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IDENTIFYING NUMERICAL INDICATORS TO PREDICT THE CONTRIBUTION OF MUSCULAR STRENGTH IN GYMNASTICS TESTS FOR ADVANCED FEMALE STUDENTS AT THE COLLEGE OF PHYSICAL EDUCATION AND SPORTS SCIENCES

Hadeel Abedlelah Abedalhusen
College of Science, Al Nahrain University, Iraq
Hadeel.a.a@nahrainuniv.edu.iq

Abstract
This research aims to identify numerical indicators to predict the contribution of muscular strength in gymnastics tests for advanced female students at the College of Physical Education and Sports Sciences. The researcher employed the descriptive methodology using the survey and correlational approach. The research sample was intentionally selected from female students enrolled in the College of Physical Education and Sports Sciences for the academic year 2023–2024, totaling fifty-two students.
The researcher concluded that general indicators for the tests were established through equations that provide direct numerical measures to assess performance level. The most significant variables in the study were identified through a questionnaire form, and appropriate statistical treatments were applied to suit the nature of the research.

Keywords: Numerical indicators, ratios, predicting, performance.

Introduction

All current tests used in the field of sports tend to assess each requirement separately, without integrating multiple factors to accurately determine the students' overall performance level. This approach does not adequately serve to evaluate the progress of advanced female students or to predict the contribution of **muscular strength** to their performance.

Gymnastics **performance tests for advanced students** require more attention from researchers to develop new, standardized, and scientifically grounded tests that align with sport's ongoing development. Establishing **objective indicators** becomes essential, as they form the foundational basis for evaluating the performance level of advanced students in colleges of Physical Education and Sports Sciences.

Evaluation, as a scientific process, involves issuing a judgment that extends beyond the surface measurement of a phenomenon. Unlike measurement, which focuses solely on quantifying traits, evaluation assesses the **value** of those traits—classifying them as excellent, good, or average, and thus providing a more comprehensive understanding of student performance.

Research Objectives

1. To establish **standard performance levels** for muscular strength requirements among advanced female students at the College of Physical Education and Sports Sciences.
2. To determine the **contribution ratios** of muscular strength to the actual performance of advanced students.
3. To develop **predictive equations** based on the muscular strength variables of advanced students.

Research Methodology

Considering the identified research problem, the researcher adopted the **descriptive method**, which is defined as:

"A methodology that describes a phenomenon according to a specific plan that includes observation, collection of facts and information, and evaluation in light of ideal standards. It also proposes recommendations for improvement or advancement based on those standards."

Research Population

The research population was selected from **advanced female students** at the **College of Physical Education and Sports Sciences, University of Misan**, who were officially enrolled for the academic year **2023–2024**.

Research Sample

The researcher **intentionally selected** a sample of **fifty-two advanced female students** from the College of Physical Education and Sports Sciences at the University of Misan for the academic year **2023–2024**. The sample was divided as follows:

Main study and standardization sample: All 52 students formed the core sample for implementing the main study, determining the **normative levels** of the tests, and calculating the **scientific validity** and reliability of the proposed tests.

Exploratory Study Sample:

Five (5) female students represented the exploratory study sample, on whom the pilot study was conducted. Table (1) illustrates the description of the research population and sample.

Table (1) Description of the Research Population and Sample

No.	Sample	Number of Students	Percentage
1	Main study and standardization sample	52 students	71.51%
2	Exploratory study sample	5 students	28.49%
3	Total	57 students	100%

Homogeneity of the Research Sample in Basic Variables:

Table (2) Mean, Standard Deviation, Median, and Skewness Coefficient of the Basic Variables *(n = 57)*

No.	Variables	Tests	Unit of Measurement	Mean	Median	Standard Deviation	Skewness
1	Basic	Age	(Years)	18.233	18.200	0.545	0.515
		Height	(cm)	160.333	160.000	2.170	0.020
		Weight	(kg)	59.178	59.000	1.247	0.415
		Intelligence	(Score)	95.200	95.000	1.800	0.722

From Table (2), it is evident that all the female students in the overall research sample fall under the normal distribution curve for all the variables under study. The results indicate that the skewness coefficients for all variables ranged between ±3, which suggests that the female students in the research sample are homogeneous in these variables.

Data Collection Tools and Instruments:

- Expert opinion survey form regarding the components of the muscle strength test (Appendix No. 2).
- Muscle strength test (Appendix No. 3).
- Gymnastics skill test (Appendix No. 4).

