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The evolution of physical and technical performance parameters in the Chinese Soccer Super League

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ABSTRACT: Performance analysis in soccer has attained greater importance for coaching staff in order to gather and manage useful information (i.e., physical, technical, and tactical) of their teams during consecutive seasons. Accordingly, we examined the evolution of physical and technical performance parameters in the Chinese Soccer Super League (CSL). Data were collected from 1,429 CSL matches from the 2012 season to the 2017 season using the Amisco Pro (Amisco, Nice, France) system. Fourteen technical performance-related indicators and 11 physical performance-related indicators were analysed using a mixed linear model for repeated measures. Significant main effects of season were followed up using the Bonferroni correction (multiple comparisons). Although there were some irregularities, performance variables generally showed significant upward trends across the six seasons ($p<0.05$), resulting in significant increases from the 2012 season to the 2017 season in the total sprint distance (2,069.7±509.3 m vs. 2,272±493.6 m; $p<0.001$; effect size [ES]: 0.40), number of sprints (100.1±22.8 vs. 104.8±20.8, $p<0.001$; ES: 0.22), high-speed distance (2568.4±503.5 m vs. 2823.1±479.2 m; ($p<0.001$; ES: 0.52), and high-speed effort (187.5±36.1 to 204.7±33.7; $p<0.001$; ES: 0.49). Furthermore, there were ~23% more crosses ($p<0.001$; ES: 0.45), ~12% more shots on target ($p<0.001$; ES: 0.22), and ~11% more opponent penalty area entries ($p<0.001$; ES: 0.20) during the 2017 season than in the 2012 season. Coaches and sports scientists should be mindful of this evolution when preparing training sessions and recruiting new players, and even when predicting future trends in the Chinese Soccer Super League.

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INTRODUCTION

The complex nature of soccer requires from players and teams a combination of physical, technical and tactical performances [1]. In recent decades, its evolution has been influenced by changes in rules and match tactics, increased professionalism, the use of new technologies, wider global exposure, international transfers of players and coaches, and transformations in training and selection processes [2, 3]. These changes open up new demands on coaching staff and recruitment managers, allowing development of their own personal understanding and improving their sport-specific knowledge, which can help to maximize the players' development and soccer club benefits.

Previous studies have shown an increasing trend in both the physical and technical demands of the game at a professional level [4]. Specifically, increasing passing rates and ball speeds in World Cup final matches over a 44-year period (1966–2010) have been observed [3]. Additionally, Barnes, et al. [4] reported that the English Premier League (EPL) underwent substantial changes from the 2006–2007 seasons to the 2012–2013 seasons, with high-intensity running and sprinting distances increasing by 30%-50% and the number of passes increasing by 40%; subsequent research identified these evolutionary trends as position- and tier-specific [1, 4]. Although these studies provide preliminary knowledge regarding the evolution of international elite soccer before the 2012–2013 seasons, research regarding the evolution of soccer in recent years is limited, especially for low level soccer leagues, such as the Chinese Soccer Super League (CSL).

The majority of teams in the CSL have invested considerable sums in recruiting numerous world-famous foreign coaches and players [5]. The increasingly skilled national league has also increased in visibility due to the presence of international stars and greater television coverage in Asia [5]. However, research on this league is scarce. Recent studies on the CSL by Zhou, et al. [6] and Mao, et al. [7] reported that shots on target, shot accuracy, sprinting distance in ball possession, quality of opposition, number of passes, and number of forward passes have an effect on the match outcome. Furthermore, Yang, et al. [8] found that upper-ranked teams had greater sprinting distance, total distance out of ball possession, possession, possession during the opponent's half, number of entry passes in the final 1/3 of the field and penalty area, and 50–50 challenges than did lower-ranked

teams. Similarly, Lago-Peñas, et al. [9] identified four playing styles in CSL teams ("possession" play, set pieces attack, counterattacking play, and transitional play) by examining 20 match performance indicators. These studies mainly focused on the key performance indicators associated with match outcome or team quality in isolated seasons. Consequently, detailed information on longitudinal trends in these indicators, which could help coaches to better monitor, prepare, and conduct training programmes, are currently lacking.

