Development of physical test norms for early age Pencak Silat

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Abstract

Background and Study Aim	The evaluation serves as a cornerstone in the continuous improvement of sports, significantly relying on the analysis of measurement data. The primary objective of this research is to develop tailored norms for physical tests specifically designed for early-age Pencak Silat practitioners.
Material and Methods	The development of the test consisted of several key stages: design of the instrument, testing of the instrument, and finally, assembly of the instrument. The study included a total of 210 participants, with a breakdown of 111 male and 109 female martial artists. The techniques for data collection involved a variety of tests and measurements. The instruments used in this research included: sit-and-reach test for assessing flexibility, 30-meter sprint for speed evaluation, side step test for agility, sit-ups for abdominal strength, push-ups for arm and chest strength, wall sit test for leg muscle strength, and beep test for cardiovascular endurance. Data analysis was performed using a technique that grouped values into five standard categories, aided by the use of Microsoft Excel.
Results	The findings of the study led to the establishment of norms for each component of the physical tests tailored to early-age Pencak Silat practitioners. These components have been classified into five distinct levels: very poor, poor, average, good, and excellent.
Conclusions	The outcomes of this research facilitate the development of specific norms for each test item, incorporating weighting for every physical test component. These weightings have been meticulously adjusted in accordance with the primary energy systems utilized in the sport of Pencak Silat.
Keywords:	norm arranging, pencak silat, martial arts, early age

Introduction

Pencak Silat, an indigenous Indonesian martial art, has started gaining international recognition, evidenced by its inclusion in national and international competitive sports arenas [1, 2]. The sport features diverse competition categories such as sparring, individual, doubles, team, and creative performances, organized across various age groups including early age, pre-teen, teen, adult, and master [3, 4]. Successful competition participation demands athletes to be in prime physical condition, showcasing advanced techniques, strategic tactics, and robust mental strength. The role of parental support and effective sports organization management is pivotal in reaching peak performance levels [5]. Consequently, sports management bodies have launched talent identification and development programs specifically for Pencak Silat, aiming to cultivate skilled athletes and ensure a seamless transition for athlete regeneration upon retirement [6, 7]. This involves designing customized training programs tailored to meet the exacting demands of competition, with coaches often innovating these programs to maximize outcomes and maintain engagement [8].

The ongoing enhancement of sports performance is being advanced through the continual development of training programs [9]. This includes the creation and application of evaluative instruments and norms to assess training outcomes effectively [10, 11]. Such instrument development covers the gamut of tools necessary for measuring an athlete's physical, technical, tactical, and mental states [12, 13, 14, 15], with rigorous testing for validity and reliability to ensure data accuracy [16, 17, 18]. Following this, norms for each measurement item are established, providing meaningful insights into the collected data. Tailored to meet the unique demands of various sports disciplines, the development of physical test instruments is crucial. Their effectiveness is significantly heightened when closely aligned with the specific requirements of a sport, resulting in more precise and actionable data from the measurement process [19, 20, 21].

In general, physical fitness assessments organized by sports organizations typically utilize a set of common instruments [22]. This approach means that the same measurement tools are applied across all sports disciplines [23], which can introduce biases into the measurement results. Such bias stems from the varying physical demands and conditions inherent to each sports discipline [11, 24, 25], including differences in dominant energy systems and muscle groups used [26]. For instance, when sports organizations conduct physical fitness tests encompassing flexibility, speed, muscle strength and endurance, agility, and cardiovascular endurance – with the cardiovascular component accounting for 25% of the total score – sports emphasizing aerobic energy systems may inherently benefit. In contrast, sports like archery and chess could be at a disadvantage, primarily because the score weighting does not reflect the unique characteristics of each sport. Despite the standardization in assessment, training programs are often specifically tailored to the needs of each sport [27]. Hence, there's a critical need to develop physical test instruments and establish norms that are aligned with the specific requirements of each sport to ensure the collection of accurate and relevant data.

The primary objective of this research is to develop tailored norms for physical tests specifically designed for early-age Pencak Silat practitioners.

