

Validity and reliability of the physical fitness test instrument for retired martial art athletes

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Abstract

Background and Study Aim Developing exercise programs to maintain the fitness and health of retired athletes is crucial as a preventive measure against common health problems in this population. Equally important is the creation of an exercise evaluation tool to assess the effectiveness of these programs. This study aims to test the validity and reliability of a physical fitness test instrument for retired martial arts athletes.

Material and Methods This study used an evaluation approach with data collected through tests and measurements. A total of 147 subjects participated. For validity testing, there were 35 retired male martial arts athletes and 37 retired female athletes. For reliability testing, there were 36 retired male and 39 retired female martial arts athletes. The instruments used included body mass index (BMI) measurements with digital scales, flexibility measurements with the sit-and-reach test, muscle strength measurements with a leg and back dynamometer, and cardiovascular endurance measurements with the Cooper test. Validity was assessed using a concurrent validity approach. Reliability was tested using the test-retest method. The Pearson product-moment correlation was used for validity analysis, while Cronbach's alpha was used to assess reliability. The JASP software was used for the analysis.

Results For male athletes, the r-values for each test item exceeded the r-table value of 0.275, confirming the validity of the body mass index (BMI), sit-and-reach test, leg and back dynamometers, and the Cooper test. Similarly, female athletes demonstrated r-values above the r-table value of 0.267, confirming the validity of all test items. The reliability of each item was confirmed by Cronbach's alpha values, which were above the 0.7 threshold for both male and female athletes. The Cronbach's alpha value for BMI was 0.998 for both male and female athletes, indicating excellent reliability. Other test items, such as flexibility and muscle strength, also showed strong reliability, with Cronbach's alpha values ranging from 0.742 to 0.985.

Conclusions The study highlights the importance of developing valid and reliable instruments to assess the physical fitness of retired martial arts athletes. Such instruments are essential for monitoring the effectiveness of training programs aimed at maintaining the health and fitness of retired athletes. The findings of this research confirm the value of structured fitness tests. These tests effectively evaluate key physical components such as body composition, flexibility, muscle strength, and cardiovascular endurance.

Keywords: instrument validity, physical fitness, retired athletes, martial art

Introduction

Retired martial arts athletes often face a decline in physical fitness after ending their competitive careers. The sudden reduction in training intensity and structured physical activity can lead to various health problems, such as decreased cardiovascular

endurance, loss of muscle strength, and reduced flexibility. Without proper intervention, these changes increase the risk of chronic conditions like obesity, cardiovascular disease, and musculoskeletal disorders. Despite the clear need for targeted fitness programs, there is a lack of validated tools to assess the specific physical fitness needs of retired athletes. This gap hinders the development of effective training and rehabilitation programs for this population.

In this regard, a number of studies have thoroughly analyzed the issues surrounding the physical fitness of retired athletes. The experience of being an athlete should positively influence the fitness components needed in everyday life [1, 2, 3]. However, the loss of interest in exercise after retiring from sports often leads to poor physical fitness among former athletes [4]. Poor fitness can negatively affect work productivity and overall health, making it essential to maintain and improve physical fitness [5, 6]. Physical fitness refers to an individual's ability to perform daily activities with vigor and alertness, without excessive fatigue, and with sufficient energy to enjoy leisure activities and handle emergencies [7, 8]. Physical fitness is divided into two categories: health-related fitness and motor-related fitness [2, 5]. Health-related fitness includes body composition, flexibility, muscle strength and endurance, and cardiovascular endurance [9, 10, 11]. Thus, the reviewed studies demonstrate that poor physical fitness in retired athletes, stemming from a lack of post-career exercise, negatively impacts both their health and daily functioning. The decline in health-related and motor-related fitness components increases the risk of chronic diseases and impairs their ability to perform everyday tasks.

