



Validez y fiabilidad de la Prueba de Agilidad de Illinois (IAT) para evaluar la agilidad en atletas de Pencak Silat

Validity and reliability of the Illinois Agility Test (IAT) for assessing agility in Pencak Silat athletes

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Abstract

Introduction: Agility is a crucial skill for martial arts athletes, significantly impacting performance, strength, speed, and power in both the upper and lower extremities. To enhance athletic performance in martial arts, agility must be measured using a valid and reliable tool.

Objective: This study evaluates the validity and reliability of the Illinois Agility Test (IAT) as a tool for assessing agility in Pencak Silat athletes.

Methodology: The research adapted Thiagarajan's Define, Design, and Develop model within a structured 3D model development approach to tailor the IAT for Pencak Silat. Seven experts, including two national coaches, two professors specializing in Pencak Silat, and three national-level physical trainers, participated in the evaluation. Expert feedback was gathered using a 4-point Likert scale, and content validity was assessed using Aiken's V.

Results: The IAT demonstrated high content validity ($V = 0.93$) and reliability ($r = 0.81$), confirming its effectiveness in assessing agility in martial arts athletes. The test produced consistent results across different evaluators.

Discussion: Findings indicate that the IAT effectively captures key agility components relevant to Pencak Silat, such as rapid directional changes and multi-directional movements.

Conclusions: The IAT is a valid and reliable tool for measuring agility in Pencak Silat athletes. Its implementation can assist coaches, athletes, and researchers in evaluating and improving agility, ultimately enhancing martial arts performance.

Keywords

Agility assessment, martial arts performance, pencak silat athletes, sports performance evaluation.

Resumen

Introducción: La agilidad es una habilidad fundamental para los atletas de artes marciales, ya que influye en el rendimiento, la fuerza, la velocidad y la potencia en las extremidades superiores e inferiores. Para mejorar el desempeño en artes marciales, es esencial medir la agilidad con una herramienta válida y confiable.

Objetivo: Este estudio evalúa la validez y fiabilidad del Illinois Agility Test (IAT) como herramienta para medir la agilidad en atletas de Pencak Silat.

Metodología: La investigación adaptó el modelo de Definir, Diseñar y Desarrollar de Thiagarajan dentro de un enfoque estructurado de desarrollo de modelo 3D para ajustar el IAT a Pencak Silat. Siete expertos participaron en la evaluación: dos entrenadores nacionales, dos profesores especializados en Pencak Silat y tres preparadores físicos de nivel nacional. Se recopiló la opinión de los expertos mediante una escala Likert de 4 puntos, y la validez de contenido se midió con el índice V de Aiken.

Resultados: El IAT mostró una alta validez de contenido ($V = 0.93$) y fiabilidad ($r = 0.81$), confirmando su efectividad para evaluar la agilidad en atletas de artes marciales. La prueba produjo resultados consistentes entre diferentes evaluadores.

Discusión: Los hallazgos indican que el IAT captura eficazmente componentes clave de la agilidad en Pencak Silat, como cambios rápidos de dirección y movimientos multidireccionales.

Conclusiones: El IAT es una herramienta válida y confiable para medir la agilidad en atletas de Pencak Silat. Su implementación puede ayudar a entrenadores, atletas e investigadores a evaluar y mejorar la agilidad, optimizando el rendimiento en artes marciales.

Palabras clave

Evaluación de agilidad, rendimiento en artes marciales, atletas de pencak silat, evaluación del rendimiento deportivo.

Introduction

Agility is a key performance attribute of several sports disciplines, particularly those in martial arts requiring fast reactive performance under changing conditions. The dynamic nature of such movement permits athletes to turn quickly and reflexively to avoid or counteract an opponent's moves (Paul et al., 2016). In martial arts such as Pencak Silat a traditional Indonesian martial art encompassing both offensive and defensive movements involving hands and feet agility is essential not only for physical performance but also for enhancing tactical decision-making and psychological resilience (Damrah et al., 2023; Nelson et al., 2022). Pencak Silat, deeply rooted in Indonesian culture and heritage, demands that athletes, known as Pesilat, master intricate movement patterns while upholding discipline, focus, and strategic precision. The physical demands of Pencak Silat necessitate a combination of speed, strength, flexibility, and, most importantly, agility to perform sequences that vary according to the flow of the match and the opponent's tactics (Jamal et al., 2024; Suwirman, 2019).

