

Validity and reliability of motor competence assessment as an instrument measuring fundamental motor skills for 12-year-olds in Indonesia

Validez y confiabilidad de la evaluación de la competencia motora como instrumento que mide las habilidades motoras fundamentales para niños de 12 años en Indonesia

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Abstract. The research aims to assess the validity and reliability of the Motor Competence Assessment (MCA) instrument for 12-year-olds. The validity and reliability test provides a comprehensive framework for objectively measuring motor competence and identifying areas for intervention to enhance motor skill development. The study included 321 participants (156 male and 165 female) from diverse Indonesian elementary school backgrounds. Motor competence assessment involved six test components, each conducted with two trials. Validity was assessed through exploratory factor analysis (EFA), and reliability was assessed via Cronbach's alpha, with raw data converted to a scale for EFA. The Kaiser-Meyer-Olkin (KMO) & Bartlett Test results and the Sampling Adequacy (MSA) measure are suitable for running EFA because they show more than 0,50. The standards for each item were met in the Communalities test by showing an extraction of >0,50 for each item. The MCA instrument proved valid because each test item (variable) firmly attaches to one instrument. Reliability tests, using Cronbach's Alpha, show that MCA instruments are reliable and usable. The Motor Competence Assessment (MCA) instrument demonstrates validity and reliability in measuring motor skills. Exploratory factor analysis (EFA) identifies two main components: locomotor skills and stability and manipulative motor skills. Cronbach's alpha further confirms MCA's reliability. Its effectiveness in various contexts, including physical education and rehabilitation, supports targeted interventions. Understanding motor skill development with MCA enhances tailored approaches for individuals, promoting physical well-being and performance.

Keywords: physical education, motor skill, elementary school, assessment.

Resumen. La investigación tiene como objetivo evaluar la validez y confiabilidad del instrumento de Evaluación de la Competencia Motora (MCA) para niños de 12 años. La prueba de validez y confiabilidad proporciona un marco integral para medir objetivamente la competencia motora e identificar áreas de intervención para mejorar el desarrollo de las habilidades motoras. El estudio incluyó a 321 participantes (156 hombres y 165 mujeres) de diversos orígenes de escuelas primarias de Indonesia. La evaluación de la competencia motora involucró seis componentes de prueba, cada uno realizado con dos pruebas. La validez se evaluó mediante análisis factorial exploratorio (AFE) y la confiabilidad se evaluó mediante el alfa de Cronbach, con los datos brutos convertidos a una escala para AFE. Los resultados de las pruebas Kaiser-Meyer-Olkin (KMO) y Bartlett y la medida de adecuación del muestreo (MSA) son adecuados para ejecutar EFA porque muestran más de 0,50. Los estándares para cada ítem se cumplieron en la prueba de Comunalidades al mostrar una extracción de >0,50 para cada ítem. El instrumento MCA demostró ser válido porque cada elemento de prueba (variable) se adhiere firmemente a un instrumento. Las pruebas de confiabilidad, utilizando el Alfa de Cronbach, muestran que los instrumentos MCA son confiables y utilizables. El instrumento de Evaluación de la Competencia Motora (MCA) demuestra validez y confiabilidad en la medición de las habilidades motoras. El análisis factorial exploratorio (AFE) identifica dos componentes principales: habilidades locomotoras y habilidades motoras de manipulación y estabilidad. El alfa de Cronbach confirma aún más la confiabilidad de MCA. Su eficacia en diversos contextos, incluida la educación física y la rehabilitación, respalda intervenciones específicas. Comprender el desarrollo de habilidades motoras con MCA mejora los enfoques personalizados para las personas, promoviendo el bienestar y el rendimiento físico.

Palabras clave: educación física, habilidad motora, educación primaria, evaluación.

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Introduction

Fundamental motor skills are the initial skills needed to perform daily physical activities, including standing, walking, and performing simple manual tasks. Fundamental motor skills involve a hierarchical representation of movement elements and allow for flexible and efficient movements (Diedrichsen & Kornysheva, 2015). Fundamental motor skills, such as standing, walking, and basic manual tasks, are crucial for daily physical activities (Li et al., 2022). These skills form the bedrock of physical development, allowing individuals to navigate and interact with their environment effectively (Han et al., 2022; Krakauer et al., 2019). Characterised by a hierarchical arrangement of movement components, fundamental motor skills enable individuals to perform tasks with agility, coordination, and precision

(Jones et al., 2020; Jovanović et al., 2020). Moreover, these skills lay the groundwork for more complex motor abilities as a platform for developing more advanced movements and activities (Logan et al., 2018). By mastering fundamental motor skills, individuals acquire a repertoire of movements that enhance their capacity for independent living, active participation in physical pursuits, and overall well-being.

