Original Article

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Current Approaches to Motor Competence Assessment in School-Age Children

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Abstract

Introduction: The importance of motor competence is particularly evident at school ages when any intervention approaches have the most significant impact. *Aim of Study:* The theoretical study aims to provide an overview and compare the descriptive and psychometric characteristics of the assessment tools that we can use to determine the level of motor competence in primary school-aged children. We paid particular attention to the possibilities of identifying motor competence deficits. *Material and Methods:* From the overview list of assessment tools, we selected the following for more detailed analysis: Movement Assessment Battery for Children-2, Körperkoordinatationstest für Kinder, Test of Gross Motor Development-Third Edition, Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, Test zur Erfassung motorischer Basiskompetenzen. The presented article compares the possibilities of using these tests in the European environment in terms of their psychometric and descriptive characteristics. *Results:* Each submitted tests has certain advantages and disadvantages in the practical use, collection, evaluation, and interpretation of the data. Based on established criteria in descriptive and psychometric characteristics, we selected using the comparative method as the most appropriate means to assess the level of motor competence of the Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition. *Conclusion:* The Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition, presents the most comprehensive diagnostic tool to assess motor competence and its difficulties, despite shortcomings such as the absence of normative-related criteria in more European countries and time-consuming testing. The time-consuming test and the suitability of individual access to the person being tested to collect and evaluate data make it difficult to establish the test battery as the gold standard in motor competence diagnostics. From a practical point of view, the material presented will help facilitate the choice of a specific assessment tool according to the educational or clinical goal of the research.

Keywords: Motor competence, primary school, validity, reliability, psychomotor development

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INTRODUCTION

Health is a state of complete physical, mental and social well-being [1]. According to World Health Organization (WHO), 60% of related factors to individual health and quality of life are correlated to lifestyle. Regular physical activity (PA) contributes to maintaining and improving health and is important for human development throughout a person's entire lifespan. Normal psychomotor development accompanied by an adequate amount of PA in infancy and early childhood is crucial for the development of mental and physiological health [2].

The concept of Physical Literacy (PL) has been created to encourage the development of health through an active lifestyle. This concept focuses not only on the facilitation of health-related fitness but also focuses on areas such as motivation, confidence, motor competence (MC), knowledge, and understanding to value and take responsibility for engagement in PA [3]. Thus, the concept of PL incorporates four interrelated domains, namely physical, psychosocial, social, and cognitive domains. The understanding of causality among particular domains included in the concept of PL is not entirely clear. Schmutz et al. [3] point in early childhood to the independent development of MC and PA. A positive relationship exists between MC and PA across childhood, according to Robinson et al. [4]. Stodden et al. [5] have proposed a theoretical model, which assigns an important role to the age of a child when examining the relationship between PA and MC. According to this model, it is assumed that the association between PA and MC is more significant and reciprocal during the stages of middle and late childhood.

Different theories of motivated behavior applied to understanding and predicting PA participation (e.g., competence motivation theory, self-efficacy theory) highlight perceived competence as one of the most consistent predictors of PA [6].

MC, which is the main topic in this article, is defined as the level of development of fundamental motor skills (FMS), including locomotor, manipulative, and balance skills appropriate to the stage of ontogenetic development. MC is a person's proficiency to execute motor skills as well as the underlying mechanisms, including motor coordination and control [7].

The evolution of terms within motor development has created ambiguity in terminology within the literature and across the various disciplines and sub-disciplines of human movement. There remain a variety of terms used to describe levels of movement skill. Contemporary use of the term MC reflects various terminologies that have been used in previous literature (i.e., motor proficiency, motor performance, fundamental movement/motor skills, motor ability, and motor coordination) [7] .

In fact, socioeconomic status (professional occupation and education levels of mother and father), house living space (the type of housing; existence near the house of a courtyard, terrace, garden, or yard where the child can play), the child's interaction with peers (age of preferred playmates, sex of preferred playmates, interaction with peers out of school), and the educational practices within the family (geographical limit of child's play in relation to household, type of toys, relative time spent by each parent with the child), are significantly associated with children's MC [8]. Appropriate development of FMS is an essential prerequisite for an active lifestyle and overall well-being. Children who display an adequate level of FMS are more likely to be physically active throughout their life and possess the well-developed aerobic capacity, and are less likely to become overweight or obese [9]. Active lifestyle positively influences parameters associated with physiological health and health-related fitness and aspects of psychosocial health such as cognitive function and social and emotional development [10].

Although motor development is a lifelong process, the essential stage for FMS learning and development is childhood, which is also a critical period for MC development. FMS acquired during early childhood are the basis for learning more complex and specific motor skills in later stages of life. Moreover, FMS developed during early childhood create a foundation for motor skills associated with everyday life [4].

