



## Research article

# Differences and relationships between talent detection, identification, development and selection in sport: A systematic review

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## ABSTRACT

Although there are numerous studies on talent, especially talent identification, development, and selection, both on influencing factors and model construction or talent prediction, they have relatively independently explored some of its stages. Undeniably, talent development is continuous and phased, with specific tasks to be completed at each step, and these steps have certain differences and relationships. The aim of this review is to provide a clear distinction between the entire talent cultivation process, with the purpose of having better methods and measures for each stage to minimize the turnover rate and ensure the integrity of the talent development process. Through searching the Web of Science™ database, this review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Selected were original articles in English containing data or models related to talent detection/identification/development/selection in sports. A total of 16 articles were included in the study by reviewing the literature. This overview presents the differences and relationships between the four stages of talent cultivation, where these different aspects are aim, purpose, approach, and emphasis. The relationship is characterized by continuity, progressive, complementary, and mutually. This finding shows that each stage is not developed independently, but is an integral part of the talent training process. Additionally, better differentiation and strengthening of the links between the various talent cultivation stages are considered to contribute to elite athlete development. This review highlights the differences and relationships that exist at each stage of talent cultivation. Meanwhile, some measures are also proposed to strengthen the connection of these phases and how to reduce the turnover rate of talent, which can provide theoretical references for coaches or stakeholders. Based on the results of the review, it is also recommended that future research on talent cultivation could take into account the intrinsic linkages between the various stages and develop talent training programs in a multidimensional way.

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## 1. Introduction

The study of talent in sports has been passionately discussed in many disciplines (e.g. in kinesiology, pedagogy, biology, psychology and physiology), not only because talent is a crucial element for the sustainable development of sports, but also because the achievement of competitive results in sports depends on excellent athletic talent. In terms of physiology and psychology, the characteristics of human physical and mental development are sequential, staged, unbalanced and individually different [1,2]. Moreover, individuals at different ages phase show various characteristics and conditions of physical and mental development along with face diverse development tasks. Therefore, from the perspective of pedagogy, educators need conducted dissimilar tasks in unequal stages according to different ages and characteristics of human biology [3]. Similarly, the cultivation of sports talent, as an educational activity, is also the case for sports talent related research, where individuals need to undergo a series of training to eventually become elite athletes. Each stage of development has varying characteristics and requirements, including talent detection (TAD), identification, development and selection in distinct stages of sports training.

Although the difference between talent identification (TID) and selection in sport has been studied [4–6], these are only two of the more discussed phases and are two concepts that are more often confused. At the same time, the research involving the distinction and interrelationship between TAD and development as well as TID and selection is still rarely approached, so the integrity and construction of the sports TDE framework still needs to be improved and constructed. In this study, the four concepts of TAD, identification, development and selection are sorted out first to clarify the specific meanings and differences in essence. Meanwhile, the four concepts are combined after screening the literature and discussing from different perspectives to discover the specific differences and connections between them, to provide practical reference and theoretical guidance for physical education teachers, coaches, and stakeholders in the whole process of sports talent cultivation.

### 1.1. Meaning of sports talent

To clarify the meaning of sports talent, of course, it is necessary to understand the concept of talent first. Undoubtedly, gift and talent are often studied together in comparison because they are very distinct, both conceptually and connotationally. In this way, it is also essential to recognize the difference between talent and giftedness. Talent is described as someone with outstanding potential in a particular field, whether in a range of activities and situations, or within a specialty and narrow area of expertise [7]. Giftedness is usually described as an innate trait (e.g. language, music, mathematics, physical education), the ability to acquire or learn faster in these areas than the general population [8]. So in this respect giftedness is natural aptitude, which is a growth characteristic that has been possessed before growth. In short, talent mainly refers to the ability to be naturally good at certain things or fields or the innate obsession (great enthusiasm), or possibly both, that allows it to grow at a higher rate than others with the same experience or even no previous experience, and has its own uniqueness and specificity [9]. In contrast to giftedness, which is an innate intelligence, talent mainly suggests a marked natural ability that needs to be developed. Thus, talent is a completely different concept from giftedness, because giftedness can be identified by the rate of learning rather than the level of ability. After gaining an overview of the concept and connotation of talent, it is easier to comprehend talent in the field of sports.

Talent may not be a stable characteristic [10], but has some dominant or obvious manifestation of athletic ability, and it can also be seen as an athlete's innate or acquired capacity. Similarly, the definition of talent is also a difficult task, while there is no consistent concept [11]. So, what is the real meaning of sports talent? This issue has also been debated by some scholars [12–14]. Baker and colleagues [15,16] argue that the concept of talent continues to play an essential role in models of athlete development and proposed that in sports, talent is defined as individuals who demonstrate superior athletic ability compared to their peers or individuals with similar lifestyle habits and who can develop over time to be able to achieve exceptional athletic performance. It is obvious that talent is an extremely complex concept and that it is the top 10% of individuals active in the field in peers group [17], that is to say, a talented athlete is someone who performs better than peers during training and competition and has the potential to become an elite athlete in the future [9]. In sports, there is sometimes the suggestion that 'talent' might have biological or even genetic roots, although there is little evidence to support this assumption [18]. Take Guth and Roth [19] research as an example, through genetic studies have shown that outstanding athletic ability has high heritability and have confirmed that maximum oxygen uptake ( $VO_{2\max}$ ) heritability in human can reach 50%. In another aspect, sport talent also have a dynamic and multi-dimensional nature, and as an individual, sports talent need to have not only sensorimotor abilities but also capacities in other areas such as leadership and problem-solving gifts [15]. Overall, sports talents are those who have accumulated or have potential for sports development and have good physical fitness to perform exceptionally in the field of sports.

After considering the opinions and concepts related to sports talent, we can conclude that individuals with a deep understanding of sports science and motor skills, who can contribute creatively to the world of sports, possess sports giftedness. In the meantime, they are also one of the basic material conditions for the development of sports undertakings. In most studies, sports talent generally refer to competitive sports talents [14,20,21], not including those in other fields, because competitive sports talent have obvious external athletic ability or potential to become elite athletes and temperament characteristics, and these traits can be identified or detected by coaches and physical education teachers, thus effectively expanding the team of sports reserve talent and providing a constant supply of excellent sports talent for the national sports career. Thus, no matter from which aspect to understand or define sports talent, it must be inseparable from the key connotation of "sports" and defined separately.

## 1.2. Notion of talent detection

Numerous researchers have discussed the topic of TAD, which is also a crucial issue in sports [22]. In fact, TAD is an invaluable step in any multi-step motion program, and it is critical for the development of each stage in the later period. As the first stage of talent cultivation, TAD is concerned about the discovery of potential performance of kids who are not currently involved in the sport [23]. From the perspective of detection alone, detection is about finding the optimal fit between qualities or characteristics of the child and the requirements of the tasks. So the characterization of detection is spotting, unearthing and discovering. In the field of Kinesiology, detection is one of the most important stages in TID and development process, and detection is the discovery of potential who are currently not involved in sports [15]. In this sense, TAD involves the ‘matching’ of a wide range of personal characteristics that may be innate or influenced by learning, training and development to core principles of athletic performance (e.g., technique, speed) [24]. Additionally, the process of TAD should be not only transitive, but also intransitive [10]. Therefore, for sports TAD, we can consider it as the first stage of sports talent cultivation or the beginning of competitive sports activities, and it is the initial work to discover that children as well as adolescents with good athletic talent or potential to participate in sports training, it is also an important part of the sports cultivation process.