The aim of this study was to examine the evolution in physical and technical performance parameters in the CSL from the 2012 season to the 2017 season. Coaches and performance analysts from developing soccer countries may benefit from more detailed knowledge regarding teams' performances. Specifically, a better understanding of the recent developmental trends could, in turn, be used in the daily training and future planning of players. Furthermore, the development of soccer in a specific country could be related to the quantity and quality of soccer research.

MATERIALS AND METHODS

Sample, data resource

The Chinese Soccer Super League is the highest level of professional soccer matches in China (16 teams playing a regular season with a balanced schedule against their opponents both at home and away from March to November every season; then each team plays 30 matches per season and the competition includes a total of 240 matches per season). A total of 1,429 matches out of 1,440 CSL matches (11 matches had missing data) from six seasons (2012 to 2017) were selected. The final sample was composed of the observation of 1,032 players (n = 36,397 match participations) with a mean age of 26.8±3.7 years old. The unit of analysis was the team's match performance. Match statistics were collected using the Amisco Pro (Amisco, Nice, France) tracking system. The reliability and validity of this system for the measurement of player movement have been previously evaluated, and it has been shown to have high precision [10]. Data were obtained from the original match report

TABLE 1. Definitions of selected technical and physical performance-related parameters

Technical performance-related parameters: operational definition	
Shot	An attempt to score a goal, made with any (legal) part of the body, either on or off target
Shot on target	An attempt to score a goal, which required intervention to stop the ball going in or resulted in a goal/shot that would have gone in without diversion
Possession in opponent half (%)	Possession by a team in the opponent's half of the pitch
Pass:	An intentionally played ball from one player to another
Pass accuracy (%)	Successful passes as a proportion of the total passes
Forward pass	An intentionally played ball from one player to another who is located closer to the opponent goal.
Forward pass accuracy (%)	Successful forward passes as a proportion of the total forward passes
Opponent 35-m entry	Number of times when the ball (possessed by the attacking team) enters the 35m area of the opponent's half of the pitch
Opponent penalty area entry	Number of times when the ball (possessed by the attacking team) enters the penalty area of the opponent's half of the pitch
Cross	Any ball sent into the opposition team's area from a wide position
Corner	Ball goes out of play for a corner kick
Offside	Being caught in an offside position resulting in a free kick to the opposing team
Foul committed	Any infringement that is penalised as foul play by a referee
Yellow card	A yellow card is shown to a player by the referee for reasons of foul play, persistent infringement, hand ball, dangerous play, time wasting, etc.
Physical performance-related parameters: operational definition	
Total distance (m)	Distance covered in a match
Total distance IP(m)	Total distance covered when in ball possession
Total distance OP(m)	Total distance covered when out of ball possession
Sprinting distance (m)	Distance covered at a speed over 23km/h in a match
Sprinting effort	Number of sprints in a match
Sprinting distance IP (m)	Sprinting distance covered when in ball possession
Sprinting distance OP (m)	Sprinting distance covered when out of possession
High-speed running distance (m)	Distance covered at a speed of 19.1–23 km/h in a match
High-speed running effort	Number of high-speed runs in a match
High-speed running distance IP (m)	High-speed running distance covered when in ball possession
High-speed running distance OP (m)	High-speed running distance covered when out of ball possession

provided by AMISCO and transferred to a database. The study design was approved by our local university ethics committee.

Procedure and statistical analysis

In accordance with previous studies [6, 8, 11], 14 technical performance-related indicators and 11 physical performance-related indicators were chosen as dependent variables; the categories and definitions of these variables are shown in Table 1 [6]. The distribution of each variable was examined for normality using the Kolmogorov-Smirnov test. A mixed linear model for repeated measures [12, 13] was applied to identify the effect of season as a fixed factor on the match performance variables and player ID was considered as a random effect. Additionally, the Bonferroni correction post-hoc test was used to verify localized differences (multiple comparisons). The effect size (ES) of localized differences was determined by the standardized Cohen's d and classified as trivial (<0.2), small (>0.2–0.6), moderate (>0.6–1.2), or large (>1.2–2.0) [14]. In addition, data visualizations of performance indicators were plotted using the R software in order to identify trends in performance evolution along the seasons. Statistical significance was set at $p<0.05$. Statistical analyses were performed using SPSS version 23 (IBM, Armonk, NY, USA).