Materials and Methods

Participants

The subjects of this research are martial artists aged 10 to 12 years. The age grouping aligns with the competition categories in Pencak Silat. To represent the characteristics of each ability, the subjects participating in this study consist of martial artists training in sports clubs, martial artists under the district training center, martial artists under the provincial training center, and martial artists who have participated in national championships. The total subjects in this study are 210, comprising 111 male martial artists and 109 female martial artists. All participants were briefed on the study's objectives, and informed consent was obtained from their parents. The study was approved by the regional ethics committee, ensuring that all procedures adhered to the ethical standards outlined in the Declaration of Helsinki.

Research Design

This research contributes to the development of a physical test evaluation model tailored for early-age martial artists. The methodology employs a modified version of the Wilson Model and the Oriondo and Antonio Model [28], encompassing the following steps: (1) instrument design, (2) instrument testing, and (3) instrument assembly. During the instrument design phase, objectives are defined, and the structure of the instrument is conceptualized. The testing phase assesses the instrument's validity and reliability. The assembly phase involves developing norms for the newly developed instruments. Throughout these stages, specific physical test instruments for early-age martial artists were devised with input from experts in physical fitness, Pencak Silat, child development, and coaching. Following their formulation, these instruments underwent validity and reliability tests before norms were established.

Validity testing in this study employs concurrent validity, while reliability is assessed through a test-retest approach. The process for conducting these tests involves having the participants – referred to as fighters – perform each physical test item twice at different times. The validity of each test result is then evaluated using the product moment method, and reliability is assessed with the Cronbach alpha formula. The validation outcomes for the physical test instruments tailored to early childhood Pencak Silat revealed scores of 0.94 for males and 0.89 for females, indicating strong validity. Reliability scores were equally impressive, with 0.96 for males and 0.94 for females, showcasing the instruments' consistency over time. Following the confirmation of validity and reliability, the next step involved the development of norms. These norms are crucial for interpreting the raw scores obtained from the measurements, serving as the foundation for this research's primary goal: to establish norms for physical tests specific to early-age Pencak Silat. The methodology for data collection in this study includes various tests and measurements, with each martial artist undergoing a set of tests provided once.

Measures. The instruments employed in this study, developed and validated by experts, encompass a comprehensive suite of tests designed to assess various aspects of physical fitness. These include the sit-and-reach test for evaluating body flexibility, the 30-meter sprint test for speed assessment, the side step test for agility measurement, sit-ups for determining abdominal muscle strength, push-ups for evaluating arm and chest strength, the wall sit test for leg muscle strength, and the beep test for assessing cardiovascular endurance of the lungs. These instruments have been rigorously tested for validity and reliability in earlier development stages, ensuring their efficacy in accurately measuring the intended physical capacities.

Procedure. The research procedure entails a sequential execution of tests and measurements for each item, utilizing a comprehensive test battery format. To accommodate this, twenty measurers are deployed, each responsible for a designated measurement station. Martial artists begin by registering, receiving a physical test form, and being assigned a chest number. They then perform stretching and warming-up exercises in preparation

for the measurements. Starting at the first station, participants systematically proceed through to the seventh station, undergoing assessments for flexibility, speed, arm muscle strength, abdominal muscle strength, agility, leg muscle strength, and lung cardiovascular endurance, in that order. A brief rest period of 1-2 minutes is allowed between stations to ensure accuracy and prevent fatigue. Each martial artist completes the series of tests once. Upon finishing all seven stations, the physical test forms are submitted to the officials. Should any test item not be completed satisfactorily, the entire set of measurements for that martial artist is deemed invalid.

Statistical Analysis

The data analysis technique employs a methodology that categorizes values into a five-tier standard scale, facilitated by Microsoft Excel. Initially, for each test item, Microsoft Excel is used to calculate the average value and standard deviation. These statistical measures are then applied to derive scores based on a formula that segments results into five standard values. The scores obtained from this segmentation are referred to as raw scores, which are subsequently converted into standard scores. These standard scores for each physical test item fall within a five-tiered scale: A (very good), B (good), C (average), D (poor), and E (very poor). The formulas for the five standard values and the conversion process to standard scores are detailed in Table 1.

