



Development and preliminary psychometric validation of the Hopscotch Motor Fitness Test (HMFT): a culturally grounded assessment of integrated motor competence in young adults

Desarrollo y validación psicométrica preliminar del Hopscotch Motor Fitness Test (HMFT): evaluación culturalmente fundamentada de la competencia motriz integrada en adultos jóvenes

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Abstract

Introduction: Field-based assessments often rely on isolated physical components and may not adequately reflect integrated movement performance in applied contexts, nor the continuous and adaptive nature of movement in applied settings.

Objective: This study aimed to develop and conduct a preliminary psychometric validation of the Hopscotch Motor Fitness Test (HMFT) as a culturally grounded assessment of Integrated Motor Competence (IMC) in young adults.

Methodology: A mixed-method research and development design was employed. Psychometric evaluation ($n = 100$) examined intra- and inter-rater reliability and criterion-related validity. Exploratory reference data ($n = 500$) and user satisfaction ($n = 60$) were also assessed.

Results: The HMFT demonstrated good reliability ($ICC \geq 0.83$). A moderate association with agility was observed ($r = 0.54$, $p < 0.01$), while correlations with isolated motor components were consistently low ($r < 0.40$), supporting construct differentiation from single-domain motor measures. High satisfaction among participants ($M = 4.56$) and favorable feasibility ratings were reported.

Discussion: Findings suggest that the HMFT reflects integrated and sequential motor performance within a continuous task, capturing coordinated movement behavior beyond isolated physical capacities, supporting its construct distinctiveness.

Conclusions: The HMFT is a feasible and reliable field-based tool for assessing integrated motor competence, functioning as a preliminary, non-diagnostic assessment framework applicable to educational and community-based health contexts.

Keywords

Integrated motor competence; field-based assessment; motor performance; cultural adaptation; construct differentiation; agility

Resumen

Introducción: Las evaluaciones motoras basadas en el campo suelen centrarse en componentes físicos aislados y pueden no reflejar adecuadamente el rendimiento motor integrado en contextos aplicados, ni la naturaleza continua y adaptativa del movimiento en contextos aplicados.

Objetivo: Este estudio tuvo como objetivo desarrollar y llevar a cabo una validación psicométrica preliminar del Hopscotch Motor Fitness Test (HMFT) como una evaluación culturalmente fundamentada de la Competencia Motriz Integrada (Integrated Motor Competence, IMC) en adultos jóvenes.

Metodología: Se empleó un diseño de investigación y desarrollo con enfoque de métodos mixtos. La evaluación psicométrica ($n = 100$) examinó la fiabilidad intraevaluador e interevaluador, así como la validez relacionada con el criterio. También se obtuvieron datos de referencia exploratorios ($n = 500$) y se evaluó la satisfacción de los usuarios ($n = 60$).

Resultados: El HMFT demostró una buena fiabilidad ($ICC \geq 0,83$). Se observó una asociación moderada con la agilidad ($r = 0,54$, $p < 0,01$), mientras que las correlaciones con componentes motores aislados fueron consistentemente bajas ($r < 0,40$), lo que respalda la diferenciación del constructo frente a medidas motoras de dominio único. Se reportaron altos niveles de satisfacción entre los participantes ($M = 4,56$) y valoraciones favorables de viabilidad.

Discusión: Los hallazgos sugieren que el HMFT refleja el rendimiento motor integrado y secuencial dentro de una tarea continua, capturando un comportamiento motor coordinado más allá de capacidades físicas aisladas, lo que respalda su distintividad conceptual.

Conclusiones: El HMFT es una herramienta viable y fiable de evaluación en campo para la competencia motriz integrada, funcionando como un marco de evaluación preliminar y no diagnóstico con aplicabilidad en contextos educativos y de salud comunitaria.

Palabras clave

Competencia motriz integrada; evaluación en campo; rendimiento motor; adaptación cultural; diferenciación del constructo; agilidad.



Introduction

Physical inactivity among children and adolescents remains a critical global public health challenge, with direct implications for the development of motor competence and sustained engagement in physical activity across the lifespan. The World Health Organization (2020) has reported that a substantial proportion of youth worldwide do not meet recommended physical activity levels, thereby increasing risks for both physical and psychosocial health problems. Within this context, contemporary research has increasingly shifted toward conceptualizing motor competence not as a set of isolated abilities, but as Integrated Motor Competence (IMC), defined as the capacity to coordinate multiple motor domains into adaptive and functional movement sequences (Barnett et al., 2016). Importantly, this perspective extends beyond the aggregation of discrete motor skills by emphasizing the dynamic integration of neuromuscular control, perceptual processing, and real-time decision-making within continuous movement contexts. In this regard, IMC can be more precisely understood as a continuous adaptive coordination process in which multiple motor and cognitive subsystems interact dynamically under task-specific constraints rather than functioning as independent components. This perspective further suggests that motor competence may be considered as a context-dependent and temporally organized construct, reflecting how coordinated movement unfolds across continuous task conditions. This perspective highlights the importance of assessing movement performance as it occurs in functional and context-specific situations, rather than relying solely on fragmented physiological outputs (Latina et al., 2025).