RESULTS

Table 2 summarizes the technical performance data according to season. Significant differences among the six seasons were found ($p<0.05$, range of CV: 2.6 to 93.8) for the shots on target, corners, crosses, passes, pass accuracy, forward passes, forward pass

TABLE 2. The evolution of technical performance in the Chinese Soccer Super League over 6 seasons (from 2012 to 2017)

	2012–2017	2012 (478)	2013 (480)	2014 (478)	2015 (478)	2016 (470)	2017 (474)	F	Sig.	CV
Shots	12.5 ±4.9	12.2 ±4.7	12.7 ±5.0	12.4 ±5.2	12.3 ±4.9	12.3 ±5.0	13.1 ±4.7*	2.12	0.060	4.9
Shots on target	4.8 ±2.6	4.3 ±2.3	5.2 ±2.7***	4.9 ±2.8**	4.6 ±2.7	4.7 ±2.7*	4.8 ±2.5**	5.88	<0.001	2.6
Corners	4.7 ±2.7	4.6 ±2.7	4.6 ±2.8	4.8 ±2.8	4.6 ±2.8	4.4 ±2.5	5.0 ±2.8	2.59	0.024	2.7
Crosses	14.3 ±6.7	12.8 ±6.0	13.7 ±6.3	14.3 ±6.8**	14.5 ±6.6***	14.9 ±7.2***	15.6 ±6.9***	10.72	<0.001	6.7
Possession in opponent's half	44.5 ±7.5	43.9 ±7.6	44.6 ±7.4	44.2 ±7.6	44.3 ±7.5	45.0 ±7.9	44.9 ±7.2	1.51	0.182	7.5
Passes	369.0 ±94.3	357.2 ±92.0	387.4 ±91.8***	379.2 ±92.9**	362.7 ±94.7	367.0 ±101.1	360.0 ±90.0	7.67	<0.001	93.8
Pass accuracy	78.9 ±5.8	77.3 ±5.9	79.7 ±5.6***	79.8 ±5.5***	79.6 ±5.7***	79.5 ±5.9***	77.8 ±5.8	17.75	<0.001	5.8
Forward passes	124.7 ±25.3	122.1 ±27.2	127.1 ±27.4**	128.3 ±24.5***	122.9 ±24.9	123.0 ±24.7	124.7 ±22.3	4.71	<0.001	25.2
Forward pass accuracy	63.4 ±8.5	62.7 ±8.8	65.6 ±9.1***	64.1 ±8.3*	63.8 ±8.2	62.7 ±8.5	61.3 ±7.7	14.62	<0.001	8.5
Opponent 35-m entries	44.6 ±14.1	43.4 ±14.1	45.7 ±14.4*	45.6 ±14.6	44.0 ±13.9	45.1 ±14.8	43.9 ±12.9	2.29	0.043	14.1
Opponent penalty area entries	6.9 ±3.8	6.4 ±3.5	6.9 ±3.8	6.7 ±3.7	6.9 ±3.8	7.2 ±4.2**	7.1 ±3.7*	2.55	0.026	3.8
Fouls committed	16.4 ±4.7	16.9 ±4.4	15.6 ±4.5***	16.7 ±4.6	17.1 ±5.1	15.7 ±4.8**	16.1 ±4.6	8.76	<0.001	4.7
Offsides	2.2 ±1.8	2.2 ±1.7	2.3 ±1.9	2.2 ±1.8	2.3 ±1.8	2.2 ±1.8	2.3 ±1.7	0.80	0.547	1.8
Yellow cards	2.0 ±1.3	2.1 ±1.3	2.0 ±1.3	1.9 ±1.3	1.9 ±1.4	2.0 ±1.4	2.1 ±1.4	1.91	0.089	1.3

* $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$ denote a significant difference from the 2012 season; CV = square root of estimates of covariance parameters.