Table 1. Five Standard Value Formulas and Standard Scores

Values on a Scale of 5	Score	Category
> M + 1.5SD	5	Excellent (A)
M + 0.5SD to M + 1.5SD	4	Good (B)
M - 0.5SD to M + 0.5SD	3	Average (C)
M - 1.5SD to M - 0.5SD	2	Poor (D)
< M - 1.5SD	1	Very Poor (E)

Note: "M" – Mean; "SD" - Standard Deviation. The ranges are determined based on the mean plus or minus the product of the standard deviation (SD) and a factor (1.5 or 0.5), specifying the boundaries for each category.

Based on these criteria, norms for physical tests tailored to early-age Pencak Silat practitioners can be established. Given that each test item employs a distinct unit of measurement, it is necessary to interpret each item's results individually before aggregating them into a comprehensive score. This interpretation can utilize numerical values, exemplified by a range such as 10-50, to accommodate the varying significance of each test item. Importantly, the norms for physical tests in early-age Pencak Silat vary across test items, reflecting the different weight each carries. This

weighting is carefully adjusted to align with the specific movement characteristics and energy systems pertinent to Pencak Silat. Details on the weighting of values for test items, along with the formula used to categorize classification norms for physical tests in early-age Pencak Silat, are delineated in Table 2. Additionally, an example formula for normative classification specifically for the sit-and-reach test is outlined in Table 3.

Table 2. Percentage (%) weighting of values for each test item

No	Test Components	Score	Weight
1	Sit and reach	10-50	10%
2	Sprint 30 meters	10-50	20%
3	Push up 30 seconds	10-50	8%
4	Sit up 30 seconds	10-50	7%
5	Side step	10-50	10%
6	Wall sit	10-50	20%
7	Beep test	10-50	25%

Table 3. Example Formula for the Normative Classification of the Sit and Reach Item

Sit And Reach (Cm)	Weight 10%	Score	Category
> M + 1.5SD	50	5	Excellent
M + 0.5SD to M + 1.5SD	40	4	Good
M - 0.5SD to M + 0.5SD	30	3	Average
M - 1.5SD to M - 0.5SD	20	2	Poor
< M - 1.5SD	10	1	Very Poor

Note: "M" – Mean; - "SD" - Standard Deviation. The notation "to" is used to indicate ranges between two statistical measures.

The table 3 specifies how scores for the sit and reach test are categorized into different levels based on deviations from the mean (M) using standard deviation (SD) as a measure.

Results

After analyzing the data, we have established normative settings for each test item. Flexibility test norms are presented in Table 4, while Table 5 contains norms for speed tests. Hand Grip Strength test norms can be found in Table 6, and Table 7 outlines norms for Abdominal Strength tests. Norms for Agility tests are detailed in Table 8, Leg Strength tests in Table 9, and Aerobic Endurance tests in Table 10. These norms are divided into five distinct categories for both male and female participants. The results of these measurements are then converted into standard scores, which fall into predetermined categories. Specifically, each score from the physical test items is categorized into one of five standard scores: A (very good), B (good), C (average), D (poor), and E (very poor).

In Table 5, the ranges indicate the minimum and maximum values for each category, tailored to gender. The 'Weight 10%' column reflects the significance of this test in the overall physical fitness assessment.

The table 5 provides a gender-specific range of times for each category, reflecting the required performance levels for male and female athletes in the sprint 30-meter test. The "Weight 20%" indicates the importance of this test in the overall physical fitness evaluation, emphasizing speed.

The table 6 outlines gender-specific performance

norms, with scores allocated according to the number of repetitions achieved. The "Weight 8%" column reflects the test's relative importance in the overall assessment of upper body strength.

In Table 7, the ranges indicate the number of sit-ups completed in 30 seconds, with separate thresholds for male and female athletes. The scores reflect the athlete's performance level, with the "Weight 7%" indicating the significance of this test in the overall physical fitness evaluation, focusing on abdominal strength.

The table 8 outlines performance levels for

Table 4. Flexibility Norms (Sit and Reach)

Sit and Reach (cm)			Weight 10%	Category
Male	Female	Score	Score	
> 33.38	> 34.41	50	5	Excellent
29.12 to 33.38	29.52 to 34.41	40	4	Good
24.86 to 29.12	24.62 to 29.52	30	3	Average
20.60 to 24.86	19.73 to 24.62	20	2	Poor
< 20.60	< 19.73	10	1	Very Poor

Note: The notation "to" is used to indicate ranges between two statistical measures.

