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SYSTEMATIC REVIEW

Talent Identification and Development in Male Football: A Systematic Review

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Abstract

Background Expertise has been extensively studied in several sports over recent years. The specificities of how excellence is achieved in Association Football, a sport practiced worldwide, are being repeatedly investigated by many researchers through a variety of approaches and scientific disciplines.

Objective The aim of this review was to identify and synthesise the most significant literature addressing talent identification and development in football. We identified the most frequently researched topics and characterised their methodologies.

Methods A systematic review of Web of Science™ Core Collection and Scopus databases was performed according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines. The following keywords were used: "football" and "soccer". Each word was associated with the terms "talent", "expert*", "elite", "elite athlete", "identification", "career transition" or "career progression". The selection was for the original articles in English containing relevant data about talent development/identification on male footballers.

Results The search returned 2944 records. After screening against set criteria, a total of 70 manuscripts were fully reviewed. The quality of the evidence reviewed was generally excellent. The most common topics of analysis were (1) task constraints: (a) specificity and volume of practice; (2) performers' constraints: (a) psychological factors; (b) technical and tactical skills; (c) anthropometric and physiological factors; (3) environmental constraints: (a) relative age effect; (b) socio-cultural influences; and (4) multidimensional analysis. Results indicate that the most successful players present technical, tactical, anthropometric, physiological and psychological advantages that change non-linearly with age, maturational status and playing positions. These findings should be carefully considered by those involved in the identification and development of football players.

Conclusion This review highlights the need for coaches and scouts to consider the players' technical and tactical skills combined with their anthropometric and physiological characteristics scaled to age. Moreover, research addressing the psychological and environmental aspects that influence talent identification and development in football is currently lacking. The limitations detected in the

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reviewed studies suggest that future research should include the best performers and adopt a longitudinal and multidimensional perspective.

Key Points

Research addressing the acquisition and development of football expertise has focused on specific key performance characteristics related to practice and training, the performer and the environment.

This critical review brings to light research evidence uncovering the aspects that are particularly relevant for talent identification and development in football, such as the players' technical and tactical skills, combined with their anthropometric and physiological characteristics scaled to age.

We suggest that future research should focus on the technical and physical development of the most talented players worldwide across their entire sport careers.

1 Introduction

According to official data from the Fédération Internationale de Football (FIFA), 265 million players and 5 million referees and officials are actively involved in the game of football, representing an 4% of the world population [1]. Modern football is characterised by increased movement of players between different countries, and by inflation of wages and transfer fees. In these circumstances, the ability to identify and nurture talented players at an early age may ensure sporting and financial success and/or survival. Accordingly, many football clubs and national federations invest substantial resources into the detection, identification and development of young talented footballers, to ensure that the most promising players receive high-quality coaching and training conditions [2].

Defining the concept of talent is not an easy task and currently there is no consensual definition [3]. Talent is traditionally associated with the notion of an athlete's precondition for success (e.g. innate potential) and with the outcome of the developmental process (e.g. athletic excellence during youth) [2, 4]. However, across different sports athletes are considered as talented if they perform better than most of their peers or if they are perceived as having the potential to reach the elite level [5]. Based on an ecological dynamics theoretical approach, we argue that talent should be considered as a dynamically varying relationship moulded by the constraints imposed by the physical and social environments, the tasks experienced and the personal resources of a player [6]. The context of modern football is characterised by repeated evaluation of footballers' potential to succeed at the elite, adult level. Traditionally, there are key stages in the talent identification and development process: (1) talent identification, or the process of recognising and/or selecting current participants with the perceived potential to become elite players; and (2) talent development, whereby players are provided with a suitable learning environment (e.g. amount of practice and specific coach support required at different levels of development) to realise their potential [2, 5, 7]. As stated by Williams and Reilly [2], a crucial question is whether the individual has the potential to benefit from a systematic programme of support and training. In this sense, talent identification should be viewed as a part of the dynamics of the talent development pathway in which identification may occur at various stages within the process. Nevertheless, some authors suggested that reliable early a priori talent identification seems to be impossible [8]. For example, Baker et al. [9] suggested that practitioners "…should not focus so intently on identifying and selecting talent. Scientific evidence suggests that if it does exist, we do not know what it looks like, and are poor predictors of athlete potential" (p. 12).

Over recent years, a growing number of research articles [10–12] have been published about this topic, adding to the various academic books [13, 14], research literature reviews [15–18], specific models of talent development [19–23] and popular books [24]. Also, there has been an increasing emphasis on the use of science-based support systems offering a more holistic approach to talent identification in soccer [25]. Nevertheless, football players were traditionally selected by coaches based on a subjective analysis that recognised the potential of young players to complement the style of play of their club. Depending on the different club philosophies, specific parameters were valued in that selection, such as speed, strength, size and creativity. This was the case despite the scientific evidence showing that unidimensional approaches exclusively favouring biological determinants were ineffective and incapable of predicting adult sport performance [25].

Predicting performance potential at an early age is a difficult and complex process, particularly since the determinants and requirements for success in top-level football are non-linear and multifactorial [12]. The process of talent identification should reflect the long-term development of the player, as short-term success may have associated limitations. Importantly, the specificities of each sport play a critical role in talent identification and

development [8]. As argued by Baker et al. [9], effective talent selection requires accurate prediction of the evolutionary tendencies of the specific sport to anticipate how the skills and capabilities underpinning successful performance will evolve between selection and demonstration of elite skill. Indeed, football has changed considerably over the last few decades (see Sarmento et al. [26] for a review) with increased demands on players, a factor that coaches and scouts may wish to consider when selecting talented performers.

Despite the significant expansion in sports talent identification and development research, specific sports have not been addressed individually, including widely practiced sports such as football. Given the specific constraints of each sport, there is a need to consider a sport-specific examination of the factors that could lead to expert performance, rather than search for a generalisable model of athlete development [18]. Thus, systematically reviewing research on football talent identification and development can provide a useful resource for coaches, scouts and scientists. Besides the specificities arising from the evolutionary tendencies of the game, football players' performance emerges from the interaction of many physical (e.g. strength, power, speed, endurance), technical, tactical and psychological capacities, which in turn are influenced by the specific but dynamic contexts of player cooperation/opposition (11 vs. 11 players) occurring during a 90-min match. Moreover, the varied playing positions in the field (e.g. goalkeeper, defender, midfielder, forward) require the development of specific abilities. Finally, talent identification in football is a dynamic process that is interconnected with the players' developmental phases [27]. Thus, the process of talent identification and development in football may be influenced by a set of determinants specific to this sport, thereby justifying the search for a contextualised knowledge, rather than relying on general aspects common to several sports [15, 18]. Furthermore, some prudence is required when analysing data from male and female football players due to their maturational, anthropometric, physiological and psychological differences. The dynamics of talent identification and development, the structure of the competitions, the laws of the game [e.g. in some countries before under (U-) age 19 (U-19) level, females can only play formal games of 9 vs. 9], the quality of the coaches and the level of professionalisation are dissimilar across different countries, for males and females.

Nevertheless, the scientific evidence on talent identification and development is not currently advanced enough to truly impact and inform sport practices. Most research has only evaluated single sports in isolation, and findings are extrapolated to other sports, despite the diverse characteristics of different sports. However, developing a systematic review of a single sport [namely in one of the most researched sports (football)] and thus synthesising knowledge about the specificity of talent identification and development in this sport, allows the identification and comparison of similarities as well as key differences between different sports [3].

Thus, to identify and develop the talented football players reliably, it is crucial to determine the skills that better match the specific demands of the game. However, despite the increasing research interest in this topic, the best scientific approaches to successfully identify and develop football players remain unclear. The aim of this article was to systematically review and organise the literature on male football talent identification and development, in order to ascertain the most frequently researched topics, characterise the methodologies and systematise the evolution of the related research trends.

2 Methods

2.1 Search Strategy: Databases and Inclusion Criteria

A systematic review of the available literature was conducted according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines [28].

To ensure article quality, the electronic databases Web of Science™ Core Collection and Scopus were searched for relevant publications prior to 17 December 2016 by using the keywords "football" and "soccer". Each of these words was associated with the terms "talent*", "expert*", "elite", "elite athlete", "identification", "career transition" or "career progression". Only empirical articles were included in the search.

The publications included in the first search round met the following criteria: (1) contained relevant data concerning talent identification and/or development; (2) were performed on male footballers; and (3) were written in the English language. Studies were excluded if they (1) included practitioners of other sports; (2) included females; and (3) did not contain any relevant data on talent development.

Two reviewers (HS, AP) independently screened citations and abstracts to identify articles potentially meeting the inclusion criteria. For those articles, full-text versions were retrieved and independently screened by those reviewers to determine whether they met inclusion criteria. Any disagreement regarding study eligibility was resolved in discussions including a third reviewer (MTA). When the decision to include or exclude a given article was not

unanimous, the author with greater experience on systematic reviews (MTA) made the final decision.

