, 2016). One of the main tasks of performance analysis is to identify the key indicators that are related to match outcome within this extensive database and to examine the relationships between key indicators and teams' match performance (Castellano, Casamichana, & Lago, 2012; Garganta, Maia, & Basto, 1997; Higham, et al., 2014).

The existing research normally uses the occurrence frequency values of actions or events to identify the key performance indicators that are related

to teams' match performance (Castellano, et al., 2012; Lago-Peñas, Lago-Ballesteros, Dellal, & Gómez, 2010; Lago-Peñas, Lago-Ballesteros, & Rey, 2011; Yang, Leicht, Lago, & Gomez, 2018; Yue, Broich, & Mester, 2014). A wide range of statistical methods has been employed such as discriminant analysis, principal component analysis and correlation analysis. In addition, predictive analyses have also been conducted to examine the linear relationships between match statistics and match outcome using generalised linear modelling (Liu, Gomez, Lago-Peñas, & Sampaio, 2015) and generalised mixed linear modelling (Liu, Hopkins, et al., 2016). Besides, repeated-measure match data of players or teams, derived from multiple matches, can be addressed properly in these models (Yi, Jia, Liu, & Gómez, 2018). The afore-mentioned studies were unanimous that technical indicators could be better predictors of match outcome than physical indicators. However, the key indicators identified within previous studies have shown relative inconsistency. Thus, there is an obvious opening for further research to apply a mixed approach to analysing the key indicators and their relationships with match performance, which may increase practical applications and the full understanding of match outcomes (Rein & Memmert, 2016).

Furthermore, match actions and events observed from the aspect of team performance are characterized by a high variability in the dynamical competing environments over a certain period of competition (e.g. one season) (Kempton, Sullivan, Bilsborough, Cordy, & Coutts, 2015; Liu, Gómez, Gonçalves, & Sampaio, 2016). These within-team variations are the result of both the internal (athletes' fitness status, motivation) and external factors (competing contexts, strategies, and tactics) (Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007). Therefore, the interpretation of match-to-match variation may provide a novel insight for us to identify the relationships between match statistics and match performance. The coefficient of variation (CV) was considered the best to present the inconsistency of performance indicators during a period (Hopkins, 2000). To the best of our knowledge, recent studies on the variability of performance in football are mainly based on players' match data (Bush, Archer, Hogg, & Bradley, 2015; Carling, Bradley, McCall, & Dupont, 2016; Gregson, Drust, Atkinson, & Salvo, 2010; Liu, Gómez, et al., 2016; Rampinini, et al., 2007) and have failed to account for the variability of teams' performance indicators. Moreover, there are some limitations raised from these studies, which may affect a more holistic understanding of variability in football matches. They have focused more on the variation of physical performance and little attention has been paid to the variation of technical performance, even though technical indicators have been identified by Bush et al. (2015) to vary more from match-to-match than physical indicators. However, limited technical variables were analysed in this study. A study by Liu et al. (2016) used a higher number of technical variables and the situational variables were considered as well. However, the study is a comparative analysis to juxtapose the differences of variation between players. There is a lack of predictive analysis to prognosticate the relationships between the variation of technical variables and match performance.

One might question the reliability and practical utility of those analysis that are based on a limited sample size. Thus, large datasets are needed to examine the inherent variability in match play (Hopkins, 2000) and the findings could be more reliable and valid than those of a single-season-based analysis. Nevertheless, there are very few longitudinal studies in this aspect, although patterns of match play have evolved over the last decades (Kuhn, 2005). Previous studies only examined the match-to-match variation of variables under a short- or mid-term effect (i.e. during one or two consecutive seasons).

Identifying performance indicators related to match outcome and exploring the variation of match variables are not two isolated aspects and should be considered as a necessary combination. Hence, this study aimed to identify the variation of technical elements occurring in teams' play and the relationships between the variation of technical variables and teams' match performance in the group stage of the UEFA Champions League from a long-term perspective (eight seasons).

## Methods

### Data and reliability

Technical performance-related match data of all the 768 matches (N=1,536 observations) for teams playing at the group stage of the UEFA Champions League (UCL) from the season 2009/2010 to 2016/2017 were collected from a public-accessed football statistic website named "whoscored.com" (https://www.whoscored.com) and the authorization of data use was obtained as well. The original data of the website was provided by the company OPTA Sportsdata. The reliability of the technical data from the tracking system (OPTA Client System) has been verified earlier (intra-class correlation coefficients: 0.88-1.00; standardised typical error: 0.00-0.37) (Liu, Hopkins, Gómez, & Molinuevo, 2013). This study was conducted in accordance with the Declaration of Helsinki and the local institutional review board approved the current study.

