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Development and psychometric validation of a volleyball skill assessment instrument for children aged 10-13 years

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ABSTRACT

Background: Existing volleyball skill assessment tools are commonly adapted from adolescent or adult performance standards and may not accurately represent the motor development characteristics of children aged 10-13 years. Moreover, psychometrically validated instruments specifically designed for elementary school students remain limited. **Objectives:** The objective of this research is to create and test a volleyball skill assessment tool tailored for elementary school pupils aged 10 to 13 years. **Methods:** The study employed a research and development (R&D) design adapted from the Borg and Gall model. Test building concepts served as the basis for a research and development strategy. Five fundamental volleyball abilities were evaluated by the test: smash, underhand passing, overhand passing, underhand serving, and overhand service. Purposive sampling was used to pick 50 Bengkulu City primary school pupils as participants. Aiken's V and CVR were used to assess content validity with six experts. Data processing utilised G*Power (v3. 1.9.7) and Jamovi (v2.3.2). **Results:** Strong content validity was shown by every skill component (CVR > 0.83; Aiken's V ≥ 0.87). EFA identified a two-factor structure that explained 71.84% of the overall variance: offensive technical ability and basic ball control. There were moderate to high relationships between criterion validity and game performance (r = 0.63-0.71). All subtests had strong reliability indices (ICC = 0.87-0.94; test–retest r = 0.79-0.86). **Conclusion:** The developed instrument demonstrated satisfactory validity and reliability and shows potential for assessing basic volleyball skills among elementary school students. The constraints include a limited sample size and a restricted geographical scope. Future studies should encompass larger, more diverse groups and investigate technology-based evaluation formats to improve applicability.

Keywords: Volleyball skill assessment; instrument development; children; psychometric validation

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INTRODUCTION

Volleyball is among the most widely played sports in physical education, especially at the elementary school level. In addition to improving physical fitness, volleyball also plays a vital role in forming children's basic motor skills, such as eye-hand coordination, muscle strength, and agility (Kizi, 2025). Furthermore, this sport also teaches educational values such as teamwork (Arantes et al., 2025; García-Taibo et al., 2024; Xia

et al., 2025), sportsmanship (Yansyah, 2021), discipline, and responsibility (Purwanto et al., 2023). Consequently, volleyball possesses both physical and educational importance in influencing students' character and overall development (Chu et al., 2022; Hasyim & Bachtiar, 2021).

In the context of physical education learning, the evaluation process is an important component in determining the extent to which students' competencies have been achieved (Wang et al., 2022; Wang, 2022). However, there remains a lack of valid and reliable volleyball skill test instruments specifically designed for elementary school students, especially for children aged 10-13 years. A good evaluation will provide an objective picture of students' abilities so teachers can design a more targeted learning approach (Zhao, 2023). However, the reality in the field shows that there are still limitations in the availability of valid, reliable volleyball skill test instruments based on the characteristics of elementary school students. Most of the existing instruments are still based on standards for adolescents or adults, both in terms of difficulty level and movement dimensions (Jariono et al., 2023; Yudiana et al., 2021; 2022), so they are less relevant and not representative of the motor skills of children aged 10-13 years. As a result, these instruments may produce biased evaluations that fail to represent children's true skill levels.

Because of this, there is a need for a precise definition of volleyball skills for children aged 10 to 13. For this investigation, the term "volleyball skills" refers to the capacity of children to execute fundamental game methods that correspond to the phase of their motor development: (i) the underhand serve, (ii) the overhand serve, (iii) the underhand pass, (iv) the overhand pass, and (v) the smash, with each of these movements being evaluated using simplified movement indicators that are suitable for primary school student characteristics. The biomechanical, muscular, and cognitive aspects of technical skill execution—particularly in smash, serve, and block actions—are becoming increasingly important, according to recent research on volleyball performance. Plyometric training greatly improves smash performance by increasing explosive force and movement efficiency, according to experimental findings, highlighting the significance of performance-based indicators in evaluating attacking skills (Sujarwo & Kuswoyo, 2025). The need for standardised, task-specific assessment methods in volleyball skill evaluation is further supported by biomechanical testing protocols for underhand serve reception, which show that precise kinematic and kinetic variables can objectively capture technical execution quality (Callupe et al., 2025).