Children who fail to acquire an appropriate level of FMS struggle with learning more complex motor skills. In addition, these children often attempt to avoid PA which require a higher level of motor skills and therefore represent a higher risk of failure. Thus, these children tend to be unwilling to participate in PA both in childhood and later in adulthood, contributing to all negative consequences of a sedentary lifestyle [10]. Most complications related to a low level of MC are demonstrated in

primary school-aged children because the school readiness is being assessed, and these children are being evaluated in a school setting.

Over the past ten years, the research regarding MC and FMS has primarily focused on motor delays and deficits. Insufficient level of MC is generally associated with poor quality of movement, motor control, and coordination. In motor deficits assessment, also commonly known as MC assessment, it is prevalent for researchers to use terms such as low MC and developmental coordination disorder or dyspraxia (DCD) interchangeably. DCD is a neurodevelopmental motor disorder characterized by psychomotor delay and fine and gross motor development delay without obvious intellectual or medical causes [11]. DCD diagnostics is frequently used in a clinical setting, and low MC is one of the crucial indicators used when diagnosing DCD. When considering the application of appropriate intervention, it is essential to distinguish whether motor deficits have been developed through the insufficient amount of PA or whether these deficits result from a neurodevelopmental disorder.

The aim of this article is to establish an overview of diagnostic tools for an assessment of MC in primary school-aged children. In addition, this research article aims to shed light on motor deficits, improve understanding of MC assessment in the concept of PL, describe the correct application of particular assessment tools, and evaluate their applicability in a European setting.

MATERIAL AND METHODS

Many tools for MC evaluation are listed in the scientific literature. To analyze descriptive and psychometric characteristics, we selected test batteries according to the following criteria. The main criteria used for selecting assessment tools include assessing FMS level, MC, movement quotient, general MC, motor skills, motor coordination, and other variables describing the same phenomenon published in indexed journals in English or German. Studies that used tests to measure fine motor skills or specific sport-related skills exclusively or used only a single test item were not included.

Another selection criterion was the age category of primary-school-age children, i.e., the period from 6/7 years to 11/12 years. Due to the selected inclusion criteria, some frequently used assessment tools for preschool children have been excluded, such as Motoriktest für Vier- bis Sechsjährige Kinder - MOT 4-6 [12].

Assessment tools designed for neurotypical children have been included. On the other hand, assessment tools with the primary focus on specific populations with disabilities such as Gross Motor Function Measure (GMFM) to measure changes in gross motor function over time or with intervention in children with cerebral palsy have not been included [13].

Furthermore, some of the assessment tools that are not being used very frequently and include outdated normative data have been excluded, for example, Trampolin-Körperkoordinationstest published in 1963 [14].

The last criterion for selecting test batteries is the availability of basic psychometric parameters in the literature. When selecting a suitable assessment tool, it is crucial to consider the psychometric properties of a particular assessment tool. The most important criteria for choosing an assessment tool are content validity, validity criteria, construct validity, test-retest reliability, inter-rater reliability, and the internal consistency – Cronbach's alpha [15].

Methodology recommended in AERA/APA/NCME [16] has been used to evaluate the validity and reliability of the selected assessment tools. The overall score consisted of evaluating content validity, validity criteria, and construct validity. Similarly, the overall score for reliability has been calculated from test-retest reliability, inter-rater reliability, and the internal consistency – Cronbach's alpha. Each component of validity and reliability is evaluated by 0 or 1 based on the quality and availability of variables in published research articles. The overall psychometric score is expressed as the sum of validity and reliability scores.

An overview of the selected assessment tools used for an evaluation of MC in primary school-aged children, their description, and the authors is provided in Table 1.

Table 1. An overview of the selected assessment tools used for an evaluation of MC in primary school-aged neurotypical children

Name of an assessment tool	Abbreviation	Authors and year of publication
Movement Assessment Battery for Children 2	MAB-C 2	Henderson, S. et al. (2007)
POLYGON - A New Fundamental Movement SkillsTest	POLYGON	Zuvela, F. et al. (2011)
Körperkoordinationstest für Kinder, 3. Aufgabe	KTK 3	Kiphard, E. J., & Schilling, F. (2007)
KTK-3 and Faber's eye hand coordination test	KTK-3+EHC	Platvoet et al. (2018)
Test of Gross Motor Development-Third Edition	TGMD-3	Ulrich, D. A. (2016)
McCarron assessment of neuromuscular development, fine and gross motor abilities	MAND	McCarron (2007)
Bruninks-Oseretsky Test of Motor Proficiency, Sec. Edition	BOT 2	Bruininks, R. H., & Bruininks, B. D. (2005)
McCarron Assessment of Neuromuscular Development	MAND	McCarron, L. T. (1997)
Allgemeiner Sportmotorischer Test	AST 6-11	Bös, K. (2000)
Manchester Motor Skills Assessment	MMSA	Bond, C. et al. (2007).
Motor Skills Development as Basis for Learning	MUGI	Ericsson, I. (2008)
Test zur Erfassung motorischer Basiskompetenzen	MOBAQ	Herrmann et al., (2016)
Zurich Neuromotor Assessment	ZNA-2	Kakebeeke et al. (2018)

RESULTS

We selected the final five test batteries for more detailed descriptive and psychometric characteristics. The manual in English or German and possibly normative criteria for the European geographical area are available for these batteries.