Physical fitness in Pencak Silat forms the foundation for an athlete's technical and tactical abilities, significantly impacting their performance in competitions. Among the critical fitness components, agility stands out as an indispensable skill that allows athletes to execute rapid directional changes and varied movements, both essential for offensive and defensive manoeuvres in Pencak Silat (Bahriyanto et al., 2024; Kovacikova & Zemková, 2021). For example, in striking or defensive block, it takes agility to produce quick footwork and right placement in order to determine the flow of movement, pace, and timing and, most of the time, it is what decides the fate of high stakes matches (Pratama et al., 2024). Agility enables athletes to respond quickly to unpredictable attacks, a skill that requires physical speed, cognitive sharpness, and spatial awareness qualities vital for high-performance athletes (Ihsan et al., 2022). However, despite its recognized importance, a standardized, valid, and reliable agility assessment tailored for Pencak Silat athletes remains limited. Various agility tests, such as the T-Test, Shuttle Run, and Hexagon Test, have been developed to evaluate this critical attribute across multiple sports disciplines. Existing agility tests often fail to address the unique movement patterns required in martial arts disciplines like Pencak Silat (Dos'Santos et al., 2020).

The Illinois Agility Test (IAT) is a widely used tool to assess agility by evaluating an athlete's ability to change direction and accelerate quickly within a set course, reflecting agility demands across various sports (Turner et al., 2022). Although the IAT has been validated in many athletic contexts, its effectiveness in measuring agility specific to martial arts, particularly Pencak Silat, remains under-researched (Raya et al., 2013).

Martial arts, including Pencak Silat, involve dynamic, multi-directional movements that general agility tests do not fully capture. Traditional tests often focus on linear motion, which does not reflect the complex movement patterns observed in combat sports (Tran Minh & Nguyen Do Minh, 2019). The agility of Pencak Silat is the ability to demonstrate a fast change in direction, attack and defence, usually in very complex physical and mental environments. Defensive moves to evade a strike followed by swift counterattack is based on the action of the agile mode of Pencak Silat, which relies on the functional coordination of both body and mind (Gumantan & Mahfud, 2020; Harun et al., 2020). IAT for Pencak Silat is adapted for this study to measure these sport-specific attributes, providing holistic consideration of the result's agility, which is appropriate given the sport's specific technical and tactical demands. Improving a reliable and valid Pencak Silat-related agility test will allow coaches and trainers to understand how the performance of the athlete translates in those specific metrics and therefore design more efficient training regimens to train the athlete for competition (Mardius et al., 2024).

There is a clear need for specific agility assessments tailored to Pencak Silat, as highlighted by previous research on agility within the sport. Existing studies have focused on developing agility norms or designing tests that measure isolated techniques, such as kick execution or footwork speed (Bafirman et al., 2023; Saputro & Siswantoyo, 2018). However, these tests frequently isolate and measure only isolated movement components without considering an overall measure of agility in combat scenarios. Existing studies may need more reliability or validation from a diverse expert panel, which is essential for ensuring that the test accurately captures the demands of Pencak Silat (Dos'Santos et al., 2022; Welis et al., 2023). Adopting the IAT for Pencak Silat is a gap filler that provides a standardized and validated agility test adaptable to a specific sport. This allows quantification of agility in a sport-specific manner, giving a complete understanding of the athlete's abilities and performance requirements.



This study evaluates the validity and reliability of IAT for Pencak Silat athletes, adapting it to meet the sport's specific physical and tactical requirements. IAT will be confirmed as an indicator of agility in Pencak Silat using expert valuation and quantitative analysis. Creating a reliable, sport-specific agility test will help coaches and athletes identify areas for improvement and focus training on the relevant, optimizing performance and the chance of competitive success.

Method

Study Design

This research employs a developmental method using a 3D design that modifies Thiagarajan's 4D model. This method comprises the following stages: define, design, and develop. These stages were applied to the IAT to measure the agility of martial arts athletes.