2.2 Quality of the Studies and Extraction of Data

As recommended in Faber et al. [17], the overall methodological quality of the studies was assessed using the Critical Review Forms in Letts et al. [29] for qualitative studies (counting 21 items) and Law et al. [30] for quantitative studies (counting 16 items).

Each qualitative article was subjected to an objective assessment to determine whether it contained the following 21 critical components: objective (item 1), literature reviewed (item 2), study design (items 3, 4 and 5), sampling (items 6, 7, 8 and 9), data collection (descriptive clarity: items 10, 11 and 12; procedural rigor: item 13), data analyses (analytical rigor: items 14 and 15; auditability: items 16 and 17; theoretical connections: item 18) and overall rigor (item 19) and conclusion/implications (items 20 and 21). Quantitative studies were assessed to determine whether they included the following 16 items: objective (item 1), relevance of background literature (item 2), appropriateness of the study design (item 3), sample included (items 4 and 5), informed consent procedure (item 6), outcome measures (item 7), validity of measures (item 8), significance of results (item 10), analysis (item 11), clinical importance (item 12), description of drop-outs (item 13), conclusion (item 14), practical implications (item 15) and limitations (item 16). Item 9 (details of the intervention procedure) was not applicable because none of the studies included interventions.

The outcomes per item were 1 (meets criteria), 0 (does not meet the criteria fully), or NA (not applicable). The versions of the Critical Review Forms used in this study are shown in Electronic Supplementary Material Tables S1 and S2. A final score expressed as a percentage was calculated for each study by following the scoring guidelines of Faber et al. [17]. This final score corresponded to the sum of every score in a given article divided by the total number of scored items for that specific research design (i.e. 16 or 21 items). We adopted the classifications of Faber et al. [17] and Wierike et al. [31] and classified the articles as (1) low methodological quality—with a score $\leq 50\%$; (2) good methodological quality—score between 51 and 75%; and (3) excellent methodological quality—with a score $> 75\%$.

A data extraction sheet (from Cochrane Consumers and Communication Review Group's data extraction template [32]) was adapted to this review's study inclusion requirements and then tested on ten randomly selected studies (pilot test). One author extracted the data and another verified it. Disagreements were resolved in discussions between these two authors (HS, AP).

To organise the results, the studies were classified into categories established according to the major research topics that emerged from the content analysis.

3 Results

3.1 Search, Selection and Inclusion of Publications

The initial search identified 2944 titles in the aforementioned databases. These data were then exported to reference manager software (EndNote™ X8, Clarivate Analytics, Philadelphia, PA, USA). Any duplicates (2325 references) were eliminated either automatically or manually. The remaining 619 articles were then screened for relevance based on their title and abstract, resulting in 479 studies being eliminated from the database. The full text of the remaining 140 articles was examined in more detail; 70 were rejected because they did not meet the inclusion criteria. At the end of the screening procedure, 70 articles were selected for indepth reading and analysis (Fig. 1).

The main factor for study exclusion ($n = 36$) was their lack of relevance to the research topic of this review. Other studies were excluded because they contained data from female participants ($n = 8$) or from other sports ($n = 26$).

The chronological analysis of the articles considered in this review, published no later than the year 2016, evidenced the recent developments in this area of research, highlighting that more than half (55.7%) of the studies were published in the last 5 years (i.e. from years 2012 to 2016).

3.2 Quality of the Studies

Concerning the quality of studies, the most noteworthy results were that (1) the mean score for the 63 selected quantitative studies was 88.5%; (2) the mean score for the seven selected qualitative studies was 86.4%; (3) seven publications achieved the maximum score of 100%; (4) no publication scored below 50%; (5) only three studies scored between 51 and 75%; and (6) 67 publications achieved an overall rating of $> 75\%$.

3.3 General Description of the Studies

The ecological dynamics theoretical framework argues that the relevant scale for understanding behaviour is the performer–environment dynamic relationship [33], in which the broad range of personal, task and environmental constraints impacts on athletes' development according to different, related, timescales [6]. As proposed by Davids and colleagues [6], skill acquisition, expert performance and talent development in sport should consider both the

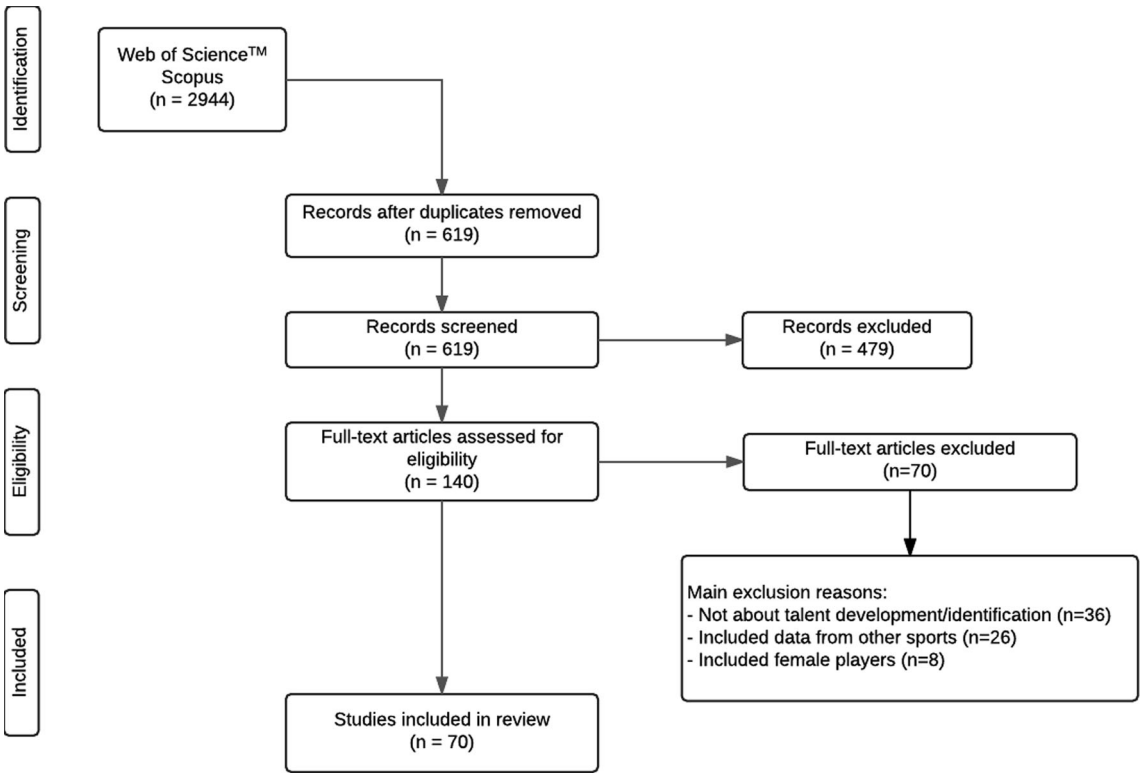

Fig. 1 Flow chart of the procedures used for the article search

macro- and the micro-structure of contextualised histories and practices. Based on this theoretical rationale, after careful analysis, it was decided that the most appropriate way to present the results would be to categorise them according to the major research topics that emerged from the analysis. Although a few studies were markedly multidimensional [34–36], the generality were focused on a single topic as follows: (1) task constraints: (a) specificity and volume of practice; (2) performers' constraints: (a) psychological factors; (b) technical and tactical skills; (c) anthropometric and physiological factors (compared according to competitive level, playing positions and birth month); (3) environmental constraints: (a) relative age effect; (b) socio-cultural influences; and (4) multidimensional analysis (Fig. 2).

3.3.1 Task Constraints

3.3.1.1 Specificity and Amount of Football-Specific Practice The relationship between the amount of time spent in activities specifically designed to improve performance (deliberate practice) and a player's level of achievement is well-documented [21, 37, 38]. Recent research indicates that early engagement (6–12 years) in football (i.e. play and practice) may be associated with higher levels of expertise (Table 1).

3.3.2 Performers' Constraints

3.3.2.1 Psychological Factors Sports research has developed heuristic models that provide valuable information about the pathways and profiles associated with success [20, 21, 39–42]. Nevertheless, only a relatively small number of papers have addressed these topics exclusively in the context of football, the most popular sport in the world (see Table 2) [43–48]. These investigations have focused mainly on the study of motivation [44, 48], stress and coping [45, 47], discipline [43], resilience [43], commitment [43], social support [43, 45, 47] and concentration [44], providing some information about the psychological factors that are associated with career success [44, 47]. The most successful players seem to express higher levels of resilience, confidence, concentration, commitment, discipline, motivation, mental rehearsal and coping with adversity [43–48].