Determination of Test Components:

The researcher reviewed several scientific references and specialized studies, which led to the identification of three components to determine the numerical indicators representing some of the basic skills in gymnastics. These skills are:

- Handstand skill
- Headstand skill
- Forward tucked roll skill

Preparation for the Test Specification Table:

The researcher presented the components to eight (8) faculty members who are experts in gymnastics and affiliated with faculties of physical education (Appendix No. 1).

Based on the content analysis of the gymnastics curriculum, the researcher prepared the test specification table, as suggested by *Mohamed Hassan Allawi* and *Mohamed Nasr El-Din Radwan* (2008), which includes the content topics and cognitive levels, and indicates the relative importance of each. *(pp. 153–158).*

Table (3) Percentage Agreement of Experts and Specialists on Determining Skill Performance Requirements

Requirement	Expert Opinions	Percentage Agreement
	Suitable	Not Suitable
Handstand Skill	0	8
Hanging Skill	7	1
Forward Tucked Roll Skill	6	3

It is evident from Table (3) that the experts approved the appropriateness of the skill test in gymnastics, with the percentage agreement ranging between **72.7% and 100%**. The researcher adopted a minimum acceptance percentage of **70%**, thus the final number of skill components included in the test is **two (2)**.

Table (4) Percentage Agreement of Experts and Specialists on Determining Physical Performance Requirements

Requirement	Expert Opinions	Relative Importance
	Suitable	Not Suitable
Muscular Strength	8	0
Speed (Transitional)	7	1
Muscular Endurance	6	2

It is clear from Table (4) that the experts approved the appropriateness of the physical performance requirements, with percentage agreements ranging from **70.58% to 100%**. The researcher adopted a threshold of **70%** as acceptable; therefore, the final number of physical components included in the test is **three (3)**.

Presentation of Tests and Their Numerical Indicators to Experts:

Given the presence of multiple variables, it was necessary to consider all these variables for each individual in the sample.

Regarding how to derive the optimal value for each variable, the exploratory experiment conducted on the female students applying for the gymnastics test aimed to obtain data that would ensure the proper application of mathematical equations and to verify the outcome of these equations. Several students were tested, and the best value for each physical performance requirement was selected — *the lowest value, since these variables are time-dependent*.

As for skill performance requirements, the best value was determined by selecting *the highest value, since the variable depends on the number of successful repetitions*.

The key question arises: **Why do we take the best performance from among the gymnastics students and divide it by the actual performance of each student in the research sample — or the reverse?**

This must be clarified: the level attained by any individual student from the applicants (research sample) is a distinguished performance, yet it is achievable by others as well. It is assumed that all students are given equal opportunity during in-class performance, as tasks are uniformly distributed, and all students face the same conditions (such as standing in a specific center and frequent movements).

The tests and their numerical indicators were presented to gymnastics experts, and all experts approved the validity of the equations used in the tests. These equations logically

indicated individual excellence by incorporating most test variables. The agreement rate was **100%**.

Performance Evaluation of the Research Sample:

The performance of the research sample was evaluated by a committee of **three (3)** expert judges in the field of gymnastics from the Faculty of Physical Education, all of whom possess teaching experience (Appendix 2). The final score was calculated as the **average of the scores assigned by the three judges**, using a pre-prepared evaluation form.

Exploratory Study:

The researcher conducted the exploratory study on a sample of **five (5)** students from the same population but not included in the main sample. The aim was to apply **scientific validation procedures (validity and reliability)** to the performance evaluation card used for assessing gymnastics skills under investigation for second-year female students at the Faculty of Physical Education.

Main Study:

The main study was conducted from **August 1, 2023, to August 14, 2023**, during which the gymnastics skill performance of the students applying to the Faculty of Physical Education was assessed. This was done with the help of **three (3)** expert judges in gymnastics from the faculty. The final scores were calculated by taking the **average of the three judges' scores**, recorded on a prepared evaluation form.

Statistical Tools Used:

The statistical analysis was conducted using **SPSS**, and the following statistical measures were employed:

- Arithmetic Mean
- Standard Deviation
- Coefficient of Variation
- Skewness Coefficient
- Standard Score
- Adjusted Standard Score

Table (5) Arithmetic Means, Standard Deviations, Coefficients of Variation, and Highest and Lowest Scores for the Tests (Unit of Measurement: Score)

Skill	Mean	Standard Deviation	Coefficient of Variation	Highest Score	Lowest Score
Forward Roll (Tucked)	5.588	5.109	0.019	7.03	5.30
Hanging Skill	4.823	1.096	0.155	8.55	6.90

From Table (5), the results of the **forward roll (tucked)** skill test indicate a mean score of **5.588**, with a standard deviation of **5.109** and a coefficient of variation of **0.019**. The highest score recorded was **7.03**, while the lowest score was **5.30**.

