2025 (December), JOR REKAT 4, (2),291-304 e-ISSN: 2985-3389, https://journal.unj.ac.id/unj/index.php/jor

BUILDING AND STANDARDIZING A TEST TO MEASURE MUSCULAR STRENGTH AND DYNAMIC BALANCE DURING ROTATION AND THEIR RELATIONSHIP TO THE DIGITAL PERFORMANCE LEVEL OF YOUNG HAMMER THROWERS

Mahdi Lafta Rahi
University of Kut
IRAQ

Corresponding Author: Mahdi.Rahi@uokut.edu.iq/mahdilafta@uowasit.edu.iq

Recieved: October 15 , 2025 **Accepted:** December 14, 2025

ABSTRACT

Background. The problem of this study lies in the urgent need for a standardized test that measures muscular strength and dynamic balance during rotation in a manner that realistically simulates the actual performance of the hammer throw. Most of the currently available tests measure these physical attributes separately and do not accurately reflect the complex, integrated nature of performance required in this event. **Objectives.** This study aimed to develop and standardize a test to measure muscular strength and dynamic balance during rotation among young hammer throwers and to identify their relationship to performance achievement. **Method.** The researcher used the descriptive method on a sample of (35) young hammer throwers aged (18–23 years) in Iraq. The proposed test consisted of performing three rotational turns inside the throwing circle using a 5 kg medicine ball, then throwing it with maximum force while maintaining balance. The analysis was assisted using the SPSS 26 application. **Results.** The results showed that the test demonstrated high scientific validity indicators: validity (0.89), reliability (0.91), and objectivity (0.95). Moreover, a very strong correlation (r = 0.89) was found between the test and the digital performance level, explaining 79% of the variance in achievement — a higher percentage compared to traditional tests. Six standard levels were established, ranging from Poor to Excellent. **Conclusion.** The researcher recommended using the test in selection and evaluation processes and emphasized integrating strength and balance training in athletic training programs. Integrating strength and balance into a single test is more effective than measuring them separately, as muscular strength and dynamic balance interact to determine performance level.

Keywords; tests and measurement, standardization, muscular strength, dynamic balance, hammer throw.

A. INTRODUCTION

With the advancement of sports training science, measurement and evaluation have become fundamental pillars in developing athletes' performance levels (Ardian et al., 2025; Ardian & Shareef, 2025; Zulnadila, 2025). Standardized measurement provides objective data that helps coaches make scientifically sound decisions in the processes of selection, training, and evaluation. According to Mohamed Sobhi Hassanein (1995), standardized tests are among the most important tools of assessment in the sports field. Furthermore, the application of physical ability assessment systems can greatly contribute to designing specialized training programs, controlling rehabilitation processes, and predicting athletic potential in educational, competitive, and selection environments (Ibragimov, 2025).

Many measurement tools have been developed to allow easy application, as muscle strength can now be tested using modern equipment and objective approaches to assess individual or multiple muscle groups, or even multiple physical abilities simultaneously with motor performance (Pamungkas et al., 2025; Suryadi et al., 2025). Tests are also used to evaluate general movement functions similar to those performed in different sports activities. Dynamic assessment tools, in particular, have gained wide popularity for identifying injury risks and predicting players' performance levels (Sookbat, 2019). The hammer throw is one of the throwing events that requires specific physical and technical capabilities. Its technical performance demands a unique integration between explosive muscular strength and dynamic balance during rapid rotational turns. Recent studies have highlighted that hammer throwing possesses unique biomechanical characteristics that have attracted the attention of scientists and coaches in the field of athletics (Dafun JR & Custodio, 2025; Imka et al., 2025; Nubatonis et al., 2025).

Successful performance in hammer throw requires the ability to generate force rapidly while maintaining balance during rotation before the moment of release. Balance control is considered a fundamental factor determining performance, based on the premise that high-level athletes possess advanced balance skills (Zago et al., 2015). Muscular strength—particularly in the legs and trunk—plays a critical role in maintaining balance during fast rotational movements (Bressel et al., 2007). Essam El-Din Abdel Khaleq (2003) affirmed that muscular strength represents the cornerstone for developing other physical abilities in

JOR ReKat (Rekreasi Masyarakat)
Prodi Olahraga Rekreasi
Fakultas Ilmu Olahraga
Universitas Negeri Jakarta

various sports activities, while Ahmed Fouad El-Shazly (2008) pointed out that maintaining balance during rotation requires integration among the nervous, muscular, and sensory systems.

Through the researcher's experience in hammer throw training, it was observed that there is a scarcity of standardized tests that measure muscular strength and dynamic balance together in a manner that simulates the actual performance of the hammer throw. This observation prompted the researcher to conduct this study. The importance of this research lies in addressing the lack of scientifically standardized tests that simultaneously measure muscular strength and dynamic balance in a way that mirrors real hammer throw performance. The study aims to provide a scientifically valid and reliable measurement tool that assists coaches in accurately and objectively evaluating athletes' levels by identifying strengths and weaknesses for each thrower, monitoring progress during training periods, and serving as a foundation for designing training programs and objective selection of throwers.

