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Generic motor tests as tools to identify sports talent: a systematic review

review paper
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ABSTRACT

Despite motor coordination being an underlying capacity for the execution of sports motor skills, more information is needed if its evaluation can contribute to identifying sports talent. Furthermore, more needs to be known about which types of generic motor tests can predict the future sporting performance of young athletes of different ages. The objective of this study was to evaluate the literature on the use of generic motor tests, which assess levels of general evolution, in identifying young talents in sport. This systematic review was carried out based on the PRISMA protocol, with a search that was undertaken in two stages: an electronic search of studies written in English in PubMed, Science Direct, Web of Science, and SPORTDiscus; and a search directed to articles written in Portuguese and Spanish in the LILACS, IBECS and SciELO databases. Twenty articles were included in the review: 12 cross-sectional, 6 longitudinal, and 2 retrospective. The methodological quality of the studies was assessed based on STROBE. No studies were classified as low-quality. The results suggest that generic motor tests may be important in the talent identification process, since the level of motor coordination is associated with sports performance and, as such, is important for performance discrimination and prediction. The predominance of studies analysed adolescents, males, soccer and the KTK (Körperkoordinationstest für Kinder) motor test. It seems plausible to recommend that sports professionals apply the findings of this study in youth sports performance and practice environments.
Key words: sport, motor coordination, talent identification, motor assessment

Introduction

Performance sport involves athletes capable of presenting high performance levels throughout their careers. To reach such levels, it is important that the athlete has gone through a multidimensional training process, in which young people are provided with an environment conducive to learning and development involving physical, technical and psychological aspects, which will sometimes need to be shaped from an adversary [1, 2]. This process is known as talent development [3]. Adult athletes who demonstrate high levels of performance are included in a development and training program since childhood or adolescence [4], without which their abilities might not have been adequately developed [5, 3].

Many sports organisations worldwide strive to recruit young people with the potential to progress in a talent development program and achieve high future performance [3, 6, 7]. This recruitment process is known as 'identification' for young athletes already involved in the sport of interest, and 'talent detection' for individuals not yet involved in the sport of interest [3]. Some individuals are excluded during the talent identification process because they do not have special skills. This misconception that talent is configured only by innate characteristics distances itself from how talent should be considered: updatable and renewable, as it develops from a well-structured practice and progresses by advancing in training levels [8].

Identifying talented young athletes with the potential for high levels of sports performance has been rec-

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ognised as a valuable task for excellence in performance sports [9–11]. To achieve this, it is important to adopt effective assessment strategies that are not limited to current performance or to physical aspects resulting from the relative age of the individuals, but that are able to predict the future potential of these young individuals for elite sport [12].

A systematic review of talent identification revealed a predominance of studies evaluating the physical aspects of athletes, such as anthropometric and physiological characteristics and sport-specific motor skills [7]. However, this predominant approach has yet to be effective in predicting the future potential of young individuals for elite sport [6, 7] as research has been inconclusive regarding how the process of identifying sporting talent should be operationalised [6, 13]. Given this scenario, a greater diversity of assessments in talent identification research has been recommended [7, 14].

In addition to the specific anthropometric, physiological, and motor characteristics of a given sport, many studies examine the importance of other aspects in the talent identification process [15]. One aspect that has received attention in recent investigations is the general level of motor coordination [13, 16–18]. Previous studies have shown that general levels of motor coordination are associated with future performance in different sport modalities, such as gymnastics [19], table tennis [20], and volleyball [21].

Motor coordination is a term that refers to the ability to efficiently control the various degrees of freedom of the different body segments involved in the movement [22]. It is, therefore, an underlying capacity for the execution of sports motor skills. The general levels of motor coordination in young athletes have been evaluated through generic tests, which include a series of fine and gross movements of general motor coordination, being very popular for evaluating young people and athletic people [23]. These results are less influenced by previous experience or training than specific motor tests [23]. Therefore, it seems plausible to consider that coordination levels are not only linked to the point in time, but can be important indicators of the motor potential that a child will develop [19]. In fact, a child around 7 years of age may not yet be able to develop sports motor skills proficiently [24] but may demonstrate strong motor coordination [25]. Therefore, generic motor tests can provide additional and valuable information in the complex process of detecting and identifying sports talent, especially in children.