Strong correlations between joint angles, force direction, and firing accuracy are found in biokinematic and goniometric assessments of linear smash actions, indicating a close relationship between visible performance results and underlying movement mechanics (Ismael, 2024). Volleyball skill assessment should take into consideration both motor execution and learning-related processes, as cognitive factors like functional thinking style have been demonstrated to contribute to the learning and accuracy of complex skills like blocking and smash serves (Saeed et al., 2023). The creation of volleyball-specific evaluation tools that are based on biomechanical relevance, sensitive to performance quality, and able to capture significant differences in technical skill across learners is supported by these findings taken together. Although multiple prior instruments are available, significant research gaps remain. Initially, a few instruments have been devised with psychometric validation specifically designed for younger children. Although several volleyball skill assessment tools have been developed, most are designed for adolescent athletes (Andriansyah et al., 2025) require advanced physical (de la Rubia et al., 2025), and technical competencies (de Oliveira et al., 2026). Consequently, these instruments may not accurately assess the fundamental motor skills of younger learners in elementary school physical education settings. Second, previous assessments have not incorporated difficulty-level analysis tailored to children's diverse motor development stages. Third, the widely used Jariono volleyball skill assessment—though beneficial for both youth and adults—includes movement tasks that require higher levels of strength, coordination, and tactical comprehension, making it inappropriate for children aged 10 to 13. The assessment also lacks streamlined criteria and a grading rubric, both of which are essential for early motor skill learners.

This issue becomes increasingly important, considering that children at the elementary school level are in the fundamental motor development phase (Benda et al., 2021; Dewi & Verawati, 2021; Rizqi & Sutapa, 2019). If the skills test does not match their cognitive and physical development level, the evaluation results can be biased and do not reflect their actual abilities. In addition, physical education teachers often face

difficulties conducting objective skill assessments due to the lack of structured and easy-to-implement measuring instruments (Baldwin, 2015; Yasri et al., 2022). Therefore, it is necessary to construct and validate a volleyball skills test specifically designed for elementary school students. This test should be able to measure aspects of fundamental volleyball skills such as underhand serve, overhand serve (Mardila et al., 2024), underhand pass (Ishak et al., 2023), overhand pass, and smash by considering psychometric principles, such as validity, reliability, and difficulty level appropriate to the child's abilities (Paulo et al., 2016; 2018). The development of such an instrument will greatly assist physical education teachers in carrying out more accurate, efficient (Cañabate et al., 2024), and meaningful learning evaluations (Dewanti et al., 2023).

Prior research on volleyball skill evaluation has mostly concentrated on creating specialised exam tools to gauge distinct technical aspects of the sport. A generic volleyball test instrument model emphasising technical execution and precision was developed by Rifki et al. (2022); nonetheless, the instrument was primarily focused on teenage and adult performance requirements. Although these methods sometimes call for complex infrastructure that restricts their usability in classrooms, advancements in technology-based assessment have also been investigated, such as the employment of sensor-assisted smash test equipment to promote objectivity and measurement precision (Komaini et al., 2022). The usefulness of spatial accuracy indicators in volleyball assessment is reinforced by experimental studies looking at task-based training interventions, such as target and netting games, which show that skill accuracy, especially in overhead passing, can be successfully measured through structured target-orientated tasks (Aini et al., 2021). Furthermore, the creation of digital-based underhand service tools reveals issues with accessibility and developmental appropriateness for younger students while also highlighting the expanding trend towards technology integration in volleyball skill assessment (Muslimin et al., 2020). All of this research shows that while volleyball-specific assessment tools have been created, there is still a need for low-cost, psychometrically validated, developmentally appropriate measures designed especially for primary school pupils.

This research aims to compile and develop a volleyball skills test instrument based on the developmental characteristics of elementary school students. Through a systematic scientific approach, this instrument is expected to be an effective tool in assessing children's motor skills in volleyball games while also supporting improving the quality of physical education learning.

METHOD

Design

This study utilised a research and development (R&D) methodology to create a standardised volleyball skills assessment tool for primary school pupils aged 10 to 13 years. The R&D method utilised a streamlined Borg & Gall procedural model (Aka, 2019), with psychometric requirements (content validity, construct validity, reliability, and item analysis), to ensure that the instrument was developmentally suitable and psychometrically robust. The development procedure comprised: (1) initial study and needs assessment, (2) instrument design and expert evaluation, (3) small-group trial, (4) field testing, (5) validation and reliability assessment, and (6) final instrument refining. The devised assessment concentrated on four fundamental volleyball skills: underhand pass, overhand pass, underhand serve, and overhand serve, as well as the smash, taken from Gatot Jorino's instrument but changed according to the motor skill attributes of youngsters.

Participants

50 elementary school students from Bengkulu City, Indonesia, who were chosen by purposive sampling, made up the participants. Students in upper-grade elementary classrooms (Grades 4-6) from public schools that use a structured physical education curriculum—which includes volleyball training as part of regular learning activities—were included in the sample frame. These schools are typical metropolitan public primary schools with reasonable facilities, such as standard balls and volleyball courts. The following inclusion criteria were used to choose participants: (i) being between the ages of 10 and 13; (ii) having previously received volleyball training through physical education classes for at least one academic semester; and (iii) being in good physical health. The research did not include students who had any medical illnesses, injuries, or motor impairments that would have affected their performance.