### Sample and variables

According to previous studies (e.g. Castellano, et al., 2012; Lago-Peñas, et al., 2010; Liu, Gomez,

et al., 2015; Liu, Yi, et al., 2015), the data of twenty technical match actions or events executed by the teams in 768 matches (N=1,536 observations) in the group stage of UCL from season 2009/10 to 2016/17 were chosen as the sample in the study. Technical actions or events were classified into three groups: (1) goal scoring; (2) attacking and passing; (3) defending (see Table 1). The grouping and operational definitions can be seen in Table 1 ( Liu, et al., 2013; Liu, Gómez, et al., 2015, 2016; ).

## Procedure and statistical analysis

### *Data normalization*

Variables in percentage units (pass success, possession, and aerial success) were analysed as raw data. Original value of each variable that related to goal scoring and attacking and passing was transformed into adjusted values of 50% of ball possession of the own team gained from one match (Liu, Gomez, et al., 2015). The formula is as follows:

$$V_{adjusted} = (V_{original} / BP_{own}) * 50\%$$

where $V_{adjusted}$ is the adjusted value, $V_{original}$ is the original value and $BP_{own}$ is the ball possession of the own team for one match.

Original data of the variables related to defending were transformed into adjusted values of 50% of ball possession of the opponent (Liu, Gomez, et al., 2015). The formula is as follows:

$$V_{adjusted} = (V_{original} / BP_{opponent}) * 50\%$$

where $V_{adjusted}$ is the adjusted value, $V_{original}$ is the original value and the $BP_{opponent}$ is the ball possession of the opponent for one match.

### *Descriptive analysis*

The coefficient of variation (CV; expressed as percentages) of the adjusted value of each variable for each team at the group stage of each season was calculated to quantify the within-team match-to-match variability of each team in each season (Atkinson & Nevill, 1998; Bush, et al., 2015; Liu, Gómez, et al., 2016). If the count value of an action or event was 0 in all the six matches in the group stage of one season, the CV was treated as a missing value. The differences in the mean of CVs between the qualified and the non-qualified teams were compared using non-clinical magnitude-based inference. Magnitude of clear differences was considered as: trivial, 0-0.2; small, 0.2-0.6; moderate, 0.6-1.2; large, 1.2-2.0; and very large,

*Table 1. Selected technical performance-related match actions and events*

| Groups | Action or event: operational definition |
|---|---|
| Variables related to goal scoring | Shot: an attempt to score a goal, made with any (legal) part of the body, either on or off target.<br>Shot on target: an attempt to score that required intervention to stop the ball from going in or resulted in a goal scored/shot which would go in without being diverted.<br>Shot blocked: a goal attempt heading roughly on target towards goal which has been blocked by a defender, where there are other defenders or a goal-keeper behind the blocker.<br>Shot from open play: a goal attempt not stemmed directly from a dead ball situation.<br>Shot from set piece: a goal attempt via a dead ball situation (corner kick, free-kick or throw in).<br>Shot from counterattack: a goal attempt generated from a counter-attack situation. A counter-attack situation is logged when (a) the ball must have been turned over in the defensive half; (b) the ball must be quickly manoeuvred (6 s, 3 passes) into the attacking third (the ball must be under control); (c) the defence must have four or less defenders in a position to defend the attack and attacking players must match or outnumber the defensive teams players, and (d) the ball must be fully under control in the opponent's defensive third. |
| Variables related to attacking and passing | Dribble: a dribble is an attempt by a player to beat an opponent in possession of the ball. OPTA also log attempted dribbles where the player overruns the ball.<br>Corner: ball goes out of play for a corner kick.<br>Offside: being caught in an offside position resulting in a free kick to the opposing team.<br>Pass: an intentionally played ball from one player to another.<br>Cross: any ball sent into the opposition team's area from a wide position.<br>Through ball: a pass that split the last line of defense and plays the teammate through on goal.<br>Long ball: an attempted pass of 25 yards or more.<br>Short ball: an attempted pass of less than 25 yards.<br>Pass success (%): successful passes as a proportion of total passes.<br>Possession: the duration when a team takes over the ball from the opposing team without any clear interruption as a proportion of total duration when the ball was in play.<br>Aerial won: two players competing for a ball in the air; for it to be an aerial duel both players must jump and challenge each other in the air and have both feet off the ground. The player who wins the duel gets the *Aerial won*, and the player who does not gets an *Aerial lost*. |
| Variables related to defending | Tackle: the action of gaining possession from an opposition player who is in possession of the ball.<br>Foul: any infringement that is penalised as a foul play by a referee.<br>Yellow card: where a player was shown a yellow card by the referee for reasons of foul, persistent infringement, hand ball, dangerous play, etc. |

>2.0 (Batterham & Hopkins, 2006). The possibilities for the effect to be true were: 25%-75%, possibly; 75%-95%, likely; 95%-99.5%, very likely; and >99.5%, most likely (Batterham & Hopkins, 2006).

