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SKILL-RELATED PERFORMANCE IN SOCCER: A SYSTEMATIC REVIEW

review paper
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ABSTRACT
The aim of the study was to evaluate and organize systematically the available literature on skill-related performance in young and adult male soccer players in an attempt to identify the most common topics, ascertain the weaknesses, and elucidate the main contributions of the scientific papers on this issue. A systematic review of the Institute for Scientific Information (ISI) Web of Knowledge database was performed in accordance with the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) guidelines. The keywords 'football' and 'soccer' were used, each associated with the following terms: 'technical analysis,' 'technical performance,' 'technical activity,' 'technical skill,' 'technical demands,' 'technical profiles,' 'technical characteristics,' 'technical actions,' 'technical scores,' 'technical ability,' 'motor skills,' and 'skill acquisition'. From the 2830 papers, only 60 were reviewed, of which 75% had been published in years 2011–2015 and 53.3% concerned professional or seniors players (above the U-20 category). Out of the 41 papers that analysed the skill-related performance in the match, 48.8% evaluated the performance in small-sided and conditioned games. Among the 27 papers that used validated instruments, 88.9% assessed technical actions outside the match context (e.g. dribbling, shooting tests). Future research should pay attention to the definition and classification of the skill-related variables under investigation in match context and propose tests for measured skill-related performance in soccer, considering that the representativeness task design allies the players' possibilities of action to the situation of the match.
Key words: ecological approach, technical performance, representative design, team sports

INTRODUCTION

The pursuit of sporting success constantly leads the coaches, performance analysts, and sports researchers to explore methods to evaluate and promote performance. In this sense, match analysis investigates the performance of teams with regard to the different scales of analysis, from the individual level (micro) towards the collective level (macro). Moreover, it provides informational knowledge regarding the development of the training process, as well as the competitive outcomes, considering various features displayed by teams in competitive matches [1]. It is a foundation for decision-making processes referring to the performance of players and sequentially enables the provision of feedbacks as part of the coaching process. However, accurate feedback on the actual players' performance requires testing with the representative task design of the specific match demands (i.e. generalization of task constraints in experimental designs to the constraints in sports; for more details, see [2]).

The theoretical principles of ecological dynamics revealed that the most relevant information for decision-making and the regulation of action in dynamic environments is emergent during continuous performer-environment interactions [3]. In this approach, the environment provides information that directly influences the behaviour of the agent (i.e. player) [4]. This information, perceived by the players, enhances the possibilities of action (i.e. affordances). Therefore, the responses to the constraints imposed by the match context materialize through the execution of technical actions in order to achieve a certain objective [5]. These actions endue an adaptive character as a func-

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tion of time and space in which they are performed. The ability to perform a technical action influences the possibilities of the player to choose the best option in the match situation. During matches, the interdependency between knowing 'how to do' (efficiency), obtaining the result accordant with the purpose of the action (efficacy), and the capability to adjust to different match scenarios (adaptation) are required from the player [6]. Thus, a successful technical action in team sports is sustained by a decision-making process that results from the exploitation of the possibilities of action (i.e. affordances) that emerge from the interaction between the player and the environment [7]. From the foregoing, the importance of the development and evaluation of technical actions in team sports (e.g. soccer) is clear.

With the advancement in the production of scientific knowledge concerning skill-related performance in soccer, notational analysis assumed an important role [8]. Notational analysis comprises the observation and the quantitative and qualitative analysis of the technical and tactical actions fulfilled during the match [9]. Quantitatively, it records the number of actions performed by players and their respective duration. Regarding the qualitative analysis, the objective is to verify the result of the action depending on its effectiveness [1]. Other forms of notational analysis focused on the actions and movements scrutinized by players that promote the emergence of different match patterns [9]. On the other hand, another approach studied in the analysis of skill-related performance in soccer refers to the analysis of technical actions outside the match context related to the efficiency of the players and teams [10–12]. This approach of evaluation has been described to conceive the identification and development of talents, as well as to allow the distinction between different levels of experience (e.g. [13–16]), although it is not clear how this dimension interacts with others or how it adapts to the play structure [17]. Vilar et al. [18] argued that the skill-related tests outside the match context (e.g. dribbling, passing, shooting) were not representative of competitive performance because they did not include critical perceptual variables that players usually use to control their actions during the match.

To date, a few review articles have explored the skill-related performance in sports (i.e. ecological dynamics approach to skill acquisition [7]) and specifically in soccer [19–21]. While one of these reviews focused on examining the validity, reliability, and sensitivity of the tests used to measure skill-related performance outside the soccer match context (i.e. juggling, heading, wall-volley, dribbling, shooting, passing, multifaceted tests [19]), others addressed critically [20] and systematically [21] the match performance analysis as a whole – without dividing it into skill-related thematic categories and without considering both in- and out-game context. Thus, the aim of this study was to evaluate and organize systematically the available literature on skill-related performance in young and adult male soccer players in an attempt to identify the most common topics, ascertain the weaknesses, and elucidate the main contributions of the scientific papers on this issue.

MATERIAL AND METHODS

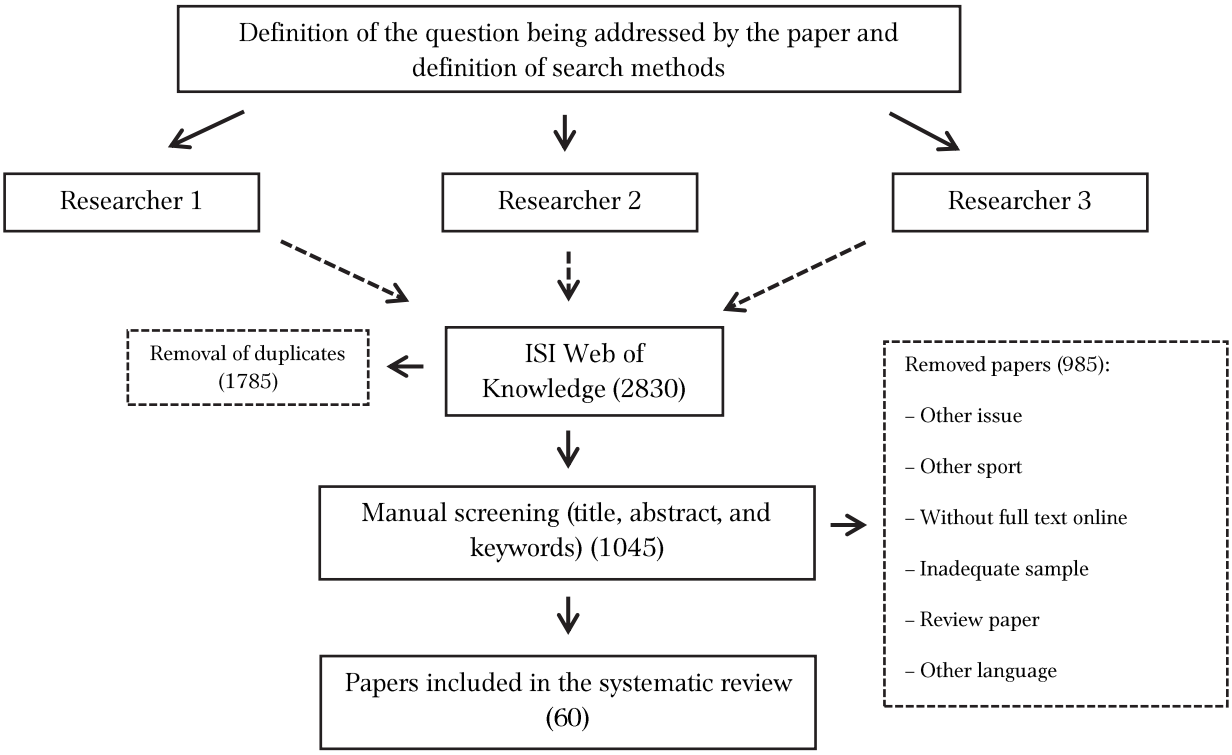
The sample of the study comprised 60 exploratory papers (Table 1), indexed in the scientific journals of databases belonging to the Institute for Scientific Information (ISI) Web of Science. A systematic review was performed in accordance with the guidelines proposed by the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) statement.

Three evaluators conducted separately the analysis process on 19th of February, 2016. The descriptors 'football' and 'soccer' were used, each associated with the following terms: 'technical analysis,' 'technical performance,' 'technical activity,' 'technical skill,' 'technical demands,' 'technical profiles,' 'technical characteristics,' 'technical actions,' 'technical scores,' 'technical ability,' 'motor skills,' and 'skill acquisition'. All search procedures were performed in accordance with ethical guidelines (protocol number: 61884716.9.0000.5659).