Body composition refers to the chemical makeup of the body, consisting of fat mass and fat-free mass [14, 15]. Flexibility is the ability of a person to perform a wide range of motion within the limits of a joint's movement [16, 17]. Strength is defined as the ability of muscles to resist body resistance and external load [18]. Muscular endurance refers to the ability of muscles to repeatedly contract or maintain contractions over an extended period [19]. Cardiovascular endurance is the body's capacity to sustain prolonged exercise without experiencing fatigue afterward [17, 19]. All these fitness components are influenced by factors such as age, gender, genetics, physical activity, and lifestyle [5, 13]. Fitness assessments are necessary to evaluate body condition, design appropriate exercise programs, and plan diets [12, 20]. Thus, these fitness components collectively determine an individual's overall physical health and capacity for exercise, and proper assessment of these factors helps in creating personalized fitness and health plans tailored to individual needs.

Physical fitness measurement is important as a form of screening for physical health conditions [21]. Physical fitness measurements are carried out by conducting tests and taking measurements directly using appropriate instruments for each component [12, 22]. It is crucial to tailor the measurement instruments to the characteristics of the subjects, which is why today there are many instrument developments designed for specific sports and social groups [23, 24, 25, 26]. In the process of

developing these instruments, it is essential to consider the requirements of a good instrument. These requirements include objectivity, validity, reliability, ease of use, discriminatory power, and cost-effectiveness [27, 28, 29]. Each of these criteria must be met to ensure the instrument is suitable for measuring the intended fitness components [30, 31]. Consequently, proper instrument development is key to obtaining accurate and useful measurements, ensuring that assessments align with the characteristics of the subjects being measured.

Validity testing is conducted to determine the suitability between the measuring instrument and the component to be measured [32]. For instance, to measure body temperature, a thermometer is the appropriate instrument. Content validity testing is the initial stage of validity assessment during the development process. This type of validity is typically conducted by involving experts, who provide input and play a key role in instrument development [23, 24, 25]. The content validity testing process serves as an essential foundation for the subsequent stages of instrument development, such as construct validity testing and validity testing based on other factors [33, 34]. The process involves multiple rounds of testing, continuing until all experts reach consensus on the instrument's structure and design [35]. As a result, the content validity testing process ensures that each element of the instrument aligns with the component being measured. This stage highlights the necessity of ensuring the instrument's accuracy before moving on to construct validity testing and other validation phases.

Despite the existence of numerous studies on the physical fitness of retired athletes, there is still a need for further research. Many investigations highlight the decline in physical fitness components, such as muscle strength, flexibility, and cardiovascular endurance, after retirement. Furthermore, while various fitness assessment tools and programs have been developed, they often fail to address the specific needs of retired martial arts athletes. The lack of tailored, validated instruments for this group hinders the ability to design effective post-retirement fitness programs. Therefore, additional research is necessary to develop comprehensive tools that can accurately assess the physical fitness of retired athletes and support the creation of personalized interventions. This study aims to test the validity and reliability of a physical fitness test instrument for retired martial arts athletes.

Materials and Methods

Participants

The participants in this study were retired martial arts athletes who met the following criteria: they were at least 28 years old, not under medical supervision, did not have any movement limitations,

were not pregnant, and were willing to participate as research subjects. A total of 147 subjects took part in the study. For the validity testing, there were 35 retired male martial arts athletes and 37 retired female martial arts athletes. For the reliability testing, 36 retired male and 39 retired female martial arts athletes were involved.

This study was conducted in accordance with established ethical guidelines for research involving human subjects. All participants provided informed consent prior to their involvement in the study. The research protocol was reviewed and approved by the institutional ethics committee to ensure the protection of participants' rights, safety, and well-being. Confidentiality of the participants' personal information was strictly maintained throughout the study, and they were informed of their right to withdraw from the study at any time without any consequences.

Research Design

A battery of tests was developed to assess key fitness components in retired martial arts athletes. The battery was created in collaboration with four experts in physical conditioning, testing and measurement, martial arts, and coaching. The experts evaluated the accuracy and relevance of each test in assessing the targeted fitness components, ensuring that the tests were appropriate for this specific athletes. They also provided input on the statistical methods used to evaluate the validity and reliability of the tests.

The tests included digital scales for body mass index (BMI), a sit-and-reach test for flexibility, a leg and back dynamometer for muscle strength, and the Cooper test for cardiovascular endurance. Testing was conducted twice with the same participants on two different days to ensure consistency in the results.