As for the **hanging skill** test, the mean score was **4.823**, with a standard deviation of **1.096** and a coefficient of variation of **0.155**. The highest score achieved was **8.55**, and the lowest score was **6.90**.

Table (6) Standard Levels, Assigned Percentages in the Normal Distribution Curve, Raw Scores, Adjusted Standard Scores, Number of Students, and Percentages for Each Level in the Forward Roll (Tucked) Skill Test Performance

Standard Score	Adjusted Standard Score	Classification	Sample Size (Frequency)	Percentage (%)
(-2) and below	29 and below	Very Poor	4	3.33%
(-1.99) to (-1)	40-49	Poor	5	24.24%
(-0.99) to (0)	50-59	Acceptable	16	45.44%
(0.01) to (1)	60-69	Average	13	21.12%
(1.01) to (2)	70 and above	Good	14	6.6%
Total			**52**	**100%**

From the analysis of **Table (6)**, it is evident that the test yielded **five standard levels**, which were distributed naturally among the students. These levels allow for evaluating their performance accordingly.

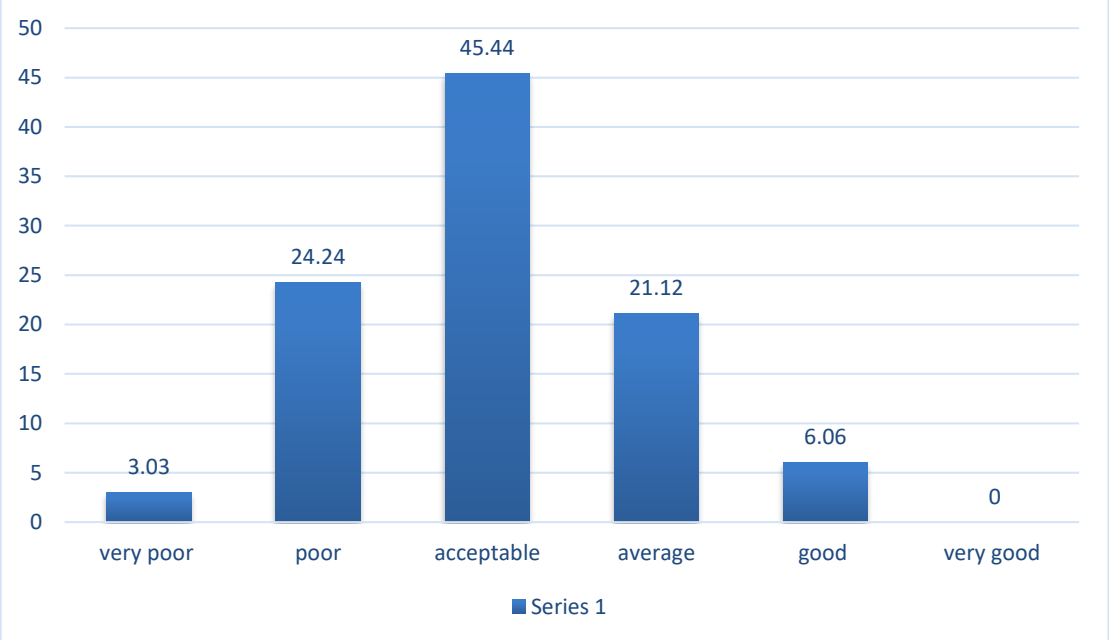

Figure (1): Shows the Levels and Percentages in the Forward Roll Test

The relationship used to determine the constant value (5 × standard deviation ÷ 50) was derived as mentioned by Qais Naji and Bastawisi Ahmed (p. 274), where the adjusted standard score was extracted using the sequential method: (mean ± constant value in sequence). The arithmetic mean represents a score of **50** in the standard score table, while the constant value represents the amount that must be added to or subtracted from the mean. The adjusted standard score is one with a mean of **fifty** and a deviation of **zero**.

Table (7): Displays the Raw Scores and the Standard Scores (Sequential Method) for the Tucked Forward Roll Skill Test