## 1.3. Definition of talent identification

Over the past two decades, numerous studies have focused on the identification of sports talent (especially in football/soccer) and it has become increasingly important in a variety of fields [25], including sports, as TID is considered to be an essential task for coaches, physical education teachers, it has long been of great interest to administrators, communities, and governments [26–28], and it also plays an important role in the practical process of sports field [29]. Consequently, a number of scholars have interpreted the definition of TID from their own perspectives. For example, Peltola [30] proposed that TID could be defined as the process of encouraging children to participate in the sport in which they are most likely to succeed, based on the results of testing selected parameters. Likewise, TID also involves alludes to the process of recognizing current participants with the potential to become elite players [31]. Or we can consider TID as understanding the athlete, their true potential, their whole potential - physical, mental, emotional, spiritual, technical, tactical and cultural aspects of being a person and an athlete - and systematically developing that potential through high quality coaching. In the same way, Abbott and Collins [32] suggested that TID refers to an attempt to predict the future capacity of performance of an individual. TID begins at a very young age to make sure that the individual can receive more than 10 years (or 10,000 h) of deliberate training, which is considered a necessary path to becoming an elite athlete [33,34], and all this is completed within a conducive/premium environment.

From the above various viewpoints and definitions of TID, they are basically similar, and their core idea is also the same, that is, TID in sports is guided by the scientific concept of talent, through the observation or measurement of individual sports skills or potential to systematically explore and cultivate such traits, so as to move towards the path of elite athletes (i.e. looking for young athletes who have the potential to become outstanding athletes).

## 1.4. Concepts of talent development

The field of talent development (TDE) has a rich history of theory and practice, and a diverse community of practitioners with various backgrounds and expertise [35]. It has been widely discussed in many studies, particularly in the field of management. TDE is also defined differently within various disciplines. In human resource management or enterprise, TDE often refers to efforts that build on employees’ existing skills while identifying new skills and opportunities to help achieve organizational goals [35]. From the perspective of management, TDE is based on the skills employees already have while developing new abilities to accomplish organizational goals. Correspondingly, in sports domain, TDE is the process of identifying or selecting athletes to become world-class players through extensive training and coaching programs, and is one of the most critical stages in achieving sporting success [36]. There have been many studies on the development of sports talent by constructing various models [37–42], including the long-term development of the overall competitiveness of performance [41], the emphasis on content and influencing factors [39], and some from the achievement field [42]. No matter from which aspect or angle these TDE models are studied, they can not be separated from the ultimate goal of achieving excellent competition results and cultivating elite athletes. In this process of sports TDE, individual pursuits become more specific and serious, and their coaches and physical education teachers will be more skilled in technical level than before. Thus, TDE is not only a socio-cultural process, but also a process of continuous adaptation [43]. For this reason, the development of sports talent can be thought of in the same way, namely, on the basis of individuals identified as having athletic talent or potential, deliberate training is used to amplify, develop and consolidate their level of athletic skills, so that they can grow into the superior athlete needed by the country and society.

## 1.5. Connotation of talent selection

Talent selection (TSE) and TID are two terms that are often confused, as they have both connections and commonalities, making them more difficult to distinguish. As a matter of fact, TID is an integral part of the selection process to develop into an elite-level athlete and is a stage that occurs prior to TSE [4], whereas, selection decision can be made throughout the entire talent training process. And TID is an integral part of the dynamic process of TDE, and it can occur at various stages of the TDE process [44]. So, how to define TSE? In business management, TSE involves using a series of tests and inspections to find the right person for the job, in other

words, the ideal individual-organization match. Similarly, in the domain of sports, TSE refers to the identification of an appropriate individual who can best carry out the given sporting activity within a specific context, such as soccer tournament [24]. Identical, Williams and Reilly [23] they also believed that TSE involves choosing the most appropriate (group of) athletes to complete a specific task (in a team). Moreover, selection decision usually occurs throughout the TDE process and involves predicting which athletes are most likely to succeed in the future [16]. In a word, in line with the opinions of various scholars, TSE can be defined as through the systematic assessment and scientific evaluation to select the corresponding elite athletes who can accomplish specific sports tasks. They have already existed in the sports training system, and may also be deselected.

Each of the above concepts has its distinctive content and has been interpreted by many scholars from different perspectives. Fig. 1 above demonstrates the differences and definitions of several terms in talent cultivation. These concepts greatly contribute to understanding the patterns of sports TDE, but more specific connotational relationships need to be further explored. In summary, at each stage of talent cultivation, some problems have been solved (i.e., can accurately grasp the growth principles of sports talent). Some areas need to be improved (e.g., the effectiveness of the connection between each stage, and the improvement of the training system), and there are specific ways of detecting, identifying, developing, and selecting different types of sports. Accordingly, based on these conceptual elements, the differences and connections between them are combined to discuss how to improve the sports TDE system and reduce the turnover rate of sports talent.

## 2. Method

### 2.1. Research objective

The purpose of this systematic review is to explore the differences and relationship between the identification, detection, development and selection of talent in sports from a multi-faceted and multidisciplinary perspective, with a view to clearly identifying their definitions, aims, purpose, approaches and emphasis. In addition, seize the important and difficult points of each stage to make the connection between them smoother, thus effectively reducing the talent turnover rate and cultivating more elite athletes. More specifically, this research seeks to provide an outline of these four stages in the training of sports talents, so that sports scientists or educators can effectively have a clear understanding of the tasks and requirements of each phase and plan for their training, while there may be potential for future research to focus on more issues related to talent transfer and connection to be explored in depth.

### 2.2. Search strategy

This study followed the requirements and steps of the latest Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to conduct a systematic evaluation of the existing literature [45]. The search strategy for identifying articles consists of three steps: (1) search the e-journal database, namely Web of Science™, according to the PRISMA guidance [45]; (2) enter the key words of this study; (3) collaborative screening with expert panels and research members.

The first step is mainly to identifying the database needed for the study. Advanced research theories and developments in a field or discipline are usually better represented in core journal publications. Papers published in core journals in a field tend to be more influential, with more advanced and representative research [46]. So to ensure the quality of the reviewed articles, this study mainly

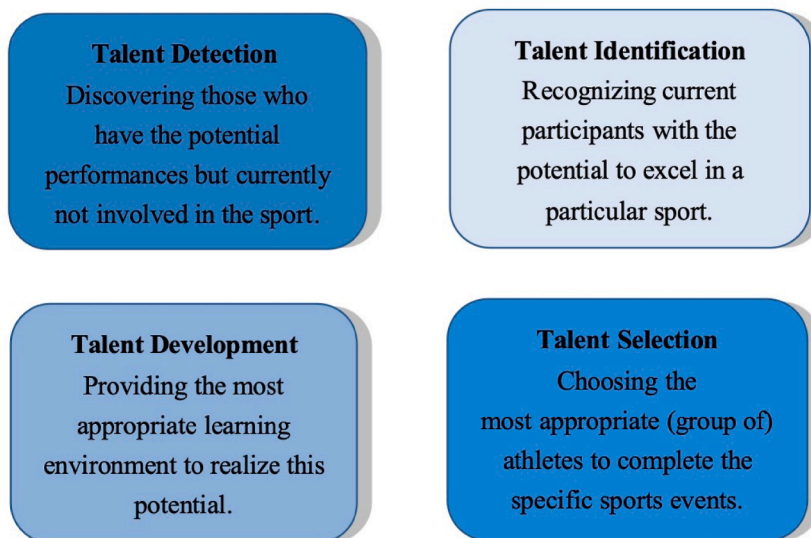


Fig. 1. The concept of talent detection, identification, development and selection.