A recent systematic review [23] found that the assessment of levels of general motor coordination can contribute to identifying sports talent, as from such measures, it was possible to distinguish levels of performance and predict the future potential of young athletes in different sport modalities. However, this systematic review was restricted to studies involving only one generic motor test, the Körperkoordinationstest für Kinder (KTK). Therefore, little is known about whether the assessment of general motor coordination levels can contribute to the process of identifying sporting talent. Furthermore, little is known about which types of generic motor tests can predict the future sporting performance of young athletes of different ages.

The objective of the present study was to verify the use of the evaluation of the levels of general motor coordination, carried out through generic tests, in identifying sports talent in young athletes of different age groups and sports modalities.

Material and methods

Search strategy

This systematic review was carried out based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol [26], and the search for documents was carried out in two stages, both conducted in March 2021 and without period delimitation.

In the first stage, an electronic search was performed for studies written in English in the PubMed, ScienceDirect, Web of Science, and SPORTDiscus databases, combining the following terms: “talent*” AND “sport*” AND “motor competence” OR “motor coordination” OR “motor skill*” OR “fundamental movement skill*” OR “motor performance”.

The second search stage was to find articles written in Portuguese and Spanish. The electronic search was carried out in the LILACS, IBECS, and SciELO databases, using terms in Portuguese: “talento” AND “esporte” AND “competência motora” OR “coordenação motora” OR “habilidade motora” OR “habilidade motora fundamental” OR “performance motora” and in Spanish “talento” AND “deporte” AND “competencia motora” OR “coordinación motora” OR “habilidad motora” OR “habilidad motora fundamental” OR “el rendimiento del motor”.

Study screening

In both stages of the search, the inclusion criteria consisted of studies with full text available, with an experimental, longitudinal, or cross-sectional design, published in indexed and peer-reviewed scientific journals. The Population, Intervention, Comparison, Out-

come and Study Design (PICOS) criteria were used to determine the inclusion and exclusion of articles for this review. We included articles with male and female participants, classified as children or adolescents, who played organised sports regularly, aged between 7 and 19 years old. This age group was chosen because it precedes the age of professional athletes.

Studies focusing on participants with a known illness or any other health or developmental disorder were adopted as exclusion criteria. For inclusion in the review, studies had to evaluate the general motor coordination of the participants through a scientifically validated motor test, or not. Furthermore, only studies that presented results from the assessment of general motor coordination were included. Investigations that used only modality-specific motor tests were discarded.

Assessment of methodological quality

After examining the eligibility of the works, two authors assessed the general quality of the studies that met all the inclusion criteria of their respective stages. This assessment was adapted from the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) [27] and previous reviews [28, 29] in a similar area of this study. As such, six criteria were considered as being of most relevance to this current review, and then a checklist was created containing dichotomous questions, whose answers should be 'yes' or 'no', namely:

1. Does the study describe the eligibility criteria for the participants?
2. Does the study describe how the sample size was determined?
3. Does the study clearly define all the variables of interest?
4. Does the study describe the strategies used to minimise bias?
5. Does the study thoroughly describe the motor tests used to assess athlete coordination?
6. Does the study describe all statistical methods used for the data analysis?

For each item on the list, a score of '0' (corresponding to the answer 'no') or '1' (corresponding to the answer 'yes') was attributed. In the end, the scores obtained from each study were summed to obtain a general measure of the methodological quality of the investigation. Hence, the amplitude of this measurement could vary between a minimum of '0' and a maximum of '6' points, with 0–2 points classified as 'low quality'; 3–4 points as 'medium quality'; 5–6 points as 'high quality' [29]. No studies were excluded based on this assessment.

Data from each of the studies were tabulated in a spreadsheet generated in the Microsoft Word® software (Microsoft Office Professional Plus ® package version 2016, developed by Microsoft®) containing information about the authors, year of publication, study design, sample, sport modality, instrument (general motor coordination test), in addition to the methodological quality of each study (Table 1). The main findings of the studies were summarised, divided by sports modalities, in the same table (Table 1).

Results

Initially, the electronic search returned a total of 391 articles, and the information regarding the flowchart of the process of inclusion and exclusion of these documents is shown in Figure 1. Of the 391 articles found, 20 (6 longitudinal, 12 cross-sectional, and two retrospective) were selected for synthesis and described in Table 1 (longitudinal/retrospective studies and cross-sectional studies, respectively). Table 1 (see before references) also summarises the main findings of the studies. During the search, no intervention studies were found.

