



Current Issues in Sport Science
ISSN: 2414-6641
claudio.nigg@unibe.ch
Universität Bern
Suiza

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van Harten, Karlijn; Bool, Kayan; van Vlijmen, Janiek; Elferink-Gemser, Marije

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Current Issues in Sport Science, vol. 6, 2021

Universität Bern, Suiza

Disponible en: <https://www.redalyc.org/articulo.oa?id=677871911008>

DOI: <https://doi.org/10.36950/2021ciss006>



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Talent transfer: A systematic review

Karlijn van Harten

Kayan Bool

Janiek van Vlijmen

Marije Elferink-Gemser m.t.elferink-gemser@umcg.nl

Abstract: Background: The effectiveness of traditional talent development (TD) programs can be questioned. Meanwhile, an extra pathway to the top has made its appearance: Talent transfer (TT). The aim of TT is to fast-track talented athletes into the high-performance environment. The first TT initiatives and studies exploring the TT process have been carried out.

Objective: This systematic review gives an overview of studies examining TT, by situating TT within the developmental framework, comparing formal and informal TT and investigating the similarities between donor and transfer sports in TT from elite and non-elite level.

Methods: A search was conducted on the PubMed and PsychINFO databases. The analysis was done according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses) statement.

Results: After screening on title and abstract and full-text review, five studies remained for inclusion. Although literature is still scarce, results show that TT can serve as an alternative pathway in addition to the traditional TD programs. Literature suggests that similarities between donor and transfer sports are helpful, but this is not a prerequisite for TT. Besides, psychological factors are perceived to play an important role. Results regarding other determining factors of TT are still lacking. Athletes, national governing bodies and TD programs might benefit from this additional pathway, but the effectiveness of formal and informal TT remains unclear.

Conclusion: A lot remains unknown about TT, hence future research is needed to increase our understanding of TT and its contribution as an extra pathway to the top.

Current Issues in Sport Science, vol. 6, 2021

Universität Bern, Suiza

Recepción: 21 Septiembre 2020

Aprobación: 30 Enero 2021

Publicación: 14 Mayo 2021

DOI: <https://doi.org/10.36950/2021ciss006>

Redalyc: <https://www.redalyc.org/articulo.oa?id=677871911008>

Introduction

The battle between countries to win medals at meaningful sports events, like the Olympic Games, has intensified over time (Vaeyens et al., 2009). To stay ahead of the game, professional sports clubs and national federations are investing considerable efforts and resources in the identification and development of talented athletes (Abbott & Collins, 2004; Williams & Reilly, 2000). To illustrate, the amount of investments made in an Olympic gold medal in Australia have been estimated to be worth around 37 million dollars, equivalent to 64 million dollars in 2020 (Hogan & Norton, 2000). With increasing performance standards and competitiveness in sports, the identification and development of talented athletes has become more and more important (Abbott et al., 2005). To maximize the return of their investments, sports organizations often seem to focus on early identification, selection and development (Suppiah et al., 2015). Ericsson et al. (1993) advocated for the necessity of an early start of sport-specific training in order to reach expertise. The traditional

and widely used programs to identify and develop talented athletes are in line with this idea. Young children with the potential to become senior elite athletes in a particular sport are identified and subsequently recruited into talent development (TD) programs, which sometimes even happens as early as ages between 8 and 12 (Güllich & Emrich, 2006). However, despite the widespread usage, the effectiveness of this traditional approach can be questioned. To illustrate, Güllich and Emrich (2006) found that only 1.7% of selected athletes at elite sport schools eventually obtained a medal at an international senior championship. Several reasons can be assigned to these seemingly low percentages.

First of all, talent identification is often done by looking at unidimensional measures (e.g. anthropometrical or physical based) as predictors for later success, although development and sports performance is rather multidimensional (Abbott et al., 2005; Baker & Wattie, 2018; Elferink-Gemser et al., 2004). Characteristics determining performance can be divided into multiple domains such as anthropometrical, physiological, technical, tactical and psychological (Elferink-Gemser & Visscher, 2012). Athletes need to develop a combination of these characteristics in order to achieve high performance. Sports vary in their demands and thus in the characteristics necessary for performance. Moreover, the importance of particular characteristics can vary within stages of development making prediction of future success even more complicated (Elferink-Gemser et al., 2007). This has been illustrated in longitudinal studies in for example tennis, where elite players showed a faster rate of development of sprint speed than non-elites until the age of 13. The differences subsequently disappeared with age, which might indicate that sprinting speed becomes less determining for tennis performance over the years (Kramer et al., 2016).

Second, the focus on early identification is based on the assumption that talent can be detected at a young age and selection decisions are made accordingly (Baker et al., 2012). In order to detect talent at an early stage, indicators of talent need to be measurable and robust. However, Baker and Wattie (2018) have pointed out that no powerful early indicators of talent have been found yet, with the exception of a few anthropometrical variables. It has also been shown that making accurate long-term predictions about future performance is very difficult in many sports based only on youth performance (Elferink-Gemser et al., 2007; Vaeyens et al., 2008). However, this does not imply that estimations regarding future performance cannot be made at all.

Other factors influencing selection are biological maturation and the relative age effect (RAE) of which the first is of greatest importance (Helsen et al., 2000). Early maturing athletes appear to have a higher chance of being selected than late maturing athletes. This effect has been found in multiple sports, for example in skiing (Steidl-Müller et al., 2019). The RAE implies that children who are relatively older, based on their birth month, typically have a performance advantage and consequently have a greater chance of being identified as talented than the younger

children in the same age group. However, this also means that an early biological maturation can compensate for the fact that an athlete is relatively young compared to others (Beunen & Malina, 2007).

Hence, traditional programs focusing on early recruitment are likely to miss or deselect many talented children in the process, while children who are unable to reach the top take their places in the talent programs (Abbott & Collins, 2004; Collins & MacNamara, 2018; Johnston & Baker, 2020). Available resources to invest in talented athletes are limited and only a small amount of athletes can be recruited in order to make sure that they can develop optimally, which highlights the importance of effective identification and development programs (Abbott et al., 2005; Vaeyens et al., 2009).

