International Journal of Medical, Medicine and Health Sciences
ISSN: 2517-9969
Vol:14, No:11, 2020

Assessment ofPsychomotor Development of Preschool Children: A Review of Eight Psychomotor Developmental Tools

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***Abstract*—**The assessment of psychomotor development allows us to identify children with motor delays, helps us to monitor progress in time and prepare suitable intervention programs. The foundation of psychomotor development lies in pre-school age and is crucial for child´s further cognitive and social development. Many assessment tools of psychomotor development have been developed over the years. Some of them are easy screening tools; others are more complex and sophisticated. The purpose of this review is to describe the history of psychomotor assessment, specify preschool children´s psychomotor evaluation and review eight psychomotor development assessment tools for preschool children (Denver II., DEMOST-PRE, TGMD -2/3, BOT-2, MABC-2, PDMS-2, KTK, MOT 4-6). The selection of test depends on purpose and context in which is the assessment planned.

***Keywords*—**Assessment of psychomotor development, preschool children, psychomotor development, review of assessment tools.

I. Introduction

PRESCHOOL age is a crucial stage of life for improving psychomotor skills such as running, jumping, throwing and others. These fundamental motor skills influence and form the foundation for health, social, educational and emotional aspects of children's life [1]. Early detection of the level of psychomotor development could help us with the identification of children with motor impairment, prepare appropriate intervention programs for them, and prevent potential problems in other domains in children's life. Nowadays, there is an enormous number of diagnostic methods, which are intended to assess the psychomotor development of children. Before using one of them for research or diagnostic work, many aspects must be considered.

This overview study discusses the different aspects of assessment methods of psychomotor development of preschool children. It aims to define the psychomotor development, characterize different types of assessment methods, present a historical preview of assessment, and provide a review of the most used methods of psychomotor development.

Assessing and monitoring the psychomotor development of young children is very important for several reasons. Firstly, human development is multifactorial. Changes in motor development influence changes in cognitive, social, and emotional spheres of life. Those areas of life are in interaction; therefore, we should try to fully understand every each of them [2]. Secondly, psychomotor development is a critical area of life, especially in small children. It is essential to have information about the actual level of psychomotor skills to set the baseline for monitoring the growth and development of children. It also helps us to identify children with psychomotor delays or impairments and allow us to establish appropriate activities and interventions for optimal development [3].

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II. Psychomotor Development

One of the most problematic aspects of research in psychomotor development is ambiguity in terminology and definition of psychomotor development. From the broadest point of view, psychomotor development is seen as all global changes in cognitive, emotional, motor, and social areas of life throughout whole life [4]. Narrower view sees psychomotor development as progressive changes in skills concerning the connection between mental and motor activities [5]. It is very often to use term psychomotor referring to human development that involves human movement. The term motor and psychomotor are often used synonymously. However, some authors distinguish these two terms and refer to the psychomotor as a movement initiated by the motor cortex, whereas motor behavior as the all movement changes in general, including reflexive movements, which are initiated in the lower brain centers [2]. Term psychomotricity is also recognized in the literature. It describes physical activities focused on experiencing feelings during movements and activities [6].

For this article, we deliberately choose to use term psychomotor development as a general term to refer to any form of human movement behavior. The article follows this definition because through the motor experience and activities, children stimulate their thinking, broaden perceptive abilities [7], raise the self-awareness and awareness of the outside world [2]. The connection between mind (psycho) and human movement (motor) is perceived as a whole, which is hard to separate from each other.

The preschool age is considered to be „the golden age" for developing fundamental motor skills [1]. During this period, children build a primary and diverse repertoire of manipulative and locomotor skills, develop goal-oriented motor behavior, and learn to put together two-three movement sequences to accomplish specific goals. That skills repertoire allows them to learn and adapt to different and specific movements contexts [8].

III. Psychological Aspects of Assessment of Psychomotor Development of Preschool Children

Research in psychomotor development is very challenging in itself. Challenges are seen in problematic terminology, an enormous quantity of diagnostics tools, and comparing the results of methodologically diverse studies. Based on these difficulties, the scientific community lacks reliable research in psychomotor development, especially in pre-schoolers.