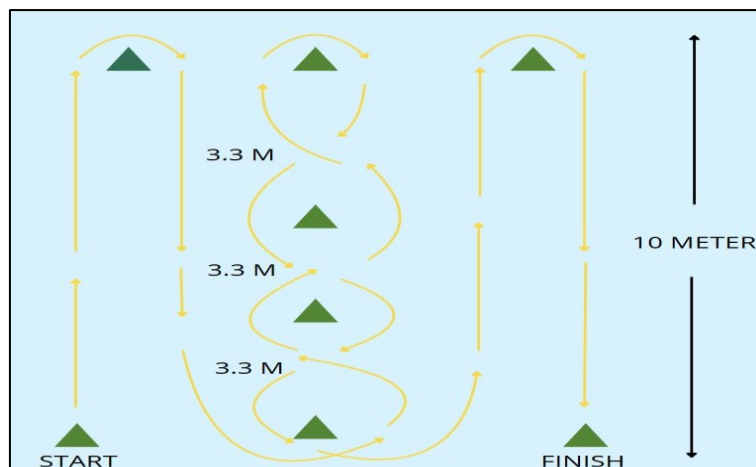
Participants

The study included seven experts as participants, consisting of two national Pencak Silat coaches, two professors of Pencak Silat, and three national physical trainers specializing in the sport of Pencak Silat.

Procedure

The procedure for implementing the IAT followed the guidelines established by Getchell (1979) and included the following steps (Mackenzie, 2008): 1) Set up the cones in the pattern illustrated in the accompanying diagram; 2) The subject starts from the starting point and moves in the direction indicated by the arrows until the finish point; 3) The timer starts when the subject begins the test and stops when they cross the finish line. The IAT requires stopwatches, cones, a suitable field, and test participants.

Figure 1. IAT Instrument



This method is developed with a mixed method approach which involves qualitative and quantitative components. The process is a structured three phase framework referred to as "3D" process. The initial phase, Define, utilizes a qualitative approach to establish the IAT's conceptual and operational definitions. In this stage, data is gathered through a narrative literature review, synthesizing relevant research findings to shape and refine these definitions (Tomoliyus & Sunardianta, 2020).

Figure 2. Research Flow



Instrument

Data collection was conducted using questionnaires distributed to assessment experts for evaluation. The questionnaire was structured using a 1-4 Likert scale. Assessment sheets from material and evaluation experts were utilized to gauge the understanding, relevance of terms, and correctness of statements. Expert assessment data were collected using the Delphi technique (Hsu & Sandford, 2007). The IAT was the research instrument conducted in the field using eight cones.

Data analysis

This study employs the Delphi, a mixed-method approach that combines qualitative and quantitative methods, to gather expert input on the IAT (Markley, 2004). The assessment sheets content validity was evaluated, using 1–4 Likert scale, by seven professionals with diverse backgrounds that rated the clarity, relevance, and accuracy of each item. The scale categories included SB = Very True, MB = Mostly True, JB = Somewhat True, and TB = Not True. Items were designed to be favorable, and assessments were made by experts to perfect clarity, precision, and strength of each element. With the formula:

$$V = \frac{\sum S}{n(C - 1)} \quad (1)$$

Where $S = r - l_0$, l_0 is the lowest score, C is the highest, and r is the rating by each expert.

A field test of the instrument was conducted to gather scores from respondents. Items were analyzed through product moment correlation to ensure alignment with agility standards. Non-compliant items were revised or removed. The questionnaire was distributed to seven experts and selected according to predetermined sampling criteria. The appendix details further validity and reliability tests on the IAT instrument. The final stage of development involved organizing and preparing the refined items for practical use in assessing martial arts athletes' agility.

Techniques for External Validity and Reliability

Before establishing external validity and reliability, a field test with 30 Pencak Silat athletes was conducted. These participants, aged between 20 and 25 years with 3 to 8 years of experience, had no prior injuries and voluntarily agreed to participate by signing informed consent forms. IAT data was analyzed using Cronbach's Alpha in SPSS (version 25) to assess reliability. Timing during the field test was performed using stopwatches, which were consistent with standard IAT protocols. This method, though practical and widely employed, presents limitations in precision, which we have noted as a potential area for methodological improvement in future research.