However, early specialization is not the only pathway to the top. A second and quite opposite pathway is referred to as early sampling, which implies involvement in multiple sports and participating in a high amount of informal, playful activities (i.e. deliberate play). Early sampling is thought to provide young children with the essential foundation of athletic abilities, so that they can eventually implement these in one sport (Côté et al., 2003). The implementation of previously learned skills is related to the process of skill transfer. It has been suggested that athletes are able to transfer certain skills, abilities or knowledge to a similar task (Gott et al., 1992). For example, previous research has examined transfer of skills between sports and showed that transfer of pattern recall skills is possible across similar ball sports such as basketball, netball and field hockey (Abernethy et al., 2005). Early sampling is not the only pathway related to the principle of transfer. A relatively new pathway has made its appearance: talent transfer (TT) (Collins et al., 2014).

TT can be defined as the process in which athletes make a switch from their original sport (i.e. donor sport) to a new sport (i.e. transfer sport). The idea behind TT is that previously developed skills or characteristics are recycled to the transfer sport, so that athletes can fast-track to the top-level (Collins & MacNamara, 2018; Rea & Lavalley, 2015). Various definitions for TT have been used, some only include athletes with experience at the top-level, where others also include athletes without any experience as an elite (Collins & MacNamara, 2018; Rea & Lavalley, 2015), both groups of athletes will be included in this review. TT initiatives have been developed by national governing bodies to formally transfer athletes. Informal transfers have also taken place, this entails athletes who self-initiate the process to switch sports. However, knowledge of TT is limited. Consequently, a closer look at the literature and results up to now could be valuable to increase our understanding of TT. To the authors' knowledge, no review has been conducted yet regarding this topic. A systematic review could provide more insight in how traditional TD programs can become more effective.

To structure the findings of this systematic review and frame them within the field of talent development, a framework will be used which illustrates different stages of athletic development. The stages can be defined differently, depending on the definition used to describe

expert performers. Most literature defines experts or elites as athletes competing at national and/or international level, other literature uses years of training experience or professionalism of the competition to define experts (Swann et al., 2015). Consequently, countries use various models to discriminate between elites and non-elites. For instance, the Netherlands and the UK use frameworks with an identification or confirmation stage, a development stage and top-level stage (Bool, 2018; Vaeyens et al., 2009). TT is also included as an extra pathway to the top in these models, since countries can benefit from TT. Namely, the return of investments previously made in athletes increases (Collins & MacNamara, 2018). To illustrate, the Netherlands aspires to belong to the top 10 countries in high-performance sports and to maximize the efficiency and eventually win more medals, investments should be made optimally. One way to realize this is that athletes can transfer into a sport along the developmental pathway (Bool, 2018). A common time frame to describe the development from the first to the last stage is around eight years, which seems comparable to the ten years proposed by Ericsson et al. (1993).

Figure 1 illustrates a developmental framework including TT, represented by the arrows between the donor and transfer sport. This framework is based on the model used by TeamNL (Bool, 2018). Athletes can withdraw and transfer from all stages in a donor sport, with or without previous involvement in a TD program. The first phase, talent identification and confirmation, entails athletes who show some aptitude or talent. However, there is still insufficient insight in whether they are able to further develop this into the necessary sport specific competences. The second phase includes talented athletes of whom is ascertained that they meet (most of) the requirements for the way to the top. The final phase guides athletes who have realistic opportunities to reach the global top-level. The arrows in figure 1 arrive at the development stage since athletes presumably need several months or years before they can perform at the top-level. No arrows arrive at the bottom of the pyramid, because this does not involve fast-tracking of athletes and would be a regular change of sports. However, this figure is a simplified model and there may be other possibilities for TT in practice additional to the ones represented. In this review a division will be made between TT of elite athletes (in the donor sport) and non-elite athletes. Elite athletes are defined as athletes who have experienced international success (Swann et al., 2015). The goal of the framework in this review is to structure the literature in a meaningful way.

Thus, the aim of this systematic review is to provide an overview of the existing literature of TT, while situating TT within the developmental framework. Formal and informal TT will be compared and similarities between donor and transfer sports in TT will be compared at the elite level as well as the non-elite level.

Methods

This review focusing on talent transfer was conducted following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) statement (Moher et al., 2009).

Search strategy and eligibility criteria

A literature search was conducted on the PubMed (n = 303) and PsycINFO (n = 50) databases on November 9, 2020. The search strategy consisted of three search strings. A detailed description of the search strategy is provided for the PubMed database in Table 1. The search terms used are part of the following categories: 1) talent, 2) athletic characteristics, 3) sports. The categories were combined using the AND operator. Although the focus of this review is on TT, the term talent transfer was not mandatory. Since various terms have been used to describe TT, a part of the articles would not appear if talent transfer was a mandatory term in the search strategy.

Table 1
Search strategy in PubMed

Construct	Related search terms
Talent	(Talent transfer*[ti] OR transition*[ti] OR talent identification*[ti] OR Talent selection[ti] OR talent development [ti] OR late special*[ti])
Athletic characteristics	(“Body composition” [Mesh] OR “physical endurance” [Mesh] OR “muscle strength” [Mesh] OR “muscle fibers, skeletal” [Mesh] OR “motor skills” [Mesh] OR “perception” [Mesh] OR “decision making” [Mesh] OR “self-control” [Mesh] OR “motivation” [Mesh] OR “physic” [tiab] OR physiologic* [tiab] OR technic* [tiab] OR tactic*[tiab] OR psycholog* [tiab] OR psychosocial* [tiab] OR body composition*[tiab] OR endurance* [tiab] OR muscle strength [tiab] OR motor skill* [tiab] OR perception* [tiab] OR decision making [tiab] OR self regulat* [tiab] OR motivation* [tiab] OR conceptual* [tiab] OR strategy* [tiab] OR goal setting [tiab] OR coping[tiab] OR commitment*[tiab] OR psycho-behavioral [tiab])
Sports	(“Sports” [Mesh] OR sport*[ti] OR athlete*[ti] OR elite*[ti] OR olympic*[ti] OR football* [ti] OR basketball* [ti] OR skiing*[ti] OR rugby[ti] OR soccer* [ti] OR bobsleigh* [ti] OR sprint*[ti] OR rowing [ti] OR cycling[ti] OR ice hockey[ti] OR snowboard* [ti] OR speedskating[ti] OR diving[ti] OR skeleton*[ti] OR volleyball* [ti] OR beach volleyball* [ti] OR gymnastic* [ti])

Articles were included if they were written in English, available in full-text and focused on athletes going through TT in sports. There were no restraints on performance level in the donor or transfer sport. Studies were excluded if they focused on transitions of athletes within a sport.