Regarding the age range of the participants, four studies (20%) included only children (between 7 and 9 years old), 11 (55%) included only adolescents (between 10 and 19 years old), and five articles (25%) assessed children and adolescents in the same investigation. As for sex, in 6 studies (30%), only females were recruited, while in 8 studies (40%), only males were recruited in their samples. In the remaining six surveys (30%), participants of both sexes were recruited.

Concerning methodological quality, 11 studies (55%) were assessed as having high quality, and the other 9 (45%) as medium quality. As stated above, no studies were classified as low quality. The results of the methodological quality assessment of each article are described in Table 1.

Longitudinal and retrospective studies

Twenty studies were included in our analysis. Six (30%) were longitudinal. Only one of the studies with a longitudinal design evaluated males, while the others investigated females (3 studies) or both sexes (2 studies). As for the age range of the samples, adolescents were in fewer studies compared to children and both age groups.

Among the sports modalities that stood out the most were soccer, gymnastics, and table tennis, each with two longitudinal investigations. All studies considered

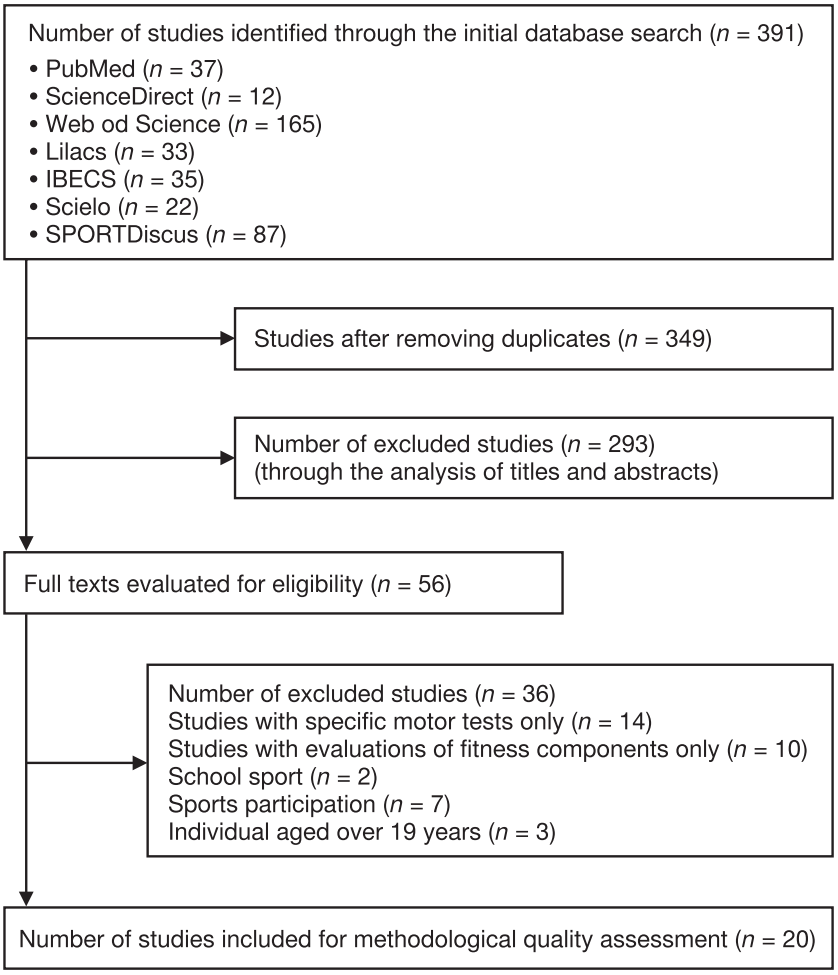

Figure 1. Summary flowchart of the article inclusion and exclusion process

the KTK general motor coordination test or a non-standard instrument.

As for the methodological evaluation, half of the studies presented high quality, while the rest were medium quality.

The two retrospective studies identified in our search [30, 31] focused on individuals who were volleyball and soccer players, respectively. Regarding the sex, a sample of females was found in volleyball and males in soccer. The instrument used to evaluate the general motor coordination of the sample of both studies was the KTK.

Cross-sectional studies

A small majority of the studies had a cross-sectional design (12/20, 60%). Of the 12 studies, six evaluated male subjects, and the other six were divided between females (2 studies) and both sexes (4 studies). Regarding age groups, six of the 12 studies directed their efforts to sample adolescents, while the other six studies to children (3 studies) and both age groups (3 studies).