Preschool children could be difficult participants even if the procedure and content of testing are adapted to their capabilities. Everything they do in the motor domain is affected by their general psychological development, primarily cognitive, emotional, and social development [9]. All these domains are still developing at the preschool age, which causes that data collection with preschool children can be challenging, patience-trying and time-consuming. One of the significant problems with testing their abilities is inconsistency in performance [10] caused by the actual emotional state and biological factors, such as the amount of sleep, fatigue and time of the day. Even with the precise instruction and demonstration of the task, the same child can perform the same task in various ways. For example, when the child is instructed to throw the ball into the target, the child may throw it with right hand overhand and second attempt with left hand underhand [11]. Variation between performances of the child during the time probably reflects normal variation in growth [9]. Children in young age can also alternate from mature stages to less mature stages, and then back to mature stages in development, which can reflect normal development according of the concept of „reciprocal interweaving" [12]. Even more, according to Piaget´s theory of cognitive development, preschool children are unable of conservation, which results in an inability to consider more than one aspect of the problem and are unable to decenter their attention from one particular component of the problem. This inability causes inhibition of activities and games involving multiple movements and sophisticated strategies. These types of activities are very often used in assessment methods of psychomotor development. An inconsistency of the performance is also caused by short spans of concentration [11].

Difficulties with assessing preschool children are also connected with their limited ability of emotional regulation. Emotion regulation is still developing; therefore, they are not always able to rectify their emotions [13]. Emotional experience is very intensive, changes very quickly, and depends on satisfaction or dissatisfaction of their needs, which can interfere with the assessment process.

Preschool children are playful, need to show off, need to be admired and praised. They also need to experience success and achieve goals, which is sometimes in conflict with their very optimistic judgments about their performance [14]. In case of failure, they have tendencies to give up and refuse to continue with the tasks.

An administrator needs to be patient and work with a child until he or she demonstrates what the tester judged to be the maximum [11]. Assessment should be a positive experience for both the child and the examiner [15]. It is helpful to present tasks attractively and to use familiar equipment to the child, do measures in familiar settings such as preschool class, carefully select appropriate assessment tools and take into account the situational conditions such as time of the day or children´s mood.

IV. History of the Assessment of Psychomotor Development

Research in psychomotor development has roots in two science disciplines, psychology, and biology. Biology provides information about the growth and general development of the human organism and psychology supplies knowledge about the development of human behaviour [8]. Some authors [16] dated the beginning of the psychomotor development research between 1920-1930. At this period, physicians and psychologists observe infant´s and children´s movement behavior, and on the base of these observations, developmental scales were created [17]. Roberton [18] set the beginning of the research to the end of the 18th and the beginning to 19th centuries. Clark and Whitall [8] identified the even earlier beginning of motor development research to 1787 when Tiedemann wrote an article about the observation of his two and a half years old son. These authors later described four periods of the history of motor development, which are used to these days.

TABLE I
Clark and Whitall´s Periods in the History of Motor Development

Period	
Precursor period	1787 – 1928
Maturational period	1928 – 1946
Normative/descriptive period	1946 – 1970
Process-oriented period	1970-present

The Precursor Period set a baseline for this scientific area. It is called the precursors period because the main interest of researchers was set more on cognitive than motor development. The primary scientific method of motor development was detailed observation, which was focused on the product of motor skills, but also the basics of studying processes of motor development. The article of Tiedemann [8] initiated the period of studying motor development by a method called baby biography. This technique aims attention to the product of motor development, considering the past of the child. The most famous authors connected with this method are Prayer [19], [20] and Shinn [21]. Fundamentals of process-oriented assessment of motor development relate to Galton [22] and his research of twins.

The Maturational Period was focused on the process of maturation as a primary process of development. The research focused moved from the one case study to multisubject research. Gessel [12] postulated several principles of developmental morphology, such as the principle of developmental directions, the principle of functional asymmetry, the principal of individuating maturation, and

others. Another very important „maturationalist" with Gessel was McGraw [23], who also argued for the importance of biological processes but also considered the importance of learning processes. One of the most critical works in this period is related to Bayley [24], who created normative scales of motor development for children to the age of 3, which are still used nowadays.

A normative/descriptive period was influenced by previous periods and focused primarily on an understanding of motor development of school children and their motor skills. The research was moved to the area of physiotherapy, physical education, and medicine. This period uses both types of assessment of motor development, process, and product, but was more oriented on product assessment. Based on this, there was some misunderstanding in the definition of motor development between product and process-oriented view in contrast to the previous periods [8].

The process-oriented period mainly focused on basics processes, which influence psychomotor development. The interest of the psychologist about psychomotor development has increased. The first decade was influenced by information-processing theory, which proposed that the human brain functions as a computer. The following decades were influenced by dynamical-system theory [25], which brought a new view on assessing psychomotor development. According to this theory, processes that influence psychomotor development are complex, coordinated, and self-organizing.

V. Types of Assessment Tools

In the historical overview of psychomotor development tools, two main types of assessment methods were identified – product and process-oriented assessment [26].

First of them is interested in the product of the psychomotor activity and the prediction of these results in the future. This type of assessment is called a product-oriented assessment. The main goal is to obtain quantitative information about the capabilities of children. It is concerned with the outcomes of the individual´s performance, such as the distance of the long jump, time of the tracked run [27]. Normative data for these tests are given in standard scores or percentiles and are used to compare an individual child with standards typical for children of comparable chronological ages [3].