Despite this conceptual advancement, many widely used motor fitness assessments continue to rely on segmented test items that quantify discrete capacities such as strength, balance, or speed in isolation. Although these instruments often demonstrate acceptable psychometric properties, they may not adequately reflect integrated motor behavior that underpins functional movement in everyday contexts and early functional screening (Abdullah & Amri, 2018). Such approaches may underestimate the complexity of coordinated motor performance, particularly in tasks requiring sequential and adaptive control across multiple domains. More specifically, segmented assessments often fail to capture the temporal continuity and interdependence of movement components, which are essential for understanding how motor actions are organized and executed in real-world settings. These limitations suggest that existing assessment approaches may not fully align with contemporary perspectives emphasizing coordinated and context-dependent movement performance. Furthermore, standardized test batteries are frequently associated with high equipment demands and limited cultural relevance, which constrain their feasibility in school and community-based environments. In practical settings, there is a growing need for simple, low-cost, and context-appropriate assessment tools that can be implemented efficiently without compromising measurement quality. In the Thai context, traditional folk games have increasingly been recognized as viable platforms for developing such tools. For example, the Thai folk game Jik Sen has been adapted into a structured recreational program for older adults, demonstrating its capacity to support functional movement, social engagement, and health-related outcomes (Tongterm et al., 2024). Furthermore, previous work has demonstrated the development of culturally grounded assessments targeting specific motor domains, including lower-limb power-endurance and dynamic motor competence across culturally grounded field-based assessments (Tongterm et al., 2026; Tongterm et al., 2025). Collectively, these studies indicate a progressive and systematic development of culturally grounded assessment approaches; however, they remain primarily focused on domain-specific evaluation and do not fully address how multiple motor capacities operate together within a continuous movement context.

Within this cultural and applied framework, the Thai traditional game Tang Te (Thai Hopscotch) represents an indigenous activity characterized by sequential, rhythmic, and coordinated movements involving hopping, balance control, agility, and object manipulation. These movement characteristics inherently require the integration of multiple motor and cognitive processes, positioning Tang Te as a naturally occurring context in which coordinated movement can be observed as a continuous and integrated process rather than as a collection of isolated skills. Empirical evidence has indicated that Tang Te-based activities can contribute to improvements in body composition and quality of life among children, supporting their relevance for movement development and health promotion (Kanlayawut & Kritpet, 2022). In addition, traditional game-based activities have been shown to enhance intrinsic motivation and adherence while preserving the functional authenticity of motor performance, thereby



supporting ecological validity in assessment contexts (Azlan et al., 2021). Furthermore, traditional games have also been shown to enhance perceptual-decisional processes and integrated motor behavior within physical education settings (Ramos-Pérez et al., 2021). These characteristics make Tang Te particularly suitable as a foundation for developing field-based assessments that reflect real-world movement demands and are feasible in applied settings such as schools and community programs (Babov et al., 2025; Sharma & Zafar, 2025).

Despite this potential, there remains a clear research gap in the absence of psychometrically examined and culturally grounded assessment tools derived from the Tang Te protocol that explicitly target Integrated Motor Competence within feasible field-based conditions. Although previous research has established the importance of motor competence as a multidimensional construct (Barnett et al., 2016) and has highlighted the role of adaptive capacity in movement performance (Latina et al., 2025), existing assessment approaches remain largely focused on discrete or domain-specific outcomes rather than on the integrated functioning of these capacities. Furthermore, prior culturally grounded assessments have primarily addressed specific components, such as lower-limb power-endurance and dynamic motor competence (Tongterm et al., 2026; Tongterm et al., 2025), without capturing how these elements interact within a continuous movement context. More specifically, current literature lacks assessment approaches capable of capturing integrated motor competence as a continuous and adaptive process occurring within ecologically valid movement tasks rather than as discrete and compartmentalized performance outcomes. This gap highlights the need for assessment approaches that better reflect the integrated and context-dependent nature of movement performance in real-world settings. To address this gap, the present study introduces the Hopscotch Motor Fitness Test (HMFT), a field-based assessment systematically adapted from the Thai traditional game Tang Te. Accordingly, the HMFT extends prior work by integrating previously isolated constructs into a unified assessment framework designed to capture continuous and adaptive motor coordination. Within this framework, motor competence is approached as a coordinated interaction of multiple movement components within a continuous task, rather than as independently measured capacities. The primary aim of this study was to conduct a preliminary psychometric validation of the HMFT. Specifically, the objectives were to develop the HMFT protocol and establish its content validity, examine intra-rater and inter-rater reliability, assess criterion-related validity against standardized motor fitness tests, and generate exploratory reference data alongside evidence of feasibility. By situating traditional Thai play within a structured measurement framework, this study provides a practical and culturally grounded approach for assessing integrated motor competence in non-clinical populations, with direct applicability to education, community health promotion, and early functional screening contexts.

Materials and methods

This study was systematically designed to develop and preliminarily validate the Hopscotch Motor Fitness Test (HMFT) as a reliable and feasible field-based assessment derived from the Thai traditional game Tang Te. The test was developed to provide a practical tool for evaluating motor performance in educational and applied settings, while maintaining both methodological soundness and cultural relevance.

Research Design

This study employed a sequential, multiphase Psychometric Research and Development (R&D) design with a quantitative-dominant approach incorporating structured user evaluation. The design followed standard procedures for test validation while also considering practical use in physical education and health contexts. The study was structured as a preliminary validation focusing on score stability, test performance, and field applicability, with attention to integrated movement performance within continuous tasks. The study was conducted as an early-phase validation to establish measurement consistency and construct differentiation prior to large-scale confirmatory testing.

All procedures, including participant recruitment and data collection, adhered to the principles of the Declaration of Helsinki and were approved by the Research Ethics Review Committee of Sisaket Rajabhat University (Protocol No. HE661013). Written informed consent was obtained from all participants prior to participation.



Participants and Rationale

The study comprised four sequential stages conducted at the Sports Science Laboratory, Sisaket Rajabhat University, between May and September 2024. Sample size determination followed established psychometric conventions to ensure adequate statistical power for Intraclass Correlation Coefficient estimates and normative analysis.

- 1) Preliminary Trials (n = 35): Two pilot groups of healthy youths were assessed to refine the test layout, ensure procedural safety, and optimize task sequencing.
- 2) Validation Stage (n = 100): A purposive sample of 100 healthy and physically active youths (50 males, 50 females) participated in the evaluation of intra- and inter-rater reliability and criterion-related validity. This population was selected to ensure that participants could safely perform continuous and sequential movement tasks while minimizing confounding influences related to physical limitations, allowing clearer observation of integrated motor performance under stable functional conditions.
- 3) Normative Stage (n = 500): A separate cohort of 500 participants (250 males, 250 females) completed the finalized HMFT protocol to generate exploratory reference data.
- 4) Satisfaction Survey (n = 60): Two subgroups (30 test administrators and 30 youth participants) evaluated feasibility and practicality. Both participant and administrator perspectives were included to capture user experience and implementation feasibility within applied settings.