In the case of more versions of a particular assessment tool, only the latest version has been included. Moreover, screening questionnaires, which are intended for a school setting but do not meet the requirements of standardized assessment tools or are supposed to be primarily answered by parents or teachers, have been excluded.

Five final assessment tools are Movement Assessment Battery for Children 2 [17], Körperkoordinationstest für Kinder, 3. Aufgabe [18], Test of Gross Motor Development-Third Edition [19], Bruininks-Oseretsky Test of Motor Proficiency, Sec. Ed. [20], Test zur Erfassung motorischer Basiskompetenzen [21]. Assessment tools are described in detail in Table 2.

Descriptive characteristics

1. Movement Assessment Battery for Children-2
   - Description: The MABC-2 is designed to assess development of FMS and is primarily focused on identification and description of motor impaiments for the application of interventions in a clinical setting, an evaluation of the effectiveness of interventions and for the use as an assessment tool in research investigations.

Table 2 Assessment tools selected for a descriptive and psychometric analysis

No.	Selected assessment tools	Main outcome
1	Movement Assessment Battery for Children 2	Total score of motor Proficiency
2	Körperkoordinationstest für Kinder, 3. Aufgabe	Motor competency
3	Test of Gross Motor Development-Third Edition	Gross motor composite
4	Bruninks-Oseretsky Test of Motor Proficiency, Sec. Ed.	Total motor composite
5	Test zur Erfassung motorischer Basiskompetenzen	Basic motor competencies

- Age range: This assessment tool is recommended for children and adolescents between ages of 3 and 16.9 years with 3 specific age groups including: the first age group (3–6 years), the second age group (7–10 years) and the third age group (11–16 years).
- Content: This assessment tool comprises of three parts: standardized motor assessment, questionnaire and an intervention manual. Standardized motor assessment and questionnaire are focused on identification and description of motor deficits. While standardized motor assessment requires a child to be present, the questionnaire is completed by an adult who evaluates motor skills of the subject. The MABC-2 includes 32 tasks in total and these tasks are divided into components: fine motor skills – manual dexterity, gross motor skills – aiming and catching and balance.
- Evaluation: The MABC-2 incorporates 8 movement tasks for every age group. Each movement task is evaluated on a scale from 0 to 6 (0 being the poorest score and 6 being the best score). Subsequently, these scores are calculated into the standard score. The standard scores are then interpreted based on the normative data using percentiles (≤ 5 percentile indicates severe motor deficits and ≤ 15 indicates low MC). It is also possible to examine individual components in detail to get a more specific assessment. In addition, the use of the qualitative evaluation is optional. This diagnostic tool is available in Swedish, Danish, Dutch, Italian, Finish, Chinese and Czech.
- Completion time: 20 – 40 minutes, Price: It is possible to buy a complete set for 816 €.
- Advantages: One of the biggest advantages of the MABC-2 is its availability for a number of European countries and its cultural validity. Another advantage of the MABC-2 is relative short completion time and an easy administration of this assessment, which enables an assessment of a higher number of participants at the same time.
- Disadvantages: The main disadvantage of the MABC-2 is a relatively wide age range, which results in a loss of sensitivity [7]. Moreover, qualitative assessment of the MABC-2 is only focused on the difficulties which participants experience throughout the testing and does not have any influence on the final score. The MABC-2 is intended for the identification of motor deficits and is not designed for an evaluation of above-average results from individual test components. Some authors criticize the assessment of younger children in the MABC-2. In addition, the MABC-2 does not include a separate evaluation for boys and girls. The last disadvantage of the MABC-2 is a relatively high price of the complete test kit.

2. Körperkoordinationstest für Kinder

- Description: The main function of the KTK is an assessment of gross body control and coordination. This assessment tool can used for both neurotypical children and children with intellectual disabilities [22]. The original version of this assessment tool was published in 1974. Since 2017, a third edition of the KTK has been available. The KTK is recommended for a clinical setting as well as a school setting.
- Age range: This assessment tool is designed for children between 5 and 14 years of age. It includes a specific assessment for boys and girls.
- Content: It consists of 4 subtests focused on coordination: walking backwards, moving sideways, hopping for height and jumping sideways.
- Evaluation: The overall score of gross body control and coordination is calculated from the results of the four subtests and is expressed in percentiles. The overall score might indicate motor deficits as well as possible strengths in motor development. The test is available in German, Dutch, and Romanian.
- Completion time: 20 minutes. Price: 570 €.
- Advantages: This assessment tool is standardized and is considered to have a very good test-rest reliability. Administration of this assessment tool is easy and takes only around 20 minutes.
- Disadvantages: The main disadvantage is that this assessment tool does not contain recent normative data, except for the normative data of the population in Germany. Moreover, this assessment tool does not include testing of object manipulation skills.