Included were papers meeting the following criteria: (i) scientific, published up to 2015; (ii) exploratory; (iii) conducted with male soccer players; (iv) performed among players of all positions and functions, excluding goalkeepers; (v) written in English; (vi) presenting relevant data for the evaluation of technical actions. If there was any disagreement among the evaluators regarding the inclusion of a particular paper, the final decision would be performed by the senior evaluator, owing to more experience in the issue [21]. The papers were grouped in accordance with the main topics of skill-related performance that emerged from a detailed analysis and with the methodological strategies used; this allowed to organize the results.

RESULTS AND DISCUSSION

At the beginning of the search process, 2830 papers were found. Then, duplicate papers were removed (1785).



ISI – Institute for Scientific Information
Figure 1. Systematic review process for the paper research

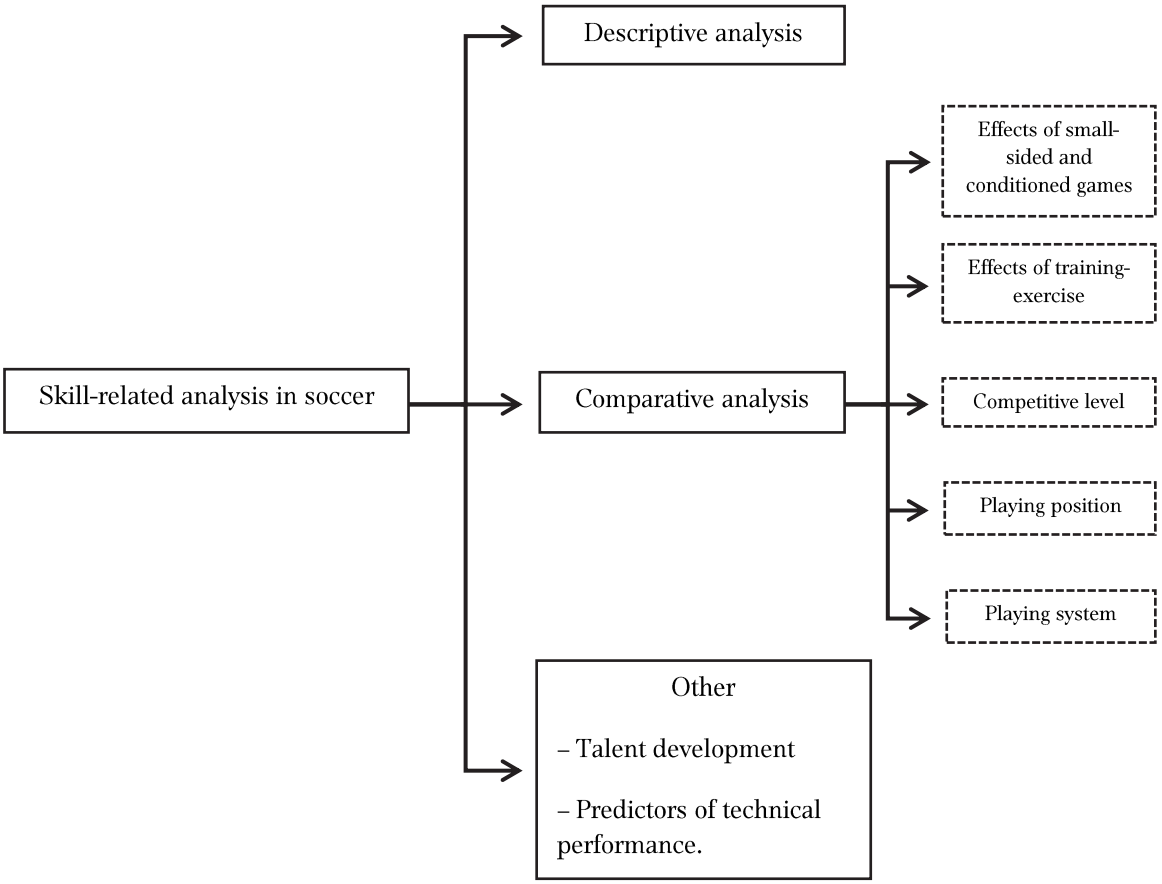


Figure 2. Issues of skill-related performance analysis in soccer.
Adapted from [21]

Table 1. Exploratory papers published on skill-related performance in male soccer players

Authors	Sample	Aim	Methods	Main findings
Almeida et al. [24]	28 U-15 male players, divided into 2 groups: non-experienced and experienced	To analyse the interaction and main effects of deliberate practice experience and SSCG format (3 vs. 3 and 6 vs. 6 + GKs) on the offensive performance of young soccer players	Offensive Sequences Characterization System was used. Duration of ball possession, number of players involved, number of ball touches, number of passes, number of shots, and result of the offensive sequence	– Experience level had a significant effect on performance indicators that characterize the development of offensive sequences, especially in 6 vs. 6 + GKs
Aslan [34]	10 male recreational soccer players	To determine the cardiovascular, perceived exertion, and technical effects of altering pitch size and number of players in recreational soccer match-play	4 variations of SSCG (except for GKs, 5-a-side and 7-a-side on small and large pitches). Ball possession, dribbling, successful pass, unsuccessful pass, tackle, and shooting	– The players performed more dribbling and successful passes, but fewer unsuccessful passes during 5-a-side games – The number of ball possessions and unsuccessful passes was higher on a small pitch than on a large one
Bradley et al. [63]	20 FAPL matches (n = 153 players)	To examine the effect of playing formation on high-intensity running and technical performance during elite soccer matches	Number of passes and percentage completion rate, passes received, touches per possession, dribbles, crosses, final third entries, possession won and lost, and total ball possession	– Overall ball possession did not differ between 1-4-4-2, 1-4-3-3, and 1-4-5-1 formations – The fraction of successful passes was highest in 1-4-4-2 compared with 1-4-3-3 and 1-4-5-1 formations
Bradley et al. [85]	FAPL (n = 190), Championship (n = 155), and League 1 (n = 366)	To compare the match performance and physical capacity of players in the top 3 competitive standards of English soccer	Number of passes, successful passes, forward passes, balls received, touches per ball possession, dribbles, tackles, interceptions, headers, crosses, shots, clearances and final third entries	– Technical indicators such as pass completion, frequency of forward and total passes, balls received, and average touches per possession were 4–39% higher in the Premier League compared with lower standards
Bradley et al. [28]	Professional players in FAPL (n = 810)	To examine the effects of HPBPT and LPBPT on physical and technical profiles in elite soccer matches	Number of passes, successful passes, received passes, touches per possession, dribbles, shots, clearances, events of tackles/tackled, crosses, final third entries, possession won and lost	– Players in HPBPT performed 44% more passes than those in LPBPT – This trend was also evident for successful passes, received passes, touches per possession, shots, dribbles, and final third entries – Technical indicators such as total passes and passes received were higher across all positions in HPBPT than in LPBPT
Bradley et al. [67]	54 EPL matches (n = 810 players)	– To examine the influence of situational variables on ball possession in elite soccer – To quantify the variables that discriminate between HPBPT and LPBPT across different playing positions	Successful and unsuccessful passes, crosses, dribbles, shots, events of tackles/tackled, corners, goals, free kicks, fouls, fouled, interceptions, and clearances	– Possession was increased when losing as compared with winning or drawing – The variables that discriminated performance between HPBPT and LPBPT were different for various playing positions, although the number of successful passes was the most common discriminating variable
Bullock et al. [25]	42 high-level amateur male soccer players	To evaluate the effect of 45 min of soccer-specific exercise in RMST, a novel test which measures sprint, passing, and reactive agility performance	Participants undertook 10 repetitions of RMST before and after 45 min of soccer-specific exercise using LIST	– The exercise protocol resulted in moderate decreases of sprint and reactive agility performance, but improved passing task time and passing accuracy
Bush et al. [62]	EPL seasons (2005–2006 to 2012–2013), 451 individual players across 3016 observations	To investigate match-to-match variability of physical and technical performances in EPL players and quantify the influence of positional and contextual factors	Number of passes attempted, passing success, number of passes received, interceptions, number of tackles completed per player and number of times the player was tackled, number of possessions won/lost, and average number of touches per possession	– Technical indicators such as tackles, possessions won, and interceptions illustrated substantial variability for attackers compared with all other positions – Central defenders demonstrated large variability for the number of times tackled per match and passes attempted and received compared with other positions