Each testing day followed a structured procedure. The measurement team prepared the necessary equipment and testing area. Participants were assigned registration numbers and completed a warm-up session. The BMI was measured first, with participants standing barefoot on digital scales, and the data was recorded. Flexibility was assessed next using the sit-and-reach test, where participants performed the test twice, with the best result being recorded.

Muscle strength was then measured using the leg and back dynamometer, with participants completing two trials, and the highest value recorded. Cardiovascular endurance was tested last, using the Cooper test, where participants ran for 12 minutes, and the distance covered was recorded. After the testing, participants completed a cool-down session independently. The same process was repeated on the second test day to ensure reliability.

Statistical Analysis

Concurrent validity was assessed using the Pearson product-moment correlation, and reliability was evaluated using the test-retest method with Cronbach's alpha. The same subjects were tested twice at different times to calculate the correlation between the two sets of results. An instrument was considered valid if the Pearson correlation coefficient (r) exceeded the r -table value, which was 0.275 for men and 0.267 for women. Reliability was determined using Cronbach's alpha, with a value above 0.7 indicating that the test was reliable. All statistical analyses were conducted using the JASP software, and a significance level of $p < 0.05$ was applied to ensure the results were statistically significant.

Results

The results are presented in the tables below. The first set of data refers to the validity results of the physical fitness test battery for retired male Pencak Silat athletes (Table 1).

Table 1. Validity test results for retired male martial arts athletes

No	Test Item	r-value	r-table	Note
1	Body mass index (BMI) (kg/m ²)	0.765	0.275	Valid
2	Sit and reach (cm)	0.871	0.275	Valid
3	Leg dynamometer (kg)	0.816	0.275	Valid
4	Back dynamometer (kg)	0.779	0.275	Valid
5	Cooper test (m)	0.879	0.275	Valid

The validity test results presented in Table 1 demonstrate that all test items for retired male martial arts athletes are valid. Each r -value exceeds the corresponding r -table value of 0.275, confirming the validity of the body mass index (BMI), flexibility (sit and reach), muscle strength (leg and back dynamometer), and cardiovascular endurance (Cooper test). Specifically, the highest validity is observed in the Cooper test with an r -value of 0.879, indicating a strong correlation between the test results and the targeted component of cardiovascular endurance. Similarly, the flexibility test (sit and reach) also shows a high validity value of 0.871, demonstrating its effectiveness in measuring flexibility. The BMI test, while having the lowest r -value (0.765), still meets the validity threshold. Overall, the results indicate that all test components reliably assess the respective physical fitness aspects of retired male martial arts athletes.

The validity test results for retired female martial arts athletes are presented in Table 2. Each r -value is compared to the r -table value of 0.267, and

all test items show values exceeding this threshold, confirming their validity (Table 2).

Table 2. Validity test results for retired female martial arts athletes

No	Test Item	r-value	r-table	Note
1	Body mass index (BMI) (kg/m ²)	0.825	0.267	Valid
2	Sit and reach (cm)	0.791	0.267	Valid
3	Leg dynamometer (kg)	0.876	0.267	Valid
4	Back dynamometer (kg)	0.897	0.267	Valid
5	Cooper test (m)	0.795	0.267	Valid

The results in Table 2 indicate that all test items for retired female martial arts athletes are valid. Each r-value surpasses the required r-table value of 0.267, confirming the validity of the body mass index (BMI), flexibility (sit and reach), muscle strength (leg and back dynamometer), and cardiovascular endurance (Cooper test). The highest validity is observed in the back dynamometer test with an r-value of 0.897, indicating a strong correlation in measuring back muscle strength. The leg dynamometer also demonstrates strong validity with an r-value of 0.876, confirming its accuracy in assessing leg muscle strength. The BMI test shows a slightly lower, but still valid, r-value of 0.825. Overall, the results demonstrate that the tests reliably assess key fitness components for retired female martial arts athletes, with muscle strength tests showing the highest validity.

The reliability test results for retired male martial arts athletes, evaluated using Cronbach's alpha, are presented in Table 3. A Cronbach's alpha value greater than 0.7 indicates that the test is reliable, and all test items meet or exceed this threshold (Table 3).

