

## Validity and Reliability of Integrated Digital-Based Jump Power Meter Test Instrument for Measuring Limb Muscle Power

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**Abstract:** Exercise evaluations and measurements are critical. Tests to measure leg muscle power have generated subpar results, prompting the development of an integrated digital-based jump power meter (JPM) instrument. Before using this method, it must be field-tested. The goal of this study was to assess the validity and reliability of the JPM test-retest procedure. The descriptive quantitative research method was used, while data was collected based on the test method. Volleyball players aged 17-20 with weights ranging from 50 kg to 75 kg and heights ranging from 160 cm to 177 cm took part in the study. Pearson's product-moment analysis was used to test the validity of the data, while Cronbach's alpha analysis was used to test the reliability. Each of the male and female players' validity and reliability test results showed a coefficient value greater than 0.9. Based on these findings, the JPM test instrument has nearly perfect validity and reliability. Therefore, the creation of the JPM can facilitate the activities of testing, measuring, and evaluating sports for athletes and coaches, resulting in improved athlete performance.

**Keywords:** validity, reliability, jump power meter, limb muscle power.

### 基于数字的综合跳跃式功率计测试仪测量肢体肌力的有效性和可靠性

**摘要：**运动评估和测量至关重要。测量腿部肌肉力量的测试产生了低于标准的结果，促进了基于数字的集成跳跃功率计（摩根大通）仪器的开发。在使用这种方法之前，必须经过现场测试。本研究的目的是评估摩根大通重测程序的有效性和可靠性。采用描述性定量研究方法，同时基于测试方法收集数据。17-20岁、体重从50公斤到75公斤、身高从160厘米到177厘米不等的排球运动员参加了这项研究。皮尔逊的乘积矩分析用于检验数据的有效性，而克龙巴赫的alpha分析用于检验数据的信度。男女选手的效度和信度测试结果均显示系数值均大于0.9。基于这些发现，摩根大通测试工具具有近乎完美的效度和信度。因此，摩根大通的创建可以促进运动员和教练员对运动进行测试、测量和评估活动，从而提高运动员的表现。

**关键词：**效度、信度、跳跃功率计、肢体肌肉力量。

## 1. Introduction

The millennial sports generation gives a different perspective that impacts individuals and groups and is associated with the advancement of the digital world [1]. As a result, adaptation to increasingly advanced technological developments is required. The effects of technological advancements in the 4.0 era can already

be felt in people's daily lives, including sports technology. According to expert opinion, digitalization is a solution for maximizing athletic performance [1]. In sports testing and measurement, one of these solutions is intended.

For determining athlete standards, measurement tests and evaluations of competitive sports are critical

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[2]. In addition, according to previous research, awareness of how to improve abilities holistically and the application of modern technology to improve sports performance is critical [3].

Thus far, there are standard guidelines for sports tests and measurements. However, these tests and measurements will need to be updated in the future. Sports experts use efficient methods to conduct tests and measurements appropriate for the sport's characteristics [4]. This effort must be realized in concrete terms through action and overall synergy from practitioners, academics, and elements that provide exceptional support. There are a variety of field-based tests available, such as leg muscle power tests.

Power is one of the important predictors of winning the match. Power is also the product of speed and strength. Power is synonymous with an athlete's ability to perform strong and fast movements in a short time. In line with previous studies, it was stated that power is the product of speed and strength [5]. An athlete's power is very dependent on the neuromuscular system to produce a large impulse in a certain time [6]. Therefore, the importance of power in achievement sports cannot be separated, especially in sports-related to physical movements such as basketball, badminton, and volleyball.

Volleyball players need much power when jumping and smashing in the opponent's zone. Therefore, a test is required to determine the characteristics and abilities. Field-based leg muscle power tests, such as standing triple jumps, standing long jumps, and vertical jump tests [7-10] are now widely available.