The second type focused on processes, which underline psychomotor development, and it is called process-oriented assessment. This type of assessment is used for the psychomotor development of very young children, such as preschool age [28]. Process-oriented assessment focused on observing children during the psychomotor task and evaluates process characteristics of the psychomotor ability of the child [27]. It aimed at quality, form, and sequences of movement. It describes specific movement patterns and identifies the level of psychomotor ability [3]. These methods are usually very informal and subjective. An observer should be educated and experienced in the assessment of psychomotor development because of lacking any norms or standardize procedures. On the other hand, more in-depth information can be earned about the psychomotor development of the child, better understanding the problems in the psychomotor abilities of children and factors, which cause impairments or delays. It sees psychomotor development in a holistic view – try to explain the processes, not just describe them. Last but not least, it is used with young children because sometimes it is not possible to use product-oriented assessment, because of the complexity, length, and difficulty.

Clark and Whitall [8] argued that both types of assessment are significant and have widespread use. Therefore the motor development should be defined as changes in motor behavior and processes, which enable them. The most practical evaluation of psychomotor development is a combination of these methods [29], [30]. The product-oriented assessment provides information about the outcomes of the movement and usually is more quantitative. On the other hand, process-oriented assessment is more qualitative and interested in how the child moves in the specific motor task. In some cases, it is very difficult to combine these types of assessments. Therefore motor development tests and scales, which are more product-oriented, are used with older children, and process-oriented scales are intended for younger children [3].

VI. Screening of Psychomotor Development

Screening tools are very often used as the first form of assessment of psychomotor development. It is a straightforward and fast method for the detection of psychomotor delays or impairments. This type of assessment will not provide profound information about psychomotor development, but usually, it is a straightforward method, which can help us identify children with problems and suggest them to undertake the in-depth assessment. Many teachers, parents, and coaches do the screening of psychomotor development by using basic knowledge of characteristics of healthy development and by the perception of signs and symptoms of potential problems in children´s movement.

It is widespread and useful to use screening tools or checklist for helping us and guide us during the observation of children's movements. There are a few tools, which were developed for screening the psychomotor development of the children. The next part describes and compares four of the best known and the most used.

Described screening methods:

1) The Denver II [31]
2) The Democritus Movement Screening Tool for preschool children (DEMOST-PRE) [32]
3) The Movement Assessment Battery for children - 2 Checklist (MABC - 2 Checklist) and Qualitative observation [33]
4) Bruininks-Oseretsky Test of Motor Proficiency: BOT-2 Short form [34].

A. The Denver Developmental Screening Test-II (Denver II) [31]

Denver II is a revised version of the original Denver Developmental Screening Test - DDST [35], which was one

of the most knows and used screening tools for assessing the general development of the child. Revised version, same as an original one, assesses fine and gross motor skills, language, and social development in young children. This method is also able to detect children with slow motor development. The revised test is designed for children from birth to six years. It is a product-oriented assessment intended only as a screening tool [31].

The test consists of 125 items, which are divided into four categories: personal-social, fine motor adaptive, language, and gross motor. Items need to be presented, as described in the manual. Testing starts with the items that fall to the age of the child and continuous to the more complicated items. Testing ends when three failures are obtained in each sector. Items are scored as a „pass", „failed", „no opportunity" or „refusal". After the test, the examiner evaluates the four items of child´s behavior: child-compliance, interest in surroundings, fearfulness, and attention span. The administrator can compare the results of the child with the results of other children in the same age group. Administration requires unique material such as colored wooden blocks, small plastic bottle or plastic cup with handle, cubes. It takes 10-20 minutes to perform the test. Results can show us the children advanced or delayed in psychomotor development. This instrument should be administrated only by the tester, who attended a two-day training course and earned a certificate from the University of Colorado [31].

Denver II standardization sample was collected in 1988 and 1989 on 2096 children from all over Colorado. The inter-rater reliability for the items was 99,7% (range of 83,3%-100%), and test-retest reliabilities were 89% (range of 42,9-100%), which demonstrates that the test is highly reliable. Denver II is not a test of a hypothetical construct; it defines ages at which children achieve a wide variety of specific tasks; therefore, construct validity is not applicable. The validity of this test should be studied through the sensitivity of the test in detecting children who have a significant deviation in development, and its specificity is not generating false-positive results. Therefore, the validity of Denver II was built on the precision with which the ages are corresponding to 25%, 50%, 75%, and 90% passing for each item [36].

The main disadvantages of the test are the need for specialized training for administration and a need for lots of unique items. However, it provides broader information about psychomotor development than just motor information and considers the testing situation such as the surroundings and psychological state of the child. It would also need new norms and psychometric evaluation.