Study selection

The initial search, yielded 303 results in PubMed and 50 results in PsychINFO. To remove duplicates and identify eligible studies, the reference management software Mendeley was used. First, articles were screened on title and abstract. Next, the remaining articles were assessed on full-text. The references of the articles included based on full-text were subsequently screened to find additional articles. The screening on title and abstract and the full-text assessment was conducted by two authors independently. Consensus was reached on inclusion decisions when inconsistencies occurred.

Results

Systematic search

The described search strategy resulted in 353 articles. After removal of duplicates and screening on title and abstract a total of 13 studies remained. After full-text assessment, three articles met the inclusion criteria. References of the included studies were screened for additional articles. Seven articles were identified and screened on abstract and full-text, two articles were included. Hence, a total of five studies remained, which are shown in Table 2. Figure 2 shows the process of study selection.

Table 2

Studies of talent transfer, sorted by elite/non-elite level at the donor sport and formal/informal structure

Authors	Donor sport	Transfer sport	Age at TT	↓/↑ tech/tact demands	Similarities between sports
Elite in the donor sport					
Informal					
MacNamara & Collins (2015)	Athletics	Water-based	25–30	NR	NR
	Horse racing	Individual power	25–30	NR	NR
	Individual power	Multi-sport	25–30	NR	NR
	2x Water-based	Individual power	25–30/30–35	NR	NR
	2x Combat	Combat	30–35/30–35	NR	All
Formal					
Bullock et al. (2009)	Surf life saving	Skeleton	21	↑ tact	Phy (sprinting)
	Sprint 100 m	Skeleton	29	–	Phy (sprinting)
Non-elite in the donor sport					
Formal					
Bullock et al. (2009)	Surf life saving	Skeleton	18	↑ tact	Phy (sprinting)
	Surf life saving/gymnastics	Skeleton	18	↑ tact/↑ tech/tact	Phy
Hoare & Warr (2000)	Volleyball	Soccer	15–19	↑ tact (no direct opponent)	Phy, tech (ball handling), tact (game sense)
	Basketball	Soccer	15–19	–	Phy, tech (ball handling), tact (game sense)
	Softball	Soccer	15–19	↑ tech (ball handling), tact (game sense)	Tact (team sport, direct opponent)
	3x Touch football	Soccer	15–19	–	Phy, tech (ball handling), tact (game sense)
	3x Netball	Soccer	15–19	–	Phy, tech (ball handling), tact (game sense)
	3x Hockey	Soccer	15–19	–	Phy, tech (ball handling), tact (game sense)
	5x Sprinting	Soccer	15–19	↑ tech/tact	Phy
Mixed elite/non elite in the donor sport					
Informal					
Rea & Lavalley (2015)	2x Skiing	Cycling	20, 35	↑ tech	Anthr (upper leg)
	2x Athletics	Cycling	25, 23	NR	NR
	Judo	Wrestling	20	↑ tech	Phy, tact, tech (throws)
Formal					
Rea & Lavalley (2015)	Rugby	Canoeing	19	↑ tact	Phy aspect canoeing is broad
	2x Athletics	Canoeing	16, 21	NR	NR
	Judo	Cycling	21	↑ tech, tact	NR
	Hockey	Cycling	19	↑ tech, tact	NR
Mixed formal/informal					
Collins et al. (2014)^b	Sprinting	Football	11–	Overall: ↓	Psy
	Basketball	Sprinting	32	tech/tact	
	Alpine skiing	Rowing			
	Rugby	Skiing			
	Lacrosse	Cycling			
		Ice Hockey			
		Snowboarding			
		Speedskating			
		Diving			
		Skeleton			
		Swimming			
		Canoe			

Notes. ^a reported by athlete in question. ^b combinations between sports are unknown, sports with an occurrence > 4 are presented. Anth = anthropometrical, phy = physiological, tech = technical, tact = tactical, psy = psychological, NR = not reported, exact sport is unknown

General study characteristics

From the five studies included, two studies looked at experiences of athletes regarding TT (MacNamara & Collins, 2015; Rea & Lavallee, 2015). Two articles have set up a research design to transfer athletes, of which one focused on skeleton (Bullock et al., 2009) and one on soccer (Hoare & Warr, 2000). Another study, by Collins et al. (2014), scrutinized the global occurrence and aimed at enhancing the understanding of the mechanisms and effectiveness of TT and provided a clear overview. One study focused only on informal TT (MacNamara & Collins, 2015). The two studies focusing on soccer and skeleton comprised of formal TT (Bullock et al., 2009; Hoare & Warr, 2000). Two studies included both formal and informal TT (Bullock et al., 2009; Rea & Lavallee, 2015). One study looked at only elite athletes (MacNamara & Collins, 2015) and one at only non-elite athletes (Hoare & Warr, 2000). Another study examined a mix of elite and non-elite athletes and reported the performance level for each athlete (Bullock et al., 2009). Two articles examined both elite and non-elite athletes as well, but did not report sufficient details regarding the level of performance (Collins et al., 2014; Rea & Lavallee, 2015).