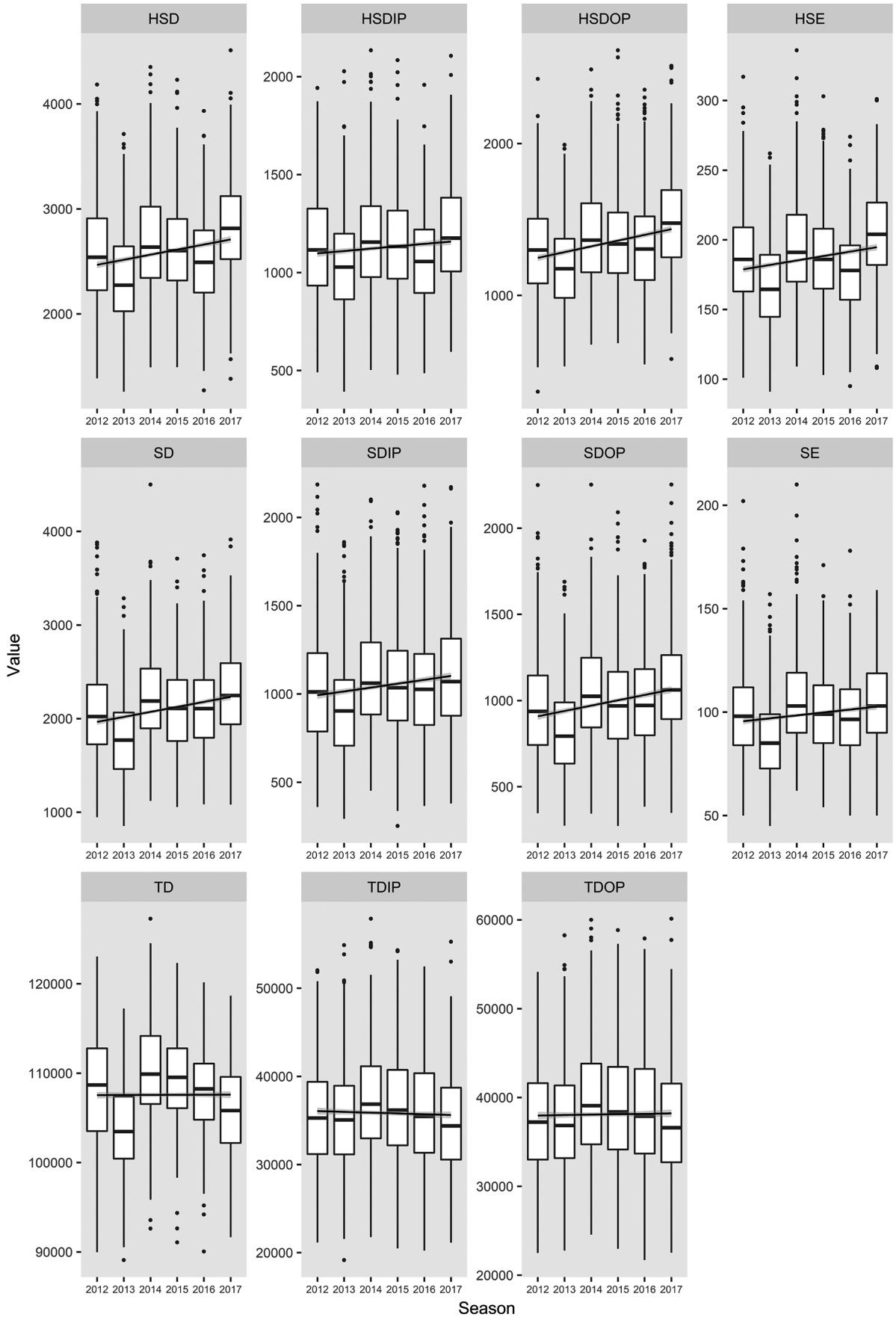

FIG. 1. The evolution of physical performance in CSL over 6 seasons from 2012 to 2017.
Note: TD=Total distance; SD=Sprinting distance; SE=Sprinting effort, HSD=High-speed running distance; HSE=High-speed running effort; IP=In ball possession; OP=Out of ball possession. Line represents the regression line and 95 % confidence interval.