B. The Democritos Movement Screening Tool for Preschool Children (DEMOST-PRE) [32]

DEMOST-PRE is a product-oriented screening assessment developed in Greece. The purpose of this method is to provide necessary information about the motor proficiency of children aged 4-6 years to educators, clinicians, and researchers. The content of the test is a selection of the items from previously designed motor assessment tools for preschool children, such as BOTMP [37], M-ABC [38], and MOT 4-6 [39].

The test is designed especially for the preschool environment. It consists of 9 items (tapping, jumping, running, carrying and placing the ball, walking backward, tossing on target and manipulation with coins), which take around 15 minutes to finish. Hand preference is conducted at the beginning of the administration. Every item is presented through a fairytale, which helps preschool children to be motivated and participate. The scoring system is straightforward. Raw score from every item is converted to a point score. The higher the score, the better is the motor performance. The sum of the nine items gives the total score of DEMOST – PRE [32].

Psychometrics characteristics were assessed on 435 healthy Greek preschool children, between the age of 48 and 71 months. Content validity was established by a panel of the eight experts. The authors also assessed face validity by a panel of 15 potential professional test users, who find the test administration clear, results form is easy to complete, and test provides brief information about the motor developmental status. Correlation between the total battery score and individual item scores ranged from 0.390 to 0.831. Inter- and intra-rater reliability had been tested on a small number of participants before the data collection. Intraclass correlation coefficient (ICC) values for inter-rater reliability were found to be 0.90 and intra-rater reliability were 0.94-0.95, which reveal excellent reliability. Regarding factor analysis, two factors were revealed – Gross motor control (consisted of 5 items) and Visual-motor control (4 items). Gross motor factor explained 33,2% of the variance and Visual-motor control 20,9% [32]. Later research [15] provided evidence for concurrent validity with BOTMP [37] ICC = 0.80.

The advantages of the tool are easily recognizable. Items of the test are easy to administer, conduct, and score. Administration through telling stories is engaging and motivational for children. The method is advantageous because any preschool professional could administrate it, it does not require any specific material and takes only 15 minutes to finish it. On the other hand, further validity and reliability research is needed for the evaluation of this promising assessment tool.

C. The Movement Assessment Battery for children - 2 Checklist (MABC - 2 Checklist) and Qualitative Observation [40]

MABC-2 Checklist is a qualitative part of the well-known complex assessment battery The Movement Assessment Battery for Children – 2 (MABC-2). It emerges from the original version of the test - The Movement Assessment Battery for Children - Checklist [38]. The checklist was added later to the original version because psychomotor development was primarily measured by motor performance tests, which was very expensive and time-consuming for preschools [41]. The primary purpose of the checklist is to describe and provide process-oriented information about the psychomotor competencies of children aged 5 to 12 years [33].

Items of the Checklist are rated by parents, caregivers,

teachers, or coaches, who observe children in their natural environment. Filling the questionnaire takes around 15 min. MABC-2 Checklist has a motor and non-motor part. The motor part consists of 30 items in two sections A and B. Section A evaluates movement in the static and/or predictable environment (e.g. transport objects without dropping them). Section B evaluates movement in a dynamic and/or unpredictable environment (e.g. catches the ball with two hands). Each item is ranked on a 4-point scale (0-very well, 3-not close). The total motor score is the sum of all items. The higher the score, the weaker is the performance. Equipment used in this screening test is usually found in every kindergarten, house, or gym [33].

The total motor score is interpreted based on normative data of 395 children from the United Kingdom [33]. Manual of the test claims that the reliability and validity of the MABC can be generalized to the MABC-2 [40]. Since authors change and add some items, it should be considered as a new instrument, which needs its specific evaluation of reliability and validity. Although the reliability and validity of the original Checklist were investigated [41], the revised version lacks research. Evidence for criterion-related validity is concluded in the manual by two studies [42] but it is not clear how it is demonstrated. Recently, Schoemaker et al. [43] in the Netherlands conducted the study, where they investigated the validity and reliability of the revised Checklist. Construct validity was established by factor validity, which revealed six factors. Discriminative validity was established by a significant difference between the scores of children with and without movement difficulties. Concurrent validity was measured by calculating correlations between Developmental Disorder Coordination Questionnaire [44] and MABC-2. Incremental validity was based on findings that the Checklist is a better predictor of motor impairment than DCDQ´07. Cronbach Alpha was 0.94 for all 30 items together. The MABC-2 Checklist meets standards for validity and reliability.

The main weakness of the MABC-2 checklist is still small reliability and validity evidence. On the other hand, it is a very easy and quick assessment of the psychomotor competencies of the children, which can be filled by parents, teachers, or caregivers.

D.Bruininks-Oseretsky Test of Motor Proficiency: BOT-2 Short Form [34].