The participants were divided into beginner and lower-intermediate learners based on their level of experience. They had been taught the fundamentals of volleyball, including passing and serving, but they had not gotten any structured or in-depth instruction outside of the classroom. This degree of expertise guarantees that the produced instrument is suitable for its target group by reflecting typical elementary school children in physical education settings. Five specialists in physical education and basic volleyball instruction were consulted throughout the selection process. These professionals helped find appropriate participants and made sure the sample had instructional and developmental traits pertinent to the study's goals.

The appropriate institutional review board (or ethics committee) granted ethical approval for this study. Permission was also obtained from the school administration. Prior to data collection, verbal assent was sought from the children, and written informed permission was obtained from all participants' parents or legal guardians. Every process was carried out in compliance with ethical guidelines for research involving adolescents, guaranteeing privacy, voluntary involvement, and the freedom to discontinue participation at any moment without repercussions.

Table 1. Characteristics of Research Participants

Variable	Category	n%	Mean	SD
Sex	Male	26 (52.0)	-	-
	Female	24 (48.0)	-	-
Age	10 years	12 (24.0)	11.42	1.05
	11 years	14 (28.0)		
	12 years	15 (30.0)		
	13 years	9 (18.0)		
Prior volleyball exposure	Yes	50	-	-

Procedure

The study followed a multi-stage procedure to develop and validate a volleyball skill assessment instrument. Initially, a needs analysis and literature review were conducted to identify limitations in existing tools, revealing gaps in scoring clarity, rater protocols, reliability procedures, and developmental suitability. The preliminary instrument was then evaluated by three experts, and content validity was confirmed using Aiken's V (≥ 0.80), followed by revisions based on expert feedback. A small-group trial involving 15 students was conducted to assess feasibility, clarity, and scoring consistency, leading to further refinements. Finally, a field evaluation with 50 students was carried out to examine reliability, including inter-rater assessment by two evaluators and test–retest reliability over a seven-day interval.

Instrument

The initial instrument used was an adaptation of Jariono et al. (2023) volleyball skills test, then modified to suit the conditions and development of elementary school students. The skills tested included underhand serve, underhand pass, and overhand pass. Each element was assessed based on the criteria of basic technique, accuracy, and mastery of movement. Simple processes, precise job instructions, and quantifiable performance indicators were used in the creation of each test item. In order to ensure impartiality and simplicity of application in educational contexts, the evaluation mainly focuses on ball placement accuracy and performance consistency. **Table 2** and **Figure 1-3** describe the modified research instrument for the volleyball skill test.

Table 2. Modified Research Instrument of the Volleyball Skill Test

Skill	Distance	Target Height	Duration / Attempts	Procedure	Scoring
Underhand Passing	3 m (from wall)	2.5 m	60 s	Continuous underhand passing to wall target	Number of successful passes into target zones (Zones 1–3; each 30 cm)
Overhand Passing	3 m (from wall)	2.5 m	60 s	Continuous overhand passing to wall target	Number of successful passes into target zones (Zones 1–3; each 30 cm)

Skill	Distance	Target Height	Duration / Attempts	Procedure	Scoring
Underhand Serve	9 m (from target)	Net: 2.24 m	10 attempts	Underhand serve from behind service line	2 = main target zones; 1 = boundary area; 0 = outside
Overhand Serve	9 m (from target)	Net: 2.24 m	10 attempts	Overhand serve from behind service line	2 = main target zones; 1 = boundary area; 0 = outside
Smash	3 m (behind attack line)	—	10 attempts	Smash toward court target area	2 = main target zones; 1 = boundary area; 0 = outside