3.3.2.2 Technical and Tactical Skills Although the process of selection of talents in football is influenced by a wide range of factors, the most prominent aspect evaluated by coaches and scouts is technical ability, as this is believed to be a strong predictor of performance. This is shown in several studies (Table 3) demonstrating that superior technical skills, such as dribbling [49, 50], short/long passing and kicking at the goal [50], provide

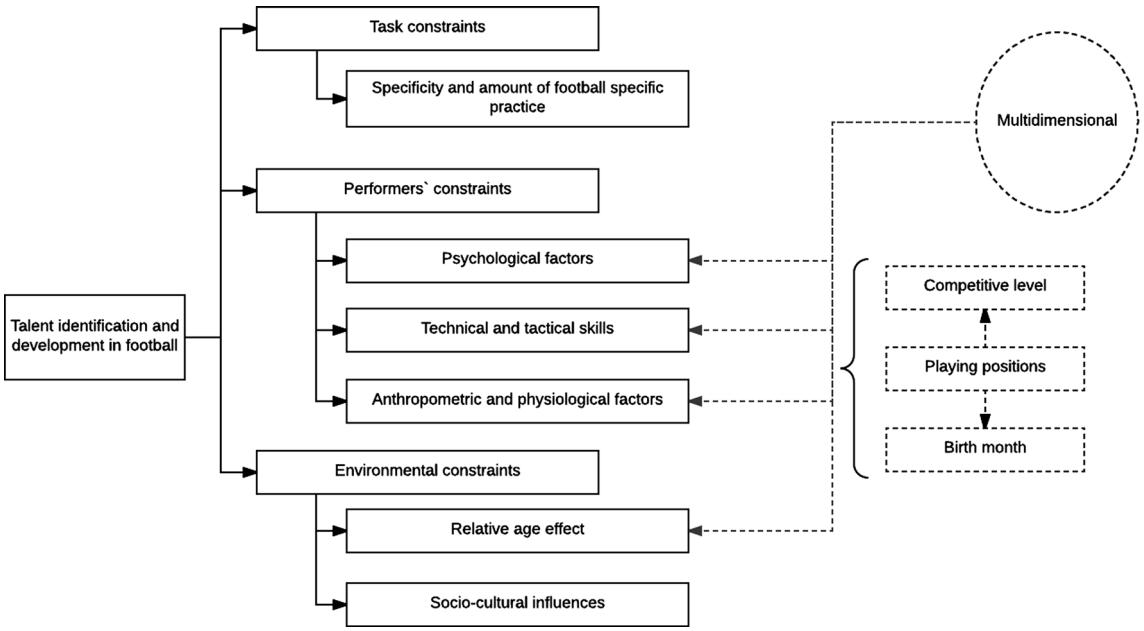

Fig. 2 Scopes of talent identification and development

relevant information for talent identification systems. Additionally, evaluation of basic sprinting and dribbling activities [51] in youth soccer can assist practitioners developing training programmes. With respect to tactical skills, positional skills and decision-making are the best predictors of the performance level in adult elite performers [52]. Also, the more skilled players (i.e. from the Dutch national youth soccer team) seem to outperform the less skilled players (i.e. from the Indonesian national youth soccer team) based on their declarative (knowing what to do) and procedural (doing it) knowledge [87].

3.3.2.3 Anthropometric and Physiological Factors Anthropometric and physiological factors have been extensively studied in the context of talent identification and development in football. The reviewed research has sought to establish 'profiles' that characterise the most talented players in different phases of their development according to their competitive level, playing positions and birth month. Most studies investigated the influence of anthropometric and physiological factors on football talent in relation to the competitive level achieved by the players; however, because different research strategies were adopted to classify those competitive levels, it becomes difficult to find clear associations (Table 4). Nevertheless, the reviewed studies showed that key morphological and functional capabilities (muscular power, agility, coordination, speed and endurance) seem to discriminate players already selected and exposed to systematic training and may provide a basis for employing more clear criteria in respect to player identification and development [53]. However, for this information to be reliable, the athlete's biological age or biological maturity should be considered [54]. This body of research offers some suggestions for developing training programmes such as match-running performance [11] and explosive power [55].

3.3.3 Environmental Constraints

3.3.3.1 Relative Age Effect Over the last three decades, it has been demonstrated in a number of sports that a player's relative age is associated with talent selection, as individuals born in the first months of a year are generally more widely represented. Indeed, individuals born early in the year may be almost a year older than those born later in the same year, even though they will be competing in the same sport task, and they are therefore more likely to be selected. This advantage of being born early within a cohort has been named the 'relative age effect' (RAE) or 'birth date effect'. This review highlighted a consensus in the literature as to the over-representation of football players born in the first months of the year (Table 5) in several European countries (e.g. Belgium, England, Spain, Germany, Portugal, Italy) [4, 12, 56–68] and FIFA designated zones [69]. Studies analysing a potential link between playing positions and RAE produced conflicting results. It was first shown that European professional players in all playing positions (goalkeeper, defender, midfielder and forward) were equally affected by RAE [69]. In agreement with this study, no relationship was found between RAE and playing position in youth teams playing in the Spanish Professional League [61]. However, another study showed that RAE

Table 1 Studies with predominantly specificity and volume of football-specific practice analysis

Study	Sample	Procedure	Results	Quality score (%)
Ward et al. [75]	Male football players ($n = 203$) between 8 and 18 years of age, from (1) 4 national-level English premier league youth football academies (elite group); (2) local elementary schools, high schools and universities (sub-elite group)	Domain-Specific Participants Questionnaire Adapted versions of the Perceived Competence Scale [116, 117] and sport commitment model [118]	Weekly and accumulated hours spent in football team practice most consistently discriminated between skill levels across age cohorts Elite players spent more time in decision-making activities during team practice, possessed higher levels of motivation and had greater parental support	93.7
Ford et al. [73]	3 Groups of British players: (1) elite group—11 players from 4 national-level English premier league youth football academies; (2) ex-elite group—11 players that had not been selected for a full-time professional scholarship at the academy and were no longer playing at the elite level; (3) 11 recreational-level players	Domain-Specific Participants Questionnaire	The elite players who went on to attain professional status accumulated more hours per year in football play activities, but not in football practice, competition or other sports, between 6 and 12 years of age than those who did not progress The 2 elite groups averaged more hours per year in football practice than recreational-level players, but not football play, competition or other sports	93.4
Ford and Williams [74]	2 Groups of British players: (1) professional—16 players from 5 football clubs in the English premier league who had been selected by their coaches at 16 years of age to continue their development via full-time scholarship at the club; (2) non-professional—16 players that had not been selected for a full-time professional scholarship	Participation History Questionnaire [119]	After starting in football at 5 years of age, professional players in England followed the early engagement pathway throughout childhood during which they spent more time in football-specific practice and play activity compared with those who did not progress to professional status in adulthood	81.2
Ford et al. [82]	Elite football players ($n = 328$) from Portugal, Brazil, England, France, Ghana, Mexico and Sweden	Participation History Questionnaire [119]	The developmental activities of elite football players were shown to follow both the early specialisation and early engagement pathway, but not the early diversification pathway. During childhood, the players engaged in relatively high amounts of football-specific practice and play, whereas not all of them engaged in additional sports and those that did engaged in a low number. During early adolescence, they engaged in relatively high amounts of football-specific practice	86.7
Roca et al. [76]	48 Skilled British football players and 16 amateur or recreational football players	Participation History Questionnaire [119] and perceptual cognitive test—life-size video sequences	The average hours per year in football-specific play activity during childhood was the strongest predictor of performance on the perceptual cognitive test and differentiated the skill groups	81.2

Table 1 continued

Study	Sample	Procedure	Results	Quality score (%)
Williams et al. [81]	48 Elite and 12 non-elite British players	Skill tests Career Practice Questionnaire [75]	The high-performing group had accumulated more hours in football-specific play activity over the last 6 years of engagement in the sport than their low-performing counterparts and the non-elite controls. No differences were reported for hours accumulated in football-specific practice or competition between the high- and low-performing groups	81.2
Zibung and Conzelmann [77]	159 Swiss players who had played at least once on U-16 to U-21 national youth team	Domain-Specific Participants Questionnaire	Two early career patterns were identified as having a favourable influence on adult performance. Both were characterised by an above-average amount of in-club training. One pattern also exhibited an above-average amount of informal football played outside the club, the other above-average scores for activity in other sports	81.3
Haugaasen et al. [79]	745 Norwegian players aged 14–21 years	Retrospective questionnaire	The professional players reported having accumulated significantly more hours in play and coach-led practice at the youngest age categories	87.5
Hornig et al. [78]	52 German football first Bundesliga professionals and 50 fourth- to sixth-league amateur players	Retrospective questionnaire	National team players differed from amateurs in more non-organised leisure football in childhood, more engagement in other sports in adolescence, later specialisation and in more organised football. Relative to other studies, these players performed less organised practice, particularly less physical conditioning, but a higher proportion of playing activities	86.7

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may be a predictor of playing positions in Swiss national teams [65]. These studies show that talent identification in football can be significantly affected by RAE.

3.3.3.2 Socio-Cultural Influences Despite the significant influence of the social environment on the development of young athletes, few studies have addressed this issue exclusively in the context of football. Furthermore, it is important to note that nearly all of these studies were qualitative (Table 6). Supportive environments for soccer development seem to have different priorities: (1) social influences and organisational culture during the games and training sessions; and (2) compatibility of the sports practice with familiar, social and school contexts. Furthermore, coaches and players disagreed on the importance of different factors [70] and clubs do not use the existing literature to improve their practices [71].