The short form of Bruininks-Oseretsky Test of Motor Proficiency - 2 is a product-oriented assessment, which can be used as a screening tool for overall motor proficiency. It should be only used as an indication for further assessment of motor impairment. Same as the Complete version of the test, the short version is aimed for the age range 4 to 21 [34].

The short version of the test consists of 4 subtests with 14 items selected from the complete form of BOT-2. It takes 15-20 minutes to finish the assessment. The scoring system is specific for every item. Raw scores are converted to point scores. The sum of point scores from every item gives a total point score of the short version of the test. The total point score is a result of fine and gross motor skills activities. Results could be reported by percentiles, age equivalents, or descriptive categories ranging from „Well-Below Average" to „Well-Above Average". BOT-2 short version kit is necessary for administration [34].

Correlation between the long and short version of the test is 0.80. The reliability and validity of the short form were assessed with the complete form of the test. The internal consistency of the short test in the three age groups was r = 0.82-0.87. Test-retest reliability is 0.80 and over. Interrater reliability are extremally high for short-form r = 0.97-0.98 [34].

Compared with complete form, the short form is easier and quicker to administer. The administrating process is more engaging than in complete version and less demanding, especially for preschool children. On the other hand, it provides just superficial information about motor development. Therefore, it should serve as a screening method only.

VII. Complex Assessment Tools

Complex assessment tools are usually used when screening tools of psychomotor development indicate some motor impairments or delays; detailed and more specific information about motor development is needed and when the researcher evaluates an intervention program for psychomotor development. The complex test can provide more in-depth information about the composition of psychomotor skills, the process of development, and individual progress of psychomotor skills in time. Many developmental tools, process and product-oriented, were designed during the years. The review includes the following tests:

1) Ulrich test of gross motor development – 2 (TGMD-2 [30]) and Ulrich test of gross motor development – 3 (TGMD-3, [45])
2) Bruininks-Oseretsky Test of Motor Proficiency: BOT-2 [46]
3) The movement assessment battery for children—second edition (MABC-2) [33]
4) Peabody developmental motor scale – PDMS – 2 [47]
5) The KörperkoordinationsTest für Kinder - 2 (KTK-2, [48])
6) Motoriktest für vier-bis sechsjährige Kinder (MOT 4-6, [39])

A. Ulrich Test of Gross Motor Development – 2 (TGMD-2 [30]) and Ulrich Test of Gross Motor Development – 3 (TGMD-3, [45]).

TGMD is one of the most famous process-oriented instruments for assessment of the psychomotor development of children. The third version is based on the original version, which was created in 1985 [49] and the second version created by Ulrich in 2002 [30]. Two skills from TGMD-2 were removed and replaced with three new in the TGMD-3. The third version of the test is available since March 2019 [45]. This third version is designed for children from three to eleven

years. The primary purpose of this method is the identification of children with motor delays or impairments. It is also used for evaluation of psychomotor intervention programs, creating those programs, evaluation of personal progress of the child, and it is used in research [50].

It assesses 13 fundamental motor skills divided into two elements of motor development: locomotor skills (running, galloping, hopping, skipping, horizontal jump and sliding) and ball skills (striking, dribbling, kicking, throwing and catching.) A lot of sports equipment is needed for administration, but the authors suggest that any available equipment is suitable for administration. Every participant has one practice attempt and two assessment trials for each skill. Every skill is evaluated by examining three to five performance criteria (e.g. skipping: 3 criteria – a step forward, position of legs and arms a complete four skips). Skill is evaluated on scale 0 – does not perform correctly or 1 – performs correctly. The highest score for locomotor subscale is 46 points, and ball skills are 54 points [45]. The higher the score, the better is the performance. It takes around 15-20 min par subtest [50].

The authors confirmed that normative data collection is finished and was relieved in 2019 [45]. Evaluation of reliability and validity of TGMD-3 was assessed on 807 children 3-10.9 years of age (M age = 6,33) in the USA. Cronbach's Alpha level exceeded over 0.95 in each age group. Total TGMD-3 test-retest scores had an excellent ICC agreement of 0.97. Test had above acceptable idem discrimination values (0.34-0.67) and also item difficulty values (0.43-0.91). Factor analysis revealed a one-factor structure with 78,82% variance explained, showing acceptable construct validity [51]. The developmental validity of the test was also supported [52]. Psychometrics features of the test were also analyzed in Germany [53], Spain [54], Brazil [55] and Finland [56]. Results show that the assessment tools show a high level of reliability and validity.

It is one of the few assessment tools, which provide both norm- and criterion-referenced interpretation [57]. It is easily administrated and provides qualitative information about movement behavior. Estevan et al. [54] argue that some of the items could be influenced by cultural background. Further work on reliability and validity is needed and it would be beneficial to complete the data collection for new norms.