Instrument Development

The Hopscotch Motor Fitness Test (HMFT) was adapted from the Thai traditional game Tang Te to assess agility, balance, coordination, and lower-limb strength within a single continuous and timed sequence. These domains collectively represent Integrated Motor Competence (IMC) within a dynamic and sequential movement context. The finalized protocol consisted of three integrated stages: 1) bilateral jumping, 2) single-leg hopping, and 3) hopping combined with object retrieval followed by cone running. These tasks were designed to reflect coordinated and sequential movement within a continuous task rather than isolated physical components. This design was intended to operationalize integrated motor competence as a coordinated and temporally organized movement construct rather than as independent performance outcomes.

Content validity was evaluated by five experts in sports science and physical education, each holding a doctoral degree and with at least five years of experience in motor performance assessment. The Index of Item–Objective Congruence (IOC) averaged 0.87, indicating strong alignment between test objectives and performance indicators (Rovinelli & Hambleton, 1976).

Testing was conducted on standardized non-slip mats (2.5 m × 3.5 m) with clearly marked grids. Participants performed the test barefoot to enhance balance control and reduce variability associated with footwear. Safety spotters and first-aid personnel were present throughout each session to ensure participant safety.

Testing Procedures

All testing sessions were conducted under standardized field conditions at the Sisaket Rajabhat University sports complex. Ambient temperature was maintained within a typical range for outdoor field testing in tropical conditions (approximately 27–30 °C), surface type (rubberized track), and environmental distractions were controlled to maintain consistency across sessions. Each session was supervised by certified physical education specialists who completed a three-day examiner training program focusing on procedural standardization, video-based scoring calibration, and inter-rater reliability verification (ICC ≥ 0.85 prior to data collection).

The HMFT protocol consisted of three progressive rounds designed to assess coordinated movement performance within a continuous task. Round 1 involved bilateral jumping to evaluate rhythmic coordination and lower-limb power. Round 2 involved single-leg hopping to assess balance and postural control. Round 3 combined object manipulation with cone running, requiring coordination and agility under time constraints.

Each participant completed two trials, and the fastest valid completion time was recorded as the final performance score, defined as Total Completion Time (TCT). A trial was considered invalid and repeated



after a one-minute rest if the participant stepped outside the grid boundary, made a sequence error, touched the floor with the hands, or failed to complete the full sequence. Performance time was recorded using a digital stopwatch (Casio HS-80TW, precision 0.01 s), and only valid trials were retained for analysis. To minimize potential learning and fatigue effects, participants completed a familiarization trial prior to data collection, and standardized rest intervals were applied to ensure stable performance measurement.

During the validation stage, participants completed both the HMFT and a set of standardized motor fitness tests, including the 50-m shuttle run, Flamingo balance test, handgrip strength, sit-ups (30 s), plate tapping, and standing broad jump. Given that the HMFT was designed to capture integrated motor competence rather than isolated physical capacities, moderate-to-low correlations with single-domain tests were theoretically expected. These tests were selected to represent distinct motor domains, allowing comparison between integrated performance and isolated physical capacities to support interpretation of construct distinctiveness. Criterion-related validity was examined using Pearson's correlation analysis.

In the normative stage, performance data from 500 participants were used to generate sex-specific percentile classifications across five levels (very poor, poor, average, good, and very good), supporting relative interpretation rather than diagnostic use. In the satisfaction stage, both participants and test administrators completed a structured five-item questionnaire using a 5-point Likert scale to assess feasibility and user satisfaction, with strong internal consistency (Cronbach's $\alpha \geq 0.80$).

Data Analysis

All statistical analyses were performed using SPSS version 28.0 (IBM Corp., Chicago, IL, USA). Descriptive statistics, including mean, standard deviation, minimum, and maximum values, were calculated for all variables. Data normality was examined using skewness and kurtosis values, with all variables falling within acceptable ranges, supporting the use of parametric analyses. The use of parametric tests was considered appropriate based on distributional characteristics and sample size. Assumptions of independence and homogeneity of variance were also considered to support the appropriateness of parametric statistical procedures.

Reliability was examined using Intraclass Correlation Coefficients (ICC) based on the framework of Shrout & Fleiss (1979). ICC(3,1) was used for intra-rater reliability, and ICC(2,1) for inter-rater reliability. Interpretation followed the guidelines of Koo & Li (2016), where values below 0.50 indicate poor reliability, 0.50–0.75 moderate, 0.75–0.90 good, and above 0.90 excellent.

Criterion-related validity was assessed using Pearson's product-moment correlation coefficients between HMFT performance and selected motor fitness tests. Correlation strength was interpreted according to Hinkle et al. (2003), with values of 0.00–0.30 considered low, 0.30–0.50 moderate, 0.50–0.70 high, and 0.70–1.00 very high. Statistical significance was set at $p < 0.05$.

Independent t-tests were conducted to examine sex differences in HMFT performance.

Percentile ranks for normative analysis were calculated and classified into five performance levels (very poor, poor, average, good, and very good) following established approaches to fitness data interpretation (Miguel-Etayo et al., 2014). Satisfaction scores were interpreted using Vonglao's (2017) classification, where mean values of 4.20 or higher indicate very high satisfaction.

Results

The following section presents the empirical findings of the study, encompassing the development process, psychometric properties, and applied functional relevance of the Hopscotch Motor Fitness Test (HMFT). Results are structured according to the study objectives and integrate quantitative and qualitative observations, supported by figures and tables to enhance clarity and transparency.