Table 5. Speed Norms (Sprint 30 Meter)

Sprint 30 Meter (seconds)			Weight 20%	Category
Male	Female	Score	Score	
< 5.11	< 5.69	50	5	Excellent
5.11 to 5.87	5.69 to 6.3	40	4	Good
5.87 to 6.57	6.3 to 6.92	30	3	Average
6.57 to 7.27	6.92 to 7.53	20	2	Poor
> 7.27	> 7.53	10	1	Very Poor

Note: The notation "to" is used to indicate ranges between two statistical measures.

Table 6. Push Up Norms (30 Seconds)

Push Up 30 Seconds (times)			Weight 8%	Category
Male	Female	Score	Score	
> 25	> 23	50	5	Excellent
19 to 25	18 to 23	40	4	Good
13 to 19	13 to 18	30	3	Average
7 to 13	8 to 13	20	2	Poor
< 7	< 8	10	1	Very Poor

Note: The notation "to" is used to indicate ranges between two statistical measures.

Table 7. Abdominal Strength Norms (Sit Up)

Sit Up 30 Seconds (times)			Weight 7%	Category
Male	Female	Score	Score	
> 23	> 21	50	3.5	Excellent
18 to 23	17 to 21	40	2.8	Good
13 to 18	13 to 17	30	2.1	Average
8 to 13	9 to 13	20	1.4	Poor
< 8	< 9	10	0.7	Very Poor

Note: The notation "to" is used to indicate ranges between two statistical measures.

the side step agility test, indicating the number of steps completed, with distinct benchmarks for male and female athletes. The "Weight 10%" column highlights the test's importance in evaluating overall agility, with scores ranging from 1 (Very Poor) to 5 (Excellent).

The table 9 specifies gender-specific benchmarks for the wall sit test, indicating endurance levels in leg strength. Scores are allocated based on the duration an athlete can maintain the wall sit position, with the "Weight 20%" reflecting this test's importance in the overall assessment of physical fitness, particularly focusing on leg strength.

The table 10 outlines the beep test levels required for different categories, with separate standards for male and female athletes. The scores reflect the athlete's aerobic endurance level, with the "Weight 25%" signifying the importance of this test in evaluating cardiovascular fitness.

After obtaining the norms for each physical test item for early-age Pencak Silat. Then a norm for the conclusion of the overall physical test results is prepared. The overall norms of physical tests are also categorized into 5 categories. The norms for the overall physical condition are presented in Table 11.

The table 11 the score ranges are consolidated

Table 8. Agility Norms (Side Step)

Side Step			Weight 10%	Category
Male	Female	Score	Score	
> 12.5	> 12	50	5	Excellent
11 to 12.5	10.5 to 12	40	4	Good
9.5 to 11	9 to 10.5	30	3	Average
8 to 9.5	7.5 to 9	20	2	Poor
< 8	< 7.5	10	1	Very Poor

Note: The notation "to" is used to indicate ranges between two statistical measures.

Table 9. Leg Strength Norms (Wall Sit)

Wall Sit (seconds)			Weight 20%	Category
Male	Female	Score	Score	
> 145.13	> 120.65	50	10	Excellent
104.95 to 145.13	87.03 to 120.65	40	8	Good
64.77 to 104.95	53.41 to 87.03	30	6	Average
24.59 to 64.77	19.79 to 53.41	20	4	Poor
< 24.59	< 19.79	10	2	Very Poor

Note: Times are measured in seconds. The notation "to" is used to indicate ranges between two statistical measures.

Table 10. Aerobic Endurance Norms (Beep Test)

Beep Test (Level)			Weight 25%	Category
Male	Female	Score	Score	
> 41	> 31	50	12.5	Excellent
32 to 41	25 to 31	40	10	Good
23 to 32	19 to 25	30	7.5	Average
14 to 23	13 to 19	20	5	Poor
< 14	< 13	10	2.5	Very Poor

Note: The notation "to" is used to indicate ranges between two statistical measures.