B. Bruininks-Oseretsky Test of Motor Proficiency: BOT-2 [46]

The second version of the test is a revision of the original test Bruininks-Oseretsky Test of Motor Proficiency [37]. The short and long version of the test could be used; however, a short version of the test is usually used as a screening tool. It is a product-oriented assessment, but the long-form has some qualitative components. The tool assesses the fine and gross motor development. It BOT-2 is intended for use by practitioners and researchers to identify children with motor impairments, to evaluate motor intervention and support diagnosis of motor impairment. The test is suitable for from 4 years children to 21 years old adults [46].

The tool assesses four motor area composites with 53 items, which are divided into eight subtests (fine motor precision, fine motor integration, manual dexterity, bilateral coordination, balance, running speed and agility, upper limb coordination and strength). The administrator should have a background in physical therapy, physical education, or psychology. The BOT-2 kit is required for administration. The scoring system is specific for every item. Item raw score is converted to point score according to information provided in Record Form. The total point score is summed for every subtest. The time of assessment of the full tool is 45-60 min. The tester alone needs at least 10 min for preparing the testing area and another 20 to fill and finish the record form [46].

Normative data collection is based on a sample of 1520 children and youth in the US. Inter-rater reliability was good for every gross motor subtest r = 0.90 and r = 0.86 for fine motor precision subtest. Test-retest reliability (Pearson product-moment correlation coefficients were ≥ 0.80). Internal consistency was medium to high (.60-92.). Content validity was built on a multiple-step process (product survey and focus group, the study of items, factor analysis, and feedback from users). The internal structure was examined by correlation among subtest and confirmatory factor analysis. Authors also proved that BOT-2 could differentiate between clinical and non-clinical groups [46]. Concurrent validity was set by comparing scores with BOTMP (r = 0.76), PDMS-2 (r = 0.77) and TVMS-R Test of Visual-Motor Skills-Revised (r = 0.62) [58].

Items of the test reflect regular preschool children's activity. Administration easel contains photos and descriptions of the administration process, which enable administration. The test shows strong reliability and validity results and has current norms for the US population. On the other hand, the test is very time-consuming and challenge for children, especially for preschoolers. Testing forms are complicated and demanding to fill up.

C. The Movement Assessment Battery for Children—Second Edition (MABC-2) [40]

The MABC-2 is conducted from two parts - Performance test and checklist, which was mentioned in the screening tools section. The second version of the test is a revision of the first test [38], which was developed from the Test of Motor Impairment (TOMI [59]). The method is designed to assess both process and product-oriented evaluation of motor development of children from 3 to 17 years. The main goal of the test is identification of children with motor delays and impairments. It is also used for intervention planning and evaluation, clinical exploration, and also as a research tool. MABC-2 also contains qualitative observation during the Performance Test. It allows the examiner to add additional information about the psychomotor ability of the child [33].

The second version added some new items and revised some existed ones. The performance test consists of 8 test items in every age category, divided into three fine and gross motor skills categories: Manual Dexterity, Aiming - Catching, and Balance. It takes around 20 to 40 minutes to finish the assessment. A special test kit is needed, which contains

specific components for administration – balance beam, coins, beads and more. The new version of the checklist implemented a traffic light scoring system. Observer classifies child in one of the three categories – green zone (normal range of ability – age accepted) amber zone (minor delays of impairments – the need for monitoring) and red zone (severe delays or impairments in motor development). The qualitative observation of performance test is a significant part of MABC-2. The administrator can refer to any factors, which could influence motor performance during the task [33].

Norms are based on a representative sample of 1172 children from the United Kingdom. Norms are provided for three age groups (3:00-6:11; 7:00-10:11 and 11:00-16:11). Detailed reliability information is missing in the manual. The authors reported test-retest reliability involving 30 3-years old children. Parson correlation results ranged from 0.86 to 0.91 for manual dexterity and 0.48-0.68 for aiming and catching [33]. An unpublished study of Visser and Jongmans [60] in the Netherlands reports test-retest reliability in the age group 1 (3:00-6:11) between 0.49-0.70. Test-retest reliability for all three groups was 0.77; 0.84; 0.73 and 0.80. Moderate correlation coefficients for the three years olds resulted in r = 0.49. Authors [33] claim that there are some problems with test-retest reliability in younger children; however, results in a full test indicate consistent reliability for the test. The content validity of the test was established by the input of the expert panel. Face validity is based on subjective impressions of a wide range of professionals, who have used the MABC-2 (psychologists therapists, physicians).

The new format is more engaging for children and three colors „Traffic light" scoring system is more user-friendly. It also helps to directly measure motor skill performance of the children, make a direct observation of the movement and also earn information from parents or teachers from the Checklist. Disadvantages relate to the lack of reliability and validity evidence. The major weakness is the lack of information about construct validity.