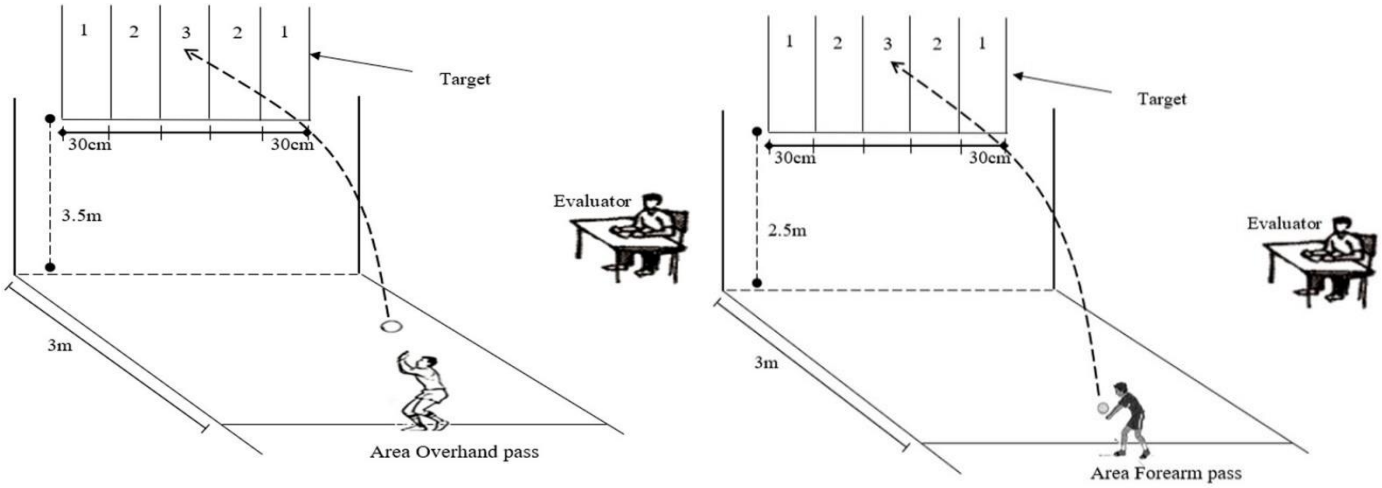

Figure 1. Layout of the Passing Skill Test Showing Target Zones and Testing Distance

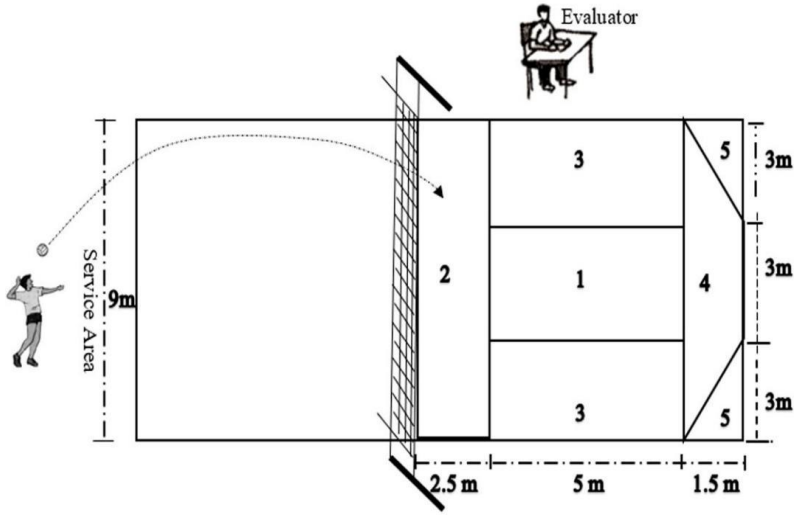

Figure 2. Layout of the Service Skill Test Showing Target Zones and Testing Distance

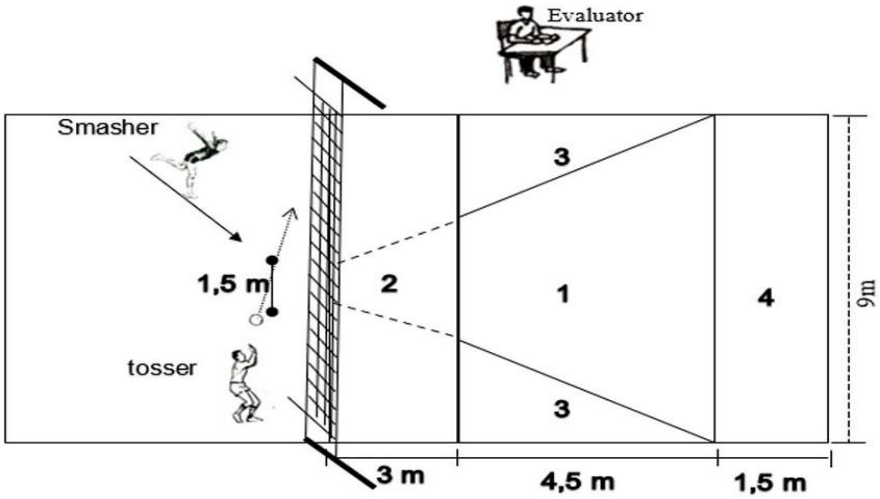

Figure 3. Layout of the Smash Skill Test Showing Target Zones and Testing Distance

Data Measurement and Analysis

This study uses content, construct, and criterion validity to ensure the instrument's theoretical and empirical measurement accuracy. Each type of validity is assessed using different methods and analytical procedures, depending on the motor performance instrument. **Table 3** lists aims, techniques, and statistical indicators for each validity type.