As for the most popular sports modalities, a similar trend was found as for the longitudinal studies, with football, artistic gymnastics, and table tennis being the most investigated sports. Specifically, football appeared in more studies, totalling four cross-sectional designs. The KTK again appeared as the most used instrument, followed by non-standard instruments. In addition, the BOT-2 (Bruininks-Oseretsky Test of Motor Proficiency) and TGMD-2 (Test of Gross Motor Development) tests also appear in this section of studies, but in low numbers, with only one investigation using each of the instruments. Finally, most studies (60%) had a medium methodological quality.

Sports

Among the sports studied, there was a predominance of studies that analysed soccer players (6 articles, 30%). In these studies, the elite athletes (Athletes who go through three stages: initiation, specialisation and improvement, in addition to a possible final stage: maintenance, which only some will pass [32]) had better levels of motor coordination than the sub-elite (Athletes who had only completed the first stage, sports initiation [32]) athletes. Four studies (20%) analysed young

artistic gymnastics athletes, demonstrating a positive relationship between motor coordination and good results in future competitions and enabling the differentiation between elite and non-elite athletes. Finally, three studies (15%) had table tennis as their axis, focusing on general motor tests to help detect young talent.

The other studies (7 articles, 35%) analysed young athletes from different sports: volleyball [30, 33], sailing [34] ice skating [18], taekwondo [35], rhythmic gymnastics [36], and skiing [37]. The investigations on ice skating and rhythmic gymnastics described athletes with better coordinative performance and good results in future competitions. In all others, the elite athletes showed better results in motor coordination and in the specific skills of a given sport compared to the non-elite athletes.

Motor tests

The KTK test appeared as the most recurrent test to estimate the level of motor coordination in young people, having been used in 12 studies (60%). In four studies, the test predicted the arrival on podiums of disputed competitions, with high performances, specifically in soccer, artistic gymnastics, and ice skating. Eight other studies used the test to measure the motor coordination of elite and non-elite athletes in volleyball, soccer, taekwondo, sailing, and artistic gymnastics. These researchers noticed a higher level of the variable in elite athletes than in their non-elite peers. Only one study noted no differences between elite athletes and those who gave up sports, in this case, soccer.

The TGMD-2 test was used in only one study (5%). The test, which measures general motor coordination involving manipulative and locomotor skills, was designed to select gmnasts for a training program [38]. At the time, the selected youngsters had a higher level of general motor coordination than the non-selected ones.

BOT-2 was also present in only one study [39]. The authors used the BOT-2 to measure the motor coordination of pre-pubescent soccer players, identifying a positive and sinificant relationship between fundamental motor skills and the acquisition of specific motor skills in soccer, such as, for example, dribbling.

The other studies (3 studies, representing 15% of the total articles) assessed motor coordination without using a standardised motor test. The three studies were related to table tennis, and the tests could predict future results in competitions they participated in and young athletes who stood out. Furthermore, using such tests could facilitate the detection of new athletes for table tennis. Finally, the general motor coordination of these athletes was significantly related to the good performance of specific motor skills in table tennis.

Discussion

This work aimed to verify the use of the assessment of general motor coordination levels, carried out through generic tests, in the process of identifying sporting talent in young athletes of different age groups and sports.

The results of longitudinal studies found a positive association between levels of motor coordination and performance in different sports [19, 36, 40–42, 31]. In these studies, developmental levels were associated with females' future performance in artistic competitions [19, 36, 40]. Furthermore, coordination levels were predictors of the future performance of males and females in table tennis [41, 42]. In terms of performance discrimination, retrospective design studies have shown that young elite athletes achieved higher levels of coordination than their non-elite peers in football [31] and taekwondo [35]. In a retrospective study with female volleyball athletes, Pion et al. [30] obtained motor coordination data assessed 5 years earlier to examine differences between current elite and sub-elite athletes. The main results of this study were that current elite athletes had better motor coordination compared to retrospective data than sub-elite athletes. Therefore, the results of these longitudinal studies confirm the hypothesis that the levels of motor coordination, assessed through generic tests, may be important indicators of the motor potential that a young individual will develop throughout childhood and adolescence [19].