Bush et al. [86]	7 consecutive EPL seasons (2006–2007 to 2012–2013), 1036 individual players across 22,846 observations	To investigate the position--specific evolution of physical and technical performance parameters in the EPL	Number of passes (short, medium, long), passing successful	– Central players (central defenders and midfielders) presented the most pronounced increases in total passes and pass success rate whilst wide players (full backs and wide midfielders) demonstrated only small-moderate increases in total passes and pass success rate
Carling [35]	45 French League 1 matches over 3 competitive seasons (2007–2008 to 2009–2010)	To examine the influence of opposition team formation on physical and skill-related performance in a professional soccer team	Frequency of passes and forward passes, mean length of passes, percentage of passes played with one touch, frequency of ball possessions, mean time and number of touches per possession, and frequency of ground and aerial duels	– Players as a whole performed more passes in 1-4-4-2 than 1-4-2-3-1 formation – More ground and aerial duels in 1-4-2-3-1 compared with 1-4-4-2 formation – More one touch passes in 1-4-2-3-1 compared with 1-4-4-2 formation and 1-4-3-3/1-4-5-1 formation – The mean number of touches per possession was highest in 1-4-4-2 compared with 1-4-3-3/1-4-5-1 and 1-4-2-3-1 formation
Carling and Dupont [29]	35 French League 1 matches and 2 UEFA Europa League matches over 3 seasons (2007–2008, *n* = 16; 2008–2009, *n* = 15; 2009–2010, *n* = 6)	To determine whether declines in physical performance in a professional soccer team during match play were associated with reductions in skill-related performance	Total number of passes, percentage of completed or uncompleted passes, number of ball possessions and possessions gained or lost, number of touches per possession, number of duels, and percentage of duels won or lost	– Analysis of skill-related measures revealed no significant decline between halves, across 15-min intervals, or in the 5-min period following that of peak high-speed activity compared with the match mean for other 5-min periods – Frequencies of passing, ball possessions, and duels were greater in the first 5-min than in the final 5-min period
Carling et al. [32]	38 league matches per season over 5 consecutive seasons (2008–2009 to 2012–2013; 190 matches)	To investigate a squad management, injury, as well as physical, tactical, and technical match performance in a professional soccer team across 5 consecutive league seasons	Ball possession and possession in opponents' half, passes, forward passes, completed passes and forward passes, crosses and completed crosses, goal attempts and goal attempts on target, successful final third entries, free-kicks, and 50/50 duels won/lost	– The team won both its highest number of points and conceded its lowest number of goals especially over the second half of the 2010–2011 season – The team won its highest number of matches directly via a goal from a substitute, and scored and conceded a goal first on the highest and lowest number of occasions, respectively
Clemente et al. [22]	Male amateur soccer players from the Portuguese regional league (*n* = 10)	To examine the effect of differences in the number of players and scoring method on heart rate responses, time-motion characteristics, and technical and tactical performance during SSCG	9 different SSCGs (i.e. 3 formats × 3 scoring methods). Conquered ball, lost ball, neutral ball, pass, successful shot on goal	– 2 vs. 2 induced significantly greater values of technical/tactical indexes
Da Silva et al. [39]	16 male young soccer players completed two bouts of 3 vs. 3 (SSCG3), 4 vs. 4 (SSCG4), and 5 vs. 5 (SSCG5) training	To examine the effect of varying the number of players on exercise intensity and technical actions during SSCG in young soccer players	Involvement with the ball, crosses, headers, tackles, shots on goal, dribbling, passing, and target passing	– No effects of number of players were found in involvements with the ball, passes, target passes, tackles, or headers – Significantly more crosses, dribbling, and shots on goal were observed during SSCG3 compared with SSCG4 or SSCG5
Dellal et al. [87]	3540 professional soccer players' activities during the 2005–2006 season	To analyse the physical and technical activities of elite soccer players from the French First League, depending on their playing positions	Percentage of successful passes, total duration of individual ball possession, and the number of ball touches per individual possession	– The players had the possession of the ball between 55.5 s and 74.2 s per match played – The players had no more than 2.2 ball touches per individual possession – Midfielders performed successful passes ranging from 75% to 78%, whereas lower values were found for forwards (71%) and central defenders (63%)

Dellal et al. [88]	5938 observations of match performance across the Spanish La Liga (n = 1896) and FAPL (n = 4704)	To compare match performance in professional soccer players across 2 major European championships: Spanish La Liga and FAPL	Heading and ground duels, passing, time in possession, and ball touches	– La Liga players won more heading duels (49.32% vs. 48.68%) and performed the same proportion of successful passes (76.17%) – FAPL wide midfielders had 20% more ball touches per possession than their La Liga counterparts
Dellal et al. [56]	International players (n = 20) and amateur players (n = 20) of the fourth French division	To examine the relationship between the playing level in soccer (i.e. amateur vs. professional players) and the physiological impact, perceptual responses, time-motion characteristics, and technical activities during various SSCG	9 SSCGs (i.e. 2 vs. 2, 3 vs. 3, and 4 vs. 4) in which the number of ball touches authorized by possession varied (1 ball touch authorized = 1T, 2 ball touches authorized = 2T, and free play = FP). Duels, percentage of successful passes, number of lost balls per possession, and the total number of possessions	– Across the various SSCGs, amateurs completed a lower percent of successful passes and higher number of ball lost per possession
Dellal et al. [41]	20 international soccer players	To examine the influence of the number of ball touches authorized per possession on the physical demands, technical performances, and physiological responses throughout the bouts within 4 vs. 4 SSCG	3 different 4 vs. 4 SSGs (4 × 4 min) in which the number of ball touches authorized per possession was manipulated (1 touch = 1T, 2 touches = 2T, free play = FP). Number of duels, percentage of successful passes, number of ball losses, and total number of ball possessions	– The FP rule affected less the technical actions (successful passes and number of ball losses) as compared with 1T and 2T forms – SSCG played in 1T form was bound with more difficulty to perform a correct technical action
Dellal et al. [42]	International players classified into 5 positional roles (n = 40)	To compare the effects of common rule changes on technical and physical demands for elite soccer players in 5 playing positions during various 4-min SSCGs in comparison with 11-a-side matches	3 different SSCGs 4 vs. 4 (1 ball touch = 1T, 2 ball touches = 2T, free play = FP), as well as 2 friendly matches. Successful passes, total number of lost balls, dribbling, passing, and total number of ball possessions	– Compared with match play, total numbers of duels and lost ball possessions were significantly greater within SSCGs for all playing positions – SSCG played with 1 or 2 ball touches was bound with a difficulty to perform technical actions, being more specific to match demands
Draganidis et al. [26]	10 elite soccer players in 3 different trials: control, low-intensity resistance exercise	To determine the recovery rate of soccer skill performance following resistance exercise of moderate or high intensity	LSPT, long passing, dribbling, shooting, and heading	– Passing and shooting performance declined post-exercise following resistance exercise – Soccer skill performance is minimally affected by acute resistance exercise, independently of intensity
Fanchini et al. [43]	19 adult soccer players; 3 bouts of a 3-a-side SSCG at 3 different bout durations: 2, 4, and 6 min	To examine whether an increase in bout duration would affect exercise intensity and technical actions	Pass, successful pass, unsuccessful pass, tackle, header, turn, interception, dribbling, shoot, and shoot on target	– No effect of duration was found for number of technical actions per minute – Duration did not influence the technical actions or proficiency
Fernandez-Gonzalo et al. [89]	30 prepubescent young soccer players with the same experience in soccer training	To offer some insight into the factors contributing to success in this sport and to describe how physiological and technical performance evolves in young soccer players	3 expert coaches with over 10 years of experience in young soccer. Each expert had to fill in a technical sheet for every subject by giving points from 1 to 100 for different technical parameters: shooting, passing, dribbling, ball control, heading, and tackling	– Among the technical skills measured, significant differences were found only in heading – Over 30% of the technical performance measured in the study can be explained with the physiological parameters
Garcia et al. [36]	54 young soccer players (U-9 and U-14)	To quantify and analyse offensive situations in different formats of SSCG	54 SSCGs played in 3 different formats (5 vs. 5, 7 vs. 7, and 9 vs. 9). Ball out of play, touches per game, touches per outfield player, touches per minute, defensive half, attacking half, attempts at goal, shots per minute, goals per minute, penalty area entries, unsuccessful dribbles, successful dribbles, unsuccessful passes, successful passes	– More touches of the ball and attacking play in the smaller game formats – Higher frequency among the variables for attacking play in all age groups and playing surfaces in the smaller-sided games (5 vs. 5 and 7 vs. 7) than in the 9 vs. 9 format