### *Correlation analysis and autocorrelation function*

Pearson correlations between CVs and points of the group stage were calculated by the bivariate correlation analysis in the data package IBM SPSS Statistics version 22 (IBM Corp., Armonk, NY). The correlations of CVs and points of the group stage for all the teams, the qualified teams and the non-qualified teams in the past eight seasons were calculated respectively to identify the associated key performance indicators. Moreover, the temporal relationships of variation of variables were examined for both the qualified teams and the non-qualified ones. Autocorrelation function (ACF) was employed to calculate the correlations of variation of the variables between their own past and future values over these eight seasons (Brockwell & Davis, 2013). The ACF was calculated in each of a one-year (season) interval of the time series and six lags were chosen according to the time series length; there was no time-offset if lag=0. The magnitude of the correlation coefficient was as follows: $r<0.1$ trivial, $0.1<r<0.3$ small, $0.3<r<0.5$ moderate, $0.5<r<0.7$ large, $0.7<r<0.9$ very large, $r>0.9$ nearly perfect (Hopkins, 2002).

### *Generalised linear model*

The generalised linear model was employed to identify the linear relationships between CV of each action or event and the probability of qualifying for the knockout stage. A binomial logistic regression was run in the model taking the variable of "qualified or not" as the dependent variable and CVs of actions or events as the independent variables to predict the logarithm of the odds of qualifying for the knockout stage. The linear relationships were identified as effects of a two-standard-deviation increase in the value of CV of each action or event on the change (%) in the probability of team qualifying for the knockout stage (Liu, Gomez, et al., 2015). Inferences were made using the non-clinical magnitude-based inferences and were evaluated by the smallest worthwhile change, which was set to 10% of change in the probability of qualification (Higham, et al., 2014; Hopkins, Marshall, Batterham, & Hanin, 2009).

## Results

### Variation of match variables

Table 2 shows the descriptive statistics of CVs for the qualified teams and the non-qualified teams from season 2009/10 to 2016/17. Figure 1 demonstrated that mean values of CVs of shot (ES; ±90% confidence limit: 0.51; ±0.21), shot on target (0.63; ±0.21), shot from open play (0.58; ±0.21), shot from set piece (0.31; ±0.21), shot from counterattack (0.40; ±0.22), corner (0.30; ±0.21), pass (0.22; ±0.21), through ball (0.66; ±0.21), pass success (0.31; ±0.21), possession (0.32; ±0.21), and aerial success (0.50; ±0.21) for the non-qualified teams were higher than those for the teams that qualified for the knockout stage, while the variation of yellow card (-0.22; ±0.21) was lower than for their counterparts from the qualified teams. However, the differences of variation in shot blocked, dribble won, offside, cross, long ball, short ball, tackle and foul between the qualified and the non-qualified

*Table 2. Descriptive statistics of variation (coefficient of variation – CV) of match variables for teams; percentage units: mean±SD(n)*

| Variables | Qualified M±SD(n) | Non-qualified M±SD(n) |
|---|---|---|
| Shot | 31.02±10.49(128) | 37.51±12.79(128) |
| Shot on target | 46.31±16.72(128) | 58.87±21.64(128) |
| Shot blocked | 63.40±21.47(128) | 68.30±23.19(128) |
| Shot from open play | 36.59±12.51(128) | 45.40±15.62(128) |
| Shot from set piece | 59.60±20.51(128) | 66.96±23.66(128) |
| Shot from counterattack | 156.41±58.79(109) | 183.98±63.29(110) |
| Dribble won | 40.65±13.00(128) | 41.53±13.52(128) |
| Corner | 47.67±15.77(128) | 53.28±18.85(128) |
| Offside | 75.22±27.25(128) | 79.03±32.55(127) |
| Pass | 8.47±3.05(128) | 9.42±3.80(128) |
| Cross | 33.27±15.39(128) | 34.32±12.53(128) |
| Through ball | 73.03±34.68(125) | 99.97±44.09(125) |
| Long ball | 22.11±8.50(128) | 22.38±8.37(128) |
| Short pass | 10.68±3.35(128) | 11.66±5.17(128) |
| Pass success | 5.64±2.46(128) | 7.95±15.92(128) |
| Possession | 16.42±7.03(128) | 18.76±7.81(128) |
| Aerial success | 22.55±8.79(128) | 28.45±12.50(128) |
| Tackle | 29.72±9.39(128) | 29.30±13.67(128) |
| Foul | 31.63±11.35(128) | 32.11±11.63(128) |
| Yellow card | 73.07±29.10(128) | 66.46±25.15(128) |