accuracy, opponent 35-m entries, opponent penalty area entries, and fouls committed. Passing-related performance variables (passes, pass accuracy, forward passes, forward pass accuracy) peaked in seasons 2013 and 2014. Players performed more passes in seasons 2013 and 2014 than in other seasons ($p<0.05$; ES: 0.13–0.33), and had higher pass accuracy in seasons 2013 and 2014 than in seasons 2012 and 2017 ($p<0.001$; ES: 0.33–0.45). Additionally, players had higher forward pass accuracy in season 2013 than in other seasons ($p<0.05$; ES: 0.17–0.51) and performed more forward passes in season 2014 than in other seasons, with the exception of season 2013 ($p<0.05$; ES: 0.15–0.24). Despite variability among seasons, there were clear increasing trends in crosses, shots on target, and opponent penalty area entries across the six seasons. There were ~23% more crosses ($p<0.001$; ES: 0.45), ~12% more shots on target ($p<0.001$; ES: 0.22), and ~11% more opponent penalty area entries ($p<0.001$; ES: 0.20) in the 2017 season than in the 2012 season.

The regression lines in Figure 1 show that most of the physical performance variables, other than the total distance and total distance according to ball possession, had significant increasing trends over the six seasons. However, variability among seasons existed; for example, high-speed running and sprint-related variables had significantly lower values in season 2013 than in other seasons ($p<0.001$; ES: 0.31–1.15). The total sprinting distance increased by 9.8% from the 2012 season to the 2017 season (2069.7±509.3 m vs. 2272±493.6 m, $p<0.001$; ES: 0.40), and increased by 4.7% in the number of sprints (100.1±22.8 vs. 104.8±20.8, $p<0.001$; ES: 0.22). Additionally, the sprinting distance in ball possession increased by 7.6% from the 2012 season to the 2017 season (1033.6±322.2 m vs. 1112.1±318.7 m, $p<0.001$; ES: 0.24) and that for out of ball possession increased by 12.9% (963.3±310.4 vs. 1087.7±307.5, $p<0.001$; ES: 0.40). Furthermore, the high-speed running distance increased by 9.9% (2568.4±503.5 m vs. 2823.1±479.2 m, $p<0.001$; ES: 0.52), high-speed effort increased by 9.2% (187.5±36.1 vs. 204.7±33.7, $p<0.001$; ES: 0.49), high-speed running distance in ball possession increased by 6.6% (1131.1±278 vs. 1205.4±275.3, $p<0.001$; ES: 0.27), and high-speed running distance out of ball possession increased by 14.6% (1301.8±314.5 vs. 1491.5±331.8, $p<0.001$; ES: 0.59). However, the total distance in ball possession ($p>0.05$, ES: 0.15) and out of ball possession ($p>0.05$, ES: 0.04) did not significantly differ between the 2012 and 2017 seasons.

DISCUSSION

To our knowledge, the present study is the first to explore the temporal evolution of physical and technical parameters of teams participating in the CSL. The present study found that the high-intensity running distance increased substantially over the six seasons, while the total running distance did not clearly change. Regarding technical performance variables, crosses, shots on target, and opponent penalty area entries showed increasing trends, whereas passing-related variables showed peak values in seasons 2013 and 2014.

Consistent with a previous study by Barnes, et al. [4], the total distance covered during a match remained constant over time, while high-intensity running distances (sprinting and high-speed running) increased over six seasons in the CSL. Bush, et al. [1] reported that an elevation in high-intensity running in the EPL was due to evolving game patterns, as opposed to natural variability. The authors also speculated that this evolution was a consequence of developments in the physical preparation of the players or an influx of players with innately higher levels of physical fitness [1, 4]. Increased high-intensity running distance would affect the training strategy, as high-intensity running has been shown to be related to the physical capacity of the players [15] and match outcome [6, 16, 17]. Interestingly, CSL teams covered less distance, especially high-intensity running distance, in the 2013 season than in other seasons. We presume that this result is related to the superior passing performance of teams participating in the 2013 season. Furthermore, Gai, et al. [18] reported the presence of gaps in physical fitness, especially in high-intensity running capacity, between Chinese and foreign players. In fact, greater recruitment of foreign players within a training squad might have contributed to some of the observed changes, or differences, in physical performance in the CSL league. On the other hand, these gaps indicate a difference in physical fitness between players in the CSL and those from developed soccer leagues. The present study results suggest a demand for high-intensity running ability in the modern game, which has increased over six seasons as the level of competition increased in the CSL.