Guilherme et al. [23]	Young soccer players (n = 71), randomly divided into experimental group (n = 35) and control group (n = 36)	To ascertain whether a specific technical training programme for the non-preferred foot has implications in the increasing utilisation rate of the respective limb during the game	System of assessment of functional asymmetry of the lower limbs in soccer (SAFALL-FOOT). Interception/disarm, reception, passing, driving/protection, feint/dribble, shooting	– The use of the non-preferred foot increased significantly with the technical training programme in the experimental group and remained constant in the control group – The use of the preferred foot decreased significantly in the experimental group and remained similar in the control group
Harper et al. [30]	18 matches involving professional European teams played between 2010 and 2014	To examine the influence of prolonged durations of professional soccer match-play on markers of technical (i.e. skilled) performance	Technical actions observed during eight 15-min epochs (E1: 00:00–14:59 min, E2: 15:00–29:59 min, E3: 30:00–44:59 min, E4: 45:00–59:59 min, E5: 60:00–74:59 min, E6: 75:00–89:59 min, E7: 90:00–104:59 min, E8: 105:00–119:59 min). Passing, dribbling, shooting, crossing	– The cumulative number of successful passes observed during E8 was lower than in E1, E2, E3, E4, and E7 – The total number of passes made in E8 was reduced when compared with E1, E3, E4, and E7 – The cumulative number of successful dribbles was reduced in E8 when compared with E1 and E3
Hodgson et al. [37]	8 university-level male soccer players	To quantify the time-motion characteristics and technical demands of SSCG played on small, medium and large pitches	SSCG comprising 4 × 4 min quarters (3 min recovery) on small (30 × 20 m), medium (40 × 30 m), and large (50 × 40 m) pitch sizes. Pass, turn, dribble, shot, tackle, header, interception	– The small pitch imposed a greater technical demand on players (more passes, shots, and tackles) compared with medium and large pitches
Höner et al. [10]	Highly selected players (the top 4% of their age groups, U12–U15) at 17 measurement points between spring 2004 and spring 2012 (n = 68,158)	To examine the reliability, differential stability, and validity of the motor diagnostics conducted nationwide with the German soccer talent identification and development programme and to provide reference values for a standardized interpretation of the diagnostics results	Sprint, agility, dribbling, ball control, shooting	– The diagnostics demonstrated satisfying factor-related validity with plausible and stable loadings on the 2 empirical factors: speed and technical skills – The score, as well as the technical skills of dribbling and juggling differed most among players of various performance levels and thus showed the highest criterion-related validity
Huijgen et al. [15]	Talented soccer players (n = 131, 14–18 years of age); professional (n = 54) or amateur (n = 77)	To investigate the development of the technical skill of dribbling	Shuttle Dribble Test	– The longitudinal results showed that during adolescence, the talented players who ultimately became professional were on average 0.3 s faster on 30-m peak dribbling performance and on average 1 s faster on 3 × 30-m repeated dribbling performance than those who ultimately turned amateur
Huijgen et al. [14]	Talented soccer players aged 12–19 years (n = 267)	To assess the development and determine the underlying mechanisms of sprinting and dribbling needed to compete at the highest level in young soccer players	Shuttle Sprint and Dribble Test, Slalom Sprint and Dribble Test	– Both dribbling and sprinting improved with age, especially at the age of 12–14, but the time of development was different – At the age of 14–16, sprinting improved rapidly in contrast to dribbling
Huijgen et al. [16]	Talented adolescent soccer players of professional soccer clubs in the Netherlands (n = 113)	To examine whether performance characteristics discriminated between selected and deselected players in talent development programmes	4 domains of multidimensional performance characteristics (technical, tactical, physical, psychological) were assessed with a test battery consisting of soccer specific field tests and questionnaires. Peak shuttle dribble, repeated shuttle dribble, and slalom dribble performance were measured by the Shuttle Sprint and Dribble Test, as well as the Slalom Sprint and Dribble Test	– The combination of the technical characteristic 'peak dribbling,' the tactical characteristic 'positioning and deciding,' and the physiological characteristic 'peak sprinting' classified 69% of talented players correctly

Impellizzeri et al. [50]	26 junior soccer players; control group or aerobic interval training group	To examine the effects of aerobic interval training on the decline in short-passing ability caused by a short bout of high-intensity intermittent activities	LSPT was applied before and 5 min after high-intensity simulation	– The aerobic interval training group, but not the control group showed worsening in LSPT penalty time after the high-intensity simulation
Juárez et al. [90]	Young top-class soccer players (n = 21)	To describe the kinematic pattern of the kicking movement of young top-class soccer players focusing on examining the linear joint markers velocity of the leg kick and the segments angular position	Maximal in-step kicks performed were analysed with a three-dimensional motion capture system	– The maximum linear velocity of the hip, knee, ankle, and toe joint markers was achieved consecutively during the kick, representing a typical proximal to distal kinetic chain
Katis and Kellis [40]	34 young soccer players	To examine (1) the movement actions performed during 2 different SSCGs and (2) their effects on a series of field endurance and technical tests	SSCG included 3-a-side (3 vs. 3 players) and 6-a-side (6 vs. 6 players) games consisting of 10 bouts of 4 min duration with 3 min active recovery between bouts. Passing (short, long), heading, tackling, shooting, dribbling, goals. Dribbling test	– The number of short passes, kicks, tackles, dribbles, and scoring goals was significantly higher during the 3 vs. 3 compared with the 6 vs. 6 game condition, while players performed more long passes and headed the ball more often during the 6 vs. 6 condition
Kelly and Drust [44]	8 young male soccer players	To examine the impact of changes in pitch size on heart rate responses and technical requirements of SSCG	SSCG on 3 different pitch sizes (SSCG1: 30 × 20 m, SSCG2: 40 × 30 m, SSCG3: 50 × 40 m). Games consisted of 4 × 4 min of game play, interspersed by 2 min of active recovery. Pass, receive, turn, dribble, header, tackle, interception, shot, target pass	– The technical actions that changed as a result of pitch size modifications were number of tackles (SSCG1: 45 ± 10, SSCG2: 15 ± 4) and shots (SSCG1: 85 ± 15, SSCG2: 60 ± 18, SSCG3: 44 ± 9)
Köklü et al. [45]	Young soccer players (n = 12)	To investigate the effects of recovery durations between bouts in 4 × 4-min 3-a-side SSCG on time-motion analysis, technical actions, and physiological responses of players	4 different 3-a-side games in which the recovery durations between bouts were different (R1: 1 min, R2: 2 min, R3: 3 min, and R4: 4 min). Touches of the ball, total passes, successful passes, tackles	– SSCG-R1 induced fewer successful passes and fewer total passes as compared with the other 3 conditions – SSCG-R3 players performed more tackles and had more ball contacts than in the R1 condition; they had more ball contacts than in the R1 and R2 conditions
Lago-Peñas and Lago-Ballesteros [68]	380 matches of the Spanish professional men's league	To identify the soccer match-related statistics that best differentiate between home and visiting teams as for the team quality	The match-related statistics registered were divided into 3 groups: (i) variables related to goals scored; (ii) variables related to offense; (iii) variables related to defence	– Home teams had significantly higher means for goal scored, total shots, shots on goal, attacking moves, box moves, crosses, offsides committed, assists, passes made, successful passes, dribbles made, successful dribbles, ball possession, and gains of possession – Visiting teams presented higher means for losses of possession and yellow cards
Lizana et al. [46]	24 athletes assigned to 6-player teams	To investigate, through videogrammetry, if the technical and tactical principles promoted through the adoption of distinct rules from 2 different SSGs (game 1: maintaining ball possession, game 2: progression to the target) would actually be achieved	Number of passes, successful passes, number of shots, successful shots	– In game 1, the average of 487 ± 42 passes were performed, twice that of game 2 (207 ± 20) – The average number of shots with feet in game 1 (10 ± 0.6) was lower than that in game 2 (49 ± 6) – In game 1, the percentage of correct passes (85 ± 2.3%) was higher than in game 2 (79 ± 2.0%) – The total number of shots was lower in game 1
Malina et al. [73]	69 players aged 13.2–15.1 years from 3 clubs that competed in the highest division for their age group	To estimate the contribution of experience, body size, and maturity status to variation in sport-specific skills of adolescent soccer players	Ball control with the body, ball control with the head, dribbling with a pass, dribbling speed, shooting accuracy and passing accuracy. Multiple linear regression analysis was used to estimate the relative contributions of age, stage of sexual maturity, height, body mass, and years of formal training in soccer to the 6 skill tests	– Dribbling with a pass: 21%; age, stage of maturity – Ball control with the head: 14%; stage of maturity, height, body height, body mass – Ball control with the body: 13%; stage of maturity, years of training – Shooting accuracy: 8%; stage of maturity, height; borderline significance