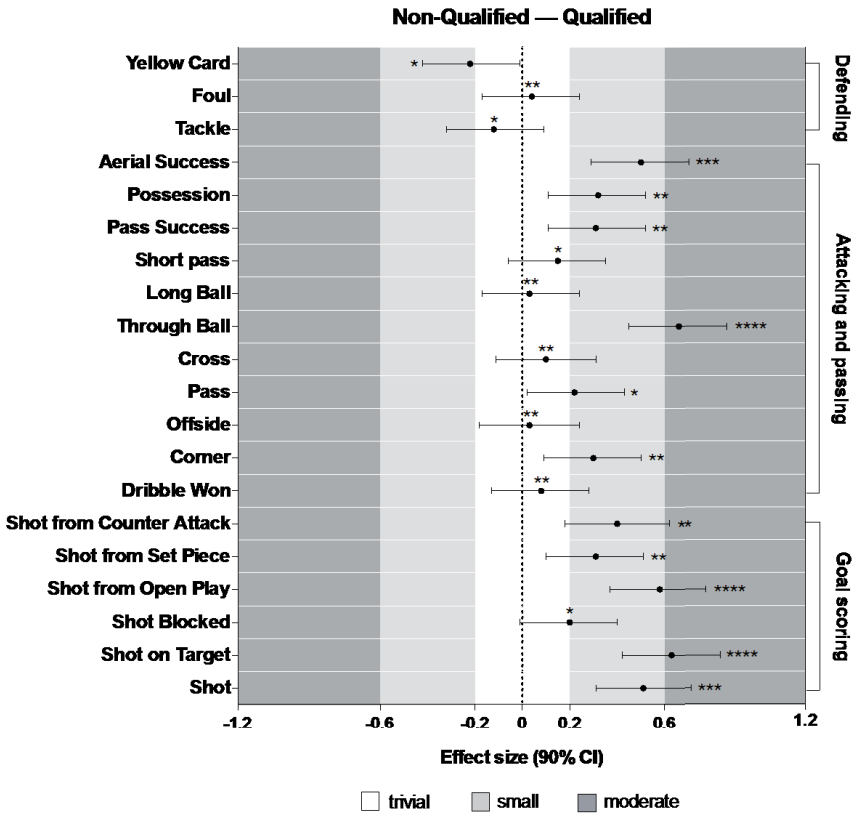


*Figure 1. Effect sizes of the differences in mean CV of each team match variable for the non-qualified and the qualified teams. Asterisks indicate the likelihood for the magnitude of the true differences in mean as follows: *possible; **likely; ***very likely; ****most likely.*

teams were trivial. Shot on target (0.63; ±0.21), shot from open play (0.58; ±0.21) and through ball (0.66; ±0.21) of the non-qualified teams were the three most unstable variables in the past eight seasons compared with the qualified teams. CVs of shot (0.51; ±0.21) and aerial success (0.50; ±0.21) also showed clear differences between the non-qualified and the qualified teams.

## Temporal relationship of variables

Table 3 shows the mean values of ACF of each variable for both the qualified and the non-qual-

*Table 3. Values of autocorrelation function (ACF) of 20 variables for the qualified teams and the non-qualified teams*

| Variables | Qualified ACF Sig. | Non-qualified ACF Sig. |
|---|---|---|
| Shot | -0.054 0.442 | -0.125 0.356 |
| Shot on target | -0.029 0.567 | -0.076 0.114 |
| Shot blocked | -0.059 0.217 | -0.091 0.705 |
| Shot from open play | -0.081 0.268 | -0.078 0.522 |
| Shot from set piece | -0.080 0.089 | -0.111 0.811 |
| Shot from counterattack | -0.057 0.456 | -0.086 0.547 |
| Dribble won | -0.106 0.562 | -0.085 0.041* |
| Corner | -0.084 0.896 | -0.010 0.974 |
| Offside | -0.107 0.637 | -0.047 0.323 |
| Pass | -0.077 0.471 | -0.084 0.863 |
| Cross | -0.076 0.563 | -0.078 0.223 |
| Through ball | -0.036 0.114 | -0.071 0.028* |
| Long ball | -0.055 0.087 | -0.041 0.197 |
| Short pass | -0.057 0.143 | -0.097 0.622 |
| Pass success | -0.103 0.770 | -0.095 0.773 |
| Possession | -0.093 0.303 | -0.062 0.327 |
| Aerial success | -0.066 0.255 | -0.076 0.207 |
| Tackle | -0.106 0,548 | -0.063 0.778 |
| Foul | -0.096 0.099 | -0.048 0.117 |
| Yellow card | -0.084 0.312 | -0.047 0.450 |

Note. Values of ACF and Sig. are presented as mean value of six lags.

ified teams. The ACF result of all the variables from the qualified and non-qualified teams did not show statistical significance except for dribble won (mean; sig.; -0.085; 0.041) and through ball (-0.071; 0.028) from the non-qualified teams. These two variables showed a trivial negative autocorrelation in all the results.

## Correlations between CVs of match variables and points of the group stage

The correlation coefficient between CVs of variables and points of the group stage were presented in Figure 2.