Standard Score	Raw Score	Standard Score	Raw Score	Standard Score	Raw Score	Standard Score
1	-1.7435	30.29	26	4	-0.68262	43.17
1	-1.7435	30.29	27	4	-0.68262	43.17
1	-1.7435	30.29	28	4	-0.68262	43.17
1	-1.7435	30.29	29	4	-0.68262	43.17
1	-1.7435	30.29	30	4	-0.68262	43.17
1	-1.7435	30.29	31	4	-0.68262	43.17
2	-1.47406	35.26	32	4	-0.68262	43.17
2	-1.47406	35.26	33	4	-0.68262	43.17
2	-1.47406	35.26	34	4	-0.68262	43.17
2	-1.47406	35.26	35	5	-0.1869	46.13
2	-1.47406	35.26	36	5	-0.1869	46.13
2	-1.47406	35.26	37	5	-0.1869	46.13
2	-1.47406	35.26	38	5	-0.1869	46.13
2	-1.47406	35.26	39	5	-0.1869	46.13
2	-1.47406	35.26	40	5	-0.1869	46.13
2	-1.47406	35.26	41	5	-0.1869	46.13
2	-1.47406	35.26	42	5	-0.1869	46.13
2	-1.47406	35.26	43	5	-0.1869	46.13
2	-1.47406	35.26	44	5	-0.1869	46.13
2	-1.47406	35.26	45	5	-0.1869	46.13
2	-1.47406	35.26	46	5	-0.1869	46.13
2	-1.47406	35.26	47	5	-0.1869	46.13
4	-0.68262	43.17	48	5	-0.1869	46.13
4	-0.68262	43.17	49	5	-0.1869	46.13
4	-0.68262	43.17	50	5	-0.1869	46.13

(Mean = 0, Standard Deviation = 1)

From Table (7), it is observed that the **mean of the standard scores** was **0** and the **standard deviation was 1**, indicating that the distribution of values falls within the normal distribution curve. These values were extracted for the purpose of developing **norms for this test** by classifying the data into standard levels and frequencies based on the adjusted standard scores presented in the table.

The researcher attributes the variation and differences among individuals in the research sample—and their attainment of various levels—to several factors, according to the indicators provided by the test. These include the **nature of skill performance**, **speed of**

execution, and **muscular strength**, all of which affect the test outcome to varying degrees. This highlights the correlation between the test components and results, as any inefficiency in one of the variables negatively impacts the result.

The researcher agrees with what **Mohamed Tawfiq Al-Walili (1989)** stated:

"The basic motor skills of the game are the backbone of the current training process, especially during the preparation stage for the student."

Therefore, it is essential to consider during performance that **specific physical requirements**—such as **muscular strength** and **speed**—play a key role. These special physical demands are considered upon which gymnastics are currently built, as students must remain in continuous and fast motion in accordance with performance requirements.

The table (8) shows the standard levels and their assigned percentages on the normal distribution curve, along with raw scores, adjusted standard scores, number of students, and percentage for each level in the performance test of the hanging skill.

Derivation of the Hanging Skill Test Standards

Standard Score	Adjusted Standard Score	Criteria	Sample Size (Frequency)	Percentage
(-2) and below	29 and below	Very Weak	5	6.06%
(-1.99) – (-1)	40 – 49	Weak	10	24.24%
(-0.99) – (0)	50 – 59	Acceptable	18	46.46%
(0.01) – (1)	60 – 69	Average	14	16.17%
(1.01) – (2) and above	70 and above	Good	5	6.06%
Total	—	—	**52**	**100%**