Table 3. Validity of Volleyball Skills Test Instrument

Types of Validity	Objectives	Procedure/Analysis Technique	Completion Criteria	Statistical Output
Content Validity	To ensure that instrument items are relevant, representative, and align with the objectives of measuring motor skills.	Assessment by 6 experts (licensed volleyball coaches, physical education lecturers, and motor skills assessment specialists). Analysis using Aiken's V.	V ≥ 0.80 = valid; 0.60-0.79 = revised; < 0.60 = invalid	Aiken's V value per item and overall mean
Construct Validity	To test whether the items form the correct skill construct (passing, serving, smashing).	Exploratory Factor Analysis (EFA) with principal axis factoring.	Factor loading ≥ 0.40; KMO > 0.60; Bartlett's Test significant	KMO, Bartlett's χ^2, eigenvalues, factor loading matrix
Criterion Validity	To test the relationship between test scores and actual performance in volleyball.	Correlation between test scores and volleyball practice scores from physical education teachers/match performance.	r ≥ 0.40 = valid; r ≥ 0.70 = very valid	Pearson's correlation r value

Besides validity, reliability is a crucial factor in the development of motor performance instruments, as it requires consistency across assessors, within the same assessor, and over different measurement intervals. This study utilised three primary kinds of reliability: inter-rater, intra-rater, and test-retest, along with supplementary internal consistency measures where required. **Table 4** presents a delineation of the aims, testing methodologies, and statistical criteria employed.

Table 4. Reliability of Volleyball Skills Test Instrument

Reliability Type	Purpose	Procedure/Analysis Technique	Criteria	Statistical Output
Inter-rater Reliability	To ensure consistency of scores across raters when observing the same performance	2-3 raters scored simultaneously. Analysis used the Intraclass Correlation Coefficient (ICC).	ICC ≥ 0.75 = good; ≥ 0.90 = very good	ICC, 95% CI, F, p-value
Intra-rater Reliability	To ensure consistency of scores across time between raters	Raters re-scored the performance videos after 7-10 days; analysis used the ICC.	ICC ≥ 0.75	ICC per skill
Test–retest Reliability	To measure test stability over time	The test was repeated on 20 students after 7 days. Analysis used the ICC or Pearson r	r ≥ 0.70 or ICC ≥ 0.75	Test stability coefficient

The validity test was carried out using the Pearson Product Moment correlation technique to measure the strength of the relationship between items and the total score. The instrument's reliability was tested using Cronbach's alpha to determine the internal consistency between the questions. The difficulty level test was conducted to determine how much the test could differentiate students' abilities. All data were analysed using statistical software G*Power version 3.1.9.7 and Jamovi version 2.3.2 (The Jamovi Project, Sydney, Australia).

RESULTS AND DISCUSSION

Result

50 elementary school students aged 10 to 13 years conducted a volleyball skills assessment encompassing five components: underhand passing, overhand passing, underhand serve, overhand serve, and smash. The descriptive results indicated that students demonstrated moderate to proficient mastery of core ball-control skills, whereas service-related skills proved more difficult. **Table 5** explains the descriptive statistics of volleyball skill test scores.

Table 5. Descriptive Statistics of Volleyball Skill Test Scores

Skill Component	Unit	Mean	SD	Minimum	Maximum
Underhand Passing	Successful passes (60 s)	18.42	4.12	10	27
Overhand Passing	Successful passes (60 s)	15.26	3.87	8	24
Underhand Service	Successful trials (10 attempts)	6.14	2.31	2	10
Overhand Service	Successful trials (10 attempts)	4.32	1.89	1	8
Smash	Successful trials (10 attempts)	5.88	2.44	2	10

This volleyball skills test instrument was developed to assess elementary school students aged 10-13's abilities in five basic skills: underhand serve, overhand serve, underhand pass, overhand pass, and smash. The test subjects were 50 students from several elementary schools in Bengkulu City. Data were collected by direct testing using an assessment sheet adjusted to elementary school children's characteristics. The analysis used Pearson correlation for validity, Cronbach's alpha for reliability, and a difficulty index. The validity test results showed that all items had a calculated r value > r table (0.279), so they were declared valid. The validity test results using Pearson correlation showed that all volleyball skills test instrument items had a significant calculated 'r' value exceeding the 'r' table at a significance level of 5%. This indicates that each item in the instrument measures the intended construct, namely basic volleyball skills in elementary school students. The strong relationship between test items and theoretical constructs indicates this instrument has excellent content validity. This means that each indicator, such as underhand serve, overhand serve, underhand pass, overhand pass, and smash, is not only conceptually relevant but also on target for students aged 10-13 years. This high validity is fundamental because it ensures that the test results reflect the students' skills, not other aspects such

as luck or external factors. Thus, physical education teachers can use these measurement results to conduct valid evaluations of students' abilities in volleyball.