D.Peabody Developmental Motor Scale – PDMS-2 [47]

The second version is a revision of the original test published in 1983 [61]. It is a product-oriented assessment, but also provides information about the process. It assesses fine and gross motor skills of children with and without any disabilities from birth to 6 years. It provides information about skills deficits, estimates motor competence relative to the peers, determines balanced of the gross and fine movement skills, can evaluate progress, and it is also used as a research tool [47].

The test consists of 127 gross motor items and 122 fine motor items divided into the six subtests (reflexes, stationary, locomotion, object manipulation, grasping, and visual-motor integration). Administrators should be familiar with and adequately trained according to the instructions of the test. Administration takes 45-60 min. Selected items are administered, using standardized instruction and materials. The test started on an item, which is suitable for the age where 75% of the standardization sample completed it. Each item provides a description, starting position of children, testing procedure, an illustration of activity, scoring criteria, materials, and the age at which at least 50% of the normative sample has acquired the skill being examined. Items are scored on a 3-point scale (0-2). The higher the score, the better is the performance [47].

Normative data were set on a sample of 2003 children in the USA. Interrater reliability of the total test is presented as r = 0.96, test-retest reliability r = 0.89 (2-11 month old children) and r = 0.96 (12-17 months old). Construct validity was set by factor analysis and subtest score correlation with age. Content validity was established by Item Response Theory, functional analysis, and item discrimination. Internal consistency of the test $\alpha = 0.97$. Concurrent validity with PDMS was 0.84 for gross motor subscales and 0.91 for fine motor scales [47].

It is a very detailed and excellent organized assessment tool. The score sheet provides instruction for all items and can be used repeatedly. The score sheet also provides information for gross and fine motor development and considers the qualitative aspect of motor performance. Good reliability and validity characteristics were reported. There is not a short form of the test, but the subtest could be administrated separately. Disadvantages are seen in length, which is demanding for small children and the absence of normative data for European children.

E. The KörperkoordinationsTest für Kinder-2 - KTK-2 [48]

KTK-2 is the revised test of The KörperkoordinationsTest für Kinder [62]. It is a product-oriented test that refers to norms. The test was designed to indicate a capacity for sensory-motor integration to control and coordinate the body. It is addressed for children with and without disabilities from 5 to 15 years old. The test assesses gross body control and coordination. It is also designed to identify children with motor delays and impairments [48].

The test consists four test items that measure gross motor coordination: walking backward on balance beams decreasing the width, moving sideways on wooden boards for 20s., one-legged hopping over a foam obstacle with increasing height and two-legged jumping from side to side for 15s. It takes 15-20 minutes to assess one child. Specialized equipment is required for testing, such as special balance beams, wooden boards, and foam blocks. Raw score from every item is transformed into a motor quotient (MQ). Total MQ of children ranges from „gifted children" to „children with motor dysfunction" [48].

The norms are set by a sample of 1228 typically developing German children in 1973-1974. The authors reported the psychometrics characteristics of the test. Test-retest reliability coefficient is 0.97. The validity of the test was proved through differentiation between typically developing children and disabled children; 91% of the children with brain damage were identified. Good internal consistency is seen in strong significant relationships (0.60-0.81) between test items. Internal consistency estimated with Cronbach's alpha was also high at 0.95. Factor analysis revealed that all test items load to one factor. A moderate correlation was found with M-ABC (r

= 0.62-0.65) [63] and with BOT-2 short form for gross motor composite scores r = 0.44- 0.64 and r = 0.25-0.37 for fine motor composite [64].

The test is easy to administer to children with or without impairments, which can help identify children above and below-average level. It is also suitable for longitudinal research because of identical items for every age. It is necessary to collect new norms because they were collected a long time ago and only on the German population.

F. Motoriktest für vier-bis sechsjährige Kinder (MOT 4-6) [39]

It is a German origin assessment tool for fundamental motor skills development for children from 4 to 6 years old. It is designed to detect children with motor difficulties. According to the authors, this age group acquires a specific approach and has a specific need. The test is rooted in Lincoln Oseretsky Motor Developmental Scales (LOMDS-[74]) and The KörperkoordinationsTest für Kinder (KTK-[62]). It is a product-oriented assessment and refers to the norms.

The test contains 18 items, including locomotion, stability, object control, and fine movement skills. Raw scores are converted into a three-level rating system from 0 (skill not mastered) to 2 (skill mastered). The highest total motor score of the test is 34. The higher the child scored, the higher is their movement skill level. The administrator sheet provides some space for qualitative notes about performance. Administration of the battery takes approximately 15-20 min. The test should be administered by a qualified administrator who is familiar with every item and can demonstrate it adequately. The test should be administrated individually and barefooted. Sports equipment which is needed for administration is usually found in every preschool [39].