3. Test of Gross Motor Development-Third Edition
   - Description: The main focus of this assessment tool is an evaluation of gross motor development, identification, planning and assessment of changes in development of FMS. This assessment tool is used for an identification of children who experience motor development delay and display symptoms of DCD. Test of Gross Motor Development-Second Edition (TGMD-2) is based on the original edition Test of Gross Motor Development (TGMD), which was published in 1985. The latest edition Test of Gross Motor Development-Third Edition (TGMD-3) was published in 2017. The main differences between TGMD-2 and TGMD-3 are changes in the content of testing components. Despite the fact that the normative data included in this assessment tool are obtained from the population in the USA, normative data from TGMD-3 has been validated in a previous study, which has examined children from Ireland [23].
   - Age range: It is recommended for children aged 3–10.9 years.
   - Content: TGMD-3 is used to assess performance of 13 FMS, which are divided into two subscales: locomotor skills and ball skills. Locomotor skills include movements requiring gross motor skills such as running, galloping, one-legged hopping, skipping, sliding and jumping. The subscale of ball skills comprises of movements such as catching, kicking, dribbling, one-hand strike, two-hand strike, overhand throw and underhand throw. In total, this assessment tool consists of 6 locomotor skill tasks and 7 ball skill tasks.
   - Evaluation: Each movement task is evaluated based on 3 to 5 performance criteria. When the quality of the movement meets the performance criteria, it is scored by 1 point. Conversely, the quality of the movement is scored by 0 point when the performance criteria are not fulfilled. Overall score is calculated as the sum of the scores from all movement tasks. Furthermore, based on the overall score, it is possible to calculate gross motor development quotient (GMDQ), locomotor composite and object motor composite. The test is available in English and German.
   - Completion time: testing time 15–20 minutes, 15–20 minutes required to evaluate the results. Price: $150.00.
   - Advantages: One of the advantages of the TGMD-3 is an easy administration and easily accessible equipment required for the administration. This equipment includes basic tools commonly used during physical education classes. The biggest advantage of the TGMD-3 is the inclusion of the qualitative evaluation in the final outcome. Furthermore, this assessment tool includes both motor deficits identification and talent identification.
   - Disadvantages: The TGMD-3 does not include an assessment of fine motor skills and balance skills. However, the biggest disadvantage of the TGMD-3 is cross-cultural differences in the ball skills subtests, specifically, one-hand strike, two-hand strike and overhand throw.

4. Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2)
   - Description: The BOT-2 is an assessment tool designed to measure overall motor development and motor performance in specific subcategories in the general population as well as in special population groups such as individuals with intellectual disabilities, autism spectrum disorders and attention deficit hyperactivity disorder. This assessment tool is used for identification of mild to moderate motor deficits. Moreover, it can be employed as a part of a complex set of assessment tools for a diagnosis of DCD. The original version of Bruininks-Oseretsky Test of Motor Proficiency was published in 1923. Over the years, there have been multiple editions of this assessment tool such as Bruininks-Oseretsky Test of Motor Proficiency (BOT) published in 1978 or the latest edition the BOT-2 published in 2005 [20]. The BOT-2 includes both a complete form and a short form. The short form consists of 14 test items selected from all 8 subcategories. Normative data for the BOT-2 scores include only the population in the USA, Canada and German speaking European countries. The BOT-2 is primarily recommended to be used in a clinical setting; however, it is possible for the BOT-2 to be used in a school setting. Due to administration time being relatively time-consuming, the BOT-2 is not recommended to be used to assess a higher number of subjects at the same time.

- Age range: The BOT-2 is designed for individuals 4–21 years of age. Recently, a new edition designed for individuals aged 40 years and older has been published. Moreover, an edition intended for German speaking countries includes a shorter age range of 4–14.9 years of age compared to the edition recommended for English speaking countries.
- Content: The complete form of the BOT-2 comprises of 4 motor area composites: fine manual control, manual coordination, body coordination, strength and agility. Each motor area composite includes two subtests and each subtest consists of 5–9 test items. A total of 53 test items is included in the complete form of the BOT-2.
- Evaluation: Outcomes of the BOT-2 include a total motor composite, gross motor composite, fine motor composite and the results of each individual subtest. In addition, qualitative evaluation, which is included in the total motor composite score, is used to assess participant's attention, effort, body posture, understanding of the activities and the quality of movement. When using the short form of the BOT-2, it is possible to get results only for a total motor composite without the results of individual subcategories or it is also possible to assess only fine motor skills or gross motor skills. The test is available in English and German with its own normative criteria for Austria, Germany, and Switzerland.
- Completion time: The short form takes 15–20 minutes; the complete form takes 45–60 minutes. An online evaluation program is not available for the German edition of the BOT-2, and manual evaluation takes around 60 minutes. Price: 1,217 €.
- Advantages: The BOT-2 is the most complex assessment tool, which includes 53 test items and a wide age range. The BOT-2 provides not only overall motor composite, but also details about the results of individual subtests, which enables an identification of specific motor deficits and consequently an application of an appropriate intervention. Moreover, overall motor composite includes qualitative evaluation, which can be beneficial for an identification of DCD.
- Disadvantages: The main disadvantage of the BOT-2 complete form is a time-consuming administration, which often results in a loss of motivation and attention in children. Even though, it is possible to divide the administration into multiple days, it is quite complicated. Another disadvantage is that in order to correctly administer the BOT-2, the administrators should possibly have an appropriate training. Moreover, the evaluation of 53 test items, subtests and a total motor composite is very time-consuming. It requires experience in proper use to eliminate errors in manual evaluation.