Measuring fundamental motor skills is paramount in physical education, particularly in primary schools. Assessing these foundational skills provides valuable insights into the physical development of young learners (Hulteen et al., 2018; Makaruk et al., 2023). By systematically evaluating abilities such as running, jumping, and throwing, educators can gauge individual proficiency levels and identify areas that require attention or improvement (Duncan et al.,

2020; Gao et al., 2021). Motor skills tests can effectively detect potential motor development problems early (Cancer et al., 2020; De Roubaix et al., 2021). Furthermore, by instilling a solid foundation of fundamental motor skills early on, children are better equipped to engage in various physical activities inside and outside the classroom (Sutapa et al., 2021a; Tsuda et al., 2020). Beyond enhancing physical literacy, measuring fundamental motor skills promotes holistic development, fostering self-confidence, social interaction, and overall well-being among primary school students (Abdelkarim et al., 2017; Bolger et al., 2021a). Emphasising the assessment of fundamental motor skills in physical education underscores the significance of cultivating lifelong habits of physical activity and healthy living from a young age, laying the groundwork for a lifetime of active participation and enjoyment of physical pursuits.

The measurement standard for fundamental motor skill development is crucial in assessing and monitoring the progress of individuals, particularly children, in acquiring basic movement abilities. Motor skills test result data can be used to design a more structured and comprehensive curriculum (Hulsteen et al., 2020a; Radanović et al., 2021). Motor skills tests can also be used as an evaluation tool to measure the effectiveness of physical education programs (Herrmann et al., 2015; Valdivia-Moral et al., 2018). This method typically employs standardised tests or assessments to evaluate fundamental motor skills such as running, jumping, throwing, and kicking. Motor competence assessment, instruments tested in this study, is a quantitative model developed to evaluate motor competence across age groups (aged 3 to 23) based on three domains (locomotor, stability, and manipulative), and it was concluded that six quantitative motor tasks could represent motor competence (Luz et al., 2016; Rodrigues et al., 2019, 2021). The Motor competence assessment is composed of two tests for each MC component, namely stability: lateral jumps (LJ), shifting platforms (SP); locomotor: standing long jump (SLJ), 10 m shuttle run (SR), and manipulative: ball kicking velocity (BKV), ball throwing velocity (BTV) (Rodrigues et al., 2021). The potential of Motor competence assessment instruments for use in Indonesia is enormous, as they provide a comprehensive framework for evaluating the motor capabilities of individuals of a wide age range. Using this instrument, researchers, educators, and professionals in Indonesia can identify the motor development of children and adolescents more objectively and design appropriate intervention programs to improve their motor skills. Test results help personally identify motor skill strengths and weaknesses, enabling a more focused approach to education that fits each student's needs (Kennedy et al., 2012; Scheuer et al., 2019; Šeflová et al., 2022).

Motor skills, encompassing a range of body movement abilities, are crucial for development, with motor skill acquisition being synonymous with behavioural development (Bukvić et al., 2021). Manipulative, locomotor, and stability motor skills are fundamental components of human movement that play essential roles in everyday activities and

physical development (Rudd et al., 2015; Sutapa et al., 2021b). Manipulative skills involve coordinating and controlling objects using hands or other body parts (Chen et al., 2016; Simone et al., 2021). These skills are crucial for playing sports and fine motor activities like writing and tying shoelaces. Locomotor skills, on the other hand, refer to movements that propel the body through space (Deliagina et al., 2019; Hyungmin & Simons, 2012). Mastering locomotor skills is essential for navigating environments and participating in various physical activities and sports. Stability skills encompass maintaining balance and controlling body positions (Bremer & Cairney, 2018; Grošelj et al., 2019). Stability skills are vital for preventing falls and injuries and executing more complex movements efficiently and precisely. Together, these three categories of motor skills form the foundation for a wide range of physical abilities and are critical for promoting overall health and well-being across the lifespan.

Measuring motor skills is a complex task because these skills involve various physical, cognitive, and emotional aspects (Balcázar et al., 2024). Each individual has different levels of development, both physically, cognitively, and emotionally (Canli et al., 2024; Samodra et al., 2024). This means the same measurement standard may not be accurate for all individuals. Motor skills encompass a wide range of abilities. Comprehensively measuring all aspects requires different types of tests and measuring devices (Hulsteen et al., 2020b). The tools and instruments used must be precise and reliable (Lopes et al., 2018). Many motor skill measurement tools are expensive and difficult to access (Komaini et al., 2021). Many measurements of motor skills rely on the teacher as observer judgment, which can lead to bias and lack of objectivity (Machts et al., 2016). Factors such as teaching experience, professional training, and learning environment conditions affect the effectiveness of teachers in becoming observers (Mardiyah et al., 2024). The implementation of good evaluation, in this case, measuring motor skills as part of learning, can create conducive and effective classroom or school conditions, as appropriate evaluations help identify needs, progress, and areas of improvement, as well as increase student motivation and engagement (Komari et al., 2024). To overcome these challenges, MCAs need a holistic and multifaceted approach.