The results of cross-sectional studies also indicated a positive association between levels of coordination and performance in different sports. Such studies indicated that elite athletes achieved better levels of motor coordination than sub-elite athletes in football [43], sailing [34], artistic gymnastics [44] and ice skating [18]. Likewise, Šalaj et al. [38] found that young athletes who participated in an artistic gymnastics training program had better levels of motor coordination than their peers participating in a recreational gymnastics program. Furthermore, in terms of the correlation between performances, the results of cross-sectional studies revealed that levels of motor coordination are positively associated with performance in table tennis [20], volleyball [33], skiing [37] and football [39]. Likewise, Chagas et al. [45] found a positive association between levels of motor evolution and performance in volleyball-specific motor skills. In fact, the results of these cross-sectional studies were expected, given that

specialised motor skills are at the top of the motor hierarchy; that is, they are considered body movements of the highest complexity [46, 24]. As such, it is expected that coordination levels are correlated with performance in sport-specific motor skills, and elite athletes show better coordination than their peers at lower levels of competition.

In general, the results indicated that motor coordination levels are positively associated with the sports performance of young athletes in different sports. In this sense, in the present study, it was found that the measurements obtained through generic motor tests, such as the KTK [25], the TGMD-2 [47] and the BOT-2 [48], were capable of predicting future sports performance, discriminating the sports performance of athletes and whether it correlated with the performance of sport-specific motor skills. Therefore, the findings of the present study suggest that the assessment of general motor coordination levels, carried out through generic tests, can contribute to the process of identifying sporting talent in young athletes.

Regarding the type of test, it is worth highlighting that the KTK [25] test was used in the majority of the studies (12/20, 60%), which is composed of tasks that require specific forms of body displacement, such as walking backwards, jumping, lateral transposition and side jumps. However, other generic motor tests were also used, such as the TGMD-2 [47], involving locomotor and manipulative skills, and the BOT-2 [48], involving fundamental motor skills such as walking on a line, jumping in a limited location, unilateral lower limb balance and object control. All of these generic tests are scientifically reliable [25, 47, 48] and, possibly for this reason, are among those most commonly used to assess the motor competence of young people in studies on sporting talent.

This research has some limitations. The most visible of all is the high number of cross-sectional investigations on the topic chosen for this systematic review. Another important point is that the literature has a vast number of investigations on football [48], which was repeated in our results, which may make it difficult to understand the relationship of these results to other sports. Furthermore, the majority of the studies selected come from the European continent and their results [17, 18, 30, 31, 40, 44] cannot be extrapolated to other countries that have long been a global sporting powerhouse. Furthermore, the two investigations that used motor tests other than the KTK, but which are also scientifically validated (BOT-2 [49] and TGMD-2 [47]) present a small sample size compared to the KTK-based studies.

Conclusion

The results obtained in this systematic review suggest that the assessment of general motor coordination levels carried out through generic tests can contribute to the identifying talent in young athletes from different sports. It is important to highlight that the results demonstrate once again the importance of being based on a multifactorial assessment [19, 30, 48] and not just on physical aspects [17].

Furthermore, our study found that levels of motor development assessed using generic tests other than the previously investigated KTK [23], such as TGMD-2 [47] and BOT-2 [49], are also associated with sports performance in young athletes. However, we suggest that further investigations using the respective tests be carried out, due to the research results, which were minimal.

Therefore, it seems plausible to recommend that sports professionals consider inserting generic motor tests to assess general motor coordination in programs aimed at discovering sports talents. Furthermore, the use of generic motor tests can also be important for making pedagogical decisions where sports performance is not the focus, such as in school and recreational contexts. In this sense, it is known that Physical Education teachers frequently incorporate motor assessments into their teaching program [50], just as sport is a content frequently used at different levels of education. Therefore, the results of generic coordination tests, which are relatively low cost, can be applied by teachers to direct pedagogical interventions in teaching sports motor skills compatible with the level of coordination of their students.

Ethical approval

The conducted research is not related to either human or animal use.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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Table 1. Characteristics of the included studies