3.3.4 Multidimensional Analysis

While most studies in this research area focused mainly on a single topic, a group of multidimensional studies (Table 7) investigated the impact of a variety of factors on talent identification and development, including technical, tactical, physiological, anthropometric and psychological factors (see Fig. 2). Given the specific nature and scarcity of these studies, these are discussed in the relevant subsections of Sect. 4.

4 Discussion

The aim of this article was to review the available literature on talent identification and development of male footballers. The results showed an incremental interest in this

Table 2 Studies with predominantly psychological factors analysis

Study	Sample	Procedure	Results	Quality score (%)
Holt and Dunn [43]	20 Canadian international youth football players, 14 English professional football players and 6 English professional youth football players	Interviews—grounded theory	4 Major psychosocial competencies that appear to be central to success in elite youth football emerged from the data: (1) discipline (i.e. conforming dedication to the sport and a willingness to sacrifice); (2) commitment (i.e. strong motives and career planning goals); (3) resilience (i.e. the ability to use coping strategies to overcome obstacles); (4) social support (i.e. the ability to use emotional, informational and tangible support)	90.5
Coetzee et al. [44]	36 South African players from 2 different competitive levels (successful and less successful)	The participants completed 4 questionnaires: (1) Competitive State Anxiety Inventory [120]; (2) Achievement Motivation Scale For Sporting Environments [121]; (3) Athletic Coping Skills Inventory-28 [122]; (4) Psychological Skills Inventory [123]	The most important skills to discriminate between successful and less successful teams were mental rehearsal, concentration, peaking under pressure, concentration, achievement motivation and activation control	80
Holt and Mitchell [45]	9 Players and 3 coaches from an English professional club from the third division	Individual interviews—case study approach	The results suggested that the players from this sub-elite club lacked volitional behaviour, delaying gratification, determination to succeed, strategic career planning, coping strategies and tangible support	90.5
Toering et al. [46]	Netherland elite ($n = 159$) and non-elite ($n = 285$) football players (11–17 years)	Different instruments were used to measure (1) self-regulations questionnaire development that was based on English-language questionnaires [124–127]; (2) planning, self-monitoring, effort and self-efficacy [124]; (3) evaluation [125]; (4) reflection [126]	High scores on reflection and effort were associated with a higher level of performance. Findings suggest that elite players may be more (1) aware of their strong and weak points as well as better able to translate this awareness into action; (2) willing to invest effort into practice and competition	81.3
Van Yperen [47]	Dutch football players who successfully progressed into professional adult football ($n = 18$) and players who did not reach this level ($n = 45$)	Different instruments were used to measure (1) initial level of performance [128]; (2) goal importance and goal commitment [129]; (3) potential stressors and coping; (4) seeking social support [130]	The psychological factors that predicted successful careers were goal commitment, engagement in problem-focused coping behaviours and social support seeking	75
Zuber et al. [48]	Swiss players ($n = 134$) from 6 regional teams	Different instruments were used to measure (1) achievement motive [131]); (2) achievement goal orientation [132]; (3) self-determination [133]	High levels of win and goal orientation, hope for success and self-determination are associated, not only individually but also collectively, with greater success and accordingly with higher performance in sports	93.8

research topic over the years (see Sect. 3.1). In the following sections we discuss some of the most interesting results emerging from the analyses performed in this review, based on an ecological dynamics theoretical framework.

Table 3 Studies with predominantly technical and tactical skills analysis

Study	Sample	Procedure	Results	Quality score (%)
Huijgen et al. [49]	Talented players ($n = 131$), aged 14–18 years. The players were identified as professional ($n = 54$) or amateur ($n = 77$) later on their career (age > 20 years)	Measurements of dribbling performance were assessed by means of the shuttle dribble test	During adolescence, the talented footballers who ultimately became professionals 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 the players who remained amateurs	87.5
Kannekens et al. [87]	2 Youth football teams: 18 players (age 18–20 years) from the Dutch and 19 players (age 18–23 years) from the Indonesian national youth team	The players completed the declarative and procedural knowledge scales of the Tactical Skills Inventory for Sports	The more skilled players outperformed their less skilled counterparts on aspects of declarative and procedural knowledge	81.2
Huijgen et al. [51]	Talented football players (Netherlands) aged 12–19 years ($n = 267$)	Two field tests: the shuttle sprint and dribble test and the slalom sprint and dribble test. The longitudinal data were analysed with multi-level modelling	Both dribbling and sprinting improved with age, especially from ages 12 to 14 years, but the tempo of development was different. From ages 14 to 16 years, sprinting improved rapidly in contrast to dribbling. In contrast, after age 16 years dribbling improved considerably but sprinting hardly improved	100
Waldron and Worsfold [50]	18 Elite players and 53 sub-elite players from England	Hand notation system including 18 performance variables	Elite players were significantly higher performers in 9 of 18 performance indicators	87.5
Kannekens et al. [52]	Elite youth (16–18 years) football players ($n = 115$) of Dutch premier league clubs who participated in their club's talent development programme	The players completed the Tactical Skills Inventory for Sports with scales for declarative and procedural knowledge in either attacking or defensive situations	Positioning and decision-making appeared to be the tactical skill that best predicts adult performance level, especially for midfielders. For players scoring high on this skill, the odds ratios indicated a 6.60 times greater chance that a player became a professional than players scoring low	87.5
Waldron and Murphy [86]	15 English premiership youth players (elite) and 16 English division 1 youth players (sub-elite)	Players were assessed for closed performance and movement, physiological responses and technical actions during 50 matches	Elite players presented more successful and unsuccessful ball retentions than sub elite players. Elite players were faster dribblers than sub-elite players	93.8
Zago et al. [134]	10 Under-13 sub-elite Italian players	Specific technical test designed for this study	Faster players were able to run with the ball through a shorter path in a more economical way	93.8

4.1 Task Constraints

4.1.1 Specificity and Amount of Football-Specific Practice

Understanding what facilitates engagement and effectiveness in sports practice may contribute to the development and implementation of effective programmes [18]. A widely held view is that 10,000 h of deliberate practice (highly structured activity with the specific goal of improving performance, which requires effort and is not inherently enjoyable [21]) are necessary and sufficient to reach expert level, as initially suggested by Chase and Simon [72]. However, there is considerable variation in these figures within and across sports, with some data suggesting that there are significant differences among sports in the average amount of practice time required to progress from novice to senior national representation [15]. Due to the inherent non-linearities in human development,

Table 4 Studies with predominantly anthropometric and physiological analysis

Study	Sample	Main variables	Strategies used to established the groups (according to competitive/skill level or birth quarters)	Groups according to playing positions	Quality score (%)
Vaeyens et al. [90]	160 Youth Belgium players (U-13 to U-16)	Chronological age, skeletal age morphology (height, body mass, 11 skinfolds, 2 diameters), fitness (flexibility, agility, speed, strength, endurance), football-specific (dribbling, shooting, lobbing, juggling) skills	Elite (players on youth teams of first- (highest) or second-division clubs), sub-elite (players on third- and fourth-division teams) and non-elite (players on regional teams)		93.8
Gil et al. [93]	194 Spanish players (U-15 to U-18)	Chronological age, skeletal age morphology (stature, weight, height, 6 skinfolds, 4 diameters and 3 circumferences), fitness (aerobic capacity, speed, strength, endurance)	Selected (selected players at the end of the season to play in the next category) vs. non-selected		86.7
Malina et al. [96]	69 Portuguese youth players (U-14 to U-16)	Height, body mass, stage of pubic hair, functional capacity (dash, vertical jump, endurance shuttle run), technical skills (ball control with the body, ball control with the head), slalom dribbling with a pass (speed and accuracy), slalom dribbling (speed, passing accuracy and shooting accuracy)	Performances on 6 football-specific tests were converted to a composite score which was used to classify players into quintiles of skill		81.3
Gravina et al. [94]	66 Spanish players (U-11 to U-15)	Chronological age, morphology (weight, height, 6 skinfolds, 4 diameters and 3 circumferences), fitness (aerobic capacity, speed, strength) and salivary testosterone	First team players vs. reserves		87.5
Le Gall et al. [53]	114 French players (U-14 to U-16)	Chronological age, skeletal age, morphology (weight, height, 4 skinfolds) and fitness (sprint, strength, aerobic capacity)	International (players who succeeded in playing at least 1 match at full-international level and/or U-21 level—all were also full-time professionals), professional (players who succeeded in signing a contract with a professional club and who played at least 1 match as a full-time professional) and amateur (players who did not acquire a professional contract)		93.8
Mirkov et al. [92]	26 Serbian players (U-12) and 63 randomly selected boys evaluated over 4 years	Chronological age, skeletal age, morphology (weight, height, 5 skinfolds, 4 diameters) and fitness (flexibility, muscle power, coordination, agility)	Elite players vs. control group (randomly selected untrained boys)		93.8
Elferink-Gemser et al. [135]	492 Dutch players (U-13 to U-19)	Body dimensions, body fat, functional capacities and training patterns	Elite players (belong to the top 0.5% of football players in their age group)		100
Gonaus and Müller [91]	1642 Austrian players (U-15 to U-18)	Chronological age and functional capacities	Drafted (players who subsequently had been drafted at least 2 times into a youth national team—U-18 to U-21) and non-drafted (players who had never been drafted to play at international youth football level)		93.8