Material and Methods

Study Participants

The study involved 321 samples with details of 156 men and 165 women who came from 9 elementary schools. The study samples came from public and private elementary schools. School locations are scattered in various places such as cities, towns, lowland, and highland areas. The students involved in the research were all grade 6 students. The sampling method used is purposive sampling, with the sample criteria must be grade 6 and 12 years old.

Study Organization

The study ran six Motor Competence Assessment

(MCA) test components. The data for each test was taken through two trials, and the best results were recorded. The MCA is the inaugural assessment tool developed to evaluate motor competence across all three components, locomotor, stability, and manipulative, using the same tests throughout a person's lifespan (Rodrigues et al., 2019). The Motor Competence Assessment comprises two tests for each Motor Competence category (stability, locomotor, and manipulative). These tests were selected from motor development literature's most used protocols and instruments. The inclusion criteria were quantitative (product-oriented) motor tests without a marked developmental (age) ceiling effect and of feasible execution (Luz et al., 2016). Before starting the tests, participants should perform a general warm-up. Each test technique should be demonstrated proficiently and explained verbally. Participants should practice each task before the actual test. Motivational feedback may be given, but no verbal feedback on skill performance will be provided. Participants should be instructed to throw or kick the ball as fast as possible for the throwing and kicking tasks. For evaluators, students of the physical education, health and recreation study program who have been trained intensively for 2 weeks to implement test procedures. Two evaluators and one result recorder monitor each test item to ensure the sample performs the test correctly.

Statistical analysis.

Statistical analysis using SPSS version 29. The validity test was carried out using exploratory factor analysis (EFA), and the reliability test of each fact was carried out using Cronbach's alpha. The raw research data is converted into a scale to carry out EFA. Before running EFA, the Kaiser-Meyer-Olkin test (KMO) and Bartlett's test and Measure of Sampling Adequacy (MSA) were performed to check the suitability of data for factor analysis. If the results show KMO and MSA values for each component are more than 0.50, and Bartlett's Test is significant ($p < 0.05$), then it indicates that the data is sufficient for EFA to be performed. Next, a Principal Component Analysis is performed to extract the underlying factors of the motor skills test component. The results of the Principal Component Analysis will bring up the loading factor. Loading factors indicate that items have a high correlation with expected factors and a low with other factors. Finally, internal reliability is calculated for each factor. All factors showing Cronbach's Alpha value above 0.70 indicate that the test has good internal consistency. Thus, EFA helps identify the underlying structure of motor skills test components and ensures that these instruments are valid and reliable.

Results

The EFA test requires Kaiser-Meyer-Olkin (KMO) & Bartlett's test and Measure of Sampling Adequacy (MSA) values to be more than 0.50. A value of more than 0.50 states that the sample meets the sufficiency standard and

that the data is suitable for factor analysis. Results from KMO & Bartlett and MSA testing showed that the test results were more than 0.50 (see Table 1). Based on these results, the EFA test can be continued in the next step.

Table 1.
Results of KMO & Bartlett and MSA Tests

Test	Standard	Result
KMO and Bartlett		0,778
SP		0,834
LJ		0,801
SR	>0,50	0,816
SLJ		0,814
BTV		0,689
BKV		0,724

The extraction results (see Table 2) show that each variable strongly relates to being an instrument. In other words, each of the variables analysed has a significant correlation with the main factors, so they are considered relevant and important to be included in the measuring instrument or instrument. Each item's standard in the communalities test must show an extraction of $>0,50$ for each item.

Table 2.
Results of the Communalities Test

Variable	Extraction
SP	0,521
LJ	0,613
SR	0,554
SLJ	0,587
BTV	0,804
BKV	0,748

The MCA instrument proved valid because each test item (variable) firmly attaches to one instrument. MCA is an instrument that divides tests based on three skills: locomotor, manipulative, and stability—the results of the pattern matrix test show that the MCA instrument is divided into two components. The pattern matrix test results align with the division of MCA's test item components. The pattern matrix reinforces that MCA test items are well grouped based on the type of skill. Component 1 is the SP, LJ, SR, and SLJ test items, while component 2 consists of BTV and BKV (see Table 3). In other words, the pattern matrix test results support the division of MCA test items based on skill type, indicating that the test items are well grouped according to the skills measured by each item.

Table 3.
Result of Pattern Matrix Test

Item Test	Component	
	1	2
SP	0,680	
LJ	0,833	
SR	0,752	
SLJ	0,696	
BTV		0,925
BKV		0,833

Reliability tests, using Cronbach's Alpha, show that MCA instruments are reliable and usable. The test results of each test item on the MCA instrument also show the same thing. Test results, both overall and per item, showed >0.70 (See Table 4). The results illustrate that MCA has

high internal consistency, so the results obtained from its use can be trusted.