Test Design and Development

The Hopscotch Motor Fitness Test (HMFT) was developed based on the Thai traditional game Tang Te, integrating four major motor domains: balance, coordination, agility, and lower-limb strength into a single field-based movement sequence. The finalized protocol consisted of three sequential rounds: bilateral jumping, single-leg hopping, and an agility run with object manipulation. Expert evaluation confirmed high content validity (IOC = 0.87), indicating strong theoretical alignment with the principles of Integrated Motor Competence (IMC).

Origin of Development

As shown in Figure 1, the traditional Tang Te game served as the conceptual foundation for the HMFT. Core elements of the folk game, including rhythmic movement, spatial precision, and controlled foot placement, were preserved in the modernized test design while ensuring standardized measurement and procedural repeatability. This adaptation maintains cultural authenticity while transforming the traditional activity into a quantifiable and reproducible assessment instrument.

Figure 1. The traditional Thai folk game Tang Te as the conceptual foundation of the Hopscotch Motor Fitness Test.



Testing Equipment

To ensure accessibility and precision, simple and low-cost materials were selected for the HMFT protocol. The equipment used is summarized in Table 1 and includes cloth tape for grid marking, rubber mats for toe-grip tasks, a measuring tape, a stopwatch, a whistle, and agility cones. The arrangement prioritized participant safety, measurement accuracy, and ease of replication in field-based settings.

Detailed visual depictions of equipment configuration and testing setup are provided in Figures 2–4 and the Appendix to support procedural clarity and reproducibility.

Table 1. Equipment Used in the Hopscotch Motor Fitness Test

Equipment	Quantity	Description
Cloth tape (1 inch)	1 roll	Used to mark 2 × 2 m grid
Rubber mat	1 piece	12 mm thick, 6 cm diameter, used for toe gripping
Measuring tape	1 piece	For setup accuracy
Stopwatch	1 piece	For timing trials
Whistle	1 piece	Start signal
Cones (30 cm)	2 pieces	For agility course (15 m apart)

Figure 2. Cloth tape (1 inch wide) used for constructing the 2 × 2 meter grid and round rubber mats (12 mm thick, 6 cm diameter) applied in Round 3 for toe-gripping performance.



Figure 3. Measuring tape and stopwatch employed for distance marking and completion time recording during the Hopscotch Motor Fitness Test.



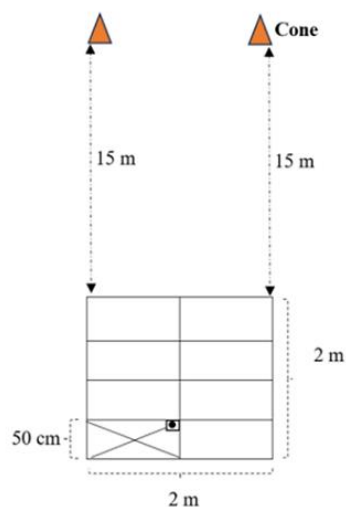
Figure 4. Whistle and 30-cm traffic cones positioned 15 meters from the grid, used as signaling and directional markers for the agility running task.



Test Station Setup

The overall test station layout is illustrated in Figure 5. It comprised an eight-square grid (2 × 2 m) connected to an agility zone marked by two cones positioned 15 meters apart. This configuration enabled a continuous transition between balance, hopping, and running components while maintaining standardized spatial conditions across all trials.

Figure 5. Layout of the Hopscotch Motor Fitness Test station.



Testing Procedures

Participants performed the HMFT barefoot to optimize balance and sensory feedback. At the beginning of each trial, participants assumed a static starting position at the central cross of the grid before initiating Round 1, as illustrated in Figure 6. The test consisted of three sequential rounds with progressively increasing motor demands.

Round 1 involved bilateral jumping through the grid squares in a continuous sequence, emphasizing coordination, rhythm, and bilateral lower-limb power (Figure 7).

Round 2 consisted of continuous single-leg hopping using the dominant leg, focusing on dynamic balance and postural stability (Figure 8).

Round 3 evaluated integrated coordination and agility through a multistage sequence combining toe-grip control, hopping, and running tasks. Participants were required to grip a rubber mat between the toes, perform an agility run around two cones, resume hopping across the remaining grid squares, and complete the sequence by returning the mat to the starting position (Figures 9–12).

Each participant completed two full trials, and the faster completion time was recorded for analysis. If the rubber mat was dropped during Round 3, the affected sequence was repeated after a brief recovery period. This structured progression allowed for a consistent assessment of coordination, agility, and neuromuscular control within a culturally grounded, field-based testing framework.

Figure 6. Static barefoot starting position at the central cross of the grid before initiating Round 1, adapted from the traditional Thai game Tang Te.



Figure 7. Round 1: continuous bilateral jumping across all grid squares following the designated sequence.



Figure 8. Round 2: continuous single-leg hopping across the grid using the dominant leg.



Figure 9. Round 3 activity (Phase 1): participant gripping the round rubber mat between the big toe and index toe while performing single-leg hopping into Square 4.



Figure 10. Round 3 activity (Phase 2): participant running with the mat in hand around the two traffic cones forming a 15-meter agility circuit before returning to the grid.

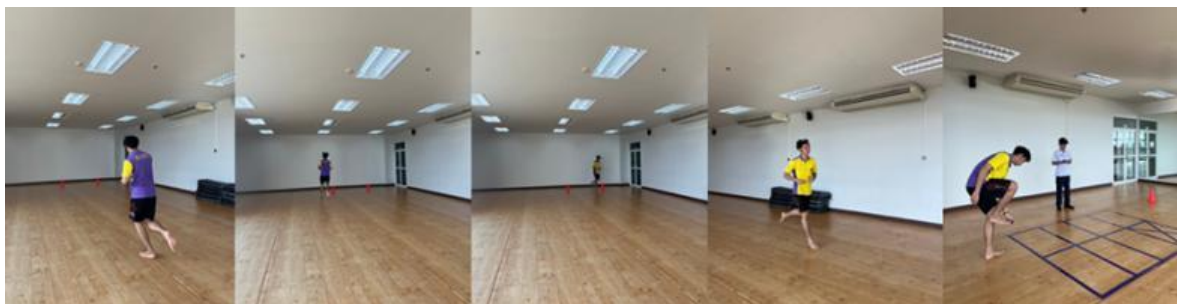


Figure 11. Round 3 activity (Phase 3): participant resuming single-leg hopping across Squares 5–8 while maintaining controlled toe grip of the rubber mat (precision hopping).