Formal and informal talent transfer

Research regarding formal programs has scrutinized the process of TT projects for soccer and skeleton (Bullock et al., 2009; Hoare & Warr, 2000) and examined which factors are perceived as facilitating by athletes (Bullock et al., 2009; Rea & Lavallee, 2015). According to the athletes, successful TT was facilitated by funding, coaching expertise, access to the best facilities, support staff and faith from the TT program (Rea & Lavallee, 2015). Subsequently, it has been suggested that the supportive environment could positively influence fast transfers (Bullock et al., 2009). Moreover, athletes were of the opinion that having a role model or example of someone who transferred successfully did not play a major role (Rea & Lavallee, 2015). The ability to learn fast has been mentioned as helpful, given that the time frame in formal TT programs is limited (Bullock et al., 2009). Formal TT programs often select athletes based on performance criteria, like 30-meter sprint time for skeleton or vertical jumps, agility, fitness and anthropometrics for soccer. Still, athletes who succeeded in informal TT have argued that they would not have been selected based on criteria used in formal TT selection procedures (Rea & Lavallee, 2015).

The two studies that focused on informal TT examined the experiences of athletes (MacNamara & Collins, 2015; Rea & Lavallee, 2015). Athletes emphasized that individual coaching and the possibility to individualize the learning environment was helpful. Since the time frame in informal TT is flexible, the pressure to perform well from the beginning is lower than in formal TT, which is perceived as positive (MacNamara & Collins, 2015). A perceived disadvantage of informal TT is the unstructured

nature and lack of consistency in opportunities offered. This makes it hard for athletes to fully utilize their potential to make progress. Finally, the lack of financial support was also seen as a barrier, since some athletes had to rely on their families (Rea & Lavallee, 2015).

Similarities between sports

Elite level

MacNamara and Collins (2015) interviewed seven athletes who all participated at the elite level in their donor sport as well as in their transfer sport. Detailed information about the type of sports was not available, due to confidentiality reasons. A consensus among all athletes was that possessing the characteristics perceived to be important for the transfer sport, such as physiological, anthropometrical or technical characteristics, is considered not the most important factor, but generic athletic ability is perceived crucial. A high level of generic athletic ability will help athletes to learn new movement and skills. Bullock et al. (2009) studied TT with the aim to transfer athletes to skeleton. Four athletes participated at the elite level in their donor sport (surf life saving and 100 m sprint), two of them eventually participated at international events in skeleton within 14 months. The former sprint athlete had the fastest 30-meter sprint time and was one of the fastest pushers, but she eventually dropped out because she struggled with the driving component of the sport. Similarities between the donor sports and skeleton existed, namely, a high demand of explosive speed. Bullock et al. (2009) stated that additional factors besides explosive speed were probably important for success in skeleton, they mentioned for instance mental toughness and perceptual cognitive skills, decision making and attention. A recurrent finding is that psychological characteristics might be crucial in TT from the elite level. The athletes in the study of MacNamara and Collins (2015) believed commitment, confidence and motivation played a key role in their success. In addition, previous sporting experience at elite level and understanding the challenges of the high-performance environment were perceived as facilitating. This is also in line with the findings from Collins et al. (2014), who emphasized that psychological factors might have critical impact on TT. More specifically, the authors referred to the PCDEs (Psychological Characteristics of Developing Excellence), which have shown to be important for maximizing potential. The PCDEs include a broad package of characteristics and help athletes to optimize development and adapt to setbacks (MacNamara et al., 2010a; 2010b).

Non-elite level

Research regarding TT from the non-elite level in a donor sport set up a program to fast-track female athletes to the highest level in soccer. Selected athletes mainly had a history in ball sports, which often have

similar physiological, technical or tactical demands (Hoare & Warr, 2000). It is not clear at what exact level the athletes were competing in their donor sport. In the study of Bullock et al. (2009), two non-elite athletes transferred from surf life saving, in which physiological demands are similar to skeleton. One of the athletes also competed in gymnastics. Although these athletes are defined as non-elite, since they did not compete at international level, they competed at state level in their donor sport.

Not all studies have reported detailed information about the level of performance of athletes in their donor sport and transfer sport. Rea and Lavalley (2015) interviewed ten athletes from formal and informal TT. Comparable to the result from elite athletes, athletes in this study mentioned that psychological skills are an absolute requirement for successful transfer. Athletes described that mental strength, confidence, attitude, character and motivation were important. Sports which functioned as donor sports were rugby, skiing, athletics, judo and hockey, transfer sports were canoeing, cycling and wrestling. The exact disciplines (e.g. athletics, cycling) were not reported, but everyone mentioned that similar demands between their donor and transfer sports were often present, like power, endurance or body shape. Other literature which also included elite and non-elite athletes suggested that similarities between donor and transfer sports are not always important. Collins et al. (2014) showed that, according to sport science specialists, many TT combinations do not have obvious similarities in physiological or technical demands.

Besides, Collins et al. (2014) investigated the incidence and distribution of TT in multiple countries. Athletes from the international, national and state level as well as athletes from youth and collegiate competitions in the USA, UK, Canada and Australia were included. This investigation resulted in 177 different TT combinations. An overview of the most common sports involved in TT, both donor and transfer sports, has been published. Bobsleigh ($n > 30$) clearly dominates in the transfer sports. Sprinting is in the top five as well. The list of donor sports is dominated by sprinting ($n > 20$), followed by football and basketball.

Discussion

The aim of this review was to provide an overview of the existing literature of TT. One of the main findings of this review is that scientific research about TT still stands in its infancy. Only five studies have examined TT, of which two studies looked at experiences of athletes (MacNamara & Collins, 2015; Rea & Lavalley, 2015) and two articles have set up a research design to transfer athletes (Bullock et al., 2009; Hoare & Warr, 2000). One study, by Collins et al. (2014), scrutinized the global occurrence and aimed at enhancing the understanding of the mechanisms and effectiveness of TT and provided a clear overview. However, this latter analysis included only four countries, of which two are TT promotional countries. Not all transfers, which took place in

practice have been studied. Besides, the published studies about TT are mainly looking at positive and significant results. The lack of negative or non-significant results regarding TT could be the result of publication bias. Hence, the incidence of donor and transfer sports in literature does not necessarily reflect the effectiveness in practice. A lot more research is needed to increase our understanding of TT.