Table 11. Overall Physical Fitness

Score Range (Male and Female)	Category
43 to 50	Excellent
35 to 42	Good
27 to 34	Average
18 to 26	Poor
10 to 17	Very Poor

Note: The notation "to" is used to indicate ranges between two statistical measures.

for both male and female athletes, indicating the overall physical fitness category based on total scores. Based on the results of the preparation of physical test norms for early childhood pencak silat, every martial artist can determine their physical condition. To determine the physical condition, the standard results from measuring each test item are then added up. The summed results are then adjusted to the standard category overall score for each item of the early childhood pencak silat physical test in Table 11.

Discussion

Based on the research findings, norms have been established for each component of the physical tests tailored to early-age Pencak Silat practitioners. These components are classified into five distinct levels: very poor, poor, average, good, and excellent. The established numerical benchmarks within these norms were derived from measurements taken from male and female early-age martial artists. These artists varied in their experience and training backgrounds, encompassing novice participants, those under district and provincial development programs, and martial artists receiving private or independent training. This comprehensive approach was adopted to ensure the resultant physical condition data would cover all essential aspects. In addition to capturing a wide range of physical conditions, the sample size for norm development was also carefully considered, with a minimum of 100 subjects deemed necessary [12]. These subjects were distinct from those involved in the validity and reliability testing of the instruments. Furthermore, all test subjects were required to be in good health and optimal condition to minimize any potential measurement bias [29].

The research findings also delineate varied weightings for interpreting the scores of each test item, tailored to the specific characteristics of the Pencak Silat sport as identified by experts. The allocated weight values for each physical test item in Pencak Silat, as determined by these experts, are as follows: sit and reach at 10%, sprint 30 meters at 20%, push-ups for 30 seconds at 8%, sit-ups for 30 seconds at 7%, side step at 10%, wall sit at 20%, and the beep test at 25%. These weightings are critical for achieving objective scores, especially when a participant's performance in one test item may be lower than in others [30]. This approach to weighting differentiates the test battery as a measurement instrument from existing methodologies. With the establishment of these norms, the newly developed instrument offers coaches and relevant organizations a valuable tool for collecting data to evaluate the efficacy of training programs [31].

Besides paying attention to the health conditions and characteristics of subjects, and weighting in the development of norms for the instrument being constructed, other aspects need consideration in the norm-setting process to obtain good data. For instance, the equipment used in the norm-setting process [32, 33] should be ensured to be in good condition and well-prepared to facilitate the data collection process [34]. Additionally, the quantity of equipment used must be adjusted according to the number of subjects [35], ensuring that subjects do not wait too long. Excessive waiting time can introduce bias to the data, especially considering predetermined time intervals between measurement stations.

Moreover, ensuring the safety of the data collection location is essential. Safety considerations for the data collection site include flat, non-slippery ground without holes, meeting the specified requirements for data collection [36, 37]. Ensuring safety helps prevent the risk of injuries during the measurement process [38, 39] and ensures that subjects are not disrupted during measurements, thereby preventing biased data collection [40]. Additionally, another important aspect of the data collection process is preparing for alternative measurements in case of unfavorable weather conditions, particularly when measurements are conducted outdoors [41].

Administrative and procedural management in physical fitness measurement is essential and should be conducted [42]. This involves assigning tasks to each administrative section, field officers, and data analysis officers. Personnel involved in data collection need to be well-prepared for the norm-setting process [43], as they are directly involved in data collection [4]. Data collectors should undergo training before commencing their duties, covering implementation procedures, completion of assessment forms, calculation processes, recording procedures, proper use of measurement tools, and consideration of errors during the measurement process [44].

Furthermore, data analysis officers play a crucial role in the norm-setting process [11]. They are responsible for inputting data into the computer and compiling norms using predetermined formulas. Therefore, it is crucial to organize all personnel involved in the data collection and data analysis processes. Researchers developing measurement instruments in sports should carefully consider these aspects.

Further research is essential to assess instruments in subsequent age stages in Pencak Silat. The development of instruments for technical, tactical, and mental abilities in Pencak Silat is also crucial. It would be advantageous if the measurement instruments developed were in digital form to simplify the measurement process.

Conclusions

Norms have been established for each item in

the physical tests for early-age Pencak Silat, as well as overall norms. These norms are categorized into five levels: excellent, good, average, poor, and very poor. Additionally, the weighting for each test item is determined according to the characteristics of Pencak Silat, as advised by experts. This weighting is carried out to adjust for the dominant energy requirements in the martial arts sports branch.

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