selected the Web of Science database, while the Web of Science™ Core Collection is a series of complex multidisciplinary databases, due to the disciplinary characteristics of sports, the citation indexes used in this paper are the Science Citation Index Expanded, the Social Science Citation Index and the Arts and Humanities Citation Index, a total of three major indexes. The second step is to perform keywords search on the e-journal database. After setting the three core collection, enter the following keywords in the Web of Science™ advanced search query builder: (((((((TS=(Talent detection)) OR TS=(talent identification)) OR TS=(talent development)) OR TS=(talent selection)) AND TS=(sport)) OR TS=(physical education)) OR TS=(sports))), and the research area is limited to sport science. The search period was from January 1, 2002, to December 31, 2022. In the third step, after the search has been conducted, experts and research members sort the literature according to author, year of publication, and title to avoid duplication. After reviewing the list of articles from step 2 and step 3, it is obvious that the selected researchers are important contributors to the literature on sports talent, particularly experts in the area of TID. Once the table for sorting through the literature are available, then the process of obtaining the abstracts and full-text content of these documents begins, as they need to be evaluated more in-depth.

2.3. Inclusion and exclusion of studies

Referring to the research objective and the demands of this study, the following inclusion criteria are developed in this study:(a) articles published are all in English to ensure consistency in the appraisal; (b) the type of papers is an article, excluding conference

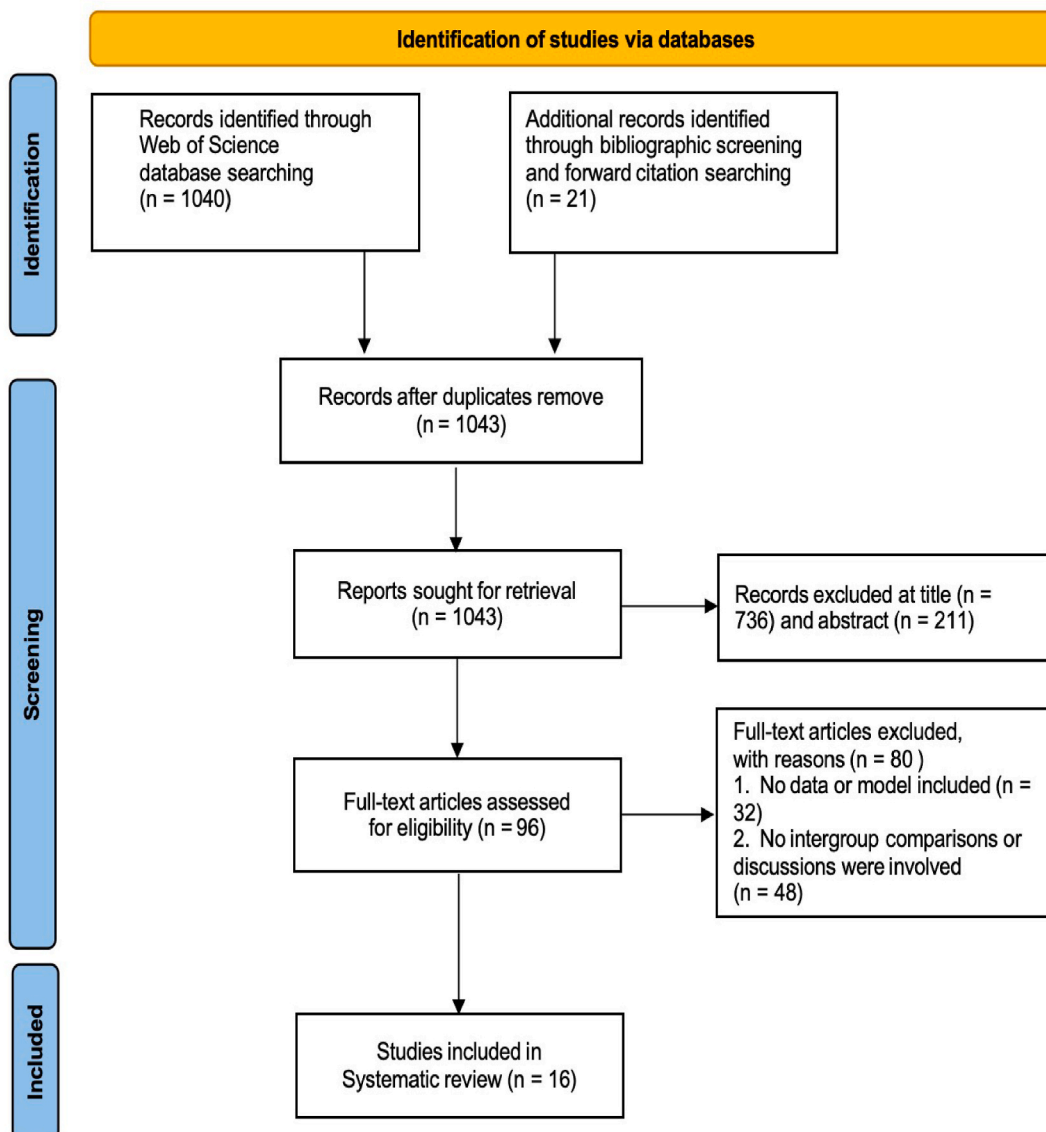


Fig. 2. PRISMA flow diagram.

**Table 1**  
Literature appraisal in the review.

Author	Sport Item	Sample	Research design	Key point	Finding
Vaeyens et al., 2008	NS	NA	Longitudinal	TID is perceived as a predecessor of, and a selection criterion for TDE, TID and TDE processes should be combined.	TID and development programmes should be dynamic and interconnected. Meanwhile, TAD, identification, development and selection involve different aspects of talent cultivation.
Baker et al., 2017	NS	NA	Retrospective	TSE decisions occur throughout TDE and have different levels of risk. Additionally, identifying and selecting talent both involves predictions about which athletes have the best potential for future success.	TSE is only one (albeit important) step in an athlete's journey, and TDE environment is a critical factor to long-term success. What's more, all stakeholders need to be engaged in the athlete development process.
Pankhurst & Collins, 2013	NS	NA	Retrospective	TID and TDE were discussed together and a number of constructs were proposed, and these constructs provides a clear picture of the degree of consistency that exists between TID and TDE research and practice.	In the process of TID, there is lack of coherence in the understanding of TID systems and processes between key stakeholders.
Falk et al., 2004	Water-polo	Twenty-four players aged 14–15 years	Longitudinal	TAD and development processes are critical in any sport programme, however, these processes are complex as well as lack clear-cut theoretical-based knowledge.	On average, the selected players demonstrated better swimming and athletic ability tasks before the program began to take place, in a selection battery that included not only in skills but also in game intelligence assessment.
Bidaurrazaga-Letona et al., 2019	Soccer	Ninety-four adolescent soccer players from the under-13 (U13; age = 12.3 ± 0.3 years; n = 50) and under-15 (U15; age = 14.0 ± 0.2 years; n = 44)	Mixed-longitudinal	Identifying the various characteristics of soccer players facilitates the implementation of optimal TDE processes and programs for coaches.	The TID program is more of a selection process than a promotion process, with selection and identification being a posteriori rather than a priori. In addition, changes to the TID process could provide a fairer selection process for young players.
Collins et al., 2018	NS	NA	Retrospective	Due to the existence of research-practice divide, talent identification and TDE research should employ multiple methods to obtain more accurate results.	There are still gaps in the practice and theory of talent identification and development, so in order to bridge these gaps it is important to overcome methodological limitations and identify ways to use research to improve the practice of talent identification and development.
Williams et al., 2020	Soccer	27 published reports included	Retrospective	The identification and selection of soccer players into the development process has a common approach and the determination of some variables has predictive value for TID.	TID, detection, development, selection, deselection and participation are different talent training processes with different concepts and operational definitions, and the identification, selection and deselection decisions usually occurs in the process of professional youth.
Suppiah et al., 2015	NS	NA	Retrospective	TID and development have some common factors to consider and share the same economic rationale, but this leads to a series of efficiency issues.	TAD and TID have different priorities, one is based on short-term goals the other on long-term success. Therefore, in TDE programs it is often those who perform better than their rivals in selection tests.