Formal and informal talent transfer

Some countries are promoting TT more than others. TT promotional countries, like the UK, Australia and the Netherlands, have set up formal programs to transfer athletes (Collins et al., 2014). UK sports has set up multiple initiatives, such as the Bounce4Gold (2020) for trampolining and Girls4Gold (2008) for TT to rowing. The latter initiative aimed at athletes between 18 and 25 years old performing at least at national level (or regional level for athletes between 15 and 17 years old). Formal programs can also target athletes without previous success in their sports career, like the yearly sport-specific talent days organized by TeamNL, which targets talented children between 12 and 18 years old with the goal to fast-track them into a talent development program in for example rowing, basketball or track and field (TeamNL, 2020). To illustrate the effects of formal TT, UK sports (2020) states: “Our projects have resulted in over 100 newly identified athletes entering the World Class system across 17 sports with over 600 international appearances made and over 250 international medals won”. These numbers regarding formal TT from the field sound promising, but they might differ from scientific results.

Results from studies examining formal and informal transfers show that each structure has its own advantages and disadvantages. Receiving social and financial support was particularly mentioned by athletes as facilitating. A supportive environment is more easily realized in formal TT and often lacking in informal TT. Both structures can result in successful TT, but the effectiveness of these programs remains unclear. To illustrate, Collins et al. (2014) found that 8% of the Olympic athletes from Australia and the UK made a transfer, which could be due to the fact that these countries are investing significantly in TT. However, countries in which formal TT is not common show similar percentages: 7.6% and 6.9% of the Olympic athletes from respectively Canada and the USA transferred successfully in an informal setting (Collins et al., 2014). Based on these numbers, it seems that formal TT does not substantially increase the total amount of transfers among Olympic athletes, but more research into the effectiveness of formal and informal TT is needed.

Similarities between sports

Athletes have shown that it is possible to transfer from different performance levels in the donor sport and to eventually reach the top

without early involvement in a talent program. A famous example from the elite level is Clara Hughes, who is one of the few athletes who has won multiple medals at the Summer (cycling) as well as the Winter Games (speed skating; Vaeyens et al., 2009). An example from the non-elite level is Yelena Isinbaeva, who transferred at an age of 15 from amateur artistic gymnastics to pole vault and won in the latter two Olympic medals. The effectiveness of TT might depend on the similarities between sports, which is in line with the theory of transfer of skills. This might imply that similarities regarding demands between donor and transfer sports are important.

Collins et al. (2014) found that many transfers do not show obvious similarities in physiological or technical demands. On the contrary, Hoare and Warr (2000), Rea and Lavalley (2015) and Bullock et al. (2009) stated that similarities in anthropometrical, physiological, technical, tactical or psychological demands are often present. However, the finding that athletes often have a history in sports with similar demands does not mean this is essential for TT. It is for example not a coincidence that the physiological demands of skeleton and the donor sports of the athletes show similarities, since the authors explicitly targeted athletes in sports involving explosive speed (Bullock et al., 2009). The study from Hoare and Warr (2000) showed that TT is also possible for athletes without a background in a similar sport (i.e. ball sports). However, information regarding exact donor and transfer sports is often lacking, which makes it hard to interpret the results. Whether similarities between athletics and water-based sports exist is for instance hard to evaluate (MacNamara & Collins, 2015).

Psychological characteristics were often mentioned as facilitative, mostly for elite athletes (Bullock et al., 2009; MacNamara & Collins, 2015; Rea & Lavalley, 2015). Previous experience with the challenges part of the high-performance environment seem important as well as factors like motivation and confidence. No study explicitly examined experiences of non-elite athletes. Another facilitating factor mentioned by TT athletes was a high level of generic athletic ability (MacNamara & Collins, 2015). It has been argued that early sampling provides young athletes with a strong foundation of different athletic skills (Côté et al., 2003). Hence, it could be possible that practicing multiple sports prior to TT also helps to transfer to a new sport.

Despite the mixed results, it seems that similarities between sports will most likely benefit the TT process, although it is not a prerequisite for non-elite as well as elite athletes who want to transfer. Findings regarding psychological characteristics are more conclusive and suggest that various factors are perceived as facilitative in TT. Next, three more factors possibly affecting TT will be discussed, namely: participation rates, technical and tactical complexity and age of peak performance.

Participation rates

It has been suggested that sports in which the participation rates are relatively low could be more suitable as transfer sports (Baker, 2003; Vaeyens et al., 2009). Consequently, popular sports with a large pool of athletes might be less suitable. From the findings it seems that formal TT programs often focus on sports with limited participation rates. Sports with limited competition depth used for formal TT are for example skeleton and canoeing (Bullock et al., 2009; Hoare & Warr, 2000; Rea & Lavallee, 2015). Results of informal TT do not show confirmative findings for the theory that sports with low participation rates are particularly suitable as transfer sports. However, the number of informal transfers and the available information about the type of sports is limited in the literature.

Technical and tactical complexity

Development of technical and tactical skills relatively takes a lot of time and it has been suggested that the ideal age to train technical skills might be at a fairly young age (Balyi et al., 2013; Helsen et al., 2013; Schulz & Curnow, 1988). This would imply that a sport requiring complex motor skills might be harder to transfer to than a sport with less complex skills. Accordingly, it has been argued that most transfers between sports with different demands in technical or tactical complexity take place in the direction of less complex sports (Collins et al., 2014). Results concerning relative technical or tactical complexity are compelling. With the results of studies examining TT from the elite level, the conjecture about the direction of TT regarding complexity in demands can neither be confirmed nor refuted, since the relevant information is lacking. Most transfers from the non-elite level showed a decrease in complexity regarding technical and tactical demands, yet five athletes from the study of Hoare and Warr (2000) transferred from sprinting to soccer, which is considered to be an increase in tactical and technical complexity. An explanation could be that female soccer on the elite level has a relatively short history and thus the sport might be less developed than sprinting and the elite level in soccer may differ from the elite level in sprinting. This possibly makes it easier to transfer to the highest level in soccer despite the increase in complexity. It seems that, despite the latter example, transfers are mainly unidirectional when looking at complexity of sports, but this is not a sine qua non, especially for relatively new transfer sports or transfer sports with low participation rates.