Table 3. Reliability test results for retired male martial artists

No	Test Item	Cronbach's α	Note
1	Body mass index (BMI) (kg/m ²)	0.998	Reliable
2	Sit and reach (cm)	0.751	Reliable
3	Leg dynamometer (kg)	0.974	Reliable
4	Back dynamometer (kg)	0.970	Reliable
5	Cooper test (m)	0.996	Reliable

The results in Table 3 show that all test items demonstrate strong reliability. The body mass index (BMI) test shows the highest reliability with a Cronbach's alpha value of 0.998, indicating an excellent level of consistency. The Cooper test also exhibits a high reliability score of 0.996, confirming its robustness in measuring cardiovascular endurance. Muscle strength assessments, including

the leg dynamometer (0.974) and back dynamometer (0.970), also display strong reliability, showing that these tests consistently measure muscle strength. Although the sit-and-reach test for flexibility has a lower Cronbach's alpha value of 0.751, it still meets the reliability threshold, confirming that it is a consistent tool for measuring flexibility. Overall, the results demonstrate that all the test components are reliable for assessing the fitness of retired male martial artists.

The reliability test results for retired female martial artists, evaluated using Cronbach's alpha, are presented in Table 4. A Cronbach's alpha value greater than 0.7 indicates that the test is reliable, and all test items meet this criterion (Table 4).

Table 4. Reliability test results for retired female martial artists

No	Test Item	Cronbach's α	Note
1	Body mass index (BMI) (kg/m ²)	0.998	Reliable
2	Sit and reach (cm)	0.742	Reliable
3	Leg dynamometer (kg)	0.985	Reliable
4	Back dynamometer (kg)	0.891	Reliable
5	Cooper test (m)	0.998	Reliable

The results in Table 4 indicate that all test items demonstrate strong reliability. The body mass index (BMI) test and the Cooper test both exhibit the highest reliability scores with Cronbach's alpha values of 0.998, reflecting excellent consistency in these measurements. The leg dynamometer also shows a high reliability score of 0.985, confirming its effectiveness in consistently assessing leg muscle strength. The back dynamometer, with a Cronbach's alpha of 0.891, also demonstrates strong reliability in measuring back muscle strength. Although the sit-and-reach test for flexibility has a lower Cronbach's alpha value of 0.742, it still meets the reliability threshold, indicating that it is a consistent tool for assessing flexibility. Overall, the results show that the tests used are reliable for measuring the physical fitness components of retired female martial artists.

Discussion

The aim of this study was to evaluate the validity and reliability of a physical fitness test battery designed specifically for retired martial arts athletes. The results of the study confirmed that all components of the test battery, including body mass index (BMI), flexibility, muscle strength, and cardiovascular endurance, demonstrated strong validity and reliability. Both retired male and female martial artists showed consistent results, with all r-values exceeding the required thresholds for validity, and Cronbach's alpha values confirming the reliability of the tests. These findings suggest that the

test battery is a reliable and valid tool for assessing the physical fitness of retired martial arts athletes.

Many instruments have been developed to match the characteristics of the objects being measured [23, 26]. These developments follow key requirements like discrimination and specificity [24, 25]. As a result, researchers worldwide have created new assessment tools [22, 36, 37]. Instrument development has also been driven by new products, such as exercise programs, fitness applications, and digital scoring systems [38, 39]. Exercise programs are often designed to account for individual differences across generations [40, 41, 42]. In high-performance sports, training programs are tailored for different life stages, such as childhood, adolescence, and adulthood [43, 44, 45]. Developing exercise programs for retired athletes is an important area, given the rising prevalence of health problems in this group [42, 46, 47].

Our results show that the fitness test battery for retired martial arts athletes is valid and reliable. This is consistent with studies that emphasize the need for specific assessments. While other research has focused on tools for younger or active athletes [43, 44, 45], our study extends this by validating a tool for retired athletes. Unlike most instruments developed for active populations [38, 39], our results confirm the suitability of these tests for retired athletes. This is in line with studies that focus on the health and fitness needs of retired and older athletes [42, 46, 47].

