

## Instruments for Measuring Motor Skills in Early Childhood (0-7 Years): A Scope Review

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### ABSTRACT

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The development of motor skills in children aged 0-7 years is an important foundation for growth, but the assessment process in the field faces challenges of physical and psychological variability, as well as fluctuations in children's motivation that are quite high. This study aims to map, identify, and categorize motor skills measurement instruments specifically intended for early childhood. The research method used was a scoping review with reference to the PRISMA-ScR guidelines. Literature searches were conducted systematically on the SCOPUS database for leading empirical articles from the range of 2021 to 2026. Out of a total of 6,443 documents identified, the final screening resulted in 1,636 relevant articles that were further analyzed. The results show a major shift in assessment, where contemporary instruments are shifting from isolated physical testing to a multidimensional approach that integrates executive function (a high-level set of cognitive processes that govern actions and plans), macro motion behavior (movements involving multiple large muscles and locomotor function), as well as specific clinical indicators. The results of the data extraction found that process-oriented measurements were much more sensitive in detecting the quality of post-intervention motion mechanics than product-oriented instruments. In addition, measuring instruments such as ASQ-3, MABC-2, and GMA show high specificity as early screening instruments for detecting developmental delays and neurodevelopmental disorders. In conclusion, current motor testing demands multidimensional precision and is oriented towards early detection. Implicitly, physical education and early childhood practitioners are recommended to move from single-product metrics to process-based assessments.

## INTRODUCTION

The development of motor skills in early childhood, from 0 to 7 years of age, is an essential foundation for children's physical, cognitive, and social growth. This period is often referred to as the golden age (Juniarwati Gea & Aeni, 2025). Neuromuscular adaptation is at an optimal level to learn as well as perfect basic movement. Good mastery of basic movements in this early phase is directly correlated with the child's level of active participation in physical activity in the future (Al Ardha et al., 2018; Ren et al., 2026).

Early childhood identification is quite complicated because the period of development that is assessed is still not significantly visible. Especially in motor skills which are considered very important for the child's growth period, besides that motor skills can also assess the potential for developmental delay (Mahfuzah Zainol, 2025). Without an accurate detection system in children who experience motor deficits, there will be a high risk of experiencing obstacles in activities and even in academic learning. With the right assessment, identification can be done early and maintain the child's growth period well (Scheiber et al., 2025).

However, the assessment of early childhood motor skills has a fairly high methodological challenge, namely a fairly high variability diversity, motivational fluctuations, which results in the evaluation process being required to be more complex (Escolano-Pérez et al., 2022). Therefore, the assessment of early childhood skills cannot simply simplify the adult test, but must be specifically in accordance with the psychological and physical characteristics of early childhood (Lin et al., 2024).

Currently, there are various motor assessment instruments scattered in the literature, such as the Test of Gross Motor Development (TGMD), Movement Assessment Battery for Children (MABC), Peabody Developmental Motor Scales (PDMS), Alberta Infant Motor Scale (AIMS), and Bruininks-Oseretsky Test of Motor Proficiency (BOT). Each of these instruments has different evaluation parameters, scoring guidelines, and specific age limits (Silva, 2025). This wide variety often causes confusion for researchers and practitioners in choosing the most relevant, efficient, and valid measurement tool to apply in school and clinical settings (D'Elia, 2026; Wijaya et al., 2024).

Mapping the literature related to this instrument is quite a crucial step, as the selection must be based on the characteristics of the data in primary studies related to heterogeneous early childhood evaluation. One of them is by using the scoping review approach which allows for a broader exploration of the literature without being hampered by rigid study quality feasibility metrics.

This study aims to map, identify, and categorize motor skills measurement instruments specifically intended for children aged 0 to 7 years. The results of this study are expected to help provide comprehensive, data-driven guidance for physical education teachers, and other researchers in terms of selecting the right instruments for early childhood movement needs.

## **METHODS**

This study uses the scoping review method to map scientific evidence regarding motor skills measurement instruments in early childhood. The selection of the scoping review method is based on the research objectives that focus on exploring the scope of available instruments, variations in measurement methods, and the characteristics of research using these instruments. Then the entire research process was carried out with reference to the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR). This approach is used to ensure transparency, systematic, and reproducibility of the search and literature selection process.