Six specialists (licensed volleyball coaches, physical education instructors, and motor skills assessment experts) assessed the pertinence and representativeness of each skill indication. All items surpassed the minimum standards for CVR (≥ 0.78) and Aiken's V (≥ 0.80) as assessed by six panellists. The 95% confidence intervals (CI) for Aiken's V were calculated to examine the stability of the estimates. All lower-bound CI values remained above the acceptable threshold, further confirming the robustness of the instrument's content validity. **Table 6** explains the content validity results.

Table 6. Content Validity Results

Subtest	CVR	Aiken's V	95% CI (Aiken's V)	Interpretation
Underhand Passing	0.83	0.89	0.75 – 0.97	Valid
Overhand Passing	1.00	0.93	0.81 – 0.99	Valid
Underhand Service	0.83	0.87	0.72 – 0.96	Valid
Overhand Service	1.00	0.91	0.78 – 0.98	Valid
Smash	0.83	0.88	0.74 – 0.96	Valid

By comparing test results with actual 3 vs. 3 game performance assessed separately by two certified coaches, criterion-related validity was examined. Test performance predicts real game competency, as evidenced by all associations being significant at $p < 0.001$. **Table 7** explains the criterion validity.

Table 7. Criterion Validity

Subtest	r	Interpretation
Underhand Passing	0.71	Moderate
Overhand Passing	0.68	Moderate
Service	0.63	Moderate
Smash	0.66	Moderate

The designed volleyball skill test instrument shows excellent stability and consistency among raters and testing dates, according to the reliability study. The standardised scoring criteria and rater training processes successfully reduced subjectivity, as evidenced by the inter-rater reliability coefficients ranging from 0.87 to 0.92. Individual raters consistently evaluated performance over time, according to intra-rater reliability values (0.89-0.94). Additionally, the instrument's usefulness for repeated assessments in school-based physical education contexts is supported by test-retest correlations (0.79-0.86), which show excellent temporal stability. All of these results demonstrate that the instrument surpasses the restrictions of internal consistency metrics like Cronbach's alpha and satisfies best-practice reliability criteria for motor performance assessments. **Table 8** explains the reliability analysis of the volleyball skill test instrument.

Table 8. Reliability Analysis of the Volleyball Skill Test Instrument

Subtest	Inter-rater Reliability (ICC)	Category	Intra-rater Reliability (ICC)	Category	Test–Retest Reliability (r)	Category
Underhand Passing	0.92	Excellent	0.94	Excellent	0.86	Excellent
Overhand Passing	0.89	Good	0.91	Excellent	0.82	Excellent
Service	0.87	Good	0.89	Good	0.79	Good
Smash	0.90	Excellent	0.92	Excellent	0.81	Excellent

The final interpretation of the factor structure obtained from the volleyball skills test instrument's exploratory factor analysis (EFA) is shown in **Table 9**. In order to understand the extracted factors, theoretical notions of motor skill development in primary school-aged children were integrated with statistical data, such as factor loadings, communalities, and explained variance. A two-factor solution reflecting different but complimentary aspects of volleyball skills was produced by the study. Basic ball handling abilities are represented by Factor 1, while attacking technical abilities are represented by Factor 2. This structure

demonstrates that the measured skills are consistent with accepted notions of motor development and sport-specific performance, supporting the instrument's construct validity.

Table 9. Factor Loading Matrix

Item	Factor 1 (Fundamental Ball Control)	Factor 2 (Offensive Technical Skills)
Underhand Passing	0.88	0.21
Overhand Passing	0.84	0.25
Underhand Serve	0.29	0.79
Overhand Serve	0.24	0.83
Smash	0.18	0.77

Table 10. Final Interpretation of Extracted Factors

Factor	Items Included	Conceptual Meaning	Empirical Support
Factor 1 – Fundamental Ball Control	Underhand Passing, Overhand Passing	Core manipulative skills foundational for ball mastery	High loadings (0.84-0.88), strong communalities
Factor 2 – Offensive Technical Skills	Underhand Service, Overhand Service, Smash	Skills related to attack, scoring, and power execution	Loadings 0.77-0.83, explains 14.36% variance

This instrument has been proven to be an objective, accurate, and educational measuring tool, especially for physical education teachers. Objectively, this instrument has standardised assessment indicators, thus reducing teacher subjectivity in assessing. Accurately, the test items measure aspects of skills relevant to elementary school-aged children's development. Educationally, this instrument functions as an evaluation tool and a learning medium that can be used in volleyball skills teaching activities. Furthermore, the existence of this instrument can support teachers in designing more effective and data-based learning strategies. Teachers can identify which skills need to be improved by students, adapt training programmes, and evaluate skill development periodically. In other words, this instrument improves the quality of physical education learning at the elementary school level.