For the qualified teams, clearly negative correlations were observed in the past eight years between CVs of the variables related to goal scoring: shot from set piece (r; ±90% confidence limit: -0.21; ±0.14), shot from counterattack (-0.20; ±0.15) and points gained during the group stage. Considering the variables related to attacking and passing, offside (-0.11; ±0.14), through ball (-0.28; ±0.14), short pass (-0.11; ±0.14), pass success (-0.27; ±0.14) and possession (-0.27; ±0.14) had clearly negative correlations with points of the group stage as well. The correlations between CVs of shot, corner, long ball, aerial success and points of the group stage were unclear. On the other hand, for the non-qualified teams, the CVs of the variable related to goal scoring: shot from set piece (-0.24; ±0.14%), CVs of the variables related to attacking and passing: dribble won (-0.13; ±0.14), corner (-0.28; ±0.14%), cross (-0.12; ±0.14), pass success (-0.11; ±0.14%), possession (-0.21; ±0.14), aerial success (-0.23; ±0.14%), and CVs of the variables related to defending: tackle (-0.22; ±0.14) and foul (-0.13; ±0.14) showed clearly negative correlations with points gained during the group stage. The correlations between CVs of shot, shot on target, shot blocked, shot from open play, shot from counterattack, pass, through ball, long ball, short pass, yellow card and points of the group stage were unclear. It is notable that there were clearly positive correlations between CVs of cross (0.16; ±0.14%), foul (0.14; ±0.14%), yellow card (0.20; ±0.14) and points of the group stage for the teams that qualified for the knockout stage, but for those that were eliminated in the group stage, there were no such relationships. The CVs of shot from set piece and possession from the qualified teams and the non-qualified teams all had relatively high negative correlation coefficients with points of the group stage.

## Linear relationships between CVs of match variables and the probability of qualifying for the knockout stage

Figure 3 shows that, for the match variables that related to goal scoring, increases of 2-SD in the CVs of shot, shot on target, shot blocked, shot from open

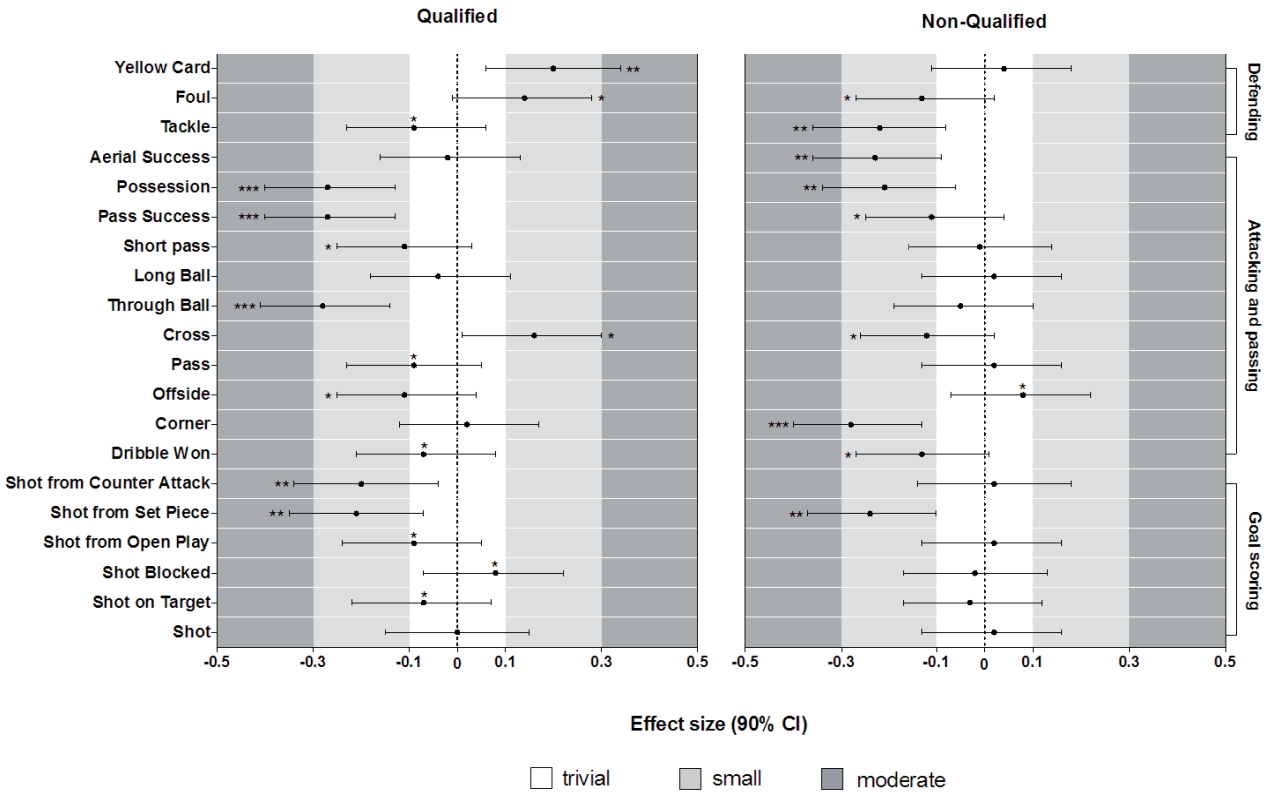


*Figure 2. Effect sizes of the correlation coefficient between CV of each match variable and points of the group stage for the qualified and the non-qualified teams. Asterisks indicate the likelihood for the magnitude of the correlations as follows: *possible; **likely; ***very likely; ****most likely. Confidence intervals for some actions or events not marked by an asterisk mean the likelihood for the magnitude of the correlations <25%.*