5. Test zur Erfassung motorischer Basiskompetenzen MOBAK
   - Description: The MOBAK test instrument is designed for an assessment of FMS in a school setting. It is possible to use the MOBAK for an assessment of individuals, groups or as a screening tool for a class of students. In German speaking countries, development of FMS is the central learning outcome of physical education and it is a fundamental part of a primary and secondary school curriculum. The MOBAK is used in order to assess a class of students by a teacher and help the teacher to adjust lessons aaccording to the results of the assessment [21]. The MOBAK includes normative data of the population from German speaking countries. Translations of the assessment and the evaluation are available in several languages.
   - Age range: MOBAK-1-2 is recommended for children aged 6–7 years old attending first and second grade, MOBAK 3-4 is recommended for children aged 8–9 attending third and fourth grade, MOBAK-5-6 is recommended for children aged 10–11 attending fifth and sixth grade, MOBAK-KG, which is still in the process of development, is supposed to be designed for children aged 4–5 attending kindergarten.
   - Content: All editions of the MOBAK encompass an assessment of FMS divided into two separate categories and these are 1) self-movement including test items such as balancing, rolling, jumping, running and 2) object movement including test items such as throwing, catching, bouncing and dribbling. Difficulty and complexity of the test items is based on the age of participants. The MOBAK assessment requires only basic equipment of an ordinary gymnasium.

Table 3. Evaluation of validity and reliability of the selected assessment tools (derived from [24,25]).

Test	Validity			Validity score	Reliability			Reliability score	Total score
	Content	Criterion	Construct		Internal	Inter-rater	Test- retest		
BOT 2	1	1	1	3	1	1	1	3	6
TGMD-3	1	1	1	3	1	1	1	3	6
KTK	0	1	1	2	0	1	1	2	4
MOBAK	1	0	1	2	0	1	1	2	4
MABC-2	1	1	1	3	1	1	1	3	6

- Evaluation: The scores are adjusted based on gender and age and percentile norms are available in the MOBAK. (MOBAK 1–2: N = 2487; MOBAK 3–4: N = 1480). Performance in individual test items is rated on a dichotomous scale as either successful = 1 or failed = 0. Overall score is calculated as the sum of the scores from the test. In addition, the evaluation can include the overall score as the outcome or self-movement and object movement can be evaluated separately. The test is available in German and English.
- Completion time: In case of a single administrator and 4 participants, the MOBAK assessment takes around 40 minutes. Price: 439,00 €.
- Advantages: The MOBAK assessment tool is easy to administer, require easily accessible equipment and includes an uncomplicated evaluation. Translation of a manual in more European countries is available.
- Disadvantages: The biggest disadvantage of the MOBAK is low criterion validity.

Psychometric characteristics

When selecting a suitable assessment tool, it is crucial to consider the psychometric properties of a particular assessment tool. The most important criteria for choosing an assessment tool are content validity, validity criteria, construct validity, test-retest reliability, inter-rater reliability, and the internal consistency – Cronbach's alpha [16].

To evaluate the psychometric characteristics, we have adjusted the data of the authors' systematic surveys [24,25] (table 3). We have always used the most recent versions of the test batteries of our selection. It represents the contribution limit, but a separate analysis of the psychometric data sources exceeds the contribution possibilities.

DISCUSSION

A study of the scientific literature shows the inconsistency of terminology concerning the concept of MC. In the concept of HRF, there is a relative agreement in aspects and their causality to health. In the area of MC, there is no such agreement. This is already evident when comparing the variables measured on the selected five test batteries. From Table 2 it is evident that the output of the chosen test batteries is five different terms: the total score of motor proficiency, motor competence, gross motor composite, total motor composite, and basic motor competencies. For mutual comparison, it is important to analyze the individual test tasks and how they are evaluated.

Another relevant fact in this context is that test instruments based on different theoretical frameworks often use almost the same motor tasks as test items, with differences arising only in contextual details or scoring [25]. For example, the tasks “aiming and catching” or “one-leg balance” appears in quite similar forms in the MABC-2 and BOT-2, the task “throwing” in the MABC-2 and MOBAQ [21].

When choosing the preferred diagnostic device, the measurement target is essential. When diagnosing MC, the primary purpose is to identify a low level of MC, motor deficits, and delays in an individual in a clinical setting, specify the deficit and propose support.