Matta et al. [74]	119 soccer players, U-15 (n = 74) and U-17 (n = 45)	To describe the association between chronological age, morphology, biological maturation, and sports experience in relation to technical performance in young Brazilian soccer players	Data were analysed with the use of the multiple linear regression model. Ball control test, number of touches on the ball, dribbling test, kicking accuracy test	– Adiposity was negatively associated with technical performance regardless age category – Weight was associated with technical performance: negatively in U-15 and positively in U-17 category – U-17 biological maturation was negatively related to the dribbling test and positively associated with the ball control test – Years of experience proved to be positively associated with technique taught to soccer players in the U-17 category
Miranda et al. [51]	30 young soccer players	To verify the influence of a 10-week soccer training programme on anthropometric, psychological, and technical skills, as well as specific performance parameters in young players	10-week soccer training. The players were evaluated 2 times along the experiment (T1: before training, and T2: after training). Slalom dribble, lob pass, juggling test	– 10-week soccer training programme with similar characteristics of volume and intensity may lead to significant changes in slalom dribble and lob pass tests (T1 vs. T2)
Le Moal et al. [57]	87 players aged 14–17 years; elite (n = 44), sub-elite (n = 22), and non-elite (n = 21)	To examine the validity and reliability of LSPT in adolescent soccer players	Two attempts of LSPT were performed at baseline. Players then completed 10 attempts over 3 weeks to familiarize themselves with the test. Subsequently, 2 main trials, separated by 1 week, were performed; the mean of the 2 attempts was recorded as the performance score	– LSPT seems to be a valid and reliable protocol to assess differences in soccer skill performance in adolescent players and can distinguish players depending on their playing level
Morgans et al. [33]	11 male professional outfield soccer players	To investigate if differences in physical and technical performance occurred across a season among 11 English Championship League soccer players who played the majority of matches in the season	Number of individual passes, individual passes completion, team possession, sprint and high-intensity running in possession of the ball	– Passes made and pass success rate per match were 55 ± 3 and 85 ± 1%, respectively, across the season – Passes made and pass success rate were relatively stable and did not significantly differ across the season – Collectively, the team kept possession of the ball for a median of 62% of total match time – Maintaining possession during matches may reduce physical demands imposed on players and help preserve performance throughout the season
Nassis et al. [91]	64 matches of the 2014 FIFA World Cup Brazil; temperate to tropical environmental conditions	To analyse performance data in relation to the environmental conditions to identify potential association	Environmental stress was estimated (low, moderate, and high) for each match. Number of passes, percentage of successful passes	– Number of passes was not different but the rate of successful passes was higher under high (76.8 ± 4.4%) than under low (73.6 ± 10.8%) environmental stress
Owen et al. [92]	15 male soccer players from a Scottish Premier League team	To examine the difference in heart rate responses and technical activities in European elite players when exposed to 2-sided games differing in the number of players and playing area	Small (3 vs. 3 plus GKs) and large (9 vs. 9 plus GKs) sided games, each lasting 3 × 5 min, interspersed with 4-min passive recovery. Block, dribble, header, interception, pass, receive, shot, turn, tackle	– Technical performance analysis revealed a large practical difference between SSGs and LSGs: smaller number of blocks, headers, interceptions, passes, and receives, but more dribbles, shots, and tackles in SSG – SSG induced significantly fewer total ball contacts per game, but significantly more ball contacts per individual when compared with LSG
Radziminski et al. [53]	20 young soccer players (U-16), divided into 2 groups (running group, SSCG group), completed two different 8-week training programmes	To investigate the effects of high-intensity interval running and SSCG training programmes on the physical capacity and the level of soccer-specific technical skills in young soccer players	2 training sessions a week (running group – 5 × 4 min running, with an active recovery period of 3 min; SSCG group – 3 vs. 3 games or 3 vs. 3 with a neutral player for 5 × 4 min, with an active recovery period of 3 min). Technical actions: battery of 7 tests proposed by the German Soccer Federation (420 points in total)	– A significant improvement in soccer-specific technical skills level was noted only in the SSCG group

Rampinini et al. [78]	Young soccer players (n = 16)	To examine whether the fatigue accumulated during match play or determined by short bouts of high-intensity intermittent activities affects short-passing ability in junior soccer players. To examine the influence of physical fitness as measured with the Yo-Yo Intermittent Recovery Test on the changes in short-passing ability after a 5-min simulation of high-intensity activities	LSPT. Players completed the LSPT in 2 sessions during a 1-week control period, followed by 2 unofficial matches with which LSPT was performed during and after the first and the second halves. The change in LSPT performance was determined after 5 min of high-intensity simulation	– A decline in LSPT performance was found during and after the match – The accuracy of LSPT decreased after the high-intensity simulation – A significant correlation was observed between the Yo-Yo Intermittent Recovery Test scores and the decline in LSPT performance (accuracy, total time, total time with penalties) after the simulation of high-intensity activities
Rampinini et al. [31]	416 individual matches, 186 professional soccer players	To examine the changes in technical and physical performance between the first and second half during official matches of the Italian Serie A league. To compare the technical and physical performance of the players of the more successful teams (ranked in the first 5 positions) with those of the less successful teams (ranked in the last 5 positions)	Short passes, successful short passes, long passes, successful long passes, crosses, headers, tackles, dribbling, shots, shots on target	– The players from the more successful teams had more involvement with the ball, completed more short passes, successful short passes, tackles, dribbling, shots, and shots on target compared with the less successful teams – A significant decline between the first and second half was found for some technical scores
Rebelo et al. [58]	Elite (n = 95) and non-elite (n = 85) soccer players	To compare anthropometric characteristics, physical fitness, and technical skills of the U-19 soccer players by competitive level and playing position (GK, central defender, fullback, midfield, forward)	Soccer-specific skills included ball control and dribbling	– Major differences were noted between elite and non-elite GKs in ball control – Elite central defenders performed better than their non-elite counterparts in ball control tests
Reilly et al. [60]	31 (n = 16, elite; n = 15, sub-elite) young soccer players (15–16 years of age)	To apply a comprehensive test battery to young players with a view to distinguishing between elite and sub-elite groups on the basis of performance on the test items	Soccer-specific skills: a shooting test and a slalom dribble test	– The elite players were better at dribbling the ball, but not shooting
Rostgaard et al. [59]	Young elite (n = 14) and sub-elite (n = 7) soccer players	To develop and examine a test for evaluating the physical and technical capacity of soccer players	Players performed a physical and technical test consisting of 10 long kicks interspersed with intense intermittent exercise. A control test without intense exercise was carried out. The test result was evaluated by the precision of the 10 kicks	– The young elite players performed better than the sub-elite players in both the physical and technical test and control test, with no difference in the relative physical and technical test results – Summed performance of the first 5 repetitions was higher than for the last 5 repetitions
Russell et al. [11]	20 soccer players (professional, n = 10; recreational, n = 10)	To examine the reliability and construct validity of new soccer skills tests	Passing, shooting, and dribbling skills tests. Each trial consisted of 28 passes, 8 shots, and 10 dribbles	– Professional players performed better than recreational players in at least 1 outcome measure for all skills (reliability and validity of new soccer skill protocols)
Russell et al. [12]	15 academy soccer players in a soccer match simulation	To examine the effects of exercise-induced fatigue on soccer skills performed throughout simulated match play	Precision, success rate, and ball speed were determined via video analysis for all skills	– The match simulation influenced shooting precision and passing speed, so that shots taken after exercise were 25.5 ± 4.0% less accurate than those taken before exercise and passes in the last 15 min were 7.8 ± 4.3% slower than in the first 15 min – Shot and pass speeds were lower during the second half compared with the first half – Dribbling performance was unaffected by the match simulation

Sinclair et al. [93]	Academy-level soccer players (n = 22)	To identify important technical aspects of kicking linked to the generation of ball velocity with the use of regression analysis	Maximal in-step kicks were obtained with a 10-camera motion capture system sampling at 500 Hz. Three-dimensional kinematics of the lower extremity segments was registered. Regression analysis was used to identify the kinematic parameters associated with the development of ball velocity	– A single biomechanical parameter; knee extension velocity of the kicking limb at ball contact adjusted was obtained as a significant predictor of ball-velocity
Stone and Oliver [49]	9 semi-professional soccer players	To examine the effect of fatigue, developed during prolonged high-intensity intermittent exercise, on the performance of soccer shooting and dribbling skill	Slalom dribble test and LSST, before and directly following the performance of three 15-min bouts of a modified version of LIST	– The LIST slalom dribbling time increased significantly by 4.5 ± 4.0% – The mean of total points scored during LSST was significantly reduced by 7.6 ± 7.0 points – In fatigued players, the frequency of shots in LSST, achieving the highest score of 5 points, was reduced by 47%, while the frequency of shots, achieving the lowest 0 point score, increased by 85%
Taylor et al. [65]	40 matches from the 2002–2003 and 2003–2004 domestic league seasons	To examine the effects of match location, quality of opposition, and match status on the technical aspects of performance within a single professional British soccer team	Aerial challenge, clearance, cross, dribble, interception, loss of control, pass, shot, tackle, times tackled, corner, free kick, throw-in	– The findings emphasize the need for notational analysts and coaches to consider the potential independent and interactive effects of match location, quality of opposition, and match status when assessing the technical components of soccer performance, particularly those relating to behaviour occurrence
Tessitore et al. [94]	Young male soccer players (n = 22)	To compare the heart rate responses and match analysis parameters of official 5-a-side young male soccer matches played over 2 pitch surface (i.e. clay vs. artificial turf) conditions	Type of action, number of players involved in an action, number of passes performed in a collective action, precision of the shots, lost balls, ball interceptions, dribblings, and tackles	– The similar heart rate responses and technical-tactical patterns observed on the 2 surfaces indicate that young match play is not affected by differences in pitch surface
Vaeyens et al. [13]	Elite, sub-elite, and non-elite young players in 4 age groups: U-13 (n = 117), U-14 (n = 136), U-15 (n = 138), and U-16 (n = 99)	To determine the relationships between physical and performance characteristics and level of skill in young soccer players aged 12–16 years	Anthropometry, maturity status, functional and sport-specific parameters. Slalom dribble, lob pass, shooting accuracy, juggling test	– Elite players scored better than the non-elite ones on several technical skills – Running speed and technical skills were the most important characteristics in U-13 and U-14 players – Cardiorespiratory endurance was more important in U-15 and U-16 players
Vilar et al. [95]	15 amateur standard male soccer players	To examine the influence of pitch dimensions in SSCG on shaping opportunities for performers to maintain ball possession, pass to teammates, and shoot at goal	5 vs. 5 SSCG in 3 varying pitch conditions (28 × 14 m, 40 × 20 m, and 52 × 26 m). The values of interpersonal distance between all attackers and immediate defenders and the relative distances of defenders to intercept a shot and a pass were computed as dependent variables	– Fewer opportunities to maintain ball possession on smaller pitches compared with medium and larger ones – The different dimensions set to the pitch did not influence the players' opportunities to shoot at goal or to perform passes to other teammates
Vilar et al. [96]	15 male young soccer players	To examine the effects of the numbers of players involved in SSCG (under-loading and overloading) on opportunities for maintaining ball possession, shooting at goal, and passing to teammates during training	3 different conditions: 5 vs. 5, 5 vs. 4, and 5 vs. 3. Interpersonal distance between an outfield attacker and nearest defender (ID), and the relative distance of a defender needed to intercept the trajectory of a shot (RDishot) or pass (RDipass)	– The mean ID values were significantly lower in 5 vs. 5 than in 5 vs. 4 and 5 vs. 3 conditions and significantly lower in 5 vs. 4 than 5 vs. 3 – The mean values of RDishot were significantly higher in 5 vs. 3 than in 5 vs. 5 conditions – The mean values of RDipass were significantly higher in 5 vs. 3 than in 5 vs. 5