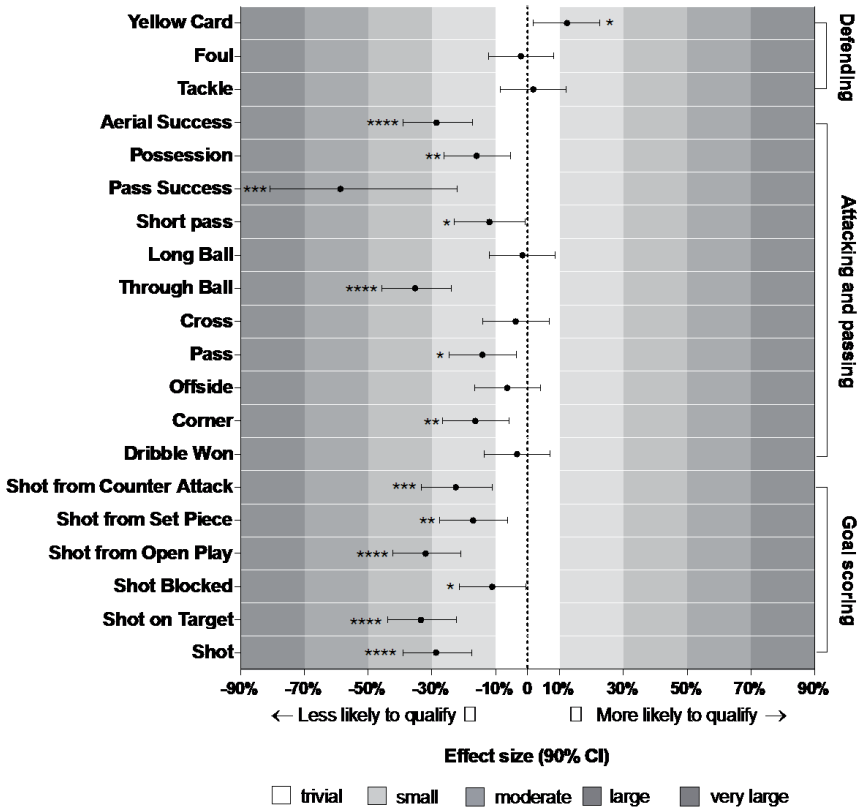


*Figure 3. Relationships between CV of each match variable and the probability of qualifying for the knockout stage. Relationships were identified as the effect of a two-standard-deviation increase in the value of CV of each performance-related action or event on the change in probability (%) of qualifying for the knockout stage. 10% and -10% represent the positive and the negative smallest worthwhile change threshold, respectively. When bars of one variable crossed the negative and positive smallest worthwhile change threshold in the meantime, the effect was unclear. Asterisks indicate the likelihood for the magnitude of the true effect as follows: * possible; **likely; ***very likely; ****most likely. Confidence intervals for the actions or events not marked by asterisks mean likelihood of trivial effect.*

play, shot from set piece, shot from counterattack would bring 28.7% (90% confidence limit: ±10.8%), 33.5% (±10.8%), 11.1% (±10.4%), 32.0% (±10.7%), 17.1% (±10.6%), 22.5% (±11.1%) lower probability of qualifying for the knockout stage, respectively. On the other hand, for the variables related to attacking and passing, a 2-SD increase in the CVs of corner, pass, through ball, short pass, pass success, possession, aerial success would decrease the probability of qualifying for the knockout stage by 16.4% (±10.5%), 14.1% (±10.5%), 35.3% (±11.0%), 12.0% (±11.1%), 58.6% (±29.3%), 16.0% (±10.4%), 28.6% (±11.0%), respectively. The CV of pass success displayed the strongest effects on the probability of qualifying for the knockout stage, whereas for the variables related to defending, a 2-SD increase in the CV of yellow card would bring a 12.3% (±10.4%) higher probability of qualification.

## Discussion and conclusions

The present study employed a collection of approaches to identify teams' technical variation and the relationships between these technical variations and match performance in the group stage of the UEFA Champions League on a large time-span basis (eight seasons). Main results include the following: the qualified teams showed a more stable match performance in the variables related to goal scoring and attacking and passing, while the non-qualified teams displayed a more stable match performance in the variables related to defending. The CVs of the variables related to goal scoring and attacking and passing had negative relationships with match performance, while the variables related to defending displayed positive relationships.