The inclusion criteria in this study include that the research subject is an early childhood, namely 0-7 years, then the data source is from SCOPUS which is considered credible and has gone through a peer-review process related to the research topic. In addition, the article is published in scientific journals in English, and is available in full text form. The exclusion criteria include non-empirical articles such as editorials, opinions, or literature reviews, in addition to articles that do not discuss specific motor measurement instruments, then research with the main subject over 7 years, and duplicate articles.

### **Study Procedures**

The review procedure was carried out through a series of systematic stages starting with a comprehensive literature search strategy through the SCOPUS academic database. The search strategy was compiled using Boolean combined with keywords related to subjects, instruments, and age ranges, namely ("motor skills" OR "motor development" OR "fundamental movement skills") AND ("assessment" OR "measurement" OR "instrument" OR "test") AND ("early childhood" OR "preschool" OR "children 0-7 years"). The inclusion criteria in this study include that the research subject is an early childhood, namely 0-7 years, then the data source is a SCOPUS base that is considered credible and has gone through a peer-review process related to the research topic. In addition, the article is published in scientific journals in English, and is available in full text form. The exclusion criteria include non-empirical articles such as editorials, opinions, or literature reviews, in addition to articles that do not discuss specific motor measurement instruments, then research with the main subject over 7 years, and duplicate articles.

There are several stages, namely the first stage of setting up the Filter Tab with a range of years from 2021-2026. The reason is, technological developments were forced to develop rapidly in that year due to the Covid-19 outbreak, then the type of document was only taken from an article, after that for the language, namely English. The second stage of the search is done by applying Boolean combined with pre-set keywords.

The article selection process is carried out in several stages according to the PRISMA-ScR flow, namely for the initial stage of checking duplicate articles, then filtering titles and abstracts, in addition to full-text reviews, the last is the determination of articles that meet the inclusion criteria.

Data from articles that meet the criteria are systematically extracted including: authors, total citations, research objectives, methods, results. The data is then synthesized narratively and presented in the form of a table to facilitate the identification of the characteristics of motor measuring instruments. At this stage, information about the research variables, the type of instrument used, the characteristics of the participants, and key findings regarding the validity or effectiveness of the instrument are extracted in depth. All findings are then synthesized and presented in the form of narratives and summary tables in accordance with the PRISMA-ScR reporting standards to provide a comprehensive overview of the literature relevant to the research statement.

## RESULTS

### *The result of PRISMA-ScR screening process*

The screening process was carried out using the PRISMA flowchart which identified 6,443 documents in the database based on the keywords used in (Fig. 1). The results are re-selected by excluding non-English articles. Then the final result is 1636 relevant and most cited articles.

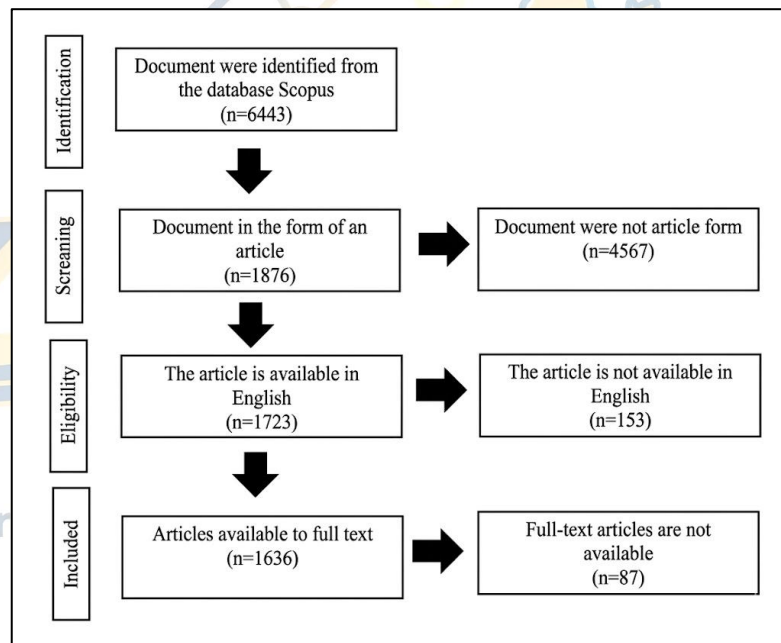


Figure 1. PRISMA-ScR flowchart of the article selection process

### *Literature Review*

Based on the coverage review that has been obtained as many as 1636 articles, and then 10 are selected for the most relevant and most cited articles based on the keywords that have been determined, this coverage review is chosen as a basis for researchers to obtain findings that are consistent and in accordance with the research objectives.