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Table 1 (continued)

Author	Sport Item	Sample	Research design	Key point	Finding
Tribolet et al., 2018	Football	277 high-level, state academy junior Australia football players aged 12–15 years (U13 = 107, U14 = 107, U15 = 63)	Cross-sectional	The age characteristics and differences of high-level players affect them to enter a higher-level development programs, and selected players have better physical attributes and skills than deselected players.	TID requires a multidimensional approach to the process and a selection policy that takes into account the potential confounding effects of different age groups' characteristics and maturity.
Bergkamp et al., 2019	Soccer	NA	Retrospective	There are a total of four methodological issues related to soccer talent identification research and are fraught with opportunities and challenges for future TID research that may contribute to the development of an evidence-based selection program.	TSE and identification are closely interrelated, and suggestions are made from the perspective of the basic principles of selection psychology as a way to provide a more coherent and scientific framework practice for talent identification.
Johnston et al., 2018	NS	20 articles included	Retrospective	A longitudinal research design is necessary to accurately study talent identification in elite sports, and the findings of the review can also help reduce the risk level of coaches' TID decisions.	TID is an essential part of the elite athlete selection process, and physical and physiological variables as well as other factors need to be considered in order to do make early talent identification effective.
Mohamed et al., 2009	Handball	Two age groups, including Under-14 (n = 34) and Under-16 (n = 47) male youth handball players, and elite (n = 18) and non-elite (n = 29) Under-16 youth handball players	Cross-sectional	TID requires a multidimensional approach to improve talent identification and detection through the results of anthropometric indicators and performance tests for youth handball players.	TAD and identification are two different parts of talent cultivation that need to be evaluated using different testing methods and parameters to build the respective models for talent identification and detection.
Till & Baker, 2020	NS	NA	Retrospective	Talent is a complex and unclear along with inconsistent phenomenon. Also, there are three main challenges related to talent identification and development in sports, and multiple possible solutions are proposed based on each challenge.	The TID and development system consists of four distinct phases, namely talent detection, identification, development and selection. In addition, TID and development is not a straightforward process and involves many physical, psychological and social factors.
Abbott & Collins, 2004	NS	NA	Retrospective	Psychological factors should be emphasized in the TID and development process because psychological factors play an important role in athletic performance and contribute to the realization of individual athletic potential.	Theoretically and practically, the traditional approach to TID and development does not take enough variables into consideration. Thus, talent needs to be redefined so that TID and development are considered dynamic and relevant.
Burgess & Naughton, 2010	Team sports (including soccer, football, rugby, Australian Rules, basketball, cricket, and netball)	NA	Retrospective	There are some issues with TDE practices in team sports, so effective TDE requires consideration of a variety of factors, especially the long-term well-being of athletes.	TDE and identification are two completely different definitions, but they are closely interrelated, and TID should be an indispensable initial part of the TDE process.
Fortin-Guichard et al., 2022	Football	110 Dutch youth male football players aged 8–12	Longitudinal	There is hardly any difference in developmental trajectories between selected and non-selected players (8–12 years old), but using cross-sectional indicators of talent can better predict selection.	TID is a complex process that requires the selection of multiple indicators, as well as comparing the characteristics of selected and non-selected players' development systems.

Note: NA = (not applicable), NS = (not specific).

article and book chapters, and they are peer-reviewed and available in full text; (c) the paper should contain data or models related to TAD and/or TID and/or TDE and/or TSE.

We excluded studies if they: (1) not related to talent cultivation; (2) there is no explanation of the relationship or influence between TAD, TID, TDE, and TSE on each other; (3) included only TAD or identification or development or selection of the cultivation that were not introducing or indicating the relationship or influence or differences between each other.



## 2.4. Extraction of data and study eligibility

The three core index sets of the Web of Science™ were searched, and the search included only those whose research orientation was sports science to be included in this paper, and initially 1040 papers were obtained, plus 21 papers were added to the forward citation search. In this filter process, two authors reviewed all the literature using the same filtering strategy. After reviewing the titles and abstracts of the literature, a total of 947 articles were removed that were clearly inconsistent with the study topic, leaving 96 articles for full-text review. After a series of thorough review and evaluation, 80 articles were removed because these articles did not involve TAD, identification, development and selection of data or models and inter-group comparison. The two authors (CX and JZ) responsible for selecting the literature checked and compared the literature that was included in the study and after discussion finalized the 16 articles that were used for analysis in this study, any disagreements were discussed and resolved, or they were referred to a third researcher for judgment. The final results were reviewed and determined by all the authors involved in the study, and a total of 16 publications were finally qualified and included in the study. The specific screening process is shown in Fig. 2, and eligibility for inclusion in the final studies was conducted via peer debriefing.

## 3. Results

As shown in Table 1, a total of 16 articles were in this review. Among them, longitudinal, retrospective and cross-sectional methods were used, with retrospective predominating. In addition, the literature was published in the time period between 2004 and 2022, and, 50% of the documents ( $n = 8$ ) involved the construction or mention of models, with the remainder involving data analysis, and the combination of models and data. The authors and institutions in this review are mainly from European countries, especially the United Kingdom, and two from Canada and two from Australia. Among all the articles, there are 6 articles involving football or soccer, accounting for 37.5%. Some studies did not mention specific sports items, but studied from the overall sports environment.

### 3.1. Differences between TAD, TID, TDE and TSE

There are four main differences among the four stages of detection, identification, development and selection of sports talent from the 16 selected literature, which are reflected in the different objectives of each stage, the respective intentions to be achieved, the methods used in each TDE stage and the different emphasis (Table 2). The following provides a general summary and a comprehensive analysis of each of the areas of difference through a holistic review of the relevant literature. It is important to note that within these broad areas of content, there will inevitably be some overlap (e.g. certain differences may exist not only in TID and TSE, but also in TID and TDE), and the overlapping content is obvious.