Table 1. Classification for validity and reliability

Validity		Reliability		
Index V	Classification	ICC	Classification	
$V < 0.4$	Low	> 0.80	Very high	
$0.4 \leq V \leq 0.8$	Enough	0.61-0.80	High	
$V > 0.8$	High	0.41-0.60	Enough	
		< 0.41	Low	

Results

The study results confirm the IAT's relevance and applicability for Pencak Silat athletes. Validation scores were computed after developing a questionnaire grid (Table 4). Aiken's V analysis revealed a minimum score of 0.85 and a maximum of 1.0, with an overall item average of 0.93 (Table 1). An additional validation phase with 20 Pencak Silat athletes produced significant correlation values at the 5% level, supporting the instrument's high content validity and applicability for agility measurement in this context. After validation, the instrument's reliability was tested with Cronbach's Alpha in SPSS v.25. The reliability coefficient exceeded 0.81, confirming reliability (Cronbach, 1951). Inter-rater reliability results are presented in Tables 3 and 4.

Table 2. Content Validity Results for the IAT Questionnaire

Program Items	Assessments							S1	S2	S3	S4	S5	S6	S7	Ss	N(C-1)	V	Description
	I	II	III	IV	V	VI	VII											
1	3	4	3	3	4	4	4	2	3	2	2	3	3	3	18	21	0,85714	HIGH
2	4	4	4	4	4	4	4	3	3	3	3	3	3	3	21	21	1	HIGH
3	4	3	4	4	4	3	3	3	2	3	3	3	2	2	18	21	0,85714	HIGH
4	3	4	4	3	4	4	3	2	3	3	2	3	3	2	18	21	0,85714	HIGH
5	4	4	4	4	3	4	4	3	3	3	3	2	3	3	20	21	0,95238	HIGH
6	4	4	4	4	3	4	4	3	3	3	3	2	3	3	20	21	0,95238	HIGH
7	4	4	4	4	4	4	4	3	3	3	3	3	3	3	21	21	1	HIGH
8	4	4	4	4	4	4	4	3	3	3	3	3	3	3	21	21	1	HIGH
Amount	30	31	31	30	30	31	30	22	23	23	22	22	23	22	157	168	7,47619	HIGH
Average	3,8	3,9	3,9	4	3,8	3,9	3,8	2,8	2,9	2,9	2,8	2,8	2,9	2,8	19,625	21	0,93452	HIGH

Notes: S1 to S7 = Seven expert raters who assessed each item on a scale from 1 to 4; Items = Individual statements or questions within the IAT questionnaire evaluated for content validity; Assessments I-VII = Different components or aspects assessed within each item; Ss = Total score assigned by each rater across all items; N(C-1) = Total possible score for each item based on the number of expert raters and assessment criteria; V = Content Validity Index (CVI) for each item, calculated as the ratio of the actual score to the total possible score (N(C-1)); Description = Categorization of content validity level based on CVI, where values closer to 1 indicate a "HIGH" level of content validity.

Table 3. Reliability of the IAT for Pencak Silat

Reliability Statistics		
Cronbach's Alpha	N of Item	Classification
0.81	9	High

Based on the reliability testing results in Table 3, the Cronbach's Alpha value for the IAT of Pencak Silat athletes is 0.81. Therefore, the rating instrument demonstrates sufficient inter-rater reliability.

Table 4. Inter-Rater Reliability of the IAT Questionnaire

Criteria and Categorical Cores	Intra-reliability	Inter-reliability	Intra-reliability	Inter-reliability
	Kappa/ICC	Kappa/ICC	Kendall's Tau B	Kendall's Tau B
1. Cone Mapping Patterns for Agility Measurement	0.87	0.94	0.88	0.87
2. The distance between each cone placement encourages athletes to focus on completing the test track pattern.	0.86	0.93	0.94	0.97
3. The layout of the agility track pattern is easy to understand, facilitating its completion.	0.93	0.94	0.97	0.96
4. Directing athletes to have a sense of responsibility to follow the measurement given to measure agility	0.95	0.98	0.89	0.90
5. Errors can be minimized as the best time is recorded based on two test repetitions.	0.93	0.97	0.86	0.88
6. The equipment used during the test is simple and can be utilized anytime.	0.87	0.93	0.95	0.98
7. The Illinois Agility Test is highly suitable for measuring the general agility performance of Pencak Silat athletes and is an effective tool for monitoring physical components.	0.89	0.90	0.94	0.87
8. Conducting measurement and control evaluations involves systematically assessing performance.	0.94	0.88	0.87	0.96



Table 4 explains the intra- and inter-observer agreement on multiple criteria within the IAT for Pencak Silat athletes, assessed using Cohen's Kappa, the Intraclass Correlation Coefficient (ICC), and Kendall's Tau B. These metrics are necessary to ensure a consistent measure across otherwise trained observers, and they support the instrument's validity within a structured agility test.