When monitoring, which focuses on population group measurements, the objective is to screen the current status of the selected groups. The primary purpose of educational monitoring is to evaluate children's achievements, create support and design future educational policies.

The MOBAQ, KTK, TGMD-3 test batteries are designed for monitoring. For diagnostics, it is preferable to choose the complete form of BOT-2 and MABC-2, which are also intended for identifying children at risk of DCD. On their own, it is not possible to decide on the presence of DCD based on the results of these test batteries, but the test batteries are part of the complete diagnostic background.

The tests designed for monitoring contain fewer tasks and are aimed at children with deficits and above-average talents. The diagnostic tests in the full version have more items; they are more time-consuming. They are better at finding potential debilitations, but they are not sensitive to above-average results.

In terms of the number of individual tasks, the most extensive battery is BOT-2. It contains 53 test tasks and details the areas of potential deficits. However, its realization requires at least one hour as well as evaluation. It is balanced by the test's high sensitivity in the complete version. According to the results of Ghrahaei et al. [26], it seems that the BOT-2 has an appropriate validity and reliability as well as a high sensitivity and can be used to evaluate motor skills and diagnose children with DCD.
Time may limit BOT-2 to a more extensive application. For these reasons, a short version of BOT-2 has been developed, which can also be used in the area of monitoring. However, the short form does not provide substantial motor performance assessment and requires a revision [27].

All selected assessment tools meet the instruction, administration, and evaluation criteria. The test kits contain clear instructions for each test item, administration manuals, and a comprehensive scoring guidebook. A convenient set of scoring sheets exists for clinical tools BOT-2 and MABC-2, including qualitative evaluation as a part of the overall score. The qualitative evaluation might focus on details about understanding the tasks' results, quality of the movement, coexisting comorbidities, or laterality problems.

In terms of age, the most extensive is BOT-2. It is designed in the original version up to 21 [20]. The normative criteria for Austria, Germany, and Switzerland have been verified for children up to 14 [28]. The age range is similar for other test batteries.

Suppose we evaluate the most significant advantages and disadvantages of individual test batteries. In that case, the benefit of MABC-2 is the existence of normative criteria in several European countries and the cross-cultural validity [29]. The situation is similar for BOT-2, other tests adopt normative standards according to the land of origin, and only manual translations are used.

The main disadvantage of the MABC-2 is a relatively wide age range, which results in a loss of sensitivity [7]. For BOT-2, the factor structure of individual subtests is determined for specific age categories [27].

KTK lacks the evaluation of fine motor items, namely object manipulation skills. For this reason, the KTK-3+EHC assessment tool, which includes Faber's eye-hand coordination test, was created [30].
The disadvantages of the TGMD-3 test include the absence of fine motor skills and balance skills. For the TGMD-3, cross-cultural validity in the ball skills subtests, specifically, one-hand strike, two-hand strike, and overhand throw, is problematic. It makes the use of this assessment tool more complicated in European countries. The criterion validity indicates that the TGMD-3 may be measuring a slightly different construct to the other assessment tools included in this study. It has a poor agreement with the MABC-2, which has a good agreement with the BOT-2 [31].

The BOT-2 is the most complex assessment tool. It includes 53 test items, encompassing fine and gross motor skills. On the other hand, the most specific assessment tool is Körperkoordinationstest für Kinder, which comprises of 4 test items.

The evaluation of psychometric qualities of the selected assessment tools has been based on the previously published scientific articles.

The BOT-2, the MABC-2, and TGMD-3 have been considered to have the best psychometric qualities. The KTK assessment tool has shown low content validity and internal consistency. The MOBAK lacks some of the psychometric qualities, possibly because this assessment tool is relatively new and has not been frequently used so far.

CONCLUSION

This research article aimed to create a synthesis of descriptive and psychometric characteristics of 5 selected assessment tools designed to evaluate MC in primary school-aged children. These selected assessment tools included Movement Assessment Battery for Children-2, Körperkoordinationstest für Kinder, Test of Gross Motor Development-Third Edition, Bruininks-Oseretsky Test of Motor Proficiency, Sec. Edition, Test zur Erfassung motorischer Basiskompetenzen.
Descriptive and psychometric characteristics can assist with selecting a suitable assessment tool based on fundamental properties, objectives of the assessment, conditions required for administration, recommended training for administers, and validity and reliability.

The objective of the investigation is crucial for the assessment of descriptive characteristics. An evaluation of MC might be conducted for several reasons, such as for educational purposes, identification of motor deficits and delays in a clinical setting, or designing a curriculum for students with special educational needs.