The vertical jump is a commonly used leg muscle power test. This test is simple and inexpensive to perform, as it only requires a vertical board and white chalk. Behind these benefits, there are a few weaknesses in this test, which requires athletes to have good arm flexibility. When performing a jump up, the arm used to reach up will automatically interfere with the jump movement if the athlete's flexibility is poor. This test's precision is also lacking [11]. Of course, more modern tool, such as the DF jump, is available. This tool has advanced technology that detects when an athlete jumps up without using their power arm [12]. Unfortunately, this tool does not have the technology to measure weight, considering that weight has an effect when making a jump. The expert reinforces this statement that bodyweight affects or correlates with jump height [13]. Therefore, the solution that has been developed to overcome these problems is creating a more modern and high novelty tool, namely an integrated digital-based jump power meter (JPM).

An integrated digital-based jump power meter (JPM) is a tool for measuring leg muscle power researchers have developed. In the previous stage, this tool was tested for content validity and inter-rater reliability, with good results. The next stage developed a real product but did not test the validity and reliability with

field testing. Therefore, this study aimed to test the empirical validity and test-retest reliability of the integrated digital-based JPM limb muscle power test instrument for volleyball players.

## 2. Material and Method

This was a descriptive quantitative study with a test method. Based on a test with a score result, the researcher used a test method to draw a developed leg muscle power test instrument, namely the jump power meter (JPM). The quantitative approach, which experts support, is centered on uncovering phenomena based on scores [14-16].

Coaches have typically relied solely on field-based tests and measurements to monitor athlete progress and talent [17]. The purpose of this field test was to determine the level of validity and reliability. The validity test is used to evaluate the structured instrument to determine how well it performs its function [18]. The level of stability of the value obtained on repeated measurements using the same measuring instrument and conditions is then referred to as reliability [18].

The participants in this study were male and female volleyball players aged 17-20 years with a weight of  $\pm 50$  kg -  $\pm 75$  kg and a height of  $\pm 160$  cm -  $\pm 177$  cm.

Participants in this study met the inclusion criteria by performing well in activities, adhering to the researcher's rules, and joining a volleyball club to prepare for the match. Exclusion criteria are those that are not included in the inclusion criteria. Based on this criterion, 25 male and 25 female volleyball players were selected, and the measurement test was administered. The data was collected using a test method using a newly developed test instrument called an integrated digital jump power meter (JPM).

### 2.1. Procedure and Data Analysis

Participants conducted a test using the jump power meter (JPM) instrument twice at different times and days. The data for Tests 1 and 2 will be obtained from this stage. The next stage is the data processing stage to determine the empirical validity and test-retest reliability. The data analysis technique was used to test the empirical validity of this research using Pearson's product-moment analysis, while for the test-retest reliability test, Cronbach's alpha was used. The research data was then processed with the help of the SPSS version 23 application. The research flow and images of test implementation are presented as follows:

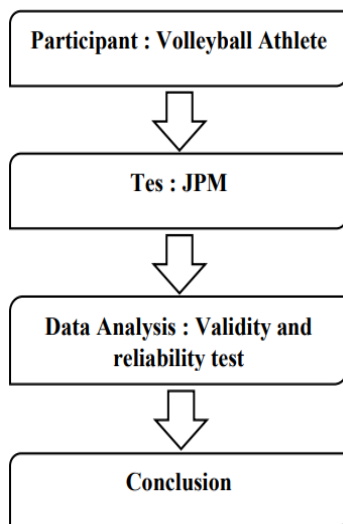


Fig. 1 Research flow



Fig. 2 JPM test procedure

### 3. Results

#### 3.1. Empirical Validity

Based on the results of processing the validity test data using Pearson's product-moment analysis, it has been found that the r-table data is 0.396, the r-count for Test 1 is 0.916, and the significance value (2-tailed) is 0.000, while the r-count for Test 2 is 0.916, and the significance value (2-tailed) is 0.000. The results can be valid because of the r-count value of the r-table value and the significance value of 0.05. Thus, the validity of an integrated digital-based jump power meter (JPM) instrument for measuring leg muscle power in male volleyball players is high.