#### 3.1.1. Aim

While the goal of talent training is to ultimately cultivate elite athletes, being in the various stages of cultivation has its own purpose. For TAD, its aims is to encourage children to choose one or more sports according to their personality characteristics, which can be transitively or intransitively [10]. This stage is to detect individuals who are not really involved in sports and who show various mental activities or actual behaviors towards sports that can be detected by coaches or physical education teachers. The sports TAD work primarily focuses on children's sport performance with the aim of providing recommendations for the inclusion of sport-specific supports [17,47]. So the aim of TAD is to motivate more children to participate in sports, constantly expand the personnel base, and ensure the normal development of follow-up work. Likewise, for TID, the program is designed to identify young athletes who have the potential to succeed in senior elite sports [48], on the other hand, TID is a predictive endeavour with the aim of future or long-term

**Table 2**  
Differences between TAD, TID, TDE and TSE.

	TAD	TID	TDE	TSE
Aim	To motivate children to choose one or more sports in accordance with their own personality traits.	To find out talented children which is trained to the higher level of performance.	To provide the most optimal learning environment to help promising youth athletes realize their potential.	To train the athlete to the highest level in order to be successful in a sport branch.
Purpose	Laying the foundation for promoting lifelong sports, reducing dropout rates and stimulating elite level sport.	Identifying participants with the ability to progress to 'elite' status within a given sport.	Providing children with specialised training and preparation for expert performance in sport from an early age.	Deciding who remains and who is removed from a sample of potential athletes.
Approaches	Family investigation, physical medical examination, investigation of detection index and genetic detection.	The time-course of the research design, the disciplines of interest and the assessment method applied (i.e., signs or samples).	A holistic ecological approach.	Quantitative assessments including both cross-sectional and longitudinal approaches.
Emphasis	The focus is on finding potential athletes who are not involved in a specific sport at the moment.	The focus is on seeking out athletes who are currently involved in sports and have the potential to become elite athletes.	The focus is on deliberate practicing of identified and selected athletes to achieve peak performance.	The preference is to select athletes who are suitable for a certain task among the population of already talented athletes and athletes in training, focusing on the athlete's ability in the moment.



success [49]. Thus, it is obviously that TID aims to identify participants with the ability to progress to ‘elite’ status within a given sport [24]. The aim of this phase becomes more precise and purposeful compared to TAD. Hence, we can also analyze the purpose of TDE in a very clear way. TDE in sports is the most important stage in the process of achieving sporting success [36], and it is aimed at providing the most optimal learning environment to help promising youth athletes realize their potential [23]. Last but not least, the main goal in selecting a talent is to train the athlete to the highest level in order to be successful in a sport branch [50]. That is to say, the aim of TSE is to select the most talented or excellent players among the trained athletes to complete the corresponding sports tasks. From the perspective of each stage with different aims, the purpose of each phase is specific and has different emphasis. Although there are differences, the ultimate core essence is to ensure the integrity and sustainability of the process of sports TDE [51].

### 3.1.2. Purpose

Purpose differs from the aim mentioned earlier in that the aim is a relatively broad statement of the long-term change that an individual or group strives to achieve, while purpose is a more specific and immediate change that a person or group strives to achieve, and is much narrower. Therefore, the understanding of purpose should be discussed from a smaller and more detailed perspective. Faber and colleagues [52] mentioned in a cross-sectional study that the purpose of TAD is to lay a foundation for promoting lifelong sports, reduce the dropout rate and stimulate elite sports. Indeed, because TAD reveals the best connection between sports, personal advantages and personal preferences, thus stimulating individual participation in lifelong sports [53]. And on the other hand, sports TAD is a strong support to stop inactivity-related diseases [39]. The purpose of TID has been studied by various scholars, including cultivating elite athletes [5,54], ensuring the success of professional clubs, national governing bodies [55], and identifying the most potential athletes [56,57]. It is crucial that the program’s focus is on identifying players with long-term potential instead of just those who can win tournaments at present. Overall, the purpose of TID is to select auspicious athletes as early as possible with the goal of systematically maximizing their potential [58]. In important international sports events, such as the Olympic Games, the World Championships, and the Asian Games, each country will send excellent athletes or sports teams to participate in the competition to complete the most significant or special tasks, in order to obtain the best results. Without doubt, this will involve the selection of talents. Of course, this is only one of the most critical aspects of TSE, and there is also TSE when it comes to confirming that an individual is best suited for a certain sport [59]. Therefore, from these contents, it is known that the main purpose of TSE is the process of identifying the most suitable individual for a certain competitive game or for a long-term future in a sport by systematically assessing and scientifically evaluating all aspects of the athlete including the content of skills, tactics, sports performance, thus paving the way for the development of elite athletes. Certainly, TDE also has its own purpose. As mentioned in Ribeiro et al. [60] research, traditional TDE program have sought to provide most promising children with specialised training and preparation for expert performance in sport from an early age. Similar, as John and Thiel [59] proposed that TDE programs intended to “produce” top performers who then achieve victories for clubs, associations, or nations. In this respect, TDE is the process of stimulating and refining an athlete’s potential with the series of professional training. It is the purpose to develop the identified athlete to be able to compete in competitive sports and obtain excellent results.

### 3.1.3. Approaches

Each stage not only has its own unique purposes, but also has a different approaches. The approach here is the way in which detection, identification, development and selection are carried out in order to accomplish the respective goals. As for TAD, some studies have explored methods that are conducted through family investigation, physical examinations, testing indicators and genetic detection [19]. So far, 214 gene entries have been included in the human genome map for performance [61] and the (the angiotensin converting enzyme) ACE is the most studied gene polymorphism associated with endurance [19,62,63]. The more practical application of these approaches is mainly conducted through physical examination and observation in physical education courses, as it can be effective in saving time and investment. The approach of TID is the most discussed and studied in all talent training stages, because this phase plays a connecting role. Since TID is longitudinal and non-linear, more TID approaches such as coach’s eye [64,65], multi-factor identification methods (e.g. athletic ability assessment) [66], and some physiological indicators (e.g. anthropometric measurements, linear velocity, change of direction speed (CODS), maximal anaerobic capacity, repetitive sprint ability (RSA), maximal aerobic capacity) are also methods that should be considered in TID [67]. Besides, psychometric tests are often used for TID. For instance, Saward et al. [68] through a mixed-longitudinal prospective method to examine the psychological characteristics associated with elite youth soccer players aged 8–18 years in three seasons. Similarly, TDE as a long-term nurturing activity is also possible through a comprehensive historical approach [69]. Therefore, in some researches of TDE, the approach is developed from the features of the stage and the physical and mental characteristics of the talent at this phase as well as the development environment, which is the holistic ecological approach [70]. For TSE, effective selection requires accurate prediction of movement-specific evolutionary trends to anticipate how the skills and competencies that underpin successful performance will evolve between the selection and demonstration of elite skills [16]. TSE is based on criteria and adheres to a number of requirements, including the competencies needed by the athlete, prioritization of selection criteria, fairness/non-discrimination, clear selection methods, and regular updates and communication with all parties [71]. As a result, TSE combines tests with the observations of expert coaches or coach’s eye to decide which athletes should progress towards more advanced training [30,72]. That is, TSE will be done through quantitative evaluation, longitudinal and cross-sectional approaches to select the athletes who are most capable of accomplishing a specific task with certainty.