Figure 12. Completion of Round 3: participant exiting the grid after the final hop and returning the mat to the starting position, concluding the integrated coordination and agility sequence.



Data Normality Check

Prior to all inferential analyses, the normality of key variables was examined using skewness and kurtosis values. All performance measures, including Total Completion Time, as well as demographic variables such as age and body mass index (BMI), fell within acceptable ranges for normal distribution. These results support the appropriateness of using parametric statistical procedures, including Pearson's correlation and independent t-tests, for subsequent analyses.

Reliability

Reliability analyses examined the scoring stability of the HMFT across repeated trials and raters. As summarized in Tables 2 and 3, intra-rater reliability demonstrated good agreement (ICC = 0.84, 95%CI = 0.77–0.89), while inter-rater reliability also indicated good consistency between examiners (ICC = 0.83, 95%CI = 0.75–0.88). These results indicate that the HMFT produces reproducible scores across measurement occasions and raters, supporting its reliability as a field-based assessment for repeated administration in non-clinical settings.

Table 2. Intra-rater Reliability of the Hopscotch Motor Fitness Test (n = 100)

Test	First Trial (M ± SD)	Second Trial (M ± SD)	ICC(3,1)	95%CI	Interpretation
HMFT	25.62 ± 3.65	25.68 ± 3.69	0.84*	0.77–0.89	Good reliability

Note. ICC = Intraclass Correlation Coefficient; *p < .05

Table 3. Inter-rater Reliability of the Hopscotch Motor Fitness Test (n = 100)

Test	Examiner 1 (M ± SD)	Examiner 2 (M ± SD)	ICC(2,1)	95%CI	Interpretation
HMFT	25.62 ± 3.65	25.32 ± 3.73	0.83*	0.75–0.88	Good reliability

Note. ICC = Intraclass Correlation Coefficient; *p < .05

Criterion-Related Validity

To examine the criterion-related validity of the Hopscotch Motor Fitness Test (HMFT), Pearson correlation coefficients were calculated between HMFT completion time and established standard motor fitness measures (Table 4). The results demonstrated a moderate positive association with agility, as assessed by the 50-m shuttle run ($r = 0.54$, $p < 0.01$). In contrast, correlations between HMFT completion time and single-domain motor measures, including static balance, handgrip strength, muscular endurance, flexibility, and upper-limb coordination, were consistently low ($r < 0.40$).

This correlation pattern indicates that HMFT performance is not strongly determined by isolated motor capacities. Rather, the relatively low associations with strength- and balance-specific tests provide empirical evidence of construct distinctiveness, suggesting that the HMFT reflects a multidimensional and integrative form of motor competence. Accordingly, the criterion-related findings should be interpreted as evidence of construct differentiation, with the HMFT capturing coordinated and sequential movement behavior rather than equivalence with discrete physical fitness tests. This outcome suggests that the HMFT has practical utility for physical education and pre-clinical functional screening contexts, where the emphasis is placed on assessing complex motor competence associated with participation and general well-being.

Table 4. Criterion-Related Validity of the Hopscotch Motor Fitness Test in Relation to Standard Motor Fitness Measures (n = 100)

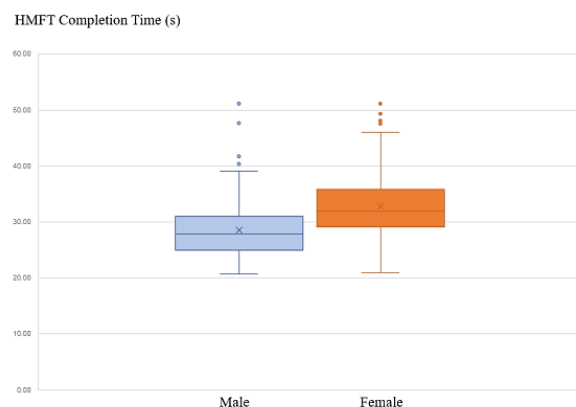
Standard Motor Fitness Test	M ± SD	r-value	Interpretation
Flamingo Balance (Left)	3.91 ± 3.48	0.33*	Low
Flamingo Balance (Right)	3.17 ± 2.89	0.24*	Low
Handgrip Strength (Left)	34.45 ± 7.60	-0.18	Low
Handgrip Strength (Right)	36.69 ± 7.97	-0.25*	Low
Relative Handgrip Strength (Left)	0.55 ± 0.13	-0.30**	Low
Relative Handgrip Strength (Right)	0.59 ± 0.14	-0.36**	Low
Sit-ups (30 s)	24.95 ± 5.32	-0.36**	Low
50-m Shuttle Run	18.46 ± 2.82	0.54**	Moderate
Plate Tapping	11.40 ± 2.57	0.17	Low
Sit and Reach	12.88 ± 6.97	-0.18	Low
Standing Broad Jump	182.38 ± 29.12	-0.40**	Low

Note. r = Pearson correlation coefficient; *p < .05, **p < .01

Gender Comparison

An exploratory analysis was conducted to examine potential gender-related differences in HMFT performance. Male participants completed the test in a shorter time (M = 28.53 s, SD = 4.75) than female participants (M = 32.83 s, SD = 5.63), with the difference reaching statistical significance (t = -9.22, p < .001). This statistically significant difference is visually represented in Figure 13 using a boxplot to illustrate the distribution, central tendency, and variability of HMFT completion time by sex. The observed difference reflects a natural variation in motor performance commonly reported in youth physical fitness assessments and does not alter the interpretation of the HMFT's overall reliability or construct-related findings.

Figure 13. Boxplot illustrating the distribution of Hopscotch Motor Fitness Test (HMFT) completion time by sex.