For purposes of monitoring in a school setting, the MOBAK, KTK, and the TGMD-3 are frequently used due to the ability of these assessment tools to evaluate both below-average performance and above-average performance. These assessment tools include sensitivity of MC results throughout the entire scale. These tools are also recommended for the measurement of large groups.
On the other hand, there are diagnostic tools primarily designed to identify motor deficits, such as MABC-2 and BOT-2. The primary function of the selected evaluation tools is the identification of motor deficites; therefore, the sensitivity of these evaluation tools to the identification of talent is low. They serve as a basis for individual DCD diagnosis, and they are not recommended for screening large groups.

The most detailed descriptive characteristics are provided by the BOT-2 test, which contains 53 test tasks. However, it is time-consuming and organizationally demanding. All these selected assessment tools meet the instruction, administration, and evaluation criteria. The test kits of these assessment tools contain clear instructions for each test item, administration manuals, and a comprehensive scoring guidebook. It is essential for more complex assessment tools like the BOT-2 and MABC-2. The possibilities of qualitative evaluation in both diagnostics test batteries might focus on details about the understanding of the tasks, quality of the movement, coexisting comorbidities, or laterality problems.

Another issue associated with the administration of assessment tools is the necessity of training related to the proper use of a particular assessment tool for administers and its availability and time requirements. In Europa, administration training is available for most of the assessment tools. In addition, it is possible to access training abroad or use available manuals to familiarize oneself with the administration and the evaluation.

Based on the results from the psychometric evaluation of the selected assessment tools, the BOT-2, the MABC-2, and the TGMD-3 have been evaluated with identical scores and have displayed better psychometric qualities than KTK and the MOBAK. KTK assessment tool has been shown to have low content validity and internal consistency. The MOBAK exhibits important curriculum validity, but it lacks some psychometric qualities because this assessment tool is relatively new and has not been frequently used yet. There is a lack of scientific research and practical implementation of the MOBAK to confirm its expected potential in motor skill assessment in a school setting.

Overall, with a joint assessment of descriptive and psychometric characteristics, BOT-2 is the most comprehensive diagnostic means of assessing MC, which includes monitoring fine and gross motor items.

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REFERENCES

1. Organization WH. WHO guidelines on physical activity and sedentary behaviour: at a glance . World Health Organization; 2020 https://apps.who.int/iris/handle/10665/337001 (accessed 2021 Jan 24)
2. Whitehead M, editor. Physical literacy across the world. Abingdon, Oxon ; New York, NY: Routledge; 2019. 290 p. (Routlede studies in physical education and youth sports)
3. Schmutz EA, Leeger-Aschmann CS, Kakebeeke TH, Zysset AE, Messerli-Bürgy N, Stülb K, et al. Motor Competence and Physical Activity in Early Childhood: Stability and Relationship. Front Public Health 2020; 8:39. doi: 10.3389/fpubh.2020.00039
4. Robinson LE, Stodden DF, Barnett LM, Lopes VP, Logan SW, Rodrigues LP, et al. Motor Competence and its Effect on Positive Developmental Trajectories of Health. Sports Med 2015; 45(9): 1273–1284. doi: 10.1007/s40279-015-0351-6
5. Stodden D, Langendorfer S, Roberton MA. The Association Between Motor Skill Competence and Physical Fitness in Young Adults. Res Q Exerc Sport 2009; 80(2): 223–229. doi: 10.1080/02701367.2009.10599556
6. Bandura A. Social Cognitive Theory: An Agentic Perspective. Annu Rev Psychol 2001; 52(1): 1–26. doi: 10.1146/annurev.psych.52.1.1
7. Logan SW, Ross SM, Chee K, Stodden DF, Robinson LE. Fundamental motor skills: A systematic review of terminology. J Sports Sci . 2017; 36(7):781-796. doi: 10.1080/02640414.2017.1340660
8. Lopes VP, Monteiro D. Socio-Cultural and Somatic Factors Associated with Children's Motor Competence. J Funct Morphol Kinesiol 2021; 6(2): 54. doi: 10.3390/jfmk6020054
9. Barnett LM, Stodden D, Cohen KE, Smith JJ, Lubans DR, Lenoir M, et al. Fundamental Movement Skills: An Important Focus. J Teach Phys Educ 2016; 35(3): 219-225. doi: 10.1123/jtpe.2014-0209
10. Lubans DR, Morgan PJ, Cliff DP, Barnett LM, Okely AD. Fundamental Movement Skills in Children and Adolescents: Review of Associated Health Benefits. Sports Med 2010; 40(12): 1019-1035. doi: 10.2165/11536850-000000000-00000.
11. Niklasson M, Rasmussen P, Niklasson I, Norlander T. Developmental Coordination Disorder: The Importance of Grounded Assessments and Interventions. Front Psychol 2018; 9: 2409. doi: 10.3389/fpsyg.2018.02409
12. Zimmer R. Handbuch Bewegungserziehung. Grundlagen für Ausbildung und pädagogische Praxis. 1. völlig neu bearbeitete Auflage. Vol. 2020. Freiburg: Verlag Herder; 2020. 277 p.
13. Mayston M. Gross Motor Function Measure (GMFM-66 & GMFM-88) User's Manual, 3rd Edition Dianne JRussell, MarilynWright, Peter LRosenbaum, Lisa MAveryLondon: Mac Keith Press, 2021, pp. 320 ISBN: 978-1-911612-49-0.
14. Kiphard EJ. Psychomotorik in Praxis und Theorie: ausgewählte Themen der Motopädagogik und Mototherapie ; mit 8 neuen Originalbeiträgen sowie zahlreichen Reprints der wichtigsten Arbeiten des Verfassers. 2. Aufl. Gütersloh: Flöttmann; 1994. 242 p.
15. Schneider W, Lindenberger U, editors. Entwicklungspsychologie. 8., überarbeitete Auflage. Weinheim Basel: Beltz; 2018. 925 p.
16. American Educational Research Association, editor. Report and recommendations for the reauthorization of the institute of education sciences. Washington, D.C: American Educational Research Association; 2011. 60 p.
17. Henderson SE, Sugden DA, Barnett AL. Movement Assessment Battery for Children-2 second edition (Movement ABC-2). London (UK): Harcourt Assessment London, The Psychological Corporation; 2007.
18. Kiphard E, Schiling F. Körperkoordinationstest für Kinder 2, überarbeitete und ergänzte Aufgabe. Weinham: Beltz test; 2007
19. Ulrich DA. TGMD-3: Test of Gross Motor Development-Third Edition. 2013th ed. Austin (TX): Pro-Ed.;
20. Bruininks H, Bruininks R. Bruininks-Oseretsky Test of Motor Proficiency | Second Edition. 2005. https://www.pearsonassessments.com/store/usassessments/en/Store/Professional-Assessments/Motor-Sensory/Bruininks-Oseretsky-Test-of-Motor-Proficiency-%7C-Second-Edition/p/100000648.html (accessed 2021 Jan 24)
21. Herrmann C, Gerlach E, Seelig H. Motorische Basiskompetenzen in der Grundschule: Begründung, Erfassung und empirische Überprüfung eines Messinstruments. Sportwissenschaft 2016; 46(2): 60–73. doi: 10.1007/s12662-015-0378-8
22. Victoria, Department of Education, Australian Council for Health PE and R, Victorian Branch. Fundamental motor skills: for sports in schools. Melbourne: ACHPER, Vic. Branch and Dept. of Education, Victoria; 1998.