Table 1. Literature Review

Author	Total Cited	Research Purpose	Method	Result
(Sutapa et al., 2021)	129	To determine that goal-oriented play activities in early childhood improve motor skills	Quasi-Experimental	In this study, there was a significant difference between before and after the intervention by showing ( $p < 0.05$ ) of the six activities, namely running 25m, walking on a balance beam, throwing, catching, arranging cans, and bouncing a ball done 3 times a week for 12 weeks was proven to provide a significant improvement in the motor skills of children aged 4.5-6 years.
(Okely et al., 2021)	80	To determine the proportion of children at the age of 3-4 years in meeting the 24-hour movement behavior guidelines from WHO, as well as assess the relationship with children's motor skills, executive function, and adiposity.	International cross-sectional	This study involved 24 countries with 14 countries including low-and middle-income countries/LMICs. Successfully proven especially on a large scale. aims to determine the proportion of 3- and 4-year-olds who meet WHO global guidelines. The article assesses whether the proportion differs based on gender, urban/rural location, and/or socioeconomic status. Executive function, motor skills, and adiposity will be assessed and the potential correlation of 24-hour motion behavior will be examined. Although the

		<p>instrument's <i>acceptability and feasibility</i> testing process was hampered by the COVID-19 pandemic, the protocol was successfully completed.</p>
<p>(Jensen et al., 2021) 69</p>	<p>To test the effectiveness of the <i>Sugira Muryango</i> (SM) home visit program in improving child development (including gross motor skills), reducing violence against children/in the household, and increasing the involvement of fathers in parenting compared to <i>usual care</i>.</p>	<p>In this study, the <i>Sugira Muryango</i> (SM) intervention program significantly improved child development in gross motor (<math>d = 0.162</math>), communication (<math>d = 0.081</math>), problem solving (<math>d = 0.101</math>), and personal-social development (<math>d = 0.096</math>) based on the ASQ-3 questionnaire. In addition, there was an increase in paternal involvement (OR = 1.592), as well as a significant decrease in harsh discipline/physical violence against children (IRR = 0.741) and intimate partner violence (IRR = 0.616). However, no significant changes were found in the child's anthropometric growth status or the results of the MDAT instrument.</p>
<p>(Binter et al., 2022) 56</p>	<p>To examine and evaluate the relationship between exposure to urban environments (such as built-up environments, natural/green spaces, and air pollution) early</p>	<p>Multi-center <i>Population-based Birth Cohort Study</i> in 4 European  <p>In general, this study proves that urban environmental factors (built environment, green space, air pollution) affect children's cognitive and motor functions, so good urban planning will be</p> </p>

	<p>in life (during pregnancy and childhood) on cognitive function (verbal and non-verbal) and motor function (gross and fine motor) in children at 5 years of age.</p>	<p>countries (UK, France, Spain, Greece).</p>	<p>beneficial for Motor development of children in early life.</p>
<p>(Palmer et al., 2021) 44</p>	<p>determine and examine whether measurements are oriented and evaluate changes in motor skills during the six basic motor skills (FMS) interventions – running, jumping, catching, and kicking</p>	<p>Pre-test and Post-test Design</p>	<p>In this study, process- and product-oriented measurement assessed various aspects of motor competence and did not equally evaluate the effectiveness of interventions. After the intervention, children showed improvement in all process-based skills (<math>p &lt; 0.01</math>) but showed only some results of jumping, throwing, kicking products; <math>P &lt; 0.001</math> of the child's rating in these two tests was correlated in pre-test (<math>RS = 0.28 - 0.72</math>) and post-test (<math>RS = 0.39-0.68</math>).</p>
<p>(Craig et al., 2021) 41</p>	<p>To research and identify subtypes of Autism Spectrum Disorder (ASD) based on the relationship between motor skills and social communication abilities in children.</p>	<p>Cross-Sectional</p>	<p>In this study, the MABC-2 instrument succeeded in detecting that ASD children with low communication experienced a drastic decrease in fine motor (manual dexterity).</p>
<p>(Örtqvist et al., 2021a) 44</p>	<p>This article compares age-specific movements and postures in infants born with EPT compared to control infants born at full term</p>	<p>observasional retrospektif.</p>	<p>In this study, the GMA and MOS-R assessment at the correction age of 3 months showed that 19% of EPT infants had abnormal FM and 100%</p>

at three months of correction age.

monotonous movements/jerks, while 100% of the infants had normal menstruation; The total MOS-R score of the EPT group was also significantly lower (median=18; IQR 17–21) compared to control (median = 26; IQR 26–28) with  $p < 0.001$ .