Feasibility and User Satisfaction

Feasibility and user satisfaction were assessed among both test administrators and participants ($n = 30$ per group). As presented in Table 5, administrators reported high satisfaction across all evaluation items, including clarity of procedures, ease of setup, safety, and participant engagement. Mean scores for all domains were rated at a high level, indicating that the HMFT protocol was practical to administer and clearly understood by test administrators.

Table 5. Satisfaction of Test Administrators ($n = 30$)

Evaluation Item	M	SD	Level
Clarity of procedures	3.90	0.88	High
Ease of setup	3.97	0.96	High
Safety	3.90	1.06	High
Participant engagement	4.07	0.83	High
Overall satisfaction	3.86	0.99	High

As shown in Table 6, participants reported very high satisfaction across all assessed domains, including enjoyment during the test, age appropriateness, and perceived challenge and fairness. Overall satisfaction among participants was rated at a very high level. These findings indicate that the HMFT was well accepted by both administrators and participants within the study sample, supporting its feasibility and usability as a field-based motor performance assessment.

Table 6. Satisfaction of Test Participants ($n = 30$)

Evaluation Item	M	SD	Level
Enjoyment during test	4.63	0.49	Very High
Appropriateness for age	4.67	0.48	Very High
Challenge and fairness	4.57	0.57	Very High
Overall satisfaction	4.56	0.56	Very High

Normative Data

The normative dataset of the Hopscotch Motor Fitness Test (HMFT) was established from 500 healthy participants (250 males and 250 females) aged 18–24 years. Table 7 presents the descriptive characteristics of the sample, showing comparable age distribution and expected anthropometric variation between sexes, confirming that the dataset represents a typical young adult population suitable for exploratory reference analysis.

Sex-specific performance outcomes of the HMFT are summarized in Table 8. Male participants demonstrated faster completion times on average than female participants, a pattern commonly observed in motor tasks involving speed and agility. Importantly, all participants successfully completed the test protocol, supporting the applicability of the HMFT across sexes in non-clinical populations.

To facilitate practical interpretation in educational and community settings, percentile distributions of HMFT completion time were calculated separately for males and females and are presented in Table 9. These percentile values describe performance dispersion within the sample and are intended to support relative interpretation rather than diagnostic decision-making. Based on these distributions, preliminary performance categories are shown in Table 10 to provide structured feedback for field-based use.

Overall, the normative results demonstrate that the HMFT can generate stable and interpretable reference data when applied to large non-clinical samples. Consistent with the scope of this study, these values are presented as feasibility benchmarks rather than diagnostic norms, providing a foundation for future large-scale validation and extended application in educational, community, and pre-clinical functional screening contexts.

Table 7. Descriptive Characteristics of Participants (n = 500)

Variable	Male (M ± SD)	Female (M ± SD)	Total (M ± SD)
Age (years)	18.92 ± 1.42	18.70 ± 1.36	18.81 ± 1.39
Height (cm)	174.12 ± 6.84	165.04 ± 6.13	169.58 ± 8.38
Weight (kg)	67.81 ± 10.42	59.21 ± 11.08	63.51 ± 12.46
BMI (kg/m ²)	22.38 ± 2.91	21.62 ± 3.78	21.99 ± 3.36

Table 8. Performance Results of the Hopscotch Motor Fitness Test by Sex (n = 500)

Sex	Mean (s)	SD	Min	Max
Male	28.53	4.75	20.44	39.12
Female	32.83	5.63	23.55	47.41
Total	30.68	5.19	20.44	47.41

Table 9. Percentile Values for HMFT Performance (n = 500)

Percentile	Male (s)	Female (s)
10th	23.36	26.45
25th	25.47	29.02
50th	28.22	32.68
75th	31.10	36.81
90th	34.18	40.84

Table 10. Preliminary Normative Classifications by Sex (n = 500)

Classification	Male (s)	Female (s)
Very Good	≤ 23.36	≤ 26.45
Good	23.37–28.21	26.46–32.67
Average	28.22–31.09	32.68–36.80
Below Average	31.10–34.17	36.81–40.83
Poor	≥ 34.18	≥ 40.84

Discussion

The findings of this study indicate that the Hopscotch Motor Fitness Test (HMFT) demonstrates acceptable psychometric quality and functional relevance as a field-based assessment of Integrated Motor Competence (IMC) in young adults. Rather than reflecting isolated performance outcomes, these findings suggest that the HMFT provides preliminary evidence of how coordinated movement can be assessed within a continuous and context-specific task structure. The reliability analysis yielded good intra-rater and inter-rater agreement (ICC ≥ 0.83), indicating that HMFT performance can be scored consistently across raters and repeated trials within a structured field setting. This level of agreement indicates that the scoring system can be applied consistently under controlled field conditions, while still allowing for natural variation in movement execution. This level of reliability is comparable to that reported in field-based and game-oriented motor assessments conducted under ecologically valid conditions, where a certain degree of variability in movement execution is expected rather than eliminated. Such variability is consistent with the nature of coordinated movement tasks, in which performance is shaped by ongoing adaptation rather than strict repetition. Taken together, these findings support the positioning of the HMFT as a preliminary validation prototype intended for applied use, rather than as a confirmatory or diagnostic assessment instrument, while also indicating its potential utility in contexts requiring practical and context-sensitive assessment approaches.

Construct Distinctiveness and Integrated Motor Competence

A central finding of this study emerges from the pattern observed in the criterion-related validity analysis. Although HMFT performance showed a moderate association with agility as measured by the 50-m shuttle run ($r = 0.54$), correlations with isolated motor components, including static balance, muscular strength, flexibility, and upper-limb coordination, were consistently low ($r < 0.40$). This pattern should not be interpreted as a limitation of measurement sensitivity but rather as evidence of



construct distinctiveness aligned with the conceptual foundation of the test. Specifically, this pattern indicates that HMFT performance reflects a coordinated form of movement behavior that cannot be sufficiently explained by individual physical capacities measured in isolation.