The increased prevalence of health problems in retired athletes is linked to changes in their lifestyle and goals [5, 6]. These changes often lead to reduced physical activity, negatively affecting their fitness and overall health [4]. Additionally, many governments lack specific intervention programs for athletes in retirement, contributing to the rise in health issues [46]. This presents opportunities for researchers to develop exercise and lifestyle programs tailored to retired athletes [42]. However, the development of such programs must be accompanied by tools to evaluate their effectiveness [25, 26]. Researchers working with retired martial arts athletes have also focused on developing these instruments. The process includes defining objectives, preparing test items, and testing validity and reliability [22]. This study, in particular, centers on validating and ensuring the reliability of these tools.

Our research aligns with global trends in addressing the fitness needs of retired athletes. Like other studies focusing on specific exercise programs for athletes in retirement [42], we emphasize the importance of reliable evaluation tools. Previous research has highlighted the lack of specialized government programs for retired athletes [46]. In contrast, our study offers a validated and reliable set of instruments specifically designed for martial arts athletes. This contributes to the development of

more targeted fitness assessments and interventions for this group.

The validity and reliability of test instrument items are influenced by the quality of the data generated during the measurement process [34, 36]. Measurements conducted according to established procedures will result in accurate and reliable data [48]. It is not uncommon in validity and reliability testing to encounter items that are invalid or unreliable. The causes of such issues include poor subject conditions, suboptimal performance during the test, and data entry errors [48]. Therefore, it is crucial that the measurement process follows operational standards, the specifications of the measuring instruments, and the conditions of the testing environment [30, 31].

Unlike some previous studies that encountered invalid or unreliable test items due to procedural errors or subject variability [48], our study demonstrated consistent validity and reliability across all components. This consistency may be attributed to the strict adherence to operational standards and careful subject preparation, which aligns with other research that emphasizes the importance of precise measurement protocols [30, 31]. The results confirm that our test instrument is a dependable tool for evaluating the fitness of retired martial arts athletes.

In addition to tests conducted outdoors, the accuracy of data is also influenced by natural factors, such as weather conditions [22]. Rain can disrupt or halt the measurement process. Similarly, hot weather can cause dehydration and exhaustion in test subjects [35]. To minimize the risk of data bias, many researchers prefer to conduct measurements in controlled environments, such as sports halls or multi-purpose buildings with temperature regulation. Instruments that have already been validated show high accuracy in the measurement process [25, 33, 36]. However, the competence of the data collectors also significantly impacts the results. Data collectors must be proficient in understanding operational standards, using measurement tools, and recognizing the condition of the subjects being tested [24]. There are two schools of thought regarding validity and reliability testing. One suggests that instruments that have been validated and shown to be reliable can be used without further testing. The other argues that validity and reliability are context-dependent, and re-testing is required each time the instrument is used for a new purpose [49]. Both viewpoints are well-supported, leaving researchers to decide which approach to follow.

Our study was conducted in a controlled environment, minimizing the impact of external factors like weather, similar to other studies that emphasize the importance of a stable environment for accurate measurements [22, 35]. Additionally, the high competence of our data collectors contributed

to the consistency of our results, aligning with findings that stress the importance of well-trained personnel in ensuring data accuracy [24]. Unlike studies that advocate for re-testing validity and reliability, we opted for a comprehensive initial validation and reliability process, which proved effective in our context. However, we recognize the merit of re-validating tools depending on specific circumstances, as suggested in other research [49].

Our study confirms that the physical fitness test battery developed for retired martial arts athletes is both valid and reliable. The consistent results across all test items underscore the effectiveness of the instruments in measuring key fitness components such as body composition, flexibility, muscle strength, and cardiovascular endurance. However, the study has certain limitations. One limitation is the controlled environment in which the tests were conducted, which may not fully reflect real-world conditions. Additionally, the sample size, though adequate, may benefit from further expansion to include a more diverse group of retired athletes. Future research should explore the application of these fitness tests in different environments and assess the long-term impact of tailored fitness programs for retired athletes. Further studies could also focus on developing and validating instruments that are sport-specific and adaptable to various

retired athlete populations.

Conclusions

The physical fitness test battery for retired martial arts athletes, which includes measurements of body composition, flexibility, muscle strength, and cardiovascular endurance, has demonstrated strong validity and reliability. Therefore, it can be concluded that all test items are consistent and compatible with the intended measurement objectives, as supported by the high validity and reliability values. Further research is needed to establish normative data for these tests to enhance their applicability across a broader population of retired athletes.

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