Table 1 The results of Pearson's product-moment analysis

Male	N	R-table	R-count (Test 1)	Sig (2-tailed)	Status
	25	0.396	0.916	0.000	Valid
	N	R-table	R-count (Test 2)	Sig (2-tailed)	Status
	25	0.396	0.916	0.000	Valid

The r-table data was 0.396 r-count (test 1) 0.933 with a significance value (2-tailed) 0.000, while the r-count (test 2) was 0.933 with a significance value (2-tailed) 0.000, according to the results of processing the validity test data using Pearson's product-moment analysis. In other words, the r-table value's r-count value and the significance value of 0.05 indicate that the instrument is valid. In conclusion, the integrated

digital-based jump power meter (JPM) instrument for measuring leg muscle power was highly valid when used to test female volleyball players.

Table 2 The Pearson product-moment analysis results

Female	N	R-table	R-count (Test 1)	Sig (2-tailed)	Status
	25	0.396	0.933	0.000	Valid
	N	R-table	R-count (Test 2)	Sig (2-tailed)	Status
	25	0.396	0.933	0.000	Valid

#### 3.2. Reliability

The reliability test data processing using Cronbach's alpha shows that the r-table data is 0.396, and the Cronbach's alpha value is 0.956. If Cronbach's alpha value is greater than the r-table value, the instrument can be reliable. An integrated digital-based jump power meter (JPM) to measure leg muscle power in male volleyball players can therefore be concluded to have high reliability because the value obtained is more than 0.7.

Table 3 The result of Cronbach's alpha analysis

Male	N	R-table	Cronbach's alpha	Status
	25	0.396	0.956	Reliable

The reliability test data processing using Cronbach's alpha showed that the r-table data was 0.396, and the Cronbach's alpha value was 0.964. If Cronbach's alpha value is greater than the r-table value, the instrument can be reliable. An integrated digital-based jump power meter (JPM) to measure leg muscle power in female volleyball players can therefore be concluded to have high reliability because the value is more than 0.7.

Table 4 The result of Cronbach's alpha analysis

Female	N	R-table	Cronbach's alpha	Status
	25	0.396	0.964	Reliable

### 4. Discussion

Of course, talking about technology is incomplete without mentioning a tool. According to previous research, modern technology is expected to make learning and performance easier [19]. In line with other viewpoints, the industrial revolution 4.0 is said to be the pinnacle of technological advancement, surpassing the previous era [20]. The advancement of the health industry and the development of sports technology [20] are examples of technological progress in this case. As a result, the public can sense technological advancements in the current era, including the development and progress of sports.

More modern sports technology provides a new color for academics and sports practitioners. Technological advances in the field of sport greatly facilitate the performance of coaches, match administrators, and athletes. This progress can be seen and felt significantly in sports health promotion related to technology, such as increasingly sophisticated

gadgets that aim to download sports applications, the emergence of smartwatches, and smart clothes to facilitate exercise activities [21, 22]. and measurement and evaluation in the field of the sport began to show comprehensive progress

Tests, measurements, and evaluations of sports are interrelated activities. They become a series of activities in the sports process, especially tests and measurements related to sports achievements. Achievement sports need a test and measurement to see the success of pre-programmed performance. Evaluation is, of course, obtained from the test and measurement process. Experts say that evaluation is used when there is already a test and measurement [23]. Test and measurement activities in the 4.0 era for sports certainly require a touch of more sophisticated technology in terms of data input, security, and the attractiveness of an instrument. For this reason, a test was developed to simplify testing and measurement.

Tools or test instruments with more meaning and innovation to support peak achievement success have been eagerly awaited. According to previous research, science and technology development is one of the efforts to support individual and team achievements, which requires someone to continue innovating to create a tool with high novelty [24, 25].

The creation of this tool entails the creation of a leg muscle power test instrument that is both innovative and novel. The integrated digital-based jump power meter is the name of this device (JPM). The stages of developing a new instrument are unquestionably organized. A conceptual design was carried out in the previous stage, followed by a real design. However, the tool only has content validity and inter-rater reliability with good results, so the next stage is to conduct advanced trials to find validity and reliability.