Results showed that shot from counterattack was the most unstable variable for both the qualified and the non-qualified teams during the past eight seasons. This is a new finding that did not appear in previous research. It was shown that there were 37 teams (14.5%; n=256) that attempted none shot from counterattack in all six matches played during the group stage. This finding may indicate that the counterattack situation has less frequency of occurrence and could represent an unstable performance (Bush, et al., 2015). Another reason that could explain the high variability in shot from counterattack is playing styles and tactics of teams and their opponents. Each team has its own playing style and not all teams are suited for playing counterattack. Teams that are good in using the counterat-

tack also need to adopt different playing styles when playing against different opponents (Bush, et al., 2015). Match performance of teams is firmly intertwined with match performance of players (Shafizadeh, Taylor, & Peñas, 2013). A previous study (Liu, Gómez, et al., 2016) identified that shot, shot on target and assist were the three technical performance parameters of players that holds the highest variability, while our study indicated that match variables of teams: shot from counterattack, shot blocked, shot from set piece, offside, through ball and yellow card were the six most unstable actions or events during the past eight seasons. A high variation does not necessarily always mean unsuccessful performance, but more attention should be paid to these sensitive actions or events during the coaching process and interventions.

Variations in the variables related to goal scoring and attacking and passing of the non-qualified teams were higher than their counterparts of the qualified teams, but in the three variables related to defending, variation of yellow card of the qualified teams were higher than those of the non-qualified teams, while variations of foul and tackle showed trivial differences. A similar finding was reported on the variation of technical match actions or events of players from La Liga (Liu, Gómez, et al., 2016). Stronger teams tend to obtain a higher ball possession percentage in a football match (Jones, James, & Mellalieu, 2004), whereas weaker teams have to concentrate more on defensive aspects when they encounter stronger teams, which might explain why weaker teams showed a more stable performance in the variables related to defending. Furthermore, in the variables related to goal scoring and attacking and passing – shot on target, shot from open play and through ball, were the three variables that showed the biggest differences between the qualified and the non-qualified teams. A similar study reported that the variations of shot on target and through ball of players when losing a match were higher than when winning the match (Liu, Gómez, et al., 2016), which means that these variables from the winning teams also showed more stable performances. Previous studies (Castellano, et al., 2012; Lago-Peñas, et al., 2010 2011; Liu, Gomez, et al., 2015) have identified that shot on target and ball possession were the key variables to succeed in football. However, in the current study, ball possession only showed likely small difference between the qualified teams and the non-qualified teams. Based on the results, it is suggested that the qualified teams are better in retaining possession and the variation of possession for both the qualified and the non-qualified teams maintained at a relatively stable level on a long-term basis. One interesting finding of this study was that there was a clear difference between the qualified and the non-qualified teams regarding the variability of through ball. Taking positional factors into account, players of full back, wide midfielder, central midfielder and forward of the stronger teams made more through balls than weaker teams except for the central defender position (Liu, Gómez, et al., 2016). This fact indicated that variation difference of through ball between the qualified and the non-qualified teams was likely to be related to the differences in the players' skill level. Most players from the top teams were always able to achieve a more stable number of through ball than those from the bottom teams (Liu, et al., 2016).

Autocorrelation function (ACF) was used to make a dynamic comparison across the seasons by identifying the correlation among the seasons' variations of a variable. Those variables that did not show statistical significance indicated that there was no relationship between the previous and the next match performance variation of these variables within these eight seasons. However, negative autocorrelations in dribble won and through ball of the non-qualified teams were found. Although their effects were trivial, this would mean that there was a certain negative relationship in match performance stability within these two variables from the non-qualified teams over the past eight seasons. The higher the ACF value, the greater the correlation (Prieto, García, & Ibáñez, 2017). The more unstable the performance of the variable the non-qualified teams have in one season, the more stable the performance of this variable would be in another season. Therefore, dribble won and through ball showed a low performance persistence across the seasons, which led to the unsuccessful performance of the non-qualified teams in the group stage.

Correlation analysis quantified the relationships between variations of match variables and match outcome (points of the group stage). We can see in Figure 2, the CVs of through ball, pass success and possession from the teams that qualified for the knockout stage showed the highest negative correlations with points of the group stage in the past eight seasons. It was suggested that the lower the variation of through ball, pass success and possession from the qualified teams, the higher the points gained. The consistency of these actions or events for the qualified teams contributed to their successful match outcome. This finding was in line with the previous study (Bush, et al., 2015) concluding that the stronger teams tended to adopt a more possession-based strategies of retaining ball possession and seeking scoring opportunities. As for the teams that did not qualify for the knockout stage, only the CV of corner displayed a very likely negative correlation with points of the group stage. The CV of corner from the non-qualified teams negatively correlated to their points, thus demonstrating that the stability of this action was responsible for the unsuccessful performance of the non-qualified teams. Additionally, this finding may indi-

cate that increasing the occurrence frequency of corner and improving its stability across matches can bring a better match outcome for the non-qualified teams.

We should also notice that the CVs of yellow card and foul from the qualified teams showed clearly positive correlations with the points obtained during the group stage. Teams were likely to manifest a better performance in matches when they had a higher variability in yellow card and foul. This may reveal that the numbers of yellow cards and fouls awarded to the qualified teams in a game can never maintain either at a relatively high level or at a relatively low level. This depends on the situation of the game and the opponent's tactics. Interestingly, the CV of foul from the non-qualified teams showed a clear positive correlation with their points gained in the group stage, which can be easily explained by their relatively worse strength in attacking, thus more fouls were committed to prevent opponents from scoring a goal. We also found that the CVs of shot from set piece and possession from the qualified and the non-qualified teams all showed clear negative correlations with their corresponding points during the group stage. It is important for both the top and the bottom teams to reduce the variations in these two actions or events, which is an effective way to enhance their match performance.

Generalised linear model also allows to identify the relationships between variations of match variables and match performance (either of the qualified or the non-qualified for the knockout stage) (Liu, Gomez, et al., 2015). Probably due to a large sample of the current study, the results not only showed differences from league competitions (Lago-Peñas, et al., 2010; Oberstone, 2009), but were also slightly different from those previously identified in other competitions (Castellano, et al., 2012; Lago-Peñas, et al., 2011; Liu, Gomez, et al., 2015). The results of prior studies showed the performance parameters that were the key to success and to discriminate the top from the bottom teams mainly were total shot, shot on target and ball possession. In the current study, the CVs of all the variables that related to goal scoring showed clear negative relationships with the probability of qualifying for the knockout phase, especially for the following: shot, shot on target and shot from open play (most likely negative effect). This result indicates that stability, quality and diversity of shots on goal are important factors of teams' success in the group stage of the UCL. The variables related to attacking and passing also showed negative relationships with the probability of qualifying for the knockout stage, especially the CV of pass success, which had the strongest negative relationship with the probability of qualifying for the knockout phase: a two-standard-deviation increase in the CV of pass success could bring a 58.6% decrease in the probability of qualifying for the knockout stage. Although the CV of pass also showed a clear negative relationship (-14.1%) with the probability of qualifying for the knockout stage, these values were lower than those for the CV of pass success. This result may reflect that the quality of pass is more important than its quantity for teams to succeed in football. The occurrence of aerial duels is usually a result of long balls and crosses (Liu, Gomez, et al., 2015). The CV of aerial success in this study showed most likely negative effect, the CVs for long ball and cross showed a trivial effect. However, the CV of corner displayed a clearly negative relationship with the probability of qualifying for the knockout stage. A high occurrence frequency of corner means that more saves were made by the goalkeeper or more clearances were executed by defenders. It may indicate that putting more pressure on the opponent's defensive area (attacking third) allows bringing more corners and improving the stability of match performance in aerial success is an effective way for teams to succeed. For the variables related to defending, only the CV of yellow card showed a clearly positive relationship with the probability of qualifying for the knockout stage. The unstable match performance of teams on yellow card produces a more successful performance. The low occurrence frequency of the yellow card in matches may result in a high variation. Hence, players should learn to reduce unnecessary fouls and to commit fouls at the right time to prevent the offensive threats from the opponent.

In summary, the qualified teams showed a more stable match performance on variables related to goal scoring and variables related to attacking and passing, such as shot on target, shot from open play and through ball, while the non-qualified teams displayed a more stable match performance in the variables related to defending such as yellow card. Stronger teams preferred to adopt possession-based attacking playing style. The CVs of the variables related to pass and organization from the qualified teams (through ball, pass success and possession) were negatively correlated with points of the group stage, while the CVs of the variables related to set piece (shot from set piece and corner) from the non-qualified teams showed negative correlations with points of the group stage. The results of generalised linear modelling showed that the CVs of the variables related to goal scoring and variables related to attacking and passing all showed clearly negative relationships with the probability of qualifying for the knockout stage, especially for the pass success. For the variables related to defending, only the CV of yellow card showed clearly positive relationship with the probability of qualifying for the knockout stage.

The current study conducted both the comparative analysis and the predictive analysis based on a large data set, aiming to identify teams' technical

variation and the relationships between variables' technical variation and match performance from a long-term perspective. Coaches and performance analysts can get a holistic insight into the variability of teams' indicators and a novel perspective to identify the key performance indicators for teams' match performance. Teams could develop specific training interventions to monitor and enhance their match performance in the identified key performance indicators. Specifically, stronger teams can improve the stability of match performance in passing, organising and goal scoring to maintain their initiative during match play. Weaker teams can improve their ability of set-piece, which is an effective way for them to increase the probability of winning a game. However, some limitations of the study should be addressed in further research. Firstly, only the quality of teams was considered in the comparisons of team's variation. More situational variables, such as match location, quality of the opponent and the match outcome, should be accounted for to establish technical performance profiles, that would be a powerful tool for the match preparation and post-match evaluation. Secondly, only technical performance related actions or events were analysed. Nevertheless, the tactical and physical performance should be further incorporated in the analysis to enhance the practical applications.

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