Table 4.
Result of Reliability Test

Test	Item	Result
Cronbach's Alpha	All Item	0,766
	SP	0,728
	LJ	0,739
Cronbach's Alpha if Item Deleted	SR	0,734
	SLJ	0,712
	BTV	0,747
	BKV	0,728

Discussion

The reason for involving a sample of 321 people is that good validity and reliability tests require many samples. Large samples support clearer validity and reliability (Alim et al., 2024). The validity test results using the exploratory factor analysis (EFA) test on the Motor Competence Assessment (MCA) instrument show that each test item has a strong relationship with the other. The validity of test items indicates that the test can be used and has promising implications for tests and measurements in physical education (Taufik et al., 2024). Furthermore, EFA divides the instrument into two main components: the locomotor motor skills and stability test component and the manipulative motor skills test component. This indicates that MCA can measure important aspects of motor ability, locomotor, stability, and manipulative skills. Assessing motor skills has an important role and impact on a healthy lifestyle in childhood (Abelairas-Gómez et al., 2022). The division of components in MCA based on EFA further emphasises that manipulative skills are indeed skills that can be mastered if locomotor skills and stability have been mastered properly. Manipulative skills involve using the hands and feet after the basic locomotor and stability skills have been mastered (Lubans et al., 2010). Manipulative skills have striking characteristics and are different from locomotor skills and stability. Manipulative skills are the only skills directly related to surrounding objects, whereas locomotor skills and stability only deal with limbs (Bolger et al., 2021b; Hill et al., 2024; Logan et al., 2012).

In addition, reliability test results using Cronbach's alpha test show that MCA is reliable. Both as an instrument as a whole and for each test item that is part of the MCA, the level of reliability is relatively high. This shows that MCA can be relied upon to measure motor skills consistently and reliably. Thus, the reliability test results reinforce confidence in the validity of this instrument as a trustworthy evaluation tool. As a valuable evaluation tool, MCAs can help evaluate physical education results. Physical education teachers are expected to check whether students have mastered specific motor skills, such as running, jumping in various directions, manipulating objects, etc (Cristian et al., 2023). Overall, the results of MCA validity and reliability tests show that this instrument is a valid and reliable tool for measuring motor skills in individuals. Findings from EFA

identifying critical components in the MCA provide valuable insight into the internal structure of the instrument. At the same time, reliability test results confirm the consistency and reliability of measurements provided by the MCA. Thus, MCA can be used as an effective tool in evaluating motor skills in various contexts, such as physical education or sports.

The potential that can arise from using MCA instruments (in the process of measuring motor skills in Indonesia is very large. MCA provides a valid and reliable tool for measuring motor skills, which helps ensure consistent and objective assessments across schools and physical education programs in Indonesia. Teachers and coaches can identify areas where students need further development by accurately measuring motor skills, allowing for more targeted interventions. Data from MCA can be used to design a more effective physical education curriculum according to the specific needs of students based on the results of their motor skills measurements. In addition, the measurement results from MCA can be used as a basis for research in the field of physical education and sports, helping to develop new and more effective methods and approaches. With reliable and standardised tools, MCA can help reduce disparities in the measurement and development of motor skills in various regions of Indonesia, including outside the island of Java. Data collected through MCA can provide valuable insights for policymakers in designing national programs that support better motor skills development among children and adolescents. By implementing MCA, Indonesia can improve the quality of physical education and sports and ensure that every individual can develop motor skills essential for their health and well-being.

Conclusion

In conclusion, the Motor Competence Assessment (MCA) instrument has demonstrated validity and reliability in measuring motor skills. The exploratory factor analysis (EFA) revealed strong relationships among test items, identifying two main components: locomotor skills and stability and manipulative motor skills. This division highlights the importance of mastering basic locomotor and stability skills before developing manipulative skills, which directly interact with surrounding objects. Such insight underscores the sequential nature of motor skill development, where manipulative skills build upon foundational abilities.

Moreover, the reliability test using Cronbach's alpha further solidified confidence in MCA as a dependable evaluation tool. High reliability scores for both the instrument as a whole and individual test items underscore the consistency and accuracy of measurements provided by MCA. These findings validate the instrument's effectiveness and provide valuable guidance for educators, coaches, and practitioners in assessing and fostering motor skill development.

Overall, the validity and reliability of MCA position it as a valuable asset in various contexts, including physical education, sports, and rehabilitation. Its ability to accurately

measure different aspects of motor skills can inform targeted interventions and support individuals in improving their motor competence. By understanding the intricacies of motor skill development and having a reliable assessment tool like MCA, practitioners can better tailor interventions to meet the specific needs of individuals, ultimately promoting overall physical well-being and performance.

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Conflict of interest

The authors declare there are no conflicts of interest.

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