### 3.1.4. Emphasis

There is no doubt that each stage of talent cultivation also has its own focus, which is not only closely related to their own definition, but also inseparable from their purpose. As the first stage of talent training, TAD focuses on finding potential athletes who do

not participate in specific sports at present [17,23]. It is worth noting that this refers to individuals who have not formally participated in specific sports and are still in the stage of sports enlightenment. Thereby, this stage focuses on universality, identifying children who are interested in sports or have sports talent in a wide range of groups. In contrast to TAD, the focus of TID is on finding athletes who are currently participating in sports and have the potential to become elite athletes [4,47,51], especially those who are already involved in the relevant sports, as opposed to TAD, which is aimed at two different groups of people. Instead, TDE focuses on the deliberate practice of identified and selected athletes to achieve peak performance [73–75]. The emphasis here is on athletes who are currently training and developing them into elite athletes through various training sessions. For TSE, the preference is to select athletes who are already talented athletes and athletes in training for a particular task, focusing on the athlete’s ability in the moment [76,77]. Synthesis of the above analysis, it is clear that the emphasis of each stage is focused on a specific different population and performance state, because this is also consistent with the different stages of individual physiological, psychological, physical development state, so the content that needs to be paid attention to at various stages is also biased, and the most important thing is that the focus is not the same population.

### 3.2. Relationships between TAD, TID, TDE and TSE

Similarly, after a comprehensive review of the 16 selected studies, the internal relationship between TAD, identification, development and selection also has four main aspects, including the progressive relationship between the four, that is, from the initial detection to the final selection, each stage is slowly progressive layer by layer in a gradual manner. Secondly, continuity, that is, each stage is linked to another stage, not a leap. For example, the next stage of TAD is TID, not directly to TDE. Thirdly, they are complementary, that is, each stage promotes and develops mutually, and one stage cannot exist independently of the other, which has an internal relationship. Lastly, mutually. Each stage needs to cooperate with each other and complement each other in order to highlight their original functions and optimize the overall effectiveness of the entire sports talent training process.

#### 3.2.1. Continuity

TAD, TID, TDE and TSE, all those level interact, and no stage can be fully understand isolated from the others. As mentioned in Suppiah and colleagues [49] research, elite sports is a combination of multiple factors, which interact in a specific time and space. As a complete educational activity, the factors affecting each stage are both overlapping and different, therefore, the cultivation of elite athletes is also a multidimensional combination. Talent cultivation is an ongoing process [78], like cultural and educational activities, should not be disconnected and carried out separately, even though different stages have specific tasks, because each stage is maintained as a continuous kind of relationship, one to the other. Furthermore, it is not irrelevant to complete their own tasks at each stage, but to take into account the tasks and implementation of the next stage and make a smooth connection to ensure that the whole talent training process is continuous. Although there can be protectionist and isolationist approaches that undermine the TID and TDE process [15], this does not allow the stages of talent cultivation to be disconnected from development. TAD and TID will guide athletes those who with sporting aspirations [79], such as sport guidance, personal future development guidance, so that they can make targeted efforts and eventually become elite athletes. Thus, the preliminary training in TAD and TID is achieved at two levels, on the one hand, the development of sports professional knowledge and technical skills, and on the other hand, the formation of sports expertise and innovation consciousness. Consciousness, as a subjective and dynamic element [80,81], has a guiding role in training and tactical skill learning. The proactive role of professionalism and innovation in the growth of students’ sports is a fundamental stimulus that leads coaches, teachers and students to make individual efforts in accordance with the established goals of training [82,83]. Based on effective initial cultivation, more complex and systematic scientific training continues to be conducted to maintain uninterrupted development, and ensure continuous improvement and strengthening of athlete performance. As a consequence, in each talent training stage, they are carried out continuously and in accordance with certain rules.

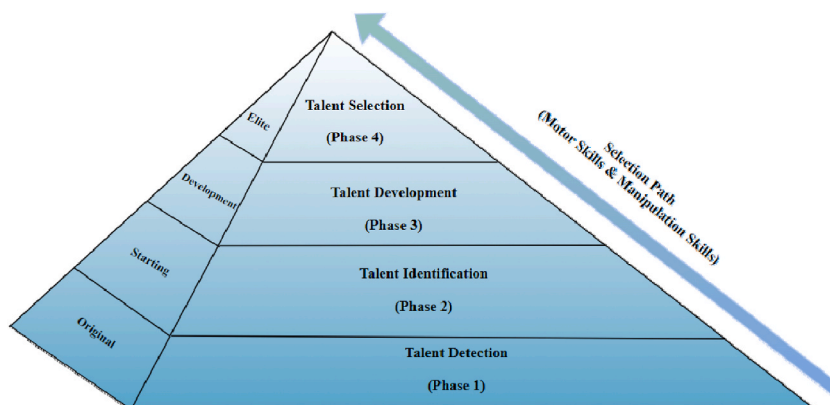


Fig. 3. The whole process of talent cultivation.

### 3.2.2. Progressive

As we know, the development of human body and mental is incremental, and similarly, the stages of talent cultivation are progressive upward like a pyramid (Fig. 3). TAD, as an original task of talent cultivation, is the first phase of the whole talent cultivation process, while TID is the second stage that follows. At this time, the motor skills of potential athletes are also in a critical period of development and improvement, which is the third stage of TDE. Finally, there is the fourth stage of TSE, which is the elitist stage, where the fittest and most likely to-win athletes or teams are selected to compete. So the various stages of talent cultivation are a progressive relationship. TAD is the foundation programme in all stages. High-quality talents must take good physical quality as the cornerstone to build up the overall deep quality. Hence, it is obvious that TAD is the most basic stage, and it is also the most primitive talent discovery work in the extensive talent pool, paving the way for the subsequent implementation of the tasks in the next stage (i.e., TID). The development to the next level is TID, which can be said to play a connecting role [15]. After the initial phase of TAD, TID begins to look for talent that has potential in sports, with a limited range of targets, and begins to expand the content requirements. In the framework of the basic work of TID, the identified talents with athletic potential need to be trained to stimulate and develop their sports performance, and this step is the TDE. Therewith, after a series of deliberate practice and special training, the elite athletes who can best able to accomplish this task will be selected according to the specific content and requirements of the competition [84,85], and this stage is what we know as TSE. Undoubtedly, as mentioned in the previous section, the physical and mental development of human beings is sequential [86], and the various stages of talent cultivation follow the laws of talent management science, which steadily promote the development activities of elite athletes in a step-by-step manner according to the real-time development, and thus from the above analysis it is known that these processes are progressive.

### 3.2.3. Complementary

Individuals cannot exist independently from society, just as the various stages of talent training cannot be separated from the requirements of the whole. A successful elite athlete must have experienced a complete and scientific and reasonable training system [87], which also shows that the various stages of talent cultivating are complementary and mutually supportive, so that the entire training process is unified and promoted together. The TDE environment is one of the important factors affecting the quality of talent cultivation and expert performance [88]. Because of the differences in the management system, culture and history of different countries, all stages of talent cultivation are carried out in a complex sociocultural environment and educational context [59]. Following this logic, all four phases are embedded in a specific environment and operate according to their respective requirements. Due with the realism of the society's need for sports talents, TAD is started from the need of social sports talents cultivation, and carried out the work of preliminary discovery of talents. For instance, as a physical education teacher or coach to launch the various stages of training, to do the fundamental work for the development of more senior elite athletes. The TID has conducted the preliminary selection of sports talents, that is, through various physiology and physical parameters, to identify talented or special talents in sports [23,89,90], and then through systematic training and deliberate practice in clubs or schools, to make them become the best in various levels of competition. In summary, each stage of talent cultivation is a complementary relationship. After completing their respective tasks, they will give each other support and assistance to achieve the overall goal together.