Age of peak performance

The age of peak performance (APP), the age at which athletes are expected to reach peak performance, varies greatly between sports and seems to be partly influenced by the demands of a sport (Schulz & Curnow, 1988).

In a review, Allen and Hopkins (2015) estimated the APP of different types of sports. APP was ranging from 20 to 39 years for endurance sports and from 20 to 27 years for explosive sports. A review by Schulz and Curnow (1988) showed similar results, namely that sports requiring pure strength, speed and explosive power have a relatively earlier APP (begin 20's), while sports requiring endurance, complex skills and knowledge have a relatively later APP (around age 30).

The type of sport and the corresponding APP might determine which sports are suitable as donor and transfer sports. Athletes who enter a new sport at a later age have limited time to develop, so it could be that TT is more likely to be effective if the transfer sport has a later APP relative to the donor sport. Hence, it can be argued that endurance sports and sports with complex skills or knowledge are particularly suitable. Another line of reasoning can follow from the findings as well. The mastering of complex motor skills or developing a highly trained aerobic capacity takes years of practice (Allen & Hopkins, 2015). TT athletes have limited time and these sports might thus not be suitable as transfer sports. Findings regarding the relation between the APP in donor and transfer sports could give substance to one of these theories. However, multiple studies about TT do not report exact sport disciplines (MacNamara & Collins, 2015; Rea & Lavalley, 2015) and the broad range of APP within one sport (e.g. track cycling and road cycling are three years apart; APP in athletics ranges approximately from 23 to 30 years; Longo et al., 2016) makes it hard to draw any conclusions about the role of APP in TT.

Recommendations and limitations

A few recommendations for future research can be made. First, no clear framework is currently available for TT, which causes inconsistency in definitions and methodologies used in the studies. A theoretical framework including a definition and the required level of performance in the donor and transfer sport would help to compare future findings. However, countries have cultural and economical differences, which results in different priorities and approaches to talent development and TT. Hence, comparing findings between sports and countries might not be the most relevant for the practical field. Investigating transfers in specific sports and age groups might be more valuable for understanding TT than mustering results from all kinds of sports. For example, examining at which age and from which type of sports athletes were able to transfer into a specific sport can provide practitioners relevant knowledge to promote future TT. Second, it would be useful to analyze the effectiveness and efficiency of formal TT programs, including the identification as well as the development of athletes during the transfer. A third recommendation is to report important information regarding the level of performance in the donor sport and transfer sport, age and type of sport more extensively, although this might be difficult due to confidentiality reasons.

From an applied perspective, it seems that athletes, national governing bodies and TD programs might benefit from flexible and alternative routes to the top. The findings seem to suggest that TT can be an alternative pathway in addition to current TD programs, but the number of studies conducted is limited and results should be interpreted with caution. Although national sporting bodies can benefit from TT, some disadvantages might arise as well. Collins and MacNamara (2018) pointed out that a shift to late specialization in sports can result in a loss of talented athletes, since other sports might already have recruited the talented athletes. Formal programs should also be careful with identification processes in TT, since measures like anthropometrics or performance measures do not always reflect an athletes' capability to learn and adapt to a new sport. However, these criteria might be useful as an initial selection if there is evidence for the predictive value of these measures for performance. Besides, stakeholders should take into account individual and sport-specific circumstances. Previous research has emphasized that TT should be seen from a holistic perspective, since the outcome of the TT process is rather unpredictable and depends on many individual factors and circumstances (Rea & Lavalée, 2015). Hence, many factors might play a role in determining whether an athlete can make a transfer and stakeholders should always consider the complete picture.

A limitation of this review is the definition used to allocate transfers to the elite/non-elite group. As mentioned before, various criteria are used in literature to define the performance level of athletes. The assigning to the elite level was done according to the definition that senior international success is required (Swann et al., 2015). The rationale to use this criterion was that this information is most consistently reported by the included articles. However, the strict definition for elites in this review may not result in the most correct distribution. A strength of this systematic review is the methodology and detailed description of the literature search, which reduces the bias in the selection of articles.

Conclusion

- Scientific research regarding TT still stands in its infancy and results should be interpreted with caution.
- TT could serve as an alternative pathway to the top and might be valuable for athletes and sports organizations. However, empirical evidence regarding the effectiveness of (in)formal TT is still lacking.
- Similarities between donor and transfer sports might be helpful, although this is not a precondition for successful transfer. Besides, athletes might benefit from a high level of generic athletic ability. Various psychological characteristics have been proposed to play a facilitative role in TT.

- Technical and tactical complexity of sports, participation rates and APP might influence TT as well, but information in literature regarding these factors is lacking.
- More research is needed to increase our understanding of TT.