Table 4 continued

Study	Sample	Main variables	Strategies used to established the groups (according to competitive/skill level or birth quarters)	Groups according to playing positions	Quality score (%)
Ostojic et al. [89]	55 Serbian players (U-15 followed for up to 8 years)	Biological and chronological age	Elite (≥ 1 full seasons played for clubs competing in top-5 football leagues—Spain's la liga, English premier league, German bundesliga, Italian Serie A, France's Ligue 1- and/or at least 1 official match played for an adult national team) vs. sub-elite (full season played for teams from other football leagues—national and international—with no appearance with a national team)		93.8
Deprez et al. [55]	388 Belgian youth players (U-10 to U-17)	Chronological age, morphology (height, sitting height, body mass and body fat, leg length), fitness (strength and football specific endurance), football-specific and non-specific motor coordination skills	Contract (professional contract) and no contract		93.8
Emmonds et al. [95]	443 Elite English players (U-9 to U-18)	Chronological age, morphology (height and body mass) and fitness (speed and endurance)	Academy football players vs. players who achieved a contract at 18 years		100
Hirose and Seki [136]	58 Elite Japanese players (U-13 to U-15)	Chronological age, morphology (weight, height, sitting height) and fitness (sprint and agility)	Elite vs. sub-elite		93.8
Goto et al. [137]	34 English premier league academy players (U-9 [$n = 22$] and U-10 [$n = 12$])	Chronological age, standing height, sitting height, body mass, fitness (speed, endurance) and match analysis (speed zones measured with GPS—standing and walking, jogging, low-speed running, moderate-speed running, high-speed running)	Retained vs. released		87.5
Nevill et al. [97]	946 Players competing in first and second professional leagues in England	Chronological age and morphology (height and body mass)	Successful (top 6 teams) vs. unsuccessful	Goalkeeper, wide defender, central defender, midfielder, central attacker, wide attacker	86.7
Coelho e Silva et al. [100]	114 Portuguese players (U-14)	Chronological age, skeletal age, morphology (weight, height, 4 skinfolds, 4 diameters and 3 circumferences), fitness (explosive power, agility, sprint), football-specific skills and goal orientation	Local vs. regional (elite)	Defenders, midfielders, forwards	93.8
Carling et al. [101]	158 French players (U-14)	Chronological age, body dimensions, functional capacities and skeletal age	Professional (players who signed a contract with a professional club and played at least 1 game) vs. non-professional (remaining players)	Goalkeeper, defender, midfielder, forward	93.8

Table 4 continued

Study	Sample	Main variables	Strategies used to established the groups (according to competitive/skill level or birth quarters)	Groups according to playing positions	Quality score (%)
Maria Gil et al. [99]	77 Spanish players (U-10 to U-11)	Morphology (height, sitting height, leg length, ratio between leg length and sitting height, weight, body fat, body mass index) and fitness (strength, speed, agility, endurance)	Players of first selection (players selected around the country belonging to around 300 teams), players of football camp (between this first selection and the end of the season, players continue training in their original clubs, but attend 1 training session per week within the club's facilities under the supervision of the club's coaches), players finally selected (small selection of players to definitely join the club)	Outfield players vs. goalkeepers	93.8
Deprez et al. [88]	744 Belgian players (U-9 to U-19 followed for 6 years)	Chronological age, morphology (height, sitting height, weight, body mass, leg length), fitness (flexibility, speed, strength, endurance), and football-specific (dribbling) and non-specific motor coordination skills	Elite players	Goalkeepers, attackers, midfielders, defenders	93.8
Saward et al. [11]	263 Elite English players (U-9 to U-14)	Match running performance according to the intensity zones (low-/high-speed/sprinting)	Retained (players were signed to their academy) vs. released	Centre back, full back, centre midfielder, wide midfielder, centre forward, multi-position	86.7
Hirose [103]	332 Japanese adolescent elite football player (U-10 to U-15)	Height, body height, body mass, chronological age, skeletal age and biological maturation	Birth quarters		93.8
Deprez et al. [102]	374 Belgian elite players (U-13 to U-17)	Height, sitting height, body mass and fitness (leg power)	Birth quarters		93.8
Fragoso et al. [54]	133 Portuguese elite football players (U-15)	Skeletal age, stature, body mass, thigh girth, calf girth and upper arm girth, and fitness (speed, strength, endurance)	Birth quarters		86.7

GPS global positioning system, *U-* under

the amount of time needed to achieve an expert level cannot be precisely specified [6]. Nevertheless, recent research indicates that the number of accumulated hours spent in football-specific team practice at early ages (6–12 years) is associated with higher levels of expertise in English [73–76], Swiss [77], German [78] and Norwegian [79] football players. The overall conclusion is that specific practice is relevant, but the quantity that is needed cannot be predicted in advance due its interaction with other constraints.

The potential benefits of being involved in enjoyable activities related to a specific sport during childhood have been extensively discussed by the scientific community [18]. The studies reviewed here support the idea that involvement in deliberate football-specific play activities per se is not an important correlate of expertise; however, at early ages (6–15 years), an optimal balance between deliberate practice and deliberate play (early developmental activities, specifically designed to maximise enjoyment, and which are intrinsically motivating and provide immediate gratification [80]) appears to be related to higher levels of expertise [37, 38, 73, 74]. Indeed, a greater number of hours accumulated per year in practice or football-specific play activity during childhood [76, 81], or between 14 and 18 years old [75], was a strong predictor of perceptual–cognitive expertise in football-related tasks.

Table 5 Studies with predominantly relative age effect analysis

Study	Sample	Main results	Quality score (%)
Helsen et al. [56]	4 Groups of Belgian players: (1) professional players in the first division in 1993–1996 ($n = 4408$); (2) youth players (10–16 years) who were selected for the 1989–1995 national youth teams ($n = 4369$); (3) youth players (6–16 years) transferred in 1995 to a first-division youth team by an official youth transfer ($n = 4485$); (4) youth players from regular youth leagues ($n = 4483$)	Youth players born from August to October (the early part of the selection year), beginning in the 6- to 8-year age group, are more likely to be identified as talented and to be exposed to higher levels of coaching. In comparison, players born late in the selection year tended to drop out as early as 12 years of age	71.4
Helsen et al. [4]	2175 Youth players U-12 to U-18 from different national teams and clubs across the Europe	There is an over-representation of players born in the first quarter of the selection year (from January to March) for all the national youth selections at the U-15, U-16, U-17 and U-18 age categories, as well as for the UEFA U-16 tournaments and Meridian Cup	71.4
Simmons and Paull [57]	4 Groups of British players: (1) 79 adolescent male footballers aged 15 years at the age of residential entry to the Football Association National School; (2) 8857 player registrations for all centres of excellence in England for 1995–1996; (3) 78 players who had been selected into English schools' U-15 teams for 1991–1995; (4) 64 England U-16 players for the years 1994–1998	The youngest children from the January start date (born September–December) are selected significantly more often than the youngest children from the September start date (born May–August)	92.9
Vaeyens et al. [58]	Study A: 2757 senior football players selected by Belgian second- and third-division teams for 5 competitive seasons (1998/1999–2002/2003). Players from fourth-division teams were limited to the 2002/2003 season	Players born in the months of January to March were over-represented compared with players born late in the period of October to December. However, players with birthdays at the start of the old selection year (August) were still represented	85.7
	Study B: 2138 football players aged 16–39 years were identified and divided into two age groups, group 1B ($n = 1640$) and group 2B ($n = 498$)	The group of semi-professional and amateur senior football players born in the first quarter of the selected age band received more playing opportunities. There were no differences for the mean number of selections and for playing minutes between players born at the start or the end of the selection year	
Jimenez and Pain [59]	3 Groups of Spanish players: (1) 1012 players from 42 adult teams, and 2053 players from 109 youth teams of 17 Spanish professional football league; (2) 86 players who participated in international competitions (2001–2007) with the U-17 to U-21 Spanish national teams; (3) 56 players selected for the national team between 2001 and 2007	Comparisons between players from: the Spanish professional football league, all age categories of these clubs' youth teams, the U-17 to U-21 national teams, the national team and the Spanish population, show a constant tendency to under-represent players from the later months of the selection year at all age groups of youth and U-17 to U-21 national teams	78.6
Mujika et al. [60]	13,519 Players from different ages (U-10 until senior) and competitive levels (regionals vs. national) of the Spanish league's team, AC Bilbao, over 21 seasons	Birth-date distributions of all groups of players showed a significant bias towards early birth in the selection year compared with the reference population	85.7
Gutierrez et al. [61]	4 Groups of Spanish players: (1) elite 2005–2006 group: 834 players of 20 clubs belonging to the Spanish professional football league; (2) elite 2008–2009 group: 2786 players of 20 clubs belonging to the Spanish professional football league; (3) amateur 2006–2007 group: 591 players belonging to the youth teams at 5 amateur Spanish football academies; (4) 'Spanish population' group: all the births ($n = 4{,}738{,}110$) falling within the range of dates under analysis in the study (1986–1997)	The RAE was stronger in the elite population than in the amateur group. The results exposed a reduction in RAE from the 2005–2006 season to the 2008–2009 season. The extent of RAE did not depend on variables such as playing position or the number of years each player had spent in their specific age group. The variable category of the team was not relevant to the level of RAE, which seemed to indicate that the time of recruitment of players for the youth academies of elite teams is a major point in the development of RAE	85.7