### 3.2.4. Mutually

Even though many sports systems focus on identifying and selecting talents at an early stage [15], the relationship between them still maintains a robust relationship, in another word, a mutually beneficial relationship. The selection and development of talent in sports is dynamic nature, so each stage can only be undertaken on the basis of interdependence to ensure the maximum success rate of elite athletes. TAD is the original work that will search for individuals with athletic talent in a wide range of population [17,31,53], laying the foundation for TID. It is precisely because of the previous work in the early stage that individuals with sports potential will be discovered to the maximum extent for special training, thus making the later stages of talent cultivating more efficient. Additionally, TID as a dynamic process is interconnected with the player's stage of development [15]. At the same time, the development level of each stage in the later period will in turn promote the continuity of the original work, and according to the effective feedback in the

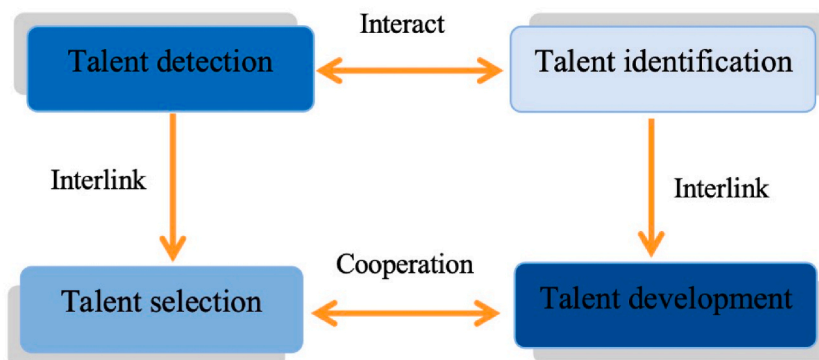


Fig. 4. The interaction between the various stages of TDE.

early phase, the problems or obstacles encountered in each stage can be avoided as much as possible. More specifically, it is the mutual cooperation of all stages that makes the talent training system more reasonable and complete.

Sports talents are the foundation and driving force for the development of competitive sports, which is related to the rise and fall of sports enterprise. In order to better ensure the efficient development of sports talent cultivating, it is certainly to take into account the role of the important players at each stage of TDE. From a retrospective view of the trajectory of the interaction between the various stages of sports TDE, each stage has its own limitations and therefore the relationship between the four should be properly handled (Fig. 4). TAD and TID should be interactive and connected to the corresponding phases (e.g. tasks, goals, methods), so that the whole talent cultivation process can form a dynamic and balanced development model.

#### 4. Discussion

The purpose of this study was to review the available literature on TAD, TID, TDE and TSE. The results show that there is a growing number of topics on the differences and interrelationships between them, especially on the relationship between TID and TDE. This study systematically discusses the differences and interrelationships among the four phases of TAD, identification, development, and selection in sports, which strengthens the understanding of the whole athlete development process. Also, it helps coaches, scouts, and sports researchers better grasp the requirements of these four different stages, making the connection between each stage of talent cultivation smoother. In addition, this study also emphasizes the need to fully utilize the characteristics of different stages, which can help reduce talent turnover rate, improve talent success rate, and lay a solid theoretical foundation for the sustainable development of the sports industry. Naturally, after clarifying the relationship between them, the most important thing is to ensure the entire training process of sports talent, and promote the detection and selection of talents through scientific guidance measures, that is, there is a need to form an institutionalized system to guide. The construction of the system strategy can be said to be crucial in the cultivation of sports talent [78], and it plays a role that cannot be ignored whether in the medium-term or long-term development. In the initial detection and identifying, as well as the implementation of training plans, and even the guarantee of athletes after retirement, the establishment and improvement of the sports talent cultivation system is also inseparable from the training of elite athletes. In the following section, based on the difference and internal relationship between TAD, identification, development and selection, and in combination with the development trend of sports, some realistic issues about how to better promote the cultivation of elite athletes are discussed.

##### 4.1. How to make the connection of each talent training stage more unhindered

As a matter of fact, the cultivation of talents is a complete educational activity, in which the training plans and arrangements are made according to different stages of development, such as age, maturity, and the environment faced, to ensure the consistency of the whole process [86,91,92]. Since these factors have an impact on the entire talent development process, it is necessary to consider the existence and degree of influence of these factors to ensure the integrity of the whole process. As mentioned earlier, each stage is interconnected, and this connection should be developed in a coordinated manner. However, due to various intermediate reasons (e.g., further education, cultural courses, pressure), each stage is fragmented, and only focuses on the development goals of each stage. The joint is not close and coherent enough to form a systematic overall view of the whole situation, which is not conducive to the training of elite athletes, but neither to the sustainable development of national sports [93]. In order to facilitate the full development of the identified sports talents' natural potential, a systematic, coherent and personalized view of talent training should be established at different stages, with individualized development paths planned in advance for students with different training requirements, and high-quality resources and environments provided to promote the development of their traits [94,95]. For athletes who are engaged in competitive sports, it is their primary task to continuously achieve excellent results. The participation of sports training will inevitably affect the input of cultural learning and the reality of high elimination rate and low cultural level of athletes makes many parents reluctant to let their athletically talented children engage in competitive sports [96,97]. For this reasons, the result of gold medal sports makes sports far away from students. The superposition of examination-oriented education and gold medal sports has facing "make bricks without straw" dilemma to cultivate young sports reserve talents.

Consequently, more social sports organizations are encouraged to participate in all stages of youth sports TDE in order to better enable the full integration and coordination of all stages of TAD, TID, TDE and TSE. By promoting the development of youth sports clubs, establishing a social sports club competition, cultivating and training system that is organically linked to school sports, supporting social sports organizations to provide guidance for school sports activities [98,99]. Meanwhile, popularizing sports skills, and building a youth sports governance system that is suitable for the characteristics of the social era with multiple participation in governance and diversified investment for the integration of sports and education to promote the healthy development of youth [100, 101]. The development of talent is a series of distinctive stages, from detection to final selection, from the establishment of individual talent information profiles, it is also necessary to do a good job in meticulous follow-up tracking services, observe their growth process and changes in demand, timely adjustment of the corresponding training methods to allow them to better enjoy the process of training, thus maximize their sports potential and performance [76,77,102]. In addition, through integrating and sharing the existing resources of traditional sports schools, schools with sports specialties, sports schools, youth teams, high-level sports teams in colleges and universities in the sports departments and education departments, it is organically linked with talent teams at all levels and national teams, and included in the training sequence of reserve talents in competitive sports, to promote the coordinated development of youth cultural learning and physical exercise. At the same time, to solve the crucial and fundamental problems of comprehensive, coordinated and sustainable development of competitive sports talent training is an important basic guarantee to ensure that each talent cultivating stage is more smooth.