The HMFT was intentionally designed as a continuous and sequential task requiring rhythmic coordination, adaptive postural control, and rapid motor transitions, thereby reflecting integrated motor behavior rather than discrete physical capacities. In this context, performance emerges from the coordination of multiple subsystems operating simultaneously within a time-constrained task, rather than from the isolated contribution of individual fitness components. This interpretation is consistent with theoretical perspectives that conceptualize motor competence as a multidimensional and context-dependent construct, in which coordinated movement patterns arise from the interaction of neuromuscular control, balance regulation, and task-specific adaptation (Barnett et al., 2016; Stodden et al., 2014). From this perspective, the moderate association with agility may reflect partial overlap in movement demands, whereas the consistently low correlations with other components indicate that HMFT captures a broader coordination structure beyond single-domain performance.

From this perspective, the relatively low correlations observed in the present study reinforce the premise that the HMFT captures a cohesive form of integrated motor competence that differs conceptually from conventional fitness assessments based on fragmented task components. Rather than indicating weak criterion validity, this pattern is more appropriately interpreted as evidence that the HMFT measures a distinct construct characterized by the integration of multiple movement domains within a continuous task. Accordingly, the HMFT may be more appropriately interpreted as an assessment of functional movement integration within continuous tasks, which more closely reflects real-world movement demands, rather than as a direct substitute for traditional single-component fitness measures. This distinction is important in clarifying that the HMFT does not aim to replace existing assessments, but to complement them by capturing aspects of motor performance that are not represented in segmented testing formats.

Cultural Grounding, Ecological Validity, and Feasibility

An additional strength of the HMFT lies in its culturally grounded design derived from the Thai traditional game Tang Te, which situates motor assessment within a familiar and meaningful movement context. The integration of toe-based object manipulation within a continuous hopping and running sequence provides an ecologically valid task structure that emphasizes movement continuity, coordination, and engagement. This task structure allows movement performance to occur in a manner that more closely resembles naturally occurring activity patterns.

This design characteristic is reflected in the high participant satisfaction observed ($M = 4.56$), together with positive evaluations from test administrators regarding feasibility, safety, and clarity of implementation. These findings align with previous research suggesting that culturally embedded movement activities can enhance engagement and intrinsic motivation while maintaining assessment integrity (Azlan et al., 2021; Lavega-Burgués et al., 2021). This observation is consistent with evidence indicating that familiar and contextually relevant activities may facilitate authentic movement performance in applied settings. Within this context, the familiar and game-based structure of the HMFT likely facilitated authentic movement performance without imposing excessive procedural constraints, which is often a limitation in more standardized and equipment-dependent testing protocols.

Consequently, the percentile classifications derived from the present sample ($n = 500$) should be interpreted as exploratory reference values intended to support practical application, rather than as normative standards for diagnostic use, in line with recommendations for early-stage instrument development (Miguel-Etayo et al., 2014). This interpretation reflects the preliminary nature of the present validation phase and the need for further confirmatory research.

Limitations and Future Directions

Several limitations should be acknowledged. First, the moderate criterion-related associations indicate that the HMFT should not be interpreted as an equivalent substitute for established assessment batteries such as EUROFIT or CAMSA. Instead, it should be considered a complementary tool that emphasizes integrated motor behavior within continuous movement tasks. This distinction is important to prevent misinterpretation of the HMFT as a replacement for established standardized assessments.



Second, the restriction of the sample to healthy young adults limits generalizability and does not allow conclusions regarding discriminative validity across populations with differing motor abilities. In addition, although the present study provides preliminary reference values, these should be interpreted with caution and not as definitive normative standards.

Future research should focus on: 1) examining discriminative validity by comparing HMFT performance between healthy individuals and populations with motor control impairments; 2) evaluating responsiveness to change in intervention or rehabilitation contexts; and 3) extending validation across broader age groups, particularly children and adolescents. In addition, advanced analytical approaches such as confirmatory factor analysis may provide further insight into the latent structure underlying Integrated Motor Competence as assessed by the HMFT, thereby strengthening both its theoretical grounding and applied relevance.

Beyond these directions, the present findings contribute to an emerging perspective in which motor competence is approached as a coordinated and context-dependent performance construct rather than as a collection of independent physical attributes. Within this perspective, the HMFT provides an applied framework for examining how multiple movement components interact within continuous task conditions, offering an alternative approach to field-based assessment that aligns more closely with real-world movement demands. While further empirical validation is required, this approach may support the development of assessment models that better reflect the complexity of coordinated human movement across diverse contexts.

Conclusions

The present study demonstrates that the Hopscotch Motor Fitness Test (HMFT), systematically adapted from the Thai traditional game Tang Te, functions as a culturally grounded and methodologically examined prototype for assessing Integrated Motor Competence (IMC) in healthy young adults. The findings indicate that traditional play can be translated into a structured assessment format that retains cultural authenticity while aligning with accepted psychometric principles. The observed pattern of criterion-related validity supports the interpretation of the HMFT as an assessment of integrated and sequential motor performance within a continuous task, rather than as a measure of isolated physical capacities, thereby supporting its construct distinctiveness and alignment with functional movement demands. High levels of user acceptance and successful field implementation further support the feasibility, safety, and practicality of the HMFT for use in educational and community-based settings. Importantly, these findings should be interpreted within the scope of preliminary validation, positioning the HMFT as a non-diagnostic, context-sensitive assessment framework where the exploratory reference values serve as a flexible benchmark for non-clinical populations rather than definitive normative standards. While further research is required to examine discriminative validity and applicability across broader populations, the HMFT provides an initial empirical basis for the continued development of culturally responsive approaches that integrate movement, context, and engagement within contemporary education and health-related practice.