Norms are based on a sample of 548 typically developing children from Germany. Authors reported high test-retest reliability(r = 0.85), high split-half reliability (α = 0.81), inter-rater reliability (0.88) and high internal consistency (α = 0.81). High concurrent validity was also reported with KTK (r = 0.78) and MABC (r = 0.68) [65]. Construct and content validity has been described based on movement skill literature.

Assessment protocol is easy to use and specifically designed for preschool children. It contains attractive assessment items which could be administered in a different order. It contains items which assess gross and fine motor skill, but unfortunately, the test does not contain subscales for these two parts of the motor performance. The significant disadvantage is missing the English translation and a small number of studies assess psychometrics characteristics.

VIII. Discussion and Conclusion

The present study aimed to review some psychomotor development assessment tools and considered their use with preschool children. The importance of developing assessment tools and intervention for psychomotor development for preschool children is recently very stressed [41], [66]. Since motor development is considered an indicator of overall health in children, it is essential to have appropriate tests [67]. Schoemaker et al. [41] emphasize the importance of identification of children with motor difficulties but also stressed the problems with appropriate assessment tools. This review suggests that any of the mentioned tests could be used to assess the motor development of the children; however, each of them emphasizes specific characteristics, which could be relevant to the sample being tested and circumstances around testing. For example, [3] suggested assessing the gross motor development of every child before entering the preschool facilities by using simple assessment tools or mainly observe them during their playtime. For this purpose, screening assessment would be probably the best choice, for example, The Denver Developmental Screening Test-II or Bruininks-Oseretsky Test of Motor Proficiency: BOT-2 Short form. Another option is to use a questionnaire that is intended for parents, teachers, and coaches, to earn an impression of the motor competencies of the children, such as the MABC-Checklist. However, as some researchers [41] stresses, it is essential to us these types of assessments only for screening purposes.

Based on the obtained information from screening tools, children with a potential problem in motor development could be identified, and complex instruments to assess their motor skills could be used carefully. The choice of the complex test should be based on many aspects, mainly the purpose of the assessment and what is best for the person being tasted. When working with children, it is also necessary to think about ethical and moral guidelines, such as gaining informed consent from parents and well-trained examiners. Testing should be performed according to the test manual, and it is necessary to think about circumstances of testing, such as environment, the time of the day, the attitude of the child or administrator features. Adequate tool for assessing psychomotor development of children should consist of clear conversion table in the test manual, test kit, clear description of the items, comprehensible scoring instructions, well-organized score sheet, and space for qualitative observation of performance. Assessment material should be easy to prepare, administer, demonstrate, and score. The last but not least, the reliability and validity evidence of the test should be established and taken into consideration.

This paper reviewed eight psychomotor development tests for preschool children. There is no comprehensive and flawless test for assessing the psychomotor development of preschool children, but with sensitive consideration of choice aspect, it is possible to choose the most appropriate one for one´s purposes. MABC stays one of the most frequently used motor development tests [68] probably because of the well organization and the division of the test into age groups allows comparison of skills the age of the child [69]. Some studies show that MABC can identify children with motor impairments better than BOT [70], which may be results of the stricter scoring system, precise instruction, or more opportunity for practice of MABC. BOT is also a well-establish tool; however, more verbal prompting and contains

more complicated items, which can cause kids with attentional disorders some problems [71]. KTK-2 and MOT 4-6 are promising and suitable for preschool children, but English translation and norms are missing.

The main criticism of assessment of psychomotor skills contains questions about psychometrics characteristics of tools, gender differences, and significant discrepancies in motor development between children of the same age. Some research [72] shows that row points scores are more objective and accurate than standard, age-related scores because the differences between the results of psychomotor test development in longitudinal studies show minimal changes. According to that, [71] suggested using developmental motor tools more to measure the changes over time than as a diagnostics tool. If diagnosis purposes are necessary using more than one assessment tool would be more than appropriate [73]. Another concern relates to the collection of normative scores of the tests, which are usually collected in specific states and populations; therefore, there may be potential confounding effects of cultural factors specific to that population. Pilot testing of the chosen population is more than recommended [71].

In conclusion, there are many assessment tools for testing the psychomotor development of children. Some of them are used as a screening tool for superficial and quick assessment, and others are more complex and profound. Researchers and administrators can also choose between tests focusing on the process or product of motor development. There are many aspects to consider before the administration of the test: the purpose of the assessment, age specificity, suitability of the test, simplicity of the test, testing time, trained administrator, and ethical aspects of testing. Long term research of psychomotor development and well-considered using assessment tools are essential for the enhancement of scientific knowledge about psychomotor development.

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