Discussion

The findings of this study underscore IAT as a valid and reliable tool for assessing agility in Pencak Silat athletes. Results showed that the IAT possessed high content validity due to the strong agreement among the expert evaluators on its relevance and applicability to Pencak Silat's unique characteristics. The results confirm that the IAT captures essential aspects of agility relevant to Pencak Silat, including rapid changes in direction and multi-directional movements that are integral to the sport. Similar to prior research in sports, agility is a key factor of success as the fastest and most adaptive player is a martial artist one should watch out (Dos'Santos et al., 2022; Paul et al., 2016). Specific sports disciplines, especially Pencak Silat, require tailored tools to measure agility effectively (Tran Minh & Nguyen Do Minh, 2019). While various general agility tests have been widely introduced, only some are crafted explicitly for unique demands in certain sports, and they have yet to be tailored for pencak silat (Azmi & Kusnanik, 2018). To design a reliable agility test, we must be valid to the main standards of validity and reliability to get the most accurate and consistent measurement. Such an agility test is highly valid if it can fulfil its measurement aims reliably and thus provides results consistent with the particular demands of the sports.

The IAT for this study proved very helpful in assessing the agility of Pencak Silat athletes. Finally, it becomes a critical tool for determining the degree to which, and any boundaries within which, agility is a core determinant of competitive success. It also guides targeted training strategies to focus on the key aspects that determine success, yet more simply direct, bottom-up innovation and learning. On the contrary, a highly invalid test would generate results inconsistent with our intended measurement goals, which could compromise the effectiveness of the training insights. Consequently, consistency and stability are essential to maintain IAT's validity and reliability, especially in the application to Pencak Silat athletes, as the test should be capable of replicating the multispatial agility demanded in the sport. Athletic performance in Pencak Silat is based on this agility test, which incorporates critical physical elements and various movement patterns. It mirrors athletes' demands in real-life competitions (Subekti et al., 2020). However, Pencak Silat competitions demand that athletes be agile, flexible, and capable of mentally and physically adapting to their opponents— skills essential to most professional athletes and coaches to improve performance. Underlines the part played by the IAT in evaluating agility as an essential performance factor, particularly in exercises comprising multi-directional agility skills, e.g. zig-zag manoeuvres. These exercises help athletes quickly respond and move in all directions, consequently, both the offensive and defensive play (T. O. Bompá & Carrera, 2015). Superior levels of agility in athletes yield an unpredictable attack that improves their competitive performance (Paul et al., 2016). Furthermore, agility-based conditioning, which combines speed and strength, enables an athlete to build a physical foundation that supports competitive success.

These findings align with prior research, such as *Agility in Young Athletes: Is It a Different Ability from Speed and Power? Which emphasizes agility as a critical component of athletic performance assessment*. The previous study showed that IAT was very sensitive and reliable in examining agility, especially regarding the extent to which athletes could make rapid directional changes and adjust speed. Here, the evidence reinforces the IAT as a robust agility measure and a means of creating a sport-specific Pencak Silat athletes' training program based on their needs (Bahriyanto et al., 2024). The study, nonetheless, has some limitations. One reason is that the variability in Pencak Silat athletes' skill levels and physical conditioning might also result in IAT data and affect data validity. The small sample size makes it impossible to generalize findings to the larger population of Pencak Silat athletes. Athlete performance in testing may be influenced by environmental factors such as field conditions (T. Bompá & Buzzichelli, 2015). This study mainly focuses on agility, leaving other essential performance aspects such as strength and strategic decision-making out of the picture, which takes part in Pencak Silat.

Conclusions

The results from this study indicate that the IAT can be instrumental in promoting Pencak Silat for the Indonesian Pencak Silat Association (IPSI), Schools, Pencak Silat organizations and trainers of Pencak Silat physical condition. This instrument provides a proven, valid, and reliable instrument for assessing agility across numerous athlete categories. As agility is essential for Pencak Silat athletes to avoid attacks and counter enemies quickly, integrating IAT into training protocols will significantly increase competitive athletic performance.

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