(Duncan et al., 2021) 42

predicted future variations in basic movement skills (FMS), physical activity (PA), and body mass index (BMI) based on previous FMS, PA, and BMI in preschoolers in the UK. Return analysis

In this study, FMS performance significantly predicted changes in BMI in Grade 2 children (12.3% by Year 1 FMS; 9.8% by Year 2 FMS), and was more strongly predictive of sedentary activity than other physical activities, where the combination of running, throwing, dribbling, and kicking ability predicted 46.1% of sedentary behavior variation in Year 2.

(Wick et al., 2021) 36

To examine the effect of integratively strength-dominated exercise programs on measures of physical fitness (including motor skills) and cognitive performance in preschoolers aged 4–6 years.

*The Randomized Controlled Trial (RCT) uses a Pretest-Posttest design with a control group (two-*

In this study, the strength training program significantly improved the performance of the long jump standing in the intervention group ( $p < 0.001$ ;  $d = 1.53$ ) compared to the control ( $p = 0.72$ ), and showed a nearly significant trend of improvement in cognitive performance (*attention* ( $p = 0.051$ )).

<p>(Duggan et al., 2023) 35</p>	<p>To assess the domain-specific concurrent validity of the <i>Ages and Stages Questionnaire (ASQ-3)</i> and the <i>Bayley Scales of Infant and Toddler Development</i> (BSID-III) in 24-month-olds, and to evaluate the ability of the two instruments to predict cognitive delay when children reach school age (5 years).</p>	<p><i>group pre-post design</i>).</p> <p>In this study involving 278 children assessed at 24 months of age, ASQ-3 showed a fairly good predictive ability for motor domain delay (AUROC = 0.630; <math>p = 0.008</math>; sensitivity 50%; specificity 76.1%). Meanwhile, at the 5-year age assessment (<math>n = 204</math>), the language and cognition domains of BSID-III were shown to show a good correlation with verbal IQ (<math>R = 0.435</math>; <math>p &lt; 0.001</math>) and nonverbal IQ (<math>R = 0.388</math>; <math>p &lt; 0.001</math>).</p>
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## DISCUSSION

Based on the results of the Scoping Review using SCOPUS data from 2021–2026, a total of 1,636 articles and of the 10 articles reported were found relevant to motor skills instruments for children aged 0–7 years. The following sections discuss the identification, and comprehensive categorization of these instruments to provide clear and data-driven guidance for researchers and practitioners.

### ***Mapping and Identification of Motor Skills Measurement Instruments (Ages 0–7 Years)***

Some literature shows a significant paradigm shift in the methodology of early childhood motor assessment (0–7 years). In today's era supported by technological advancements, motor skills instruments are no longer seen as isolated physical tests, but have evolved into a holistic multidimensional approach that means looking at things as a whole, not just separate pieces (Liu et al., 2025; Sutapa et al., 2021). This approach integrates executive function (a high-level set of cognitive processes that govern actions and plans), macro motion behavior (movements involving multiple large muscles and locomotor function), and specific clinical indicators. This evolution was driven by the need for high-precision instruments capable of accommodating the psychological and physical variability as well as fluctuations in children's motivation (Arif et al., 2024; Han et al., 2022; Okely et al., 2021).

Through this scope review, some of the leading instruments widely used in global research have been identified. For the general population, the literature frequently identifies the Gross Motor Development Test (TGMD), the Movement Assessment Battery for Children (MABC), the Peabody Developmental Motor Scale (PDMS), the Alberta Infant Motor Scale (AIMS), the Bruininks-Oseretsky Motor Ability Test (BOT), and the Age and Stage Questionnaire (ASQ-3). In a clinical or intervention-specific context, the identification process also highlights the use of the Malawi Development Assessment Tool (MDAT), General Movement Assessment (GMA), Movement-Revision Optimality Score (MOS-R), and Bayley Infant and Toddler Development Scale (BSID-III). This identification suggests that the current phenomenon of motor testing is very diverse, from questionnaires reported by parents to highly sophisticated observational assessment systems (Duggan et al., 2023; Örtqvist et al., 2021).