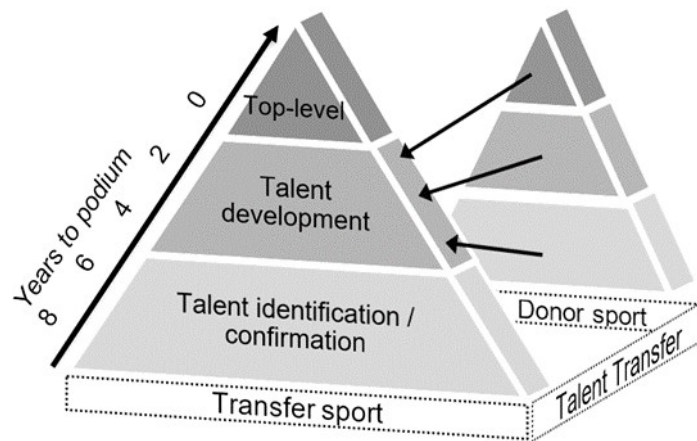


Figure 1
TT within the developmental framework

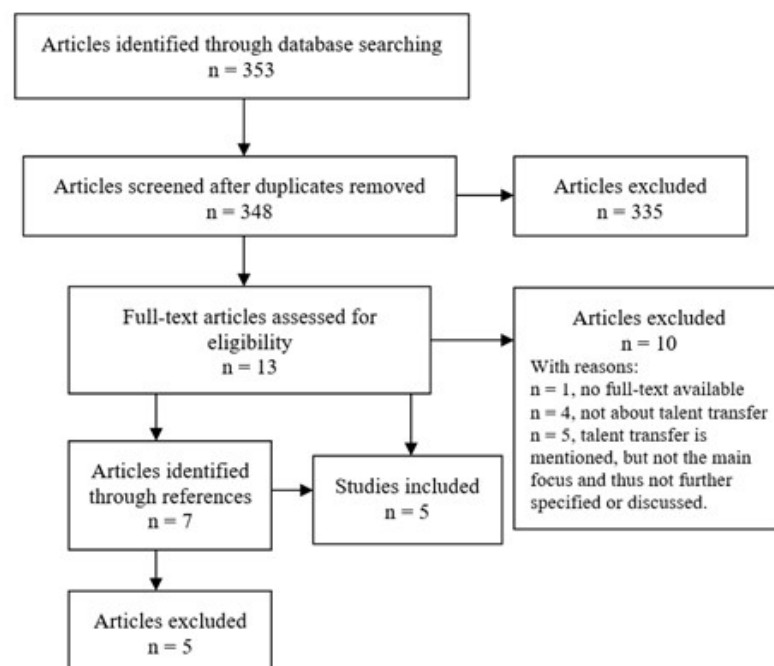


Figure 2
Flow chart of study selection

Acknowledgments

Funding: The authors have no funding or support to report.

Competing interests: The authors have declared that no competing interests exist.

Data availability statement: All relevant data are within the paper.

Referencias

- Abbott, A., Button, C., Pepping, G. J., & Collins, D. (2005). Unnatural selection: Talent identification and development in sport. *Nonlinear Dynamics, Psychology, and Life Sciences*, 9, 61-88.
- Abbott, A., & Collins, D. (2004). Eliminating the dichotomy between theory and practice in talent identification and development: Considering the role of psychology. *Journal of Sports Sciences*, 22, 395-408. <https://doi.org/10.1080/02640410410001675324>
- Abernethy, B., Baker, J., & Côté, J. (2005). Transfer of pattern recall skills may contribute to the development of sport expertise. *Applied Cognitive Psychology*, 19, 705-718. <https://doi.org/10.1002/acp.1102>
- Allen, S. V., & Hopkins, W. G. (2015). Age of peak competitive performance of elite athletes: A systematic review. *Sports Medicine*, 45, 1431-1441. <http://doi.org/10.1007/s40279-015-0354-3>
- Baker, J. (2003). Early specialization in youth sport: A requirement for adult expertise? *High Ability Studies*, 14, 85-94. doi:10.1080/13598130304091
- Baker, J., Cobley, S., & Schorer, J. (Eds.). (2012). *Talent identification and development in sport. International perspectives*. London: Routledge. <https://doi.org/10.4324/9780203850312>
- Baker, J., & Wattie, N. (2018). Innate talent in sport: Separating myth from reality. *Current Issues in Sport Science*, 3: 006. <https://doi.org/10.36950/2018ciss006>
- Balyi, I., Way, R., & Higgs, C. (2013). *Long-term athlete development*. Champaign, IL: Human Kinetics.
- Beunen, G., & Malina, R. M. (2007). Growth and biologic maturation: Relevance to athletic performance. In H. Hebestreit & O. Bar - Or (Eds.), *The young athlete* (pp. 3-17). Oxford, UK: Blackwell. <https://doi.org/10.1002/9780470696255.ch1>
- Bool, K. (2018). *De weg naar het podium: Talentherkenning- en ontwikkeling in de nederlandse topsport* [The road to the top: Talent identification and development in Dutch high performance sports] (1st ed.). Nieuwegein: Arko Sports Media.
- Bullock, N., Gulbin, J., Martin, D. T., Ross, A., Holland, T., & Marino, F. (2009). Talent identification and deliberate programming in skeleton: Ice novice to Winter Olympian in 14 months. *Journal of Sports Sciences*, 27, 397-404. <https://doi.org/10.1080/02640410802549751>
- Collins, D., & MacNamara, Á. (2018). *Talent development: A practitioner guide*. London; New York: Routledge.
- Collins, R., Collins, D., MacNamara, Á., & Jones, M. I. (2014). Change of plans: An evaluation of the effectiveness and underlying mechanisms of successful talent transfer. *Journal of Sports Sciences*, 32, 1621-1630. <https://doi.org/10.1080/02640414.2014.908324>
- Côté, J., Baker, J., & Abernethy, B. (2003). From play to practice: A developmental framework for the acquisition of expertise in team sport. In J. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 89-110). Champaign, IL: Human Kinetics.
- Elferink-Gemser, M. T., & Visscher, C. (2012). Who are the superstars of tomorrow? Talent development in Dutch soccer. In J. Baker, J. Schorer,