## 4.2. How to reduce the turnover rate of talents more effectively

As competitive sports continue to develop and become more demanding, the talent gap of elite athletes has become the key to restricting the horizontal and in-depth development of competitive sports. Post-career support for athletes has also become an essential factor influencing talent turnover rate [22]. While the economic rationale for TID and TDE is to focus limited resources on the athletes with the highest chance of success, paradoxically, the system can lead to a different set of efficiency problems [49]. One of the obvious problems is the turnover rate of talents. Talent turnover may be caused by multidimensional factors, including environmental, institutional, and personal reasons. Detecting, as the primary stage of TDE, is considered an important factor in improving the success rate of elite sports and is one of the main priorities of national governing bodies and sports associations [53]. Therefore, it is important to establish the foundation well and do substantial work to prepare for the corresponding later stages.

Since both sports participation and TDE are inherently multidimensional, there is a need to complete the talent testing profile from multiple perspectives [52]. So the establishment of a full range of tracking and talent information database can be improved to understand their changes and adjust the corresponding training mode as well as method to adapt to different situations. However, scouts and coaches should also be aware of the possible risks of early specialization and selection at such a young age (e.g., injuries, mental fatigue, and dropouts) [102,103]. After all, due to various external environmental factors and subjective factors, the implementation of any talent cultivation stage may cause or lead to the talent turnover. Therefore, the management of detection, identification, development and selection is developed accordingly to the various ages and physical developmental characteristics of the child, which is also compatible with the creation of a talent profile. Moreover, most professional senior athletes are selected and deselected through a frequent process [48]. However, there are inevitably various covariates that can lead to selection and deselection situations, and early detection can have adverse consequences such as high attrition rates in terms of dropouts and poor performance, and high opportunity costs for undiscovered true talent [49]. For these reasons, it is particularly important and necessary to reduce the occurrence of these situations and decrease the talent turnover rate. At the same time, it is crucial to know which important parameters need to be referred to at each stage, such as height, running speed and agility in TID [31], while in TSE, the focus is more on the athlete's current athletic performance and ability.

The relative age effects, also known as birth date effect, can have a significant impact on TID [44,104,105]. As a result, selecting and identifying talent at an early age might lead to overlooking potential individuals who have not yet manifested their talent and, therefore, losing talent. Most notably, athletes who were identified or identified early were not maintained through adolescence, whereas many who succeeded as senior professionals were able to do so without the early intervention of a TDE program [49]. Early evidence from German elite sports athletes also shows that the earlier an athlete is identified for a TDE program, the younger he or she leaves the sports TDE system [106]. Therefore, in each stage of talent training, it is necessary to grasp the influence of relative age and properly consider relevant factors to reduce the talent turnover rate in this process. Although there are many studies on TID, all of them are aimed at identifying and developing more sports talents to ensure the sustainable development of sports. But for how to find as many sports talent as possible in the whole process, reduce the talent turnover rate and expand the talent base, it will involve the entire process of talent cultivation. As mentioned by Till and Baker [5], in order to optimize work and pursue future elite performance, the process needs to integrate both talent acquisition (i.e., detection, identification, and selection) and TDE (i.e., proper skill acquisition) to ensure the maximum possible guarantee for later development and to effectively improve talent success. Besides, it is important to learn from the past, learn more from the previous events and experiences, and improve the corresponding testing methods. According to Snapshot TID Evaluation Testing [107], anecdotal reports of outstanding Olympic athletes who were denied participation in TDE programs are also instructive of early TID situations that led to wasted talent. In a similar vein, talent transfer or crossover approaches are another factor considered in developing successful elite athletes and are detailed in some of the literature [48,108], which is an area that needs to be included in research to reduce the rate of talent turnover. For example, UK Sport [109] and the Japanese Sports Council [110] have developed talent transfer programs. Stakeholders (e.g., coaches, parents and national sports associations) have an essential role to play in the TID, TDE and TSE system, and multi-stakeholder collaboration is an imperative part of an effective talent cultivation process.

## 5. Conclusion

Based on the aforementioned knowledge, the cultivation of talent is a gradual, multidimensional and complex process, which is a disciplined educational activity of growth and indoctrination in terms of both physical and skill acquisition. Human growth cannot be separated from society and exist independently, and the same is true for the cultivation of sports talents. So the tasks and activities at each stage cannot be separated from each other and develop isolated. Detection, identification, development and selection constitute a complete circle of educational activities for the training of sports talent, forming a ladder, step by step, with the content and depth changing again and again with each stage of the task, while their ultimate goal is to develop elite athletes. This systematic review provide a comprehensively synthesis the differences and interrelationships between the four stages of TAD, TID, TDE and TSE in sports in the last decade, and through comprehensive analysis, their differences are mainly reflected in: (1) Aims; (2) Purposes; (3) Approaches, and (4) Emphasis (see Fig. 2). And the interrelationship between the four is mainly (a): Progressive; (b) Continuity; (c) Complementary, and (d) Mutually reinforcing.

TAD, TID, TDE and TSE in sports are not uniformly defined in different disciplines, as if a hundred schools of thought contend and express their own opinions. Some authors define related terms according to specific sports events, which is undoubtedly a more specific statement. Some scholars interpret it according to the overall characteristics of sports, and others explain it from the essential characteristics of the word talent. From a comprehensive analysis of these different perspectives, it is true that each definition of TAD, TID,



TDE and TSE has its own scientific and principled approach, following the core idea of sport. Indeed, the evidence from the reviewed literature also shows that the definitions of TAD, TID, TDE and TSE are each context-specific, which is closely related to the differences between them. In addition, according to each age, maturity state and specific sport, this systematic review of the literature also highlights the existence of a complex relationship between TAD, TID, TDE and TSE. This complex interaction and internal relationship should be carefully considered in the whole process of sports talent cultivating. Moreover, the relative age effects seems to be relevant in early identification and early selection as well as in later performance. At the same time, better understanding and making full use of their internal connections can create an optimal talent training environment. To summarize, regardless of the various distinctions and inherent relationships that exist between TAD, TID, TDE and TSE, distinguishing the differences and strengthening the links must provide a clearer framework in the long-term development of sports talent.

However, this research is not without its limitations. The first is that this review explores less of the differences and connections between the two, and instead provides a comprehensive review of the differences and inherent relationships between TAD, TID, TDE and TSE as a whole. Another one is that the citation index in the core set of Web of Science imposes greater restrictions, so there may be omissions of potential published literature. It may have been interesting to consider other databases, such as Scopus to avoid bias due to lack of information. In addition, this study does not include research on the topic published in other languages. Consequently, the comprehensiveness of the reviewed dataset is questionable. From these aspects, future research can pay more attention to the multi-dimensional distinction and connection between detection and identification, identification and selection, and selection and development. This will help in achieving the optimal state of the entire process of sports talent cultivation. As a result, coaches can formulate more targeted athlete development programs.

### Consent for publication

All authors have read and agreed to the published version of the manuscript.

### Data availability statement

The datasets generated analysed during the current study are available from the corresponding author on reasonable request.

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### CRediT authorship contribution statement

**Jie Zhao:** Writing – original draft, Methodology, Formal analysis. **Changqing Xiang:** Writing – review & editing, Writing – original draft, Resources, Methodology, Conceptualization. **Tengku Fadilah Tengku Kamalden:** Writing – review & editing, Data curation. **Wenting Dong:** Data curation, Conceptualization. **Hua Luo:** Validation, Data curation. **Normala Ismail:** Writing – review & editing.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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