Papers	Study design	Sample characteristic	Instrument	Methodological quality of the study	Outcomes
Bennet (2020) [43]	cross-sectional	*N* = 165 males age: 13–14 elite athletes	KTK	5-high quality	Males participating in a level (superior) training program performed better in motor coordination than males involved in a level 2 program
Callewaert (2014) [34]	cross-sectional	*N* = 47 males age: 10–18 elite athletes	KTK	5-high quality	Young elite sailing athletes showed higher levels of motor coordination than their non-elite sailing peers
Deprez et al. (2015) [31]	retrospective	*N* = 388 males age: 8–18 elite athletes	KTK	4-medium quality	Soccer athletes had greater motor coordination than players who dropped out, when analysed retrospectively, 6 years later
di Cagno et al. (2014) [36]	longitudinal	*N* = 100 females age: 11–13 elite athletes	non-standard instrument	5-high quality	Gymnasts who had higher levels of general motor coordination achieved better results in competitions three years later
Faber et al. (2016) [20]	longitudinal	*N* = 48 females and males age: 7–11 elite athletes	non-standard instrument	5-high quality	Assessment of underlying perceptual motor skills was a predictor of future performance 6 months later in both males and females playing table tennis
Faber et al. (2017) [41]	longitudinal	*N* = 1191 females and males age: 7–10 non-elite athletes	non-standard instrument	5-high quality	Tests of 'dribbling speed' and 'throwing a ball' were shown to be significant predictors of table tennis performance 15 years later in both males and females
Faber et al. (2017) [42]	cross-sectional	*N* = 267 females and males age: 8–10 non-elite athletes	non-standard instrument	5-high quality	Male and female, table tennis practitioners, outperformed their primary school peers in all 'ball control' items
Kokstejn et al. (2019) [39]	cross-sectional	*N* = 40 males age: 12 elite athletes	BOT-2	4-medium quality	Motor coordination levels showed a positive correlation with dribbling speed in soccer
Mroczek et al. (2017) [33]	cross-sectional	*N* = 150 males age: 15 non-elite athletes	non-standard instrument	4-medium quality	Volleyball athletes with good levels of general motor coordination showed good performance levels in specific volleyball motor skills
Mostaert et al. (2016) [18]	cross-sectional	*N* = 32 females age: 9–12 elite athletes	KTK	4-medium quality	Elite ice skating females showed better levels of motor coordination than non-elite females

Norjali Wazir et al. (2019) [35]	cross-sectional	*N* = 98 females and males age: 12–17 elite athletes	KTK	3-medium quality	Young elite taekwondo athletes showed better levels of coordination than their sub-elite peers
Pion et al. (2015) [40]	longitudinal	*N* = 243 females age:6–9 elite athletes	KTK	3-medium quality	Motor coordination levels were related to the continuity of athletes in artistic gymnastics and to good results in competitions in this sport
Pion et al. (2015) [30]	retrospective	*N* = 21 females age: 15 elite/non-elite athletes	KTK	4-medium quality	Elite female volleyball athletes showed better levels of motor coordination than sub-elite female athletes
Platvoet (2020) [51]	longitudinal	*N* = 131 males age: 8–11 elite/non-elite athletes	KTK	5-high quality	No differences were found in motor coordination levels between elite and non-elite soccer players
Šalaj (2019) [38]	cross-sectional	*N* = 31 females and males age: 6 elite/non-elite athletes	TGMD-2	3-medium quality	Young athletes participating in an artistic gymnastics training program showed better levels of motor coordination than their peers participating in a recreational gymnastics program
Stöggl et al. (2015) [37]	cross-sectional	*N* = 51 females and males age: 13 elite athletes	Non-standard instrument	5-high quality	Young people who had good results in general motor coordination assessments performed well in ski-specific motor skills
Tribolet et al. (2018) [17]	cross-sectional	*N* = 277 males age: 12–15 elite athletes	KTK	3-medium quality	Motor coordination levels did not show significant variation according to the level of young athletes (selected vs. excluded from a high-level training program)
Vandendriessche et al. (2012) [52]	cross-sectional	*N* = 78 males age: 15–16 elite athletes	KTK	5-high quality	Levels of motor coordination did not distinguish athletes in terms of biological maturity
Vandorpe et al. (2011) [44]	cross-sectional	*N* = 168 females age: 6–8 elite/non-elite athletes	KTK	4-medium quality	The potential elite athletes showed better levels of coordination than gymnasts with sub-elite potential in artistic gymnastics
Vandorpe et al. (2012) [19]	longitudinal	*N* = 23 females age: 7–8 non-elite athletes	KTK	4-medium quality	Levels of motor competence were predictors of the performance 2 years later of females in artistic gymnastics competitions

KTK – Körperkoordinationstest für Kinder, BOT-2 – Bruininks-Oseretsky Test of Motor Proficiency Second Edition, TGMD-2 – Test of Gross Motor Development
Non-standard instrument: a non-standardised motor test refers to tests that have not gone through a validation process and do not meet reliability ratings in the scientific community

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