Table 5 continued

Study	Sample	Main results	Quality score (%)
Augste and Lames [62]	911 Players from 41 German U-17 first-league teams	There was a significant correlation between the RAE and success defined by teams' final rankings. Selecting players with a higher relative age favours immediate success in competition with other teams. Teams with no RAE are able to compete in the league, having the benefit to promote players with a better perspective for long and successful careers at an adult age	78.6
Helsen et al. [63]	All professional players that competed in the 2000–2001 ($n = 4675$) and 2010–2011 ($n = 4661$) sporting seasons	In the 2000–2001 competitive season, all countries, with the exceptions of Portugal and Spain, showed a significant RAE. In the 2010–2011 season, only Portugal did not show a RAE. There has been no decrease in the prevalence of the RAE during the last decade	92.3
Romann and Fuchslocher [65]	50,581 Football players registered in the Swiss youth sport database	RAE apparently has substantial influence on the talent identification process for U-15 to U-18 teams, significantly influencing the selection of players in talent development teams already at an early age. RAE bias may be a predictor of playing positions in national teams	100
Votteler and Höner [66]	10,130 German players in the age groups U-12 ($n = 3606$), U-13 ($n = 3064$), U-14 ($n = 2138$) and U-15 ($n = 2138$)	The birth distribution differed significantly from the reference population with approximately 61% of the players born in the first half of the year. The selection probability was approximately 2 times higher for players born in the first quarter of the year than for players born in the last quarter	93.4
Toering et al. [64]	256 Elite Dutch youth football players: 76 international-level players and 178 national-level players	Players scoring high on reflection and players born in the first half of a selection year were more likely to belong to the international group. RAE did not affect the relationship between reflection and performance level	93.3
Sæther [68]	92 Norwegian players born in 1991 selected from ≥ 1 U-15 and U-19 national team matches in 2006–2010	Players born during the two first quartiles of the year appear to be over-represented among Norwegian national youth team players compared with those born during the second half of the year	85.7
Gonzalez-Villora et al. [67]	841 Football players participating for their country in different categories (professional, U-21, U-19, U-17) in the European football championship	RAE was not evident in the professional category, but it was in the 3 youth categories examined. Concerning the teams that participated in the final stages of competitions (quarter-final, semi-final and final), it was observed that RAE had no evident impact on the professional category; however, it influenced the lower categories (U-21, U-19, U-17)	78.6
Padron-Cabo et al. [69]	12,144 Professional players who participated in the professional leagues during the 2014–2015 season	RAE was found in the first and second division of competitions and in all the leagues analysed, excluding the Premier league (England) and the K-League Classic (South Korea). All playing positions (goalkeeper, defender, midfielder and forward) were affected by RAEs	78.6
Skorski et al. [12]	495 German football players (U-16, U-17, U-18, U-19, U-20, U-21)	Overall, more players were born in BQ 1 (January to March) than in all other BQs. Players born in BQ 4 (October to December) were more likely to become professional than those born in BQ 1	100

BQ birth quarter, *RAE* relative age effect, *U-* under, *UEFA* Union of European Football Associations

Table 6 Studies with predominantly socio-cultural influences analysis

Study	Sample	Procedure	Results	Quality score (%)
Mills et al. [110]	50 Elite English players (U-17 to U-19)	Talent Development Environment Questionnaire	Elite player development environments are perceived to be of a good quality. Academies need to pay close attention to the psychosocial environments they create for developing players	100
Mills et al. [109]	10 Expert English coaches	Semi-structured interviews	Optimal development environment factors were identified and included organisational core, adaptability, player welfare, key stakeholders' relationship, involvement and achievement oriented	81
Morley et al. [70]	6 Elite English players (U-14 to U-19) and 5 expert English coaches	Delphi technique	When key contexts of player development reflected the consensus between players and coaches, they were heavily dominated by ability within the game and training. Personal, social, school and lifestyle contexts featured less prominently. Coaches and players disagreed on the importance of training	76.2
Ivarsson et al. [112]	195 Swedish youth elite football players (U-14 to U-17)	General Health Questionnaire; Recovery-Stress Questionnaire for Athletes; Talent Development Environment Questionnaire	Players perceiving their talent development environment as supporting and focusing on long-term development seemed to be less stressed and experienced greater well-being than other players	100
Miller et al. [111]	7 Elite English youth football coaches	Semi-structured interviews	The results revealed 3 superordinate themes, relating to (1) a primarily 'nurtured' and trainable understanding of the broad concept of talent itself; (2) an ostensibly contradictory model of semi-static player psychology; (3) a highly selective mechanism for separating evidence for 'mental strength' and 'social skills'	90.5
Morris et al. [71]	2 Clubs from English premier league	Meeting minutes, websites, interviews ($n = 17$) with players, coaches, support staff and parents, and e-mail communications	Despite a body of existing knowledge, individual clubs may not adhere to or utilise this literature. Preliminary indications imply that a proactive intervention programme targeting demands, barriers and resources associated with transition may be beneficial to youth athletes in terms of their development and the club's success, both in terms of reputation and finance	76.2
Horrocks et al. [10]	1 Club from English premier league	3 Players, 1 coach and 1 parent of an elite-level player	The culture of the club was facilitative and encouraging of their intensive individualistic behaviour. Future models should always be developed with an eye on the culture where they must reside	81

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Additionally, evidence from different sports demonstrated that early specialisation is not the only pathway to reaching high levels of expertise. It seems that early diversification can also lead to elite performance (see Coutinho et al. [18] for a review), especially in sports where the peak performance is achieved after biological maturity [15]. However, playing other sports in addition to football at a young age does not have a significant influence on the level of expertise achieved in football [73–75, 82]. These two contrasting development pathway patterns (early specialisation and early diversification) have been discussed extensively in the literature [6]. Nonetheless, the characterisation of past sport experiences based on footballers' perceptions is somewhat restricted, thus highlighting the need for longitudinal studies integrating macro-structural approaches (e.g. deliberate practice) with theoretical ideas

Table 7 Studies with predominantly multidimensional analysis

Study	Sample	Measurements	Main results	Quality score (%)
Forsman et al. [34]	114 Elite Finnish players (U-16)	Technical (2 specific field tests to measure dribbling and passing), tactical (Tactical Skills Inventory for sports was completed by players), physiological (speed, agility, explosive leg strength and endurance) and psychological (motivation, confidence, concentration and mental preparation) characteristics	Performance level at age 19 was clearly associated with technical skills of passing and centring as well as agility and motivation levels recorded at age 15 years	81.3
Huijgen et al. [35]	113 Talented adolescent football players (U-13 to U-19) attending one of 2 talent development programmes of professional football clubs in the Netherlands participated in this study	Technical (peak shuttle dribble, repeated shuttle dribble and slalom dribble), tactical (Tactical Skills Inventory for sports was completed by players), physiological (peak shuttle sprint performance, repeated shuttle sprint performance, slalom sprint performance and interval endurance capacity) and psychological (motivation, self-confidence, anxiety control, mental preparation, team emphasis and concentration) characteristics	The decisions made by the investigated clubs to either select or deselect players in their talent development programme were mostly discriminated by aspects of the players' technical, tactical and physiological skill performances	93.8
Reilly et al. [36]	31 (16 Elite and 15 sub-elite) youth players (U-17)	Anthropometric (height, body mass, 7 skinfolds, 2 diameters and 4 girth measurements), physiological (aerobic and anaerobic performance, 40-m sprint, repeated sprint and standing vertical jump), psychological (motivation and anxiety) profiling and football-specific skills test (shooting and dribbling)	The elite players were significantly leaner, possessed more aerobic power and were more tolerant of fatigue. They were also better at dribbling the ball, but not shooting The most discriminating of the measures were agility, sprint time, ego orientation and anticipation skill	93.8

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concerning the micro-structure of different learning activities [6, 18]. For this, future research on footballers' retrospective reports should be complemented with real-time systematic observation of players' practice and play activities [18].