The problem of this study lies in the urgent need for a standardized test that measures muscular strength and dynamic balance during rotation in a manner that realistically simulates the actual performance of the hammer throw. Most of the currently available tests measure these physical attributes separately and do not accurately reflect the complex, integrated nature of performance required in this event. Through his field experience, the researcher observed that coaches often face difficulties in accurately evaluating athletes' performance levels due to the lack of scientifically standardized measurement tools. This shortcoming negatively affects the processes of selection, training, and performance monitoring.

Accordingly, the research problem can be formulated through the following questions: (1) What are the appropriate tests for measuring muscular strength and dynamic balance during rotation among hammer throwers? (2) What is the relationship between muscular strength, dynamic balance, and achievement in the hammer throw? (3) Is it possible to establish standardized performance levels for the proposed test? The research aims to: (1) Develop a test to measure muscular strength and dynamic balance during rotation among young hammer throwers. (2) Identify the relationship between muscular strength, dynamic balance, and performance achievement in the hammer throw. (3) Establish standardized performance levels for the proposed test.

B. METHOD

Participant

The research population consisted of young hammer throwers aged 18–23 years, registered in the Iraqi Central Athletics Federation for the 2024–2025 sports season, totaling 35 athletes distributed across different Iraqi provinces. The research sample was intentionally (purposively) selected from young hammer throwers in the provinces of Baghdad, Wasit, Najaf, Diwaniyah, and Karbala, with a final sample size of 30 athletes.

The researcher conducted a homogeneity test for the main research sample (n = 30) on the variables of chronological age, training age, height, weight, and digital performance level to ensure the normal distribution of the sample. The following table illustrates this:

Table 1. Statistical Description of the Main Research Sample in the Homogeneity Variables

Variable	Unit of Measurement	Mean	Median	Standard Deviation	Skewness Coefficient
Chronological age	Year	20.43	20.00	1.52	0.28
Training age	Year	4.67	4.50	1.21	0.14
Height	cm	178.53	178.00	5.68	0.31
Weight	kg	86.27	85.50	7.43	0.32
Digital performance	m	52.18	52.00	4.87	0.12

It is evident from Table (1) that the skewness coefficient values for all variables range between (±1), indicating that the distribution of the sample members in these variables is normal and homogeneous.

Research Design

The researcher used the descriptive approach in both its survey and correlational styles, as it is the most appropriate for the nature of the research problem and its objectives. A set of precise scientific instruments, tools, and means were used to collect data related to the research topic. The selection of these tools was based on their suitability for the nature of the studied variables, their accuracy in measurement, ease of field application, and their reliability and validity for use within the local sports environment.

To verify the practical validity of the proposed test in measuring explosive muscular strength and dynamic balance among hammer throwers, the researcher employed several

JOR ReKat (Rekreasi Masyarakat)
Prodi Olahraga Rekreasi
Fakultas Ilmu Olahraga
Universitas Negeri Jakarta

complementary (standardized) tests to determine the degree of correlation between the new test results and the actual performance of hammer throwers in athletics, as well as to confirm the test's validity in measuring the intended variables.

The researcher conducted a comprehensive survey of available tests in the scientific literature and then presented them to a panel of specialized experts to identify the most suitable ones for the nature of the study. Tests that received an agreement rate of 80% or more from the experts were approved for use.

Table 2. Proposed Tests and Expert Agreement Rates

No.	Test	Purpose of the Test	Agreement Rate	Decision
1	Standing vertical jump	To measure the explosive power of the legs	90%	Accepted
2	Standing broad jump	To measure the horizontal power of the legs	100%	Accepted
3	Medicine ball throw (5 kg) from a standing position	To measure arm and trunk strength	80%	Accepted
4	Medicine ball throw during rotation	To measure speed-strength during rotation	90%	Accepted
5	Y Balance Test	To measure multi-directional dynamic balance	70%	Rejected
6	Modified Bass Test	To measure dynamic balance	60%	Rejected
7	Proposed test: Muscular strength and dynamic balance during rotation	To measure strength and balance simultaneously	100%	Accepted

Full Description of the Proposed Test (Main Research Test)

1. Test Name: Explosive Muscular Strength and Dynamic Balance During Rotation for Hammer Throwers
2. Test Objective: To measure explosive strength and dynamic balance during hammer throw performance.

Required Equipment: (1) A standard throwing circle marked with two parallel lines perpendicular to the throwing sector. (2) Medicine ball weighing 5 kg. (3) Measuring tape (metal). (4) Cones to define the throwing area.

Performance Specifications

1. Draw two parallel lines inside the circle, perpendicular to the throwing sector, to stabilize the movement of the athlete's feet.
2. The athlete stands inside the throwing circle, holding the 5 kg medicine ball with both hands.

3. The athlete performs rotational turns (360° per turn), keeping the movement along the lines drawn inside the circle