- & S. Copley (Eds.), *Talent identification and development in sport* (pp. 95-105). London, UK: Routledge. <http://doi.org/10.4324/9780203850312-15>
- Elferink-Gemser, M. T., Visscher, C., Lemmink, K., & Mulder, T. (2007). Multidimensional performance characteristics and standard of performance in talented youth field hockey players: A longitudinal study. *Journal of Sports Sciences*, 25, 481-489. <https://doi.org/10.1080/02640410600719945>
- Elferink-Gemser, M., Visscher, C., Lemmink, K., & Mulder, T. (2004). Relation between multidimensional performance characteristics and level of performance in talented youth field hockey players. *Journal of Sports Sciences*, 22, 1053-1063. <https://doi.org/10.1080/02640410410001729991>
- Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100, 363-406. <https://doi.org/10.1037/0033-295X.100.3.363>
- Gott, S. P., Parker-Hall, E., Pokrny, A. R., & Dibble, E. (1992). A naturalistic study of transfer: Adaptive expertise in technical domains. In D. K. Detterman & R. J. Sternberg (Eds.), *Transfer on trial: Intelligence, cognition and instruction* (pp. 258-288). Norwood, NJ: Ablex.
- Güllich, A., & Emrich, E. (2006). Evaluation of the support of young athletes in the elite sports system. *European Journal for Sport and Society*, 3, 85-108. <https://doi.org/10.1080/16138171.2006.11687783>
- Helsen, W. F., Hodges, N. J., Winckel, J. V., & Starkes, J. L. (2000). The roles of talent, physical precocity and practice in the development of soccer expertise. *Journal of Sports Sciences*, 18, 727-736. <https://doi.org/10.1080/02640410050120104>
- Helsen, W., Van Winckel, J., Buekers, M., & Meert, J. P. (2013). *Trainingsleer teamsporten* [Training principles in team sports]. Leuven, Belgium: Acco.
- Hoare, D. G., & Warr, C. R. (2000). Talent identification and women's soccer: An Australian experience. *Journal of Sports Sciences*, 18, 751-758. <https://doi.org/10.1080/02640410050120122>
- Hogan, K., & Norton, K. (2000). The 'Price' of Olympic gold. *Journal of Science and Medicine in Sport*, 3, 203-218. [https://doi.org/10.1016/S1440-2440\(00\)80082-1](https://doi.org/10.1016/S1440-2440(00)80082-1)
- Johnston, K., & Baker, J. (2020). Waste reduction strategies: Factors affecting talent wastage and the efficacy of talent selection in sport. *Frontiers in Psychology*, 10: 2925. doi:10.3389/fpsyg.2019.02925
- Kramer, T., Valente-Dos-Santos, J., Coelho-E-Silva, M. J., Malina, R. M., Huijgen, B. C. H., Smith, J., ... & Visscher, C. (2016). Modeling longitudinal changes in 5 m sprinting performance among young male tennis players. *Perceptual and Motor Skills*, 122, 299-318.
- Longo, A. F., Siffredi, C. R., Lentini, N. A., Cardey, M. L., & Aquilino, G. D. (2016). Age of peak performance in Olympic sports. *Medicine & Science in Sports & Exercise*, 48, 849. <http://doi.org/10.1249/01.mss.0000487542.85095.65>
- MacNamara, Á., Button, A., & Collins, D. (2010a). The role of psychological characteristics in facilitating the pathway to elite performance. Part 1: Identifying mental skills and behaviors. *The Sport Psychologist*, 24, 52-73. <https://doi.org/10.1123/tsp.24.1.52>

- MacNamara, Á., Button, A., & Collins, D. (2010b). The role of psychological characteristics in facilitating the pathway to elite performance. Part 2: Examining environmental and stage-related differences in skills and behaviors. *The Sport Psychologist*, 24, 74-96. <https://doi.org/10.1123/tsp.24.1.74>
- MacNamara, Á., & Collins, D. (2015). Second chances: Investigating athletes' experiences of talent transfer. *PloS One*, 10(11), e0143592. <https://doi.org/10.1371/journal.pone.0143592>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Journal of Clinical Epidemiology*, 62, 1006-1012. <https://doi.org/10.1016/j.jclinepi.2009.06.005>
- Rea, T., & Lavalley, D. (2015). An examination of athletes' experiences of the talent transfer process. *Journal of Talent Development and Excellence*, 7, 41-67.
- Schulz, R., & Curnow, C. (1988). Peak performance and age among superathletes: Track and field, swimming, baseball, tennis, and golf. *Journal of Gerontology*, 43(5), P113-P120. <https://doi.org/10.1093/geronj/43.5.P113>
- Steidl-Müller, L., Hildebrandt, C., Raschner, C., & Müller, E. (2019). Challenges of talent development in alpine ski racing: A narrative review. *Journal of Sports Sciences*, 37, 601-612. <https://doi.org/10.1080/02640414.2018.1513355>
- Suppiah, H. T., Low, C. Y., & Chia, M. (2015). Detecting and developing youth athlete potential: Different strokes for different folks are warranted. *British Journal of Sports Medicine*, 49, 878-882. <http://dx.doi.org/10.1136/bjsports-2015-094648>
- Swann, C., Moran, A., & Piggott, D. (2015). Defining elite athletes: Issues in the study of expert performance in sport psychology. *Psychology of Sport and Exercise*, 16, 3-14. <https://doi.org/10.1016/j.psychsport.2014.07.004>
- TeamNL. (2020). NOC*NSF. *Sportspecifieke Talentdagen* [Sportspecific talentdays]. Retrieved from <http://www.nocnsf.nl/talentdag>
- UK sports. (2020). UK Sport. *Previous campaigns*. Retrieved from <https://www.uksport.gov.uk/our-work/talent-id/previous-campaigns>
- Vaeyens, R., Güllich, A., Warr, C. R., & Philippaerts, R. (2009). Talent identification and promotion programmes of Olympic athletes. *Journal of Sports Sciences*, 27, 1367-1380. <https://doi.org/10.1080/02640410903110974>
- Vaeyens, R., Lenoir, M., Williams, A. M., & Philippaerts, R. M. (2008). Talent identification and development programmes in sport: Current models and future directions. *Sports Medicine*, 38, 703-714. <https://doi.org/10.2165/00007256-200838090-00001>
- Williams, A. M., & Reilly, T. (2000). Talent identification and development in soccer. *Journal of Sports Sciences*, 18, 657-667. <https://doi.org/10.1080/02640410050120041>