Future investigation about task constraints in football may also consider, for instance, the impact of rule manipulation, boundary locations and equipment (scaled to the players' morphology).

4.2 Performers' Constraints

4.2.1 Psychological Factors

The influence of psychological factors on sports performance is well-established; however, research on the role they may play on football talent identification and development is scarce. Moreover, studies addressing the psychological characteristics of talented football players vary widely in research design (interviews vs. questionnaires), player performance level (elite, sub-elite and regional players), sample size and analysed psychological skills. Thus, the interpretation of those data remains challenging. Nevertheless, investigation of psychological factors related to high performance tends to address two main questions: (1) which psychological skills are needed to reach top performance?; and (2) how can these skills be developed in young talents? [83]. The reviewed studies suggest that the most successful athletes express high levels of goal commitment, engagement in problem-focused coping behaviours [47], discipline, resilience [43], mental rehearsal, concentration, peaking under pressure, achievement motivation [44], effort [45, 46] and self-regulation [46]. These findings are useful for monitoring

improvements in training and game performance and for identifying the necessary changes in practice regimens [46]. Additionally, accurate diagnosis of the role of psychological factors in athletes who are not making the expected career progress can be useful in the design of specific development programmes [43]. Nevertheless, little is known about training of motivational and self-regulatory skills as well as how these skills change across different phases of player development. From an ecological perspective [84, 85], it makes no sense to perceive psychological skills as inner, independent and stable features of the individual. In contrast, practitioners and sport scientists may perceive these competencies as socially supported and dependent on the specific environmental circumstances. Thus, further research is needed to better understand this complex relationship across different organisational cultures. Additionally, greater knowledge of the psychological skills specific to different playing positions may contribute to a better understanding of their importance on talent identification and development.

4.2.2 *Technical and Tactical Skills*

Although few studies have addressed the importance of technical and tactical skills for talent identification and development in football, there is a clear association between high achievement and superior technical skills, including dribbling, short/long pass, ball retention and shooting [34–36, 49, 50, 86]. For instance, research suggests that players with superior dribbling skills in their teens become high performers as adults [51]. The complex relationship between the factors (advanced age, lean body mass, hours of practice, playing position) that predict dribble performance deserves more research to improve trainers' and coaches' understanding of performance development [50].

Tactical skills refer to the quality of an individual player to perform a timely action [52] that is effective for achieving a task goal. A study of German young players highlights the relevance of tactical skills for a successful high-profile career in football [52, 87]. Thus, development of tactical skills seems crucial for achieving top-level performance in football. However, how to implement effective strategies that develop technical and tactical skills in footballers is not clear. For this, the ecological dynamics approach can offer theoretical guidance for coaches, sport scientists and practitioners to carefully design the micro-structure of practice environments through manipulations of task constraints [6]. The precise micro-structure of practice needs to simulate relevant and effective solutions demanded in dynamic competitive environments. Nevertheless, the constant evolution of football (playing systems, laws of the game, etc.) requires continuous adaptations to changing task and environmental constraints, shaping skill performance and enhancing the non-linearity of the relationship between the game and players as complex adaptive systems [6]. An interesting example emerges from most recent rule changes (back pass and 6 s release rules) that have imposed new requirements for goalkeepers during match play, namely taking active part in attacking play, assuming the role of a 'libero' in the defensive phase, and developing goalkeepers' skills of controlling and passing the ball with their feet. Despite this significant change, football goalkeepers were often ignored in the reviewed studies.

4.2.3 *Anthropometric and Physiological Factors and Multidimensional Analysis*

There are some differences in anthropometric and physiological traits between successful and less successful youth football players; however, variations in biological maturation may affect player identification based on those factors. Thus, longitudinal studies with multidimensional evaluations are necessary to reveal pathways to high levels of expertise [55, 88, 89].

Overall, studies analysing the influence of anthropometric and physiological factors on talent identification reveal that elite players score better in tests measuring strength [90, 91], flexibility [90], coordination [92], agility [92, 93], speed [55, 90, 91, 93–95], football-specific speed [91], aerobic endurance [90, 93, 95], anaerobic capacity [90] and several technical skills [90]. The most successful players are often also taller [94] and leaner [36, 94]. Moreover, speed is associated with player selection at the ages of 10–14 [94, 96] and 16 years old [95], while agility and coordination are associated with future success in 11-year-old players [92]. Successful U-15 and U-16 players have greater aerobic endurance [90, 96].

Similar anthropometric and physiological analyses, but which also considered the players' field positions, showed that goalkeepers, defenders [88, 97, 98] and central strikers [97] were taller, heavier and older than players based in central and wider positions [88, 97]. Moreover, midfielders and players in wider positions had a lower body mass index and reciprocal ponderal index than central players [97], and goalkeepers had more body fat and performed worse in physical tests than outfield players [99]. Whilst the physical advantages of goalkeepers and central defenders might be envisaged in competitive match-play scenarios, they were not evident in the physical fitness tests (agility, sprinting and endurance). Lateral midfielders seem to be faster sprinters than central midfielders at U-15/U-16 (small effect), and this difference is greater at U-17/U-18 [97]. Towlson et al. [98] suggested that such variation, observed before the peak height velocity, may reflect the

development of position-specific physical attributes, and not necessarily an identification phenomenon. In turn, Coelho e Silva et al. [100] showed that variations in several anthropometric and physiological traits according to field position were negligible in Portuguese footballers, except for the 'ego orientation' psychological variable. Indeed, midfielders had higher ego orientation than defenders and forward players. In addition, in every field position, the most successful players (selected as regional players) were heavier, taller and showed more advanced skeletal maturation. Nevertheless, the inter-individual paths of biological maturation are more flexible than what is demanded for playing position allocation [98]. Coaches and scouts may need to include an estimation of years to peak height velocity for an individualised training prescription [55].

Analysis of secular changes in body size, shape and age characteristics in the top English League (from 1973/1974 to 2003/2004) showed that professional players were taller (by a mean 1.2 cm) and heavier (by a mean 1.29 kg) each decade. When compared with less successful teams, players from successful teams (top six) were found to be taller, leaner (as identified by a greater reciprocal ponderal index and ectomorphy score) and younger, a characteristic that was most marked for forwards [101]. Despite these findings Carling et al. [101] demonstrated that size, maturity and functional characteristics remained unchanged over 15 years (from 1992/1993 to 2002/2003) in young players who were selected for elite sport academies and reached professional level. These authors suggested that there may have been a lack of change in selection philosophies in the identification practices of coaches and scouts across the studied period.

Recent research has addressed the relationships between birth month and anthropometry, biological maturity and physical fitness in younger footballers [54, 102–104]. As mentioned in Sect. 4.1, overall there are more players born in the first quarter (Q1) than in the last (Q4), suggesting that the former have a selection advantage because, in general, they reach biological maturity earlier [54, 102–104]. Consistent with this assumption, players born in Q4 were significantly smaller than those born in Q1 (U-11, U-13 and U-14 categories) when maturation differences were controlled for statistically [103]. Moreover, Fragoso et al. [54] showed in a study of 133 Portuguese elite football players (U-15) that players born in Q1 had a fitness advantage (sprint time and squat jump). However, Deprez et al. [102] found no differences in height, weight (except for U-15) or any anaerobic parameter between players born in different birth quarters (374 Belgian players, U-13 to U-17). In addition, a study of 332 Japanese players (U-10 to U-15) revealed no significant maturation disparities between players born in different birth quarters for any age category [103]. Nevertheless, studies of Belgian [102] and English [104] youth football players concluded that the relatively older footballers had an increased likelihood of being selected [102, 104] with a particular strong RAE bias observed in the U-9 and U-13/U-16 squads [104]. This was independent of their maturity status, whereas relatively younger footballers had a chance of selection only if they were early maturing [102, 104]. A longitudinal study by Ostojic and colleagues [89] showed that significantly more late-maturing players reached elite level in adult football than early-maturing players, suggesting that player selection favours late-maturing footballers as level of performance increases. The reduced percentage of later-maturing players selected for academies highlights a need for players' evaluation beyond immediate performance. Late-maturing youth may need to be nurtured until maturity is attained [105] and this presents a challenge for those involved in making early selection decisions [101]. Nonetheless, the reviewed research demonstrates some disadvantages when identifying the ways by which footballers in different quartiles are similar in respect to relevant football-specific constraints. For this, a person-oriented analysis could be a useful direction for future research instead of a variable-oriented analysis (see Wattie et al. [106] for a review).

The empirical and theoretical literature shows that identification of specific performance characteristics for a development programme, supported by appropriate procedures to follow and recapture late maturers, offers sports clubs a clearer picture of the type of characteristics (technical, tactical, anthropometrical, physiological) they can identify and develop in the young players [35].

4.2.4 Genetic Factors

The reviewed scientific evidence concerning performers' constraints (Sects. 4.2.1, 4.2.2 and 4.2.3) demonstrated that one of the most debated topics in this area of research, namely the genetic influence, has not been studied in football players.