De Villarreal et al. [52]	26 young soccer players	To determine the influence of a short-term combined plyometric and sprint training (9 weeks) within regular soccer practice on explosive and technical actions in pubertal soccer players during the in-season	2 groups: control group (soccer training only) and combined group (plyometric + acceleration + dribbling + shooting). Ball-shooting speed test	– Baseline training results showed no significant differences between the groups in ball-shooting speed test; however, meaningful improvement was found

EPL – English Premier League
FAPL – English FA Premier League
GK – goalkeeper
HPBPT – high percentage ball possession teams
LIST – Loughborough Intermittent Shuttle Test
LPBPT – low percentage ball possession teams
LSG – large-sided game
LSPT – Loughborough Soccer Passing Test
LSST – Loughborough Soccer Shooting Test
RMST – reactive motor skills test
SSCG – small-sided and conditioned game
SSG – small-sided game

The next stage comprised reading the title, abstract, and key words. As a result, 954 papers were excluded owing to various criteria, such as other issue, other sport, lack of full text online, inadequate sample (e.g. women, referees, goalkeepers), the character of a review article, and other language. After these eliminations, 91 full texts were read, which showed that 31 of them were not relevant to the review. Summing up, out of the 2830 initial papers researched, only 60 met all the inclusion criteria (Figure 1). For each paper, the authors (year of publication), participants, aims, methods, and the main findings related to technical actions were recorded (Table 1).

Regarding the chronological analysis of the published papers, it was found that 15 articles (25%) that were relevant to the scope of this review came from before 2010. The remaining 45 gathered papers (75%) were published in the five years of 2011–2015 (2011 – 13 papers; 2012 – 3 papers; 2013 – 8 papers; 2014 – 12 papers; 2015 – 9 papers), which highlights the recent substantial growth of interest in skill-related performance in soccer. Considering the age group of the participants, 32 articles (53.3%) referred to professional or senior players (above the U-19 category). The other 28 papers (46.7%) concerned young players (the U-20 or lower category), which shows a certain equivalence.

Additionally, 41 papers studied skill-related performance in match context, out of which 20 (48.8%) described small-sided and conditioned games (SSCG) and 21 (51.2%) friendly and official games. The total of 27 recruited papers carried out an analysis of technical actions with the use of validated instruments; 3 of them (11.1%) employed the following instruments in match context: Team Sport Assessment Procedure (TSAP) [22], system of assessment of functional asymmetry of the lower limbs in football (SAFALL-FOOT) [23], Offensive Sequences Characterization System (OSCS) [24]; 24 (88.9%) assessed technical actions outside the match context, applying the reactive motor skills test (RMST) [25], as well as dribbling, shooting, heading, and Loughborough passing tests [10–12, 26].

After a detailed analysis of each paper, a categorization system was applied, contemplating two levels of analysis [21, 27]: the first level encompassed the topic of analysis (descriptive or comparative) and the second level comprised the skill-related variables employed in the analysis (Figure 2).

DESCRIPTIVE ANALYSIS

The exploratory papers framed by the descriptive analysis usually aimed to verify the technical actions during an official match. In general, the studies demonstrate that: (i) teams with higher ball possession performed more passes (44%) compared with teams with less ball possession [28]; (ii) in the last 15 min of the match, there occurred lower frequency of passes, successful passes, and dribbles as compared with other match periods, i.e. 0–15 min, 15–30 min, 30–45 min, 45–60 min, and 60–75 min [29–31]. Some studies of descriptive analysis aimed to assess the differences in skill-related performance within one or more seasons. Carling et al. [32] investigated the skill-related performance of a team in a sample of 190 matches for 5 consecutive seasons (2008–2013). The authors found that in the 2010/2011 season (champion), especially in its second half, the team conceded fewer goals, showing an increase in the number of passes, percentage of completed passes, forward passes, and percentage of completed forward passes across the seasons. Morgans et al. [33] verified the differences in skill-related performance during the whole season of the English Championship League, and concluded that successful passes were relatively stable throughout the season.

These papers resorted to notational analysis, with the main skill-related variables of the number of passes, successful passes, received passes, short passes, successful short passes, long passes, successful long passes, touches per possession, dribbling, shooting, clearances, events of tackles/tackled, headers, ball interceptions, and crosses. However, there is a lack of

transparency regarding the definitions and classifications of skill-related performance during in-game context. Considering all the papers that performed analysis of the skill-related performance in the match (i.e. SSCG, friendly and official matches), 63.4% provided no definitions or classifications for the analysed variables (e.g. [29, 34–37]). Subsequently, it becomes difficult to compare the results derived from different studies, so that reproducibility can be ensured, an essential feature of scientific research, as exposed by O'Donoghue [38]: 'it is essential for system operators and the eventual consumers of the information generated by performance analysis to have a shared understanding of the variables used' (p. 36).

A positive example of this question refers to the study of Rampinini et al. [31], which provides the definitions of the skill-related variables under investigation: short passes – number of short foot passes (length < 37 m) performed by a player; long passes – number of long foot passes (length > 37 m) performed by a player. As stated by Mackenzie and Cushion [20], different interpretations of definitions (e.g. successful or unsuccessful pass) can generate different results and conclusions. Therefore, on the basis of the literature research, we proposed definitions of 5 offensive and 2 defensive skill-related performances for soccer players (Table 2).

Furthermore, the search for quantitative information that depicts the match (e.g. notational analysis), despite continuing to be an important approach, has the potential to augment its relevance when associated with methodologies that embrace the dynamics presented in the coordination of players' actions across the match [9].

Table 2. Proposed definitions for skill-related performance in soccer based on literature search

Skill-related performance		Definitions
Offensives	Goal attempts	Directing the ball into the opposing goal, with any part of the body allowed by the game rules, in an attempt to make it cross the line between the goalposts. Successful: results in a goal. Unsuccessful: does not result in a goal
	Passes	Transferring the ball from one player to another of the same team, using the body parts allowed by the game rules (long passes: > 37 m; short passes: ≤ 37 m). Successful: the team continues with the ball possession. Unsuccessful: the team does not continue with the ball possession
	Carry/protect the ball	(i) Progressing in any direction when carrying the ball; (ii) when carrying the ball, making one or more contacts with it without progressing on the field, but in order to protect it from the opponent. Successful: the team continues with the ball possession. Unsuccessful: the team does not continue with the ball possession
	Received balls (oriented / not oriented)	Receiving and controlling the ball from a teammate, in a way: (i) oriented, allowing to continue sequentially the other actions with the ball possession; (ii) not oriented, not allowing to continue sequentially the other actions. Successful: the team continues with the ball possession. Unsuccessful: the team does not continue with the ball possession
	Dodge/feint	When carrying the ball, overtaking the direct opponent in an attempt to: (i) overtake and promote an offensive advantage for the team; (ii) create an imbalance for the defence opponent. Successful: the team maintains the ball possession. Unsuccessful: the team does not maintain the ball possession
Defensives	Crosses	Action of the player who is to take the ball from the player in possession of the ball impeding him to continue his action. Successful: the team wins the possession of the ball. Unsuccessful: the team does not win the possession of the ball
	Interceptions	Anticipation of the pass/goal attempt trajectory performed by the opponent, not allowing the ball to reach the destination when transmitted by the opponent. Successful: the team takes ball possession. Unsuccessful: the team does not take ball possession

Comparative analysis

Effects of small-sided and conditioned games

Some practice effects induced by different task constraint manipulations (e.g. number of players or field dimensions) in SSCG on skill-related performance are often studied. In these investigations, the main findings are as follows:

1. Decrease in the field size dimensions with the same number of players promotes an increase of technical actions [22, 34, 36, 37]. According to Hodgson et al. [37], 'the smaller pitch size reduces the active playing area and requires players to make faster decisions and execute skills with higher frequency' (p. 31).