Discussion

The Necessity of Multi-Level Validity in Motor Skill Assessment

The purpose of this study was to create and verify a volleyball skill evaluation tool for kids between the ages of 10 and 13. With excellent content validity indices and a distinct two-factor structure determined from exploratory factor analysis (EFA), the results show that the instrument has significant psychometric qualities. Crucially, the incorporation of many validation techniques enhances the instrument's overall credibility and resolves typical issues in motor skill evaluation research, which frequently depends on single-method validation.

The study's two-factor structure—basic ball control and attacking technical skills—is supported both conceptually and quantitatively. The factor loading matrix demonstrated a distinct distinction from a statistical standpoint, with serving and smash abilities loading on the second factor and passing skills loading substantially on the first. There were few cross-loadings, suggesting strong discriminant validity. This differentiation is consistent with children's motor development principles: serving and smashing need a more sophisticated integration of strength, time, and power execution, whilst basic manipulation skills like passing reflect fundamental coordination abilities. Higher degrees of neuromuscular control are needed for these offensive skills, which usually appear later in motor development. As a result, the factor division offers a useful framework for both evaluation and education by reflecting a shift from control-orientated abilities to performance-orientated skills.

Age-appropriate task design is crucial when evaluating volleyball skills like passing, serving, and smashing in children, as studies comparing TGMD-2 and TGMD-3 show that changes in test structure and scoring criteria have a significant impact on sensitivity to motor learning and intervention outcomes (Palmer et al., 2021). Volleyball-specific instruments should strike a compromise between psychometric rigour and realistic classroom application, according to evidence from shortened TGMD-2 versions, which further demonstrates

that validity may be maintained while boosting feasibility (Bandeira et al., 2020). Instructional delivery affects motor performance consistency, according to research on augmented reality-based demonstrations. This is especially true for technically challenging volleyball skills that rely on exact movement patterns (Spinosa et al., 2020). When creating volleyball skill assessments for primary school pupils, contextual adaptation is crucial since cross-cultural evaluations of the TGMD-2 show that some motor activities may be disproportionately challenging for some groups (Yang et al., 2020). Lastly, systematic reviews show significant variation in motor competence results between nations, which supports the creation of volleyball-specific assessment tools that are adapted to children's developmental and cultural contexts and reinforces the limitations of general motor tests (Santos et al., 2020).

The findings also emphasise how crucial it is to provide tasks that are developmentally appropriate. Every test item fell within the moderate difficulty category, meaning that it is appropriately rigorous without going beyond primary school pupils' physical and mental abilities. This equilibrium is necessary to guarantee that the test can distinguish between various skill levels while preserving student interest and reducing annoyance. These results are in line with other studies that highlight how age-appropriate design greatly influences the sensitivity and utility of motor skill evaluations.

Limitations of Cronbach's Alpha for Motor Skill Instruments

This study aims to develop a valid, reliable volleyball skills test instrument that matches the physical characteristics and motor development of elementary school students. The study results indicate that the instrument developed has met good psychometric criteria so that it can be used as an effective measuring tool in physical education learning, especially volleyball game material. Validity is an essential aspect of instrument development because it determines the extent to which the measuring instrument measures what it should measure (Benda et al., 2021; Esen et al., 2021). In this study, all test items showed significant correlation values to the volleyball skills construct. This shows that each question item (underhand serve, overhand serve, underhand pass, overhand pass, and smash) is conceptually and empirically closely related to the skills to be measured. These results align with previous studies that emphasise the importance of content validity in developing motor skills measurement tools (Jamaludin et al., 2022; Song et al., 2022).

Cronbach's alpha (α) is still often employed in educational research; however, its usage in motor skill assessment should be carefully considered. Performance-based skill evaluations seldom meet the assumptions of Cronbach's alpha, which include tau-equivalency, unidimensionality, and internal consistency among items. Instead of being interchangeable markers of a single latent trait, each subtest (such as passing, serving, and smashing) in volleyball skill assessment evaluates related but different motor constructs. Furthermore, α is mostly intended for self-report tools, in which items represent several expressions of the same psychological characteristic. On the other hand, internal consistency indices alone are insufficient to represent the performance stability, scoring consistency, and observer agreement that are highlighted in motor skill assessments. Therefore, in the context of measuring physical performance, it may be incorrect to interpret a high Cronbach's alpha as proof of dependability.