Validity is an important consideration when creating a test instrument; it refers to the instrument's ability to precisely and accurately measure what it is intended to measure [26, 27]. Furthermore, reliability refers to how consistently and consistently the test instrument produces relatively the same results in the same situation on multiple occasions [28]. Therefore, the test instrument can be good when it has validity and reliability. This study will test the empirical validity and reliability of the integrated digital-based JPM test-retest. A more detailed description is explained in this section.

The r-table value was 0.396, the r-count (Test 1) was 0.916, and the significance value (2-tailed) was 0.000, according to the validity test using Pearson's product-moment analysis. The r-count (Test 2) was 0.916, and the significance value (2-tailed) was 0.000. According to these data, the r-count value is greater than the r-table, where the significance value is less than 0.05. As a result, the digital-based integrated jump power meter test instrument has good validity for measuring male volleyball players' leg muscle power.

The validity test using Pearson's product-moment analysis found that, in Test 1, the r-table value was 0.396, the r-count was 0.933, and the significance value (2-tailed) was 0.000. In Test 2, the r-count value obtained was 0.933 with a significance value (2-tailed) of 0.000. Furthermore, it can be explained that the r-count value is greater than the r-table. However, the significance value is less than 0.05, which indicates that the integrated digital-based jump power meter test instrument has good validity for measuring the leg muscle power of female volleyball players.

The results of testing the validity of Pearson's product-moment analysis on male and female soccer players have high empirical validity. This finding is in accordance with the literature review that the coefficient value from 0.9 to 0.99 can be said to be high or near-perfect [29]. Therefore, the integrated digital-based jump power meter (JPM) test instrument has high validity for measuring leg muscle power in volleyball players.

Based on the results of data processing using Cronbach's alpha reliability test, the r-table value obtained is 0.396 with the value of Cronbach's alpha of 0.956. In other words, Cronbach's alpha value is greater than the r-table value, indicating that the test instrument can be reliable in the measurements made on male volleyball players. The reliability test on the measurement of female athletes found that Cronbach's alpha value got a value of 0.964, which indicates that the instrument is reliable. In line with previous studies, the Cronbach's alpha value of more than 0.7 indicates that the instrument has good reliability [30]. This finding is strengthened by previous research, which revealed that the reliability value of Cronbach's alpha 0.9 was included in the excellent category [30]. In conclusion, the digital-based jump power meter (JPM) test instrument integrated into the reliability testing of male and female volleyball players has high reliability.

## 5. Conclusion

Based on the results and discussion, an integrated digital-based jump power meter (JPM) leg muscle power test instrument has been found where this instrument has a very good level of validity and reliability or can be categorized as almost perfect. This finding is evidenced by the results of empirical validity testing using the Pearson product-moment formula on male volleyball players who get r-count values of 0.916 and 0.916. Meanwhile, Cronbach's alpha formula was used to perform a test-retest reliability test, and the obtained was 0.956. The Pearson product-moment formula was used for the empirical validity test, and the r-count value obtained for female volleyball players was 0.933, while the Cronbach's alpha formula was used for the test-retest reliability test, where a value of 0.965 was obtained.

The JPM test is certainly novel in terms of technology, with simpler and faster procedures and

data input than field-based tests, which still rely on manual data input with questionable validity and reliability. The presence of the JPM test undoubtedly adds new nuances and technology to the world of sports, particularly in the area of measurement and evaluation tests.

This discovery is expected to add meaning and value to the overall sport by determining aspects of physical condition, particularly leg muscle power. Following the collection of data, coaches, trainers, and sports teachers can evaluate individually and in relation to the sports program that has been developed. However, this study has limitations because the validity and reliability tests were only performed on a small number of volleyball players. It is hoped that future testing will include a variety of sports so that the JPM test instrument produced is of higher quality.

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