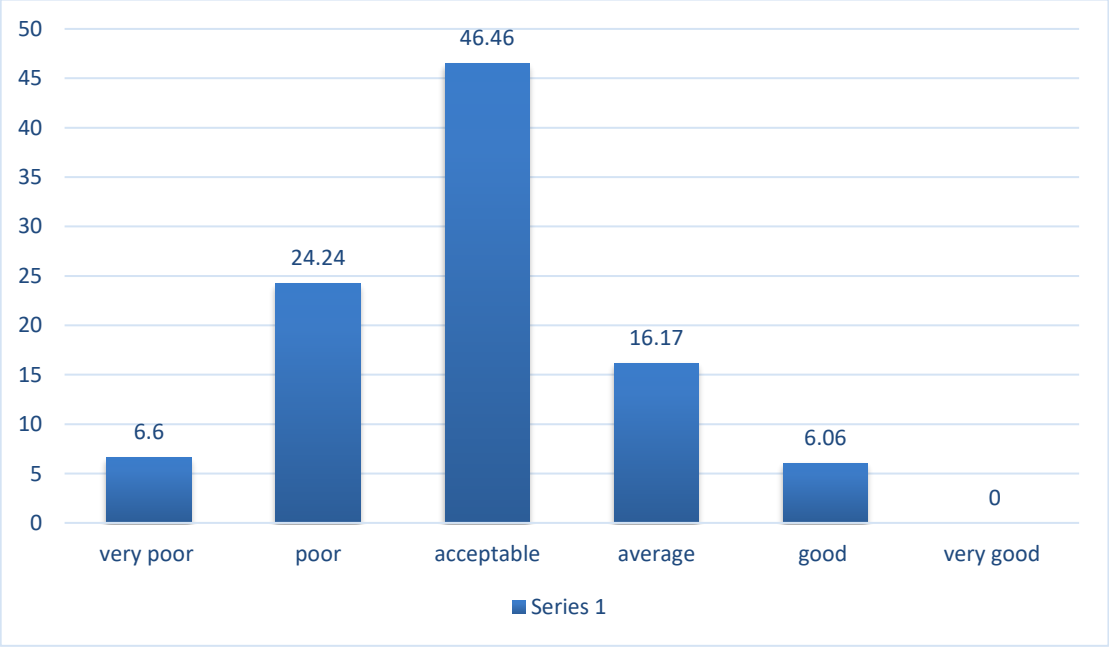

Figure (2): Shows the Levels and Percentages in the Hanging Skill Performance Test

After extracting the results in Table (8), the formula to determine the constant value (5 * standard deviation / 50) was derived. The standardized score was also extracted using the

following formula: the mean (+/−) the constant value (successively). The mean represents the score (50) in the standardized score tables, while the constant value represents the amount to be added or subtracted from the mean. The adjusted standardized score is a score with a mean of fifty and a standard deviation of zero.

Table (9) Shows the raw scores and standard scores sequentially for the attachment test.

Standard Score	Raw Score	Standard Score	Raw Score	Standard Score	Raw Score	Standard Score
1	-1.7435	30.29	26	4	-0.68262	43.17
1	-1.7435	30.29	27	4	-0.68262	43.17
1	-1.7435	30.29	28	4	-0.68262	43.17
1	-1.7435	30.29	29	4	-0.68262	43.17
1	-1.7435	30.29	30	4	-0.68262	43.17
1	-1.7435	30.29	31	4	-0.68262	43.17
2	-1.47406	35.26	32	4	-0.68262	43.17
2	-1.47406	35.26	33	4	-0.68262	43.17
2	-1.47406	35.26	34	4	-0.68262	43.17
2	-1.47406	35.26	35	5	-0.1869	46.13
2	-1.47406	35.26	36	5	-0.1869	46.13
2	-1.47406	35.26	37	5	-0.1869	46.13
2	-1.47406	35.26	38	5	-0.1869	46.13
2	-1.47406	35.26	39	5	-0.1869	46.13
2	-1.47406	35.26	40	5	-0.1869	46.13
2	-1.47406	35.26	41	5	-0.1869	46.13
2	-1.47406	35.26	42	5	-0.1869	46.13
2	-1.47406	35.26	43	5	-0.1869	46.13
2	-1.47406	35.26	44	5	-0.1869	46.13
2	-1.47406	35.26	45	5	-0.1869	46.13
2	-1.47406	35.26	46	5	-0.1869	46.13
2	-1.47406	35.26	47	5	-0.1869	46.13
4	-0.68262	43.17	48	5	-0.1869	46.13
4	-0.68262	43.17	49	5	-0.1869	46.13
4	-0.68262	43.17	50	5	-0.1869	46.13

(S = 0) (+ X = 1)

From observing Table (9), it is evident that the mean of the standard scores was (0) and the standard deviation was (1), and their distribution was limited between (+3), which indicates that the standard test scores are within the normal (bell-shaped) distribution. These values were extracted, and to derive the criteria for this test, the data from Table (9) were tabulated, placing the standard levels and frequencies based on the values of the standard and final modified scores.

The researcher attributes the differences and variations in the sample's performance levels to the fact that the variables involved in rhythmic gymnastics performance are numerous, and the correlation between these variables is crucial to achieving the final performance outcome. Without this correlation, superior performance cannot be achieved. Therefore, the researcher believes that complex skill performance requires a high degree of strength endurance during the performance period, as this physical trait enhances the student's ability

to perform throughout the test period with minimal errors, which will reflect negatively on the performance result. This is what we observe when applying for this test, as it indicates the degree of correlation between physical and skill abilities and their effect on performance.

Hence, the test's ability to distinguish between students based on the effect of each variable on the test indicator is clear, which provides objective evaluation insights into the students' performance level. The researcher agrees with what Singer (1990) pointed out that "motor skills are not achieved at a high level of performance unless the specific physical capabilities are present."

Barrow, as cited by Abu Al-Ala and Muhammad Sobhi (1997), confirms that "the connection between muscular strength and muscle speed is one of the performance requirements in elite levels of sports. This factor is one of the main distinguishing features of superior athletes. They possess a great amount of strength and speed and have the ability to integrate both in a cohesive manner to produce rapid, powerful movement, ultimately achieving superior performance."

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