4.3 Environmental Constraints

4.3.1 Relative Age Effect

From an ecological dynamics approach [106, 107], different categories of constraints (individual, environmental, task) can be considered in a development systems model for RAEs. The influence of a player's RAE on talent identification has been extensively studied in football; however, as identified by Wattie and colleagues [106] for the generality of sports, the main body of the reviewed research has been de-contextualised with respect to the broader characteristics of footballers' developmental

ecology. Several studies have reported this effect in players from Belgium [4, 56, 58, 63], England [4, 57, 63], Spain [4, 59–61], Germany [4, 12, 62–64, 66], Switzerland [65], and Portugal, Netherlands, France, Italy, Denmark and Sweden [4, 63]. These studies show that talent identification in football can be significantly affected by RAE, because coaches and scouts select those players who are the best performers at the time of selection, rather than the most promising players in the long-term. The pressure on some clubs and coaches to obtain immediate results, even with young players, favours the selection of footballers who are more likely to succeed in the short-term due to their age (months) advantage, thus compromising the selection of players with greater potential in the long-term. Almost 20 years ago, Helsen et al. [56] showed that players born in the early months of the selection year (6–8 years age group) were more likely to be exposed to more (and better) coaching, while players born later in that year had higher probability of dropping out, at as early as 12 years of age. More recently, Skorski and colleagues [12] demonstrated that players born in the last birth quarter of the selection year were more likely to become professional players than those born in the first birth quarter. Moreover, this study also showed that RAE cannot be explained by anthropometric or performance-related parameters. Interestingly, this early-birth selection bias was perpetuated over the years in a 'cascade effect', as being selected at an early age increased the players' chances of being selected in subsequent years in youth football in England [60, 65], and this effect remained even when body mass was normalised [57]. However, Gonzalez-Villora et al. [67] showed that RAE is less significant at the professional level than in youth elite levels, in particular U-17.

The RAE has been explained based on cognitive and physical maturation. Athletes who were born earlier (relatively older athletes) in the selection year had significant advantages when compared with those who were chronologically younger (relatively younger athletes) [102], which could be explained by explanation the maturational differences between them. Nevertheless, the reviewed studies [12, 102, 103] suggest that players born later in the selection year but with advanced biological maturity, resulting in better performance, tend to be selected for elite teams (see Sect. 4.2.3 for more details). Studies analysing the link between playing positions and RAE present conflicting results and fail to clarify whether RAE influences the playing position when at the adult level. According to Wattie et al. [106], the reviewed literature has focused on some individual (birth date, physical maturation and size), task (participation level, playing position) and environmental (age grouping policies) constraints, revealing the need to investigate other types of constraints, such as the popularity of sport, family and coach influences, training time and laterality advantage. This micro-level approach could also be used to test the efficacy of the specific policies which have been proposed to limit the negative effect of relative age on talent identification: (1) design calendars with alternative age limits of selection [4]; (2) create more age categories with smaller bandwidth [4]; (3) divide players into categories according to skill level; and (4) allow players born later in the year to temporarily change to a younger age category [67].

In addition, studying the simultaneous influence of multiple constraints, possibly from multiple sources and from multiple research methods (qualitative and quantitative) [106], for the understanding of the RAE in football is warranted.

4.3.2 Socio-Cultural Influences

While it is well-accepted that several environmental factors influence the development of young athletes [39, 108], few studies have addressed this topic exclusively in the context of football. Moreover, these studies were performed mainly in English [10, 70, 71, 109–111] and Swedish [112] clubs. Horrocks et al. [10] reported that consistent high-level performers in an English club developed intensive individualistic developmental behaviours and routines that were encouraged by the club. However, Morley et al. [70] found that players and coaches may have diverging priorities concerning the key aspects of player development. For instance, game and training were considered essential for player development by both players and coaches, but no consensus could be obtained on the relative importance of aspects concerning personal and social life, school and lifestyle. 'Discipline' emerged as a prominent feature of player development.

Mills et al. [109, 110] highlighted the importance of establishing well-integrated youth and senior teams, positive working relationships with parents, and strong and dynamic organisational cultures at elite youth football academies. Although academies seemed helpful in specific areas related to coaching, organisation and sport-related support, areas related to athlete understanding and links to senior progression were perceived less favourably. The authors therefore suggested that academies should pay close attention to the psychosocial environments they create for developing players. Morley et al. [70] analysed two operational youth-to-senior transition programmes in professional football and the factors that may influence transition outcomes. The data suggested that a proactive intervention programme targeting demands, barriers and resources associated with transition may be beneficial for the development of youth athletes and club success, both in terms of reputation and finance.

Interestingly, Ivarsson et al. [112] found that Swedish players (13–16 years old) who perceived the environment for their talent development as supporting and focused on long-term development were less stressed and experienced greater well-being than other players. A study by Pazo et al. [113] performed with talented Spanish players proposed that sport context is among the most influential dimensions in the training process of a football player. Moreover, training in an elite academy is key for achieving success in football. Finally, the coordination between all staff members in a football academy, such as psychologists, doctors, fitness coaches and directors, also seemed relevant for the players' personal development.

Deep understanding of the broader development context, through an ecological dynamics approach [114], can be fruitful for identifying (and promoting) optimal environments for talent development. According to an ecological dynamics approach, footballers and their contexts of practice are adaptive systems that need to be understood at an irreducible level of analysis: that of the performer–environmental relationship. In this view, talent has been conceptualised as an enhanced and functional relationship developed between a performer and a specific performance environment [6]. The studies reviewed in the present work reveal a lack of investigation into the design of the practice micro-structure over time in youth football practice (see Sect. 4.2.2). Additionally, greater understanding of the influence of the family (parents, siblings) in talent development, namely what support parents can offer to their children as footballers and how parents can support football players as they move across key transition points in their sport career, is required [115]. At the macro-structure level, more attention may be given to the management of school activities and those of the football club. Football federations may potentially want to consider which everyday school activities are conducive to the talent development process.

4.3.3 Other Factors

In addition to the reviewed topics (RAE and socio-cultural influences), studies of environmental constraints need to address many other constraints such as physical environments (e.g. playing in the sand, dirt-field, grass [8]), climatic conditions (e.g. temperature, humidity) and geographic constraints (e.g. altitude).

4.4 Limitations

A possible limitation of this systematic review is that it only includes studies in English from the Web of Science™ Core Collection and Scopus databases, thereby potentially overlooking other relevant publications. Additionally, the inclusion of a panel of experts after electronic database searching who suggest more articles that align with the inclusion criteria may be a useful future step.

5 Conclusion

Over recent years, there has been growing research interest in youth player talent development and identification in football. The considerable number of studies reviewed here allowed the identification of the most frequently addressed topics in this research area: (1) task constraints: (a) specificity and volume of practice; (2) performers' constraints: (a) psychological factors; (b) technical and tactical skills; (c) anthropometric and physiological factors; (3) environmental constraints: (a) RAE; (b) socio-cultural influences; and (4) multidimensional analysis (Fig. 2).

The definition of talent is not consensual across different sports and scientific disciplines (see Sect. 1). Some authors [3] raise the difficulty of an operational definition of talent, given the continuous evolution of performances, scientific procedures and sport rules. One of the possible ways that could be used to explore a domain-specific operational definition of talent would be through the publication of systematic reviews [3]. Indeed, the reviewed evidence indicated that the most talented players tend to be heavier, taller, showed more advanced skeletal maturation and scored better in tests measuring strength, flexibility, coordination, agility, speed, aerobic and anaerobic capacity, technical (e.g. dribbling, short/long passing, maintaining ball possession, shooting) and tactical skills. In regards to the psychological competencies, talented players seem to express higher levels of motivation, confidence, concentration, commitment, discipline, mental rehearsal, resilience and coping with adversity. It seems that coaches and scouts could avoid the negative influence of the RAE on talent selection by being aware of the impact of physical and biological maturation on immediate performance and not discriminating against younger or late-maturing players.

The reviewed literature highlighted that there is a complex relationship between the tactical, technical, anthropometric, maturational, physiological and psychological factors according to each age, maturational status and specific playing positions. This complex interaction should be carefully considered by those involved in the process of identification and development of talented football players. Moreover, an optimal balance between specialisation (e.g. deliberate practice) and diversification (e.g. deliberate play) appears to be related to higher levels of performance at both early ages and adulthood. Finally, close attention should be paid to the supportive

psychosocial environments created in the sport academies for developing players. Overall, talent identification and development programmes in football must be dynamic, providing opportunities for changing evaluation parameters in the long-term.

We found several limitations in the available literature. First, there is currently a need for more longitudinal studies following the entire career path of the most successful players. Second, research addressing the influence of genetic factors in elite athletic status is lacking. Third, goalkeepers are excluded from many studies and few studies included the most talented footballers. Another research gap identified in this review was a multidimensional analysis of how different elements interact to influence talent identification and development in football. Moreover, reviews offering an overview of the literature are also lacking. Finally, there is a need for more research on the psychological and environmental aspects impacting talent development in football.

Compliance with Ethical Standards

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