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References

- Abdullah B., Amri S. (2018). Effects of traditional games on age equivalent scores of locomotor and manipulative skills among early stage school children. *International Journal of Academic Research in Business and Social Sciences*, 8(12), 134-145. <https://doi.org/10.6007/IJARBS/v8-i12/5001>
- Azlan A., Ismail N., Fauzi N.F.M., Talib R.A. (2021). Playing traditional games vs. free-play during physical education lesson to improve physical activity: A comparison study. *Pedagogy of Physical Culture and Sports*, 25(3), 178-187. <https://doi.org/10.15561/26649837.2021.0306>
- Babov K., Plakida A., Balashova I., Zabolotna I., Gushcha S., Bobylov D. (2025). Comparative assessment of Barthel index and functional independence measure in providing rehabilitation care for military personnel with combined injuries. *Physical Rehabilitation and Recreational Health Technologies*, 10(1), 49-56. [https://doi.org/10.15391/prrht.2025-10\(1\).07](https://doi.org/10.15391/prrht.2025-10(1).07)
- Barnett L.M., Lai S.K., Veldman S.L., Hardy L.L., Cliff D.P., Morgan P.J., Zask A., Lubans D.R., Shultz S.P., Ridgers N.D., Rush E., Brown H.L., Okely A.D. (2016). Correlates of gross motor competence in children and adolescents: A systematic review and meta-analysis. *Sports Medicine*, 46(11), 1663-1688. <https://doi.org/10.1007/s40279-016-0495-z>
- Hinkle D.E., Wiersma W., Jurs S.G. (2003). *Applied statistics for the behavioral sciences*. 5th ed. Boston (MA): Houghton Mifflin.
- Kanlayawut O., Kritpet T. (2022). Effects of square hopscotch exercise program on body composition and quality of life in overweight children. *Journal of Liberal Arts Maejo University*, 10(1), 192-207. <https://so03.tci-thaijo.org/index.php/liberalartsjournal/article/view/261801>
- Koo T.K., Li M.Y. (2016). A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *Journal of Chiropractic Medicine*, 15(2), 155-163. <https://doi.org/10.1016/j.jcm.2016.02.012>
- Latina H., Kalynychenko I., Tkachuk O., Danysko O., Ivanova T. (2025). Integral evaluation of the formation of adaptive capacity of the children's body under the condition of systematic specific physical load. *Physical Rehabilitation and Recreational Health Technologies*, 10(2), 77-86. [https://doi.org/10.15391/prrht.2025-10\(2\).03](https://doi.org/10.15391/prrht.2025-10(2).03)
- Lavega-Burgués P., Bortoleto M.A.C., Pic M. (2021). Traditional sporting games and play: Enhancing cultural diversity, emotional well-being, interpersonal relationships and intelligent decisions. *Frontiers in Psychology*, 12, 766625. <https://doi.org/10.3389/fpsyg.2021.766625>
- Miguel-Etayo D., Gracia-Marco L., Ortega F.B., Intemann T., Foraita R., Lissner L., Oja L., Barba G., Michels N., Tornaritis M., Molnár D., Pitsiladis Y., Ahrens W., Moreno L.A. (2014). Physical fitness reference standards in European children: The IDEFICS study. *International Journal of Obesity*, 38(S2), S57-S66. <https://doi.org/10.1038/ijo.2014.136>
- Ramos-Pérez, D., Fernández, F. T. G., Burgueño, R., & Morente-Oria, H. (2021). Curricular proposal through the traditional game of Mate: Tool for improving perceptual-decisional skills in Secondary school physical education students (Propuesta didáctica mediante el juego tradicional del Mate: Herramienta para la mejora de las habil. *Retos*, 42, 517-523. <https://doi.org/10.47197/retos.v42i0.87357>
- Rovinelli R.J., Hambleton R.K. (1976). On the use of content specialists in the assessment of criterion-referenced test item validity. *ERIC Document*. Available from: <https://eric.ed.gov/?id=ED121845>
- Sharma C.K., Zafar S. (2025). Effect of external sensory integration on motor functional disorder in children with attention deficit hyperactive disorder (ADHD). *Physical Rehabilitation and Recreational Health Technologies*, 10(3), 203-210. [https://doi.org/10.15391/prrht.2025-10\(3\).07](https://doi.org/10.15391/prrht.2025-10(3).07)
- Shrout P.E., Fleiss J.L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin*, 86(2), 420-428. <https://doi.org/10.1037/0033-2909.86.2.420>

- Stodden D.F., Gao Z., Goodway J.D., Langendorfer S.J. (2014). Dynamic relationships between motor skill competence and health-related fitness in youth. *Pediatric Exercise Science*, 26(3), 231-241. <https://doi.org/10.1123/pes.2013-0027>
- Tongterm T., Chimphali K., Pongthanu M., Pengseesang T., Kaewma J., Namboonlue S. (2024). The Thai folk game "jik Sen" has become a recreational sport for older people in senior citizen schools. *Physical Education Theory and Methodology*, 24(4), 568-578. <https://doi.org/10.17309/tmfv.2024.4.08>
- Tongterm, T., Chimphali, K., Pengseesang, T., Pongtanu, M., Namboonlue, S., & La-bantao, K. (2026). Development and validation of the Kradot Kop Test: a culturally grounded field-based assessment of restricted lower-limb power–endurance in Thai children aged 10–12 years. *Retos*, 76, 168-181. <https://doi.org/10.47197/retos.v76.118433>
- Tongterm, T., Kaewma, J., Chansrisukot, G., & Boonprom, T. (2025) 4-Corner Elastic Jumping (Kradod Yang) Test: Culturally Grounded Assessment of Dynamic Motor Competence in Youth. *JEPonline*, 28(6), 65-81. <https://www.asep.org/resources/jep-online>
- Vonglao P. (2017). Application of fuzzy logic to improve the Likert scale to measure latent variables. *Kasetsart Journal of Social Sciences*, 38(3), 337-344. <https://doi.org/10.1016/j.kjss.2017.01.002>
- World Health Organization. (2020). *Physical activity*. Available from: <https://www.who.int/news-room/fact-sheets/detail/physical-activity>

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