2. Decrease in the number of players prompts an increase of technical actions [36, 39, 40]. A possible explication of this refers to the fact that a bigger playing area can facilitate technical actions performed in more space (e.g. crosses, dribbling, and shots).

3. When restrictions are applied in the number of ball touches during the SSCG, the restriction to one ball touch results in a high level of difficulty regarding the performance of successful technical actions, while exercises without restrictions in the number of ball touches weakly affect the realization of successful passes and loss of ball possession [41]. Dellal et al. [41] clarify that players have a reduced time to make decisions and to analyse the game, which explains the lower quality of their technical actions in one-touch form as compared with the two-touches and free play.

4. The application of SSCG promotes a higher frequency of technical actions compared with friendly matches [42], probably owing to a smaller area per player, as aforementioned.

5. The duration of the SSCG does not influence the number of technical actions per minute or the proficiency [43]. Two reasons can explain this behaviour: first, the authors normalized the data as number of technical actions per minute; second, they applied 3 bouts (the previous study demonstrated a decrease in technical action with 4 bouts [44]).

6. SSCG with higher recovery time between sets promotes an increase in the number of technical actions [45].

7. SSCG with the objective of maintaining ball possession contributes to an increase in the total number of successful passes and decrease in the number of shots, compared with SSCG whose objective comprehends the progression towards the goal [46], i.e. the players only progress to goal-scoring situations when they are able to create safer options for the play, which results in fewer shots.

These results may help coaches directly in the preparation of training sessions. For example, a coach who aims in his training session to increase the technical actions might use SSCG with smaller dimensions (e.g. 30 × 20), smaller number of players (3 v 3), without limitations regarding the number of ball touches and exercises with longer recovery periods between sets (e.g. 3 × 4 min with 3–4 min of recovery). This topic of comparative analysis (e.g. effects of SSCG) represented the highest frequency of occurrence in 15 papers. The scenario can be explained by the growing interest in verifying the effects of these training tools in soccer [47]. Furthermore, it is considered that SSCG promotes the increase of the number of actions with the ball, as well as the participation of all players during the matches [5]. A recent narrative review (Serra-Olivares et al. [48]) referring to the tactical assessment of soccer training with the use of representative tasks to measure the tactical expertise of young soccer players during SSCG is an important study that gives an overview of the ecological approach to training and the principles of a representative task design, providing relevant contribution and the direction for future research into the assessment of tactical expertise in young soccer players.

Therefore, on the basis of the ecological approach and the idea of representative task design, it is possible to recommend the development of measured skill-related performance with SSCG for future research.

Effects of training-exercise

Several researchers have studied the effects of training and exercises on the skill-related performance of soccer players. The main conclusions of the studies on this subject are the following:

1. Passing and shooting performance declines after low- and high-intensity acute strength exercises [26, 49] and after a simulated soccer match (induced fatigue protocol) [12]. The skill to pass and shot is based on inter-segmental coordination; therefore, following strength exercises, muscle fatigue induces a negative effect on motor coordination [26].

2. The use of the non-preferred foot increases with analytical technical training [23]. According to the ecological dynamic approach, because the non-preferred foot was less stimulated during the daily practice, it is not perceptibly accessible (i.e. it is not a relevant option to make part of the decision-making

and performed actions [23]). Therefore, the functional asymmetry of the lower limbs tends to reduce with the increase in specific training for the non-preferred limb.

3. Aerobic interval training (4 × 4 min at 90–95% of maximum heart rate [HR_{MAX}] with 3 min of recovery between series) attenuated the deterioration in Loughborough Soccer Passing Test (LSPT) time after a simulated high running protocol [50]. Ten weeks of soccer training (continued running, 70–80% HR_{MAX} + sprints + soccer-specific activities) affect positively slalom dribble and lob pass in young soccer players [51]. Short-term training (plyometric + acceleration + dribbling + shooting) positively influences shooting speed [52]. This suggests that the trained players probably experienced less fatigue and, consequently, a lower impairment of skill-related proficiency.

4. Significant improvement of soccer-specific technical skill level in a battery of tests proposed by the German Soccer Federation (i.e. juggling, passing, dribbling) was higher in SSCG (3 vs. 3 or 3 vs. 3 with joker player; 5 × 4 min with 3 min of active recovery) than high-intensity running training (5 × 4 min at 90% HR_{MAX} with 3 min of active recovery between series) [53]. Therefore, SSCGs are more highly recommended training drills than the generic (e.g. interval) training by engaging physical, technical, and tactical aspects simultaneously [54].

Competitive level

The informational knowledge derived from studies that examine different competitive levels may provide useful and valuable insights for coaches who search for more appropriate conditions to help their players reach high performance levels [21, 55]. Almeida et al. [24] verified that high level youth soccer players performed more passes and had more ball possession in SSCG (i.e. 3 vs. 3; 6 vs. 6) than low level players. In addition, Dellal et al. [56] observed that amateur players completed less successful passes and exhibited less ball possession when compared with professional players, regarding various configurations of SSCG (i.e. 2 vs. 2; 3 vs. 3; 4 vs. 4). Furthermore, other research performed in the same scope of analysis revealed the existence of differences in skill-related performance (e.g. shooting, slalom dribbling, ball control, LSPT) between competitive levels, to the advantage of elite players and elite teams [11, 57–60]. Experience is an aspect influencing the competitive performance that is directly related to the time of practice/competition in soccer [61]. Nevertheless, Almeida et al. [24] complement: 'it seems that it does not require long periods of deliberate practice in order to verify differences in the collective performance comparatively to youngsters who only play the game for enjoyment and fun (i.e. deliberate play)' (p. 102).

Playing position and playing system

Another important issue that emerged from the comparative analysis of exploratory research refers to the playing position and different systems. Some discrepancies were observed regarding the designations adopted in different studies to tactical positions, which makes it difficult to compare the results between the papers. However, in general, one can distinguish 3 main tactical positions [21]: defenders, midfielders, and forwards. In summary, the research shows that forwards have a higher coefficient of variation (match-to-match) for performed passes, received passes, and number of times tackled as compared with other positions; they also exhibit higher coefficient of variation for tackles and interceptions than midfielders and defenders. The ability of forwards to hold up play will be affected by the number and quality of possessions won along with the aptitude and tactics of the opposition defenders, thus influencing the variability in performance. Midfielders performed higher successful passes (75–78%) than forwards (71%) and defenders (63%) (i.e. players in this position frequently gain the ball in the attacking area and are responsible to create finishing situations for the forwards, which results in more passes) [62]. These outcomes show that the frequency, variation, and efficacy of technical actions vary depending on the role and specific tactical position of each player on the field.

In addition, studies that analyse skill-related performance and playing systems are scarce in literature. In the course of this review, it was noticed that only 2 papers reported on these issues. Bradley et al. [63] highlighted that ball possession maintenance usually did not differ between the 1-4-4-2, 1-4-3-3, and 1-4-5-1 systems. However, the fraction of successful passes was higher in the 1-4-4-2 system compared with the 1-4-3-3 and 1-4-5-1 systems, but the authors mentioned that caution was needed when interpreting the findings, as a relatively small number of matches (n = 20) were analysed. Carling [35] found that, in general, players performed more passes against teams in the 1-4-4-2 than in the 1-4-2-3-1 system. Additionally, the same author reports the existence of more duels, those that result with the ball in an aerial trajectory, as well as those derived, for example, from 1 vs. 1 situations, against teams in the 1-4-2-3-1 when

compared with the 1-4-4-2 system. Finally, the author reports that more one-touch-ball passes against teams occur in the 1-4-2-3-1 as compared with the 1-4-4-2, 1-4-3-3, and 1-4-5-1 systems (e.g. the higher frequency of one-touch passes against teams with the 4-2-3-1 formation suggests that players in the reference team could have benefited from performing one-touch passing drills in preparation for matches against this particular formation).