### **Categorization of Instruments Based on Measurement Orientation and Target Population**

The categorization of early childhood motor skills measuring instruments can theoretically be separated based on two main dimensions, namely the orientation of the measurement and the characteristics of its target population (Craig et al., 2021; Palmer et al., 2021). Based on its methodological orientation, measuring instruments are classified into process-oriented (process-oriented) instruments that assess the quality of children's motion mechanics, as well as product-oriented (product-oriented) instruments that focus only on the final quantitative results of a movement. Process-based measurements have been shown to be much more sensitive and accurate in detecting changes in the quality of children's basic motor competencies post-intervention, whereas product-based measurements often fail to capture those improvements in the quality of movement.

Meanwhile, based on the function and characteristics of the target population, the instrument is categorized into a general population developmental screening tool and clinically in-depth diagnosis of the instrument. Screening tools such as the ASQ-3 questionnaire are highly effective at uniting the general population and predicting developmental delays early (Duggan et al., 2023), while clinical instruments such as MABC-2, GMA, and MOS-R have rigid and specific evaluation parameters to detect certain neurodevelopmental disorders, such as decreased manual dexterity in children with Autism Spectrum Disorder (ASD) or monotonous movement characteristics in babies born extremely preterm (Craig et al., 2021).

### **Mechanisms and Determining Factors Affecting Instrument Results**

On these instruments are closely related to neurophysiological factors (ability to think, feel, and act) and the underlying environment that affect children's scores (Binter et al., 2022; Lynn Bar-On et al., 2024). From a physiological perspective, goal-oriented structured play and strength-dominated exercise programs utilize neuroplasticity early in life (Sánchez Pastor et al., 2023; Wick et al., 2021). This intervention optimizes the corticospinal pathway and stimulates the prefrontal cortex through the cerebellum, thalamus, and cortical circuits.

This explains why the motor tasks evaluated by the instrument often show trends along with cognitive improvements, particularly in attention and focus (Khanmohammadi et al., 2025).

In addition, the variability captured by this measurement instrument is highly dependent on environmental and socio-pedagogical factors (the teaching-learning process is influenced by the social environment) (Binter et al., 2022; Rinakit Adhe et al., 2020). Early exposure to urban environments, air pollution, and limited green space can inhibit cognitive and motor development at age 5. A supportive environment provides a natural "opportunity" for the exploration of movement, which acts as a protective factor against sedentary behavior and an increase in Body Mass Index (BMI) (Adhe et al., 2018; Duncan et al., 2021). Therefore, the selection and categorization of an instrument must consider whether it is able to reflect the influence of this environment on the child's development.

### ***Limitation***

Although this coverage review presents a comprehensive mapping, there are some methodological limitations that need to be acknowledged. First, the search for primary literature in this study was completely limited to the SCOPUS academic database. Although SCOPUS is known to have a very credible peer-review standard, this restriction has the potential to override relevant studies indexed in other international databases such as PubMed, Web of Science, or Embase. Second, language inclusion criteria that include only English-language scientific articles may create geographical bias, thereby eliminating local motor measurement instruments or modifications of measuring instruments developed in developing countries and published in their national languages. These limitations need to be a consideration for future researchers to expand the scope of databases and language variations.

### **CONCLUSION**

This study concludes that motor skills measurement instruments for early childhood (0–7 years) have undergone a significant paradigm evolution, from isolated physical performance assessments to holistic approaches that integrate cognitive, clinical, and behavioral aspects of macro movement. The selection of the right instrument is highly dependent on the objectives of the assessment, where process-oriented instruments are more recommended to monitor the effectiveness of educational interventions, while tools with high clinical specificity are required for the early detection of neurodevelopmental barriers. For education practitioners, it is recommended to no longer use single-product metrics, but instead switch to assessments that are more sensitive to the quality of children's motion mechanics. Future research is suggested to expand the scope of international literature databases and consider cross-lingual studies to obtain a more inclusive and geographically unbiased global picture.

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### **CONFLICT OF INTEREST**

The authors declare that they have no conflicts of interest regarding the publication of this article.



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