23. Duncan MJ, Martins C, Ribeiro Bandeira PF, Issartel J, Peers C, Belton S, et al. TGMD-3 short version: Evidence of validity and associations with sex in Irish children. J Sports Sci 2021; 40(2): 138-145. doi: 10.1080/02640414.2021.1978161.
24. Scheuer C, Herrmann C, Bund A. Motor tests for primary school aged children: A systematic review. J Sports Sci 2019; 37(10): 1097-1112. doi: 10.1080/02640414.2018.1544535
25. Eddy LH, Bingham DD, Crossley KL, Shahid NF, Ellingham-Khan M, Otteslev A, et al. The validity and reliability of observational assessment tools available to measure fundamental movement skills in school-age children: A systematic review. Montazeri A, editor. Plos One 2020; 15(8): e0237919. doi: 10.1371/journal.pone.0237919
26. Gharaei E, Shojaei M, Daneshfar A. The Validity and Reliability of the Bruininks–Oseretsky Test of Motor Proficiency, 2nd Edition Brief Form, in Preschool Children. Ann Appl Sport Sci 2019; 7(2): 3–12. doi: 10.29252/aassjournal.7.2.3
27. Carmosino K, Grzeszczak A, McMurray K, Olivo A, Slutz B, Zoll B, et al. Test Items in the Complete and Short Forms of the BOT-2 that Contribute Substantially to Motor Performance Assessments in Typically Developing Children 6-10 Years of Age. J Stud Phys Ther Res 2014; 7(2): 1
28. Blank R, Barnett AL, Cairney J, Green D, Kirby A, Polatajko H, et al. International clinical practice recommendations on the definition, diagnosis, assessment, intervention, and psychosocial aspects of developmental coordination disorder. Dev Med Child Neurol 2019; 61(3): 242–285. doi: 10.1111/dmcn .14132.
29. Psotta R, Hendl J. Movement Assessment Battery for Children - second edition: Cross-cultural comparison between 11-15 year old children from the Czech Republic and the United Kingdom. Acta Gymnica 2012; 42(3): 7–16. doi: 10.5507/ag.2012.013
30. Platvoet S, Faber IR, de Niet M, Kannekens R, Pion J, Elferink-Gemser MT, et al. Development of a Tool to Assess Fundamental Movement Skills in Applied Settings. Front Educ 2018; 3: 75. doi: 10.3389/feduc .2018.00075
31. Griffiths A, Toovey R, Morgan PE, Spittle AJ. Psychometric properties of gross motor assessment tools for children: a systematic review. BMJ Open 2018; 8(10): e021734. doi: 10.1136/bmjopen-2018-021734.