Clearly, there is a need to perform more studies emphasizing the role of the playing system, as well as the skill-related performance. Furthermore, it is substantial to describe how players are positioned on the field in each playing system (e.g. 1-4-4-2, 'diamond' or 'square') and to analyse the differences in skill-related performance at each playing position in accordance with the team playing system (e.g. 1 defender in the 1-4-4-2 system cannot perform the same functions and technical actions if the team plays in the 1-3-5-2 system).

Match situational variables

In the soccer context, match location (home or away), quality of the opponent (strong or weak), and match status (winning, drawing, or losing) comprise the main situational variables that influence the performance of teams in competitive matches [64–66]. However, research on the skill-related performance appears to disregard these situational variables. In the presented review, among the papers referring to the analysis of skill-related performance in the official match context, 38.1% consider these situational variables (e.g. [65, 67, 68]). Lago-Peñas and Lago-Ballesteros [68] found that the teams playing at home had higher results in scored goals, shots in goal, attacking moves, crosses, assists, passes made, successful passes, dribbles made, successful dribbles, ball possession, and gains of possession when compared with teams that played away. In addition, the visiting teams had greater loss of ball possession. Taylor et al. [65] observed that the match location had a significant influence on the frequency of clearances, crosses, dribbles, interceptions, shots, and tackles. One explication for these performances is that home environment (i.e. social support of the crowd) is bound with an increased functional aggressive response, measured by more offensive than defensive behaviour [69]. These authors [65] also reported that when teams were losing, they showed an increase in ball possession and performed more crosses and dribbles (i.e. the teams try to 'control' the match, creating more offensive situations), while when wining, they performed more interceptions, clearances, and aerial challenges. Regarding the quality of the opponents, no substantial differences in technical actions were found. Talyor et al. [65] used a symmetrical division based on the team's final ranking and guided their analysis according to the dichotomy of 'strong opposition' vs. 'weak opposition.' However, the authors concluded that this division did not provide the sensitivity needed to detect any differences. The definition of the quality of the opponents according to k-means cluster analysis seems to be more robust [70–72].

OTHER CONCERNS

Other themes commonly addressing skill-related performance related to the determination of predictor variables that intend to enhance the development and selection of talented players. Malina et al. [73] and Matta et al. [74] found that the main predictors that explained the results of skill-related performance (e.g. dribbling, ball control, shooting) were: age, maturation, height, interaction of body height and body mass, and years of training.

Studies that regard the process of soccer players selection seek objective measures to assist in identifying supposedly talented players. Höner et al. [10] observed that the technical actions such as dribbling and juggling differ between high and low level players. Huijgen et al. [16] studied multidimensional characteristics that distinguished selected and non-selected young players belonging to a talent development programme in the Netherlands, and found that 69% of selected players were correctly classified on the basis of the evaluation of four domains (physical, technical, tactical, and psychological). The main variable with a discriminatory power in the technical domain comprised the dribbling test. Other studies prove that dribbling, shooting, lob pass, and juggling tests have high criterial validity [13–15, 60].

In this context, the understanding of talent is largely linked with the idea that innate assignments are responsible for talent detection, and there is an evident concern to find players with physiological, motor, and psychological attributes above average [75]. However, as stated by Howe et al. [76], the conditions that lead to excellence are related with multidimensional characteristics in a multitude of factors, such as early experience, preferences, opportunities, habits, structured and sustained training to promote increased sports performance, resilience, and cultural aspects. Therefore, it becomes questionable to apply unrepresentative tests for 'detecting' talents, the more so young players not 'detected' as talents will be rejected by clubs and

may leave practice earlier. In fact, the journey to sporting excellence not only derives from talent identification, but mainly depends on a complex fusion of skills, capacities, and competences [77] related to the development of potential talent in response to training and other environmental conditions [75].

LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The main limitation of most studies mentioned in this review interferes with the principle of scientific reproducibility and the consistency of research findings [11, 12, 25], as already demonstrated in previous review studies [20, 21]. Particularly, it comes from: (i) the lack of definition and classification of the skill-related variables under investigation concerning match context (we proposed these definitions [Table 2] on the basis of the literature research); (ii) the contextualization of the sample omitted and the influence of match situational variables (e.g. location, quality of opponent, status); and (iii) the absence of representative task design to measure skill-related performance.

Few revised papers (36.6%) defined clearly the skill-related variables under investigation in match context (e.g. [23, 30, 31, 78]). Mackenzie and Cushion [20] reported that the intensive use of notational analysis through data generated by computational software (e.g. Amisco® Pro, GECA Sport®, ProZone®) can be considered as an explanatory factor that underpins this lack of definitions. Moreover, as already exposed, 38.1% of the papers comprehended in this review contemplated the effects of match situational variables on skill-related performance during official matches (e.g. [65, 67, 68]). There seems to be little agreement with regard to the sample size necessary for a power generalization of the results found in these examined studies.

Regarding the representative design of the tests used to measure skill-related performance in soccer, we consider it necessary to return to some approaches. An important task in sports science and performance analysis is to understand the relationship between the skill acquisition and development of players in order to achieve sporting excellence. Therefore, it is essential to develop theoretical principles that guide the concession of skill acquisition programmes, as well as to provide an informational base for the organization and implementation of evaluation tests concerning sports performance [7]. The ecological dynamics theory has revealed that the most relevant information for decision-making and regulation of action in dynamic environments (e.g. soccer) emerges from the continuous performer-environment interactions (for more details, see [3]). The opportunities for action (e.g. affordances) constantly shape players' intentions and interfere with the decision-making processes by adjusting the key properties of the environment and organismic limitations inherent to each player [7, 79]. For example, performing a pass, dribble, or shot in the course of a soccer match, emerges owing to critical information on the relative positioning of the defenders, as well as the area of the field (e.g. identification of the opportunities for action to achieve the target performance). Thus, creating a rational basis to determine and manipulate the constraints acting on the players provides a fundamental principle for the development and implementation of tests to evaluate the skill-related performance in soccer (see [48]). For instance, 88.9% of the papers presented in this review evaluated skill-related performance through validated tests performed outside the match context (e.g. [10–12, 25, 26]). However, these tests are not representative of the actual skill-related performance of soccer players since they do not encompass critical perception variables (e.g. environmental contextual information) that players normally use to control their actions during the course of matches [18], which could compromise the ecological validity of the conclusions obtained in these studies. To achieve this representation, skill-related performance tests should incorporate the same informational variables that specify match contexts (e.g. friendly or official matches) or SSCG [80–82]. Furthermore, to ensure representativeness, the technical performance tests should not be limited to examining only the result of the action [20, 83], but also take into account the evaluation of representative tasks, which interact with each other and influence the behaviour displayed by players at the time of carrying out the action (e.g. possibilities for action, the positioning of opponents and teammates, spatial references). As exposed by Hayes [84], 'show me the results of notational analysis, not the notational analysis results,' (p. 4; *apud* Mackenzie and Cushion [20], p. 655). Moreover, notational analysis does not measure the possibilities of the participants' action in relation to the selection of technical actions performed by players. For example, let us consider two match situations: (i) a midfield player performs a pass to a defensive player, while the team maintain the ball possession; (ii) the same midfield player performs a pass to an offensive player, which enables a finish to the goal. In the technical analysis used in the reviewed studies, both situations would be labelled as successful pass. However, it is understood that in situation (ii) the midfield player's

pass to the offensive player resulted in the possibility of a goal, and thus in obtaining a score different from that in situation (i). Therefore, future research should propose tests to measure skill-related performance in soccer, considering that the representativeness contexts ally the players' possibilities of action to the situation of the match (see a positive example of tactical expertise assessment during SSCG in a study by Serra-Olivares et al. [48]).

CONCLUDING REMARKS

The main purpose of the study was to evaluate and systematically organize the available literature on the skill-related performance in young and adult male soccer players. Furthermore, we identified the most common topics, as well as examined the weaknesses of the analysed papers and their main contributions to the technical performance. The emerging themes were: (i) descriptive analysis (e.g. characterizations of skill-related performance in championships); (ii) comparative analysis (e.g. effects of SSCG, effects of training-exercise, competitive level, playing position and playing system, match situational variables); and (iii) other issues (e.g. talent development, predictors of skill-related performance). The review has raised some methodological concerns regarding the use of scarce representativeness analysis for the skill-related performance of the players, e.g. dribbling, shooting, and passing tests without match context. In addition, notational analysis can augment its relevance when associated with methodologies that consider the dynamics inherent to the coordination of players in match situations, as well as the representative task design combined with the possibilities of the players' action in each match situation. Some concerns evidenced in other studies were related to the absence of clarification of the definitions and of technical variables under investigation (see our proposed definitions in Table 2) and omission of the context of the sample (e.g. location, quality of opponent, status). These limitations can largely compromise the reproducibility of the reviewed studies. Finally, given the limitations presented in this review, it is suggested that future research may lead to a congruous understanding of the discussed topics, providing significant and substantial impact also on professional daily practice.

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Conflict of interest

Authors state no conflict of interest.

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