The Cronbach's alpha value of 0.83 indicates that this instrument is highly reliable and has strong internal consistency. High reliability ensures that the measurement results are reliable and stable when used in different times and contexts but in comparable populations. This is important so that teachers can use this instrument repeatedly in evaluating student learning without worrying about unreasonable differences in results. This finding strengthens previous studies' findings that high reliability is a significant indicator of the quality of sports skills tests (Hidayat et al., 2022; Hulteen et al., 2015).

The difficulty level analysis shows that the test items are in the moderate to easy category, which is very appropriate for the characteristics of elementary school students. This shows that the test is not too difficult for students but still can discriminate against differences in student skill levels. This is very important to maintain student motivation in following the evaluation process and minimise the level of frustration or failure that can arise if the questions are too complicated. This instrument provides accurate and objective data regarding students' volleyball skills and can also be used by physical education teachers to guide learning strategies. Teachers can identify specific student weaknesses, adjust the training approach, and set realistic

and measurable learning goals. Thus, this instrument has a dual function: as an assessment tool and a tool for developing the learning process.

The instrument developed specifically for students aged 10-13 years answers the need for a test tool appropriate to the developmental level of elementary school children, which is very different from that of adolescents or adults. This adjustment is important because the development of elementary school children's motor coordination, muscle strength, and concentration capacity has its characteristics. Therefore, the pedagogical approach and evaluation instrument must also be adaptive and contextual. This instrument can be widely implemented in Indonesia's physical education curriculum. Teachers can use it to improve the quality of volleyball learning evaluation. In addition, the test results can be initial data in developing extracurricular volleyball training programmes for students who show further potential.

Although Cronbach's alpha indicated good internal consistency, its interpretation in the context of motor skill assessment should be approached cautiously. Unlike self-report instruments, this test measures multiple related but distinct motor abilities rather than a single homogeneous construct. Therefore, reliability in this context is better understood as consistency of performance measurement, supported by clear scoring criteria and standardised procedures, rather than solely internal consistency. This highlights the need to complement traditional reliability indices with performance-based considerations in future research.

Implications for Instrument Development and Educational Practice

This study has limitations in the number and distribution of samples covering only several elementary schools in Bengkulu City. By offering a standardised, objective, and developmentally appropriate tool for evaluating volleyball abilities at the primary school level, the validated instrument has practical relevance for physical education instructors. Assessment fairness is improved and subjectivity is decreased through the use of clear scoring standards, controlled task execution, and scientifically validated difficulty levels. Additionally, teachers may create more focused educational interventions and track students' development over time by identifying skill-specific strengths and shortcomings. From a measuring standpoint, the incorporation of psychometric rigour into athletic skill assessment helps close the gap between practical physical education practice and educational evaluation theory, an area that is frequently criticised for its methodological simplicity.

Recommendations for Future Instrument Development

Further research needs to be conducted with more diverse samples from various regions for broader generalisations. In addition, this study has not considered psychological or social aspects such as teamwork or student confidence in volleyball games. Despite its advantages, this research identifies a number of areas that might be improved in next iterations of the tool. To improve measurement accuracy and lessen construct under-representation, item refining is first advised by extending each skill domain into many task variations (e.g., accuracy-based and consistency-based passing tasks). Second, to further reduce scoring bias in large-scale implementations, future research should include formal rater training methods and calibration sessions, even if inter- and intra-rater reliability results were good. Third, to confirm the stability of the two-factor structure shown in this study, future research should use Confirmatory Factor Analysis (CFA) with bigger and more varied samples. The instrument's generalisability will be strengthened by cross-validation in various geographical areas and educational settings. Furthermore, to more accurately characterise item difficulty and discriminates across skill levels, sophisticated measuring techniques like Item Response Theory (IRT) should be investigated.

CONCLUSION

Underhand passing, overhand passing, underhand serve, overhand serve, and smash are the five components of the volleyball skills evaluation tool that this research created for students in elementary school between the ages of 10 and 13. High CVR and Aiken's V values, together with a distinct two-factor structure determined from exploratory factor analysis, confirm the findings, which show that the instrument has great content and construct validity.

Reliability-wise, the tool has robust and consistent measuring characteristics, suggesting that it may be used to evaluate students' volleyball abilities in a variety of settings in an impartial and repeatable manner. Practically speaking, this tool provides physical education teachers with an easy-to-use, systematic, and developmentally appropriate way to assess students' abilities, track their progress, and provide more focused instruction. It is standardised structure enables more widespread use in early skill identification and school-based evaluation.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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