It is important to note that, from the 2012 season to the 2017 season, the increase in high-intensity running distances was greater for out of ball possession than for in ball possession (sprinting distance: 12.9% vs. 7.6%; high-speed running distance: 14.6% vs. 6.6%, respectively). This trend indicates that changes in physical ability demands in the CSL were greater for defending than for attacking. This result is expected, as the execution of high-intensity actions with the ball (i.e. offensive actions) is technically more difficult than that without the ball (i.e. defensive actions). Consequently, increasing the defensive pressure allows more balls to be recovered during high-intensity actions. Previous results imply that there were more balls lost and turnovers in the CSL than in top-level competitions [19]. Therefore, a constant interchange of ball possession via high-intensity actions and recoveries occurs during the game, resulting in an increased interchange of opportunities occurring close to the opponent's area. Other studies have shown an advantage of recovering ball possession as close to the opponent's goal as possible, increasing goal scoring opportunities [20–23]. Moreover, it has become increasingly common in soccer matches for players to restrict passing options and the available space once a team loses possession of the ball, by immediately applying defensive pressure. This requires high levels of intense running, but can effectively delay the opposition's offensive play, and allow the team to regain possession of the ball as well.

Regarding technical performance parameters, the number of shots on target is an important indicator determining the success of CSL teams [6–8]. The present study showed that the number of shots on target increased over six seasons. This may result from better player recruitment, both in physical and technical terms, as well as improved tactics due to the influx of experienced coaches (e.g., team coaches, trainers, or managers). Although ball possession in the opponent's half and the number of opponent 35-m entries did not significantly change, the number of opponent penalty area entries increased over six seasons in the CSL. This result may imply that once the team controlled the ball in the opponent's half (including recovering the ball in this area), they tried their best to pass the ball into the opponent's penalty area via more forward passes or crosses. Although the number of crosses is not a key performance indicator affecting the match outcome in the CSL [6], it is an important measure of the playing style, in terms of the offensive pressure against opponents [24]. Thus, crosses may not directly lead to a goal, but they do contribute to creating more attack opportunities.

Passing performance was better in seasons 2013 and 2014 than in other seasons in the CSL. Pass density (number of passes per minute of possession) and pass precision (number of completed passes relative to the total number of passes) are strongly associated with match success [25]. Additionally, passing rates and ball speeds during World Cup finals have continued to increase over a 44-year period [3]. Thus, it could be inferred that CSL teams improved their ability to control the game by making more passes and maintaining higher passing success rates during this period. However, the number of passes and pass accuracy decreased continuously from the 2015 season to the 2017 season; this result may be related to increasingly greater defensive pressure on ball possession when passing the ball, and less available space via more high-intensity activities by opponents, as shown in the current study. As an opponent increases the defensive pressure, the team must constantly adapt their spatial configuration. This requires greater concentration and decision-making capacity from the players, as well as higher levels of physical fitness [25].

CONCLUSIONS

Physical performance, especially high-intensity running distances, together with technical performance parameters, such as crosses, shots on target, and opponent penalty area entries, have increased over six seasons in the CSL. The evolution in these variables reflects the recent performance trends in CSL match play over a six-season period. The current findings regarding performance evolution in the CSL can enable coaches to better understand the development of Chinese soccer and optimize training methods. Knowledge regarding evolutionary patterns could provide soccer club managers new perspectives in talent identification and player recruitment. The normative profiles and developmental trends in the present study can help elite soccer players (especially for younger players) to better prepare and adapt their physical and technical ability for their professional career. The current results could also be used to compare the current situation in Chinese soccer with that in developed soccer leagues internationally.

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Conflict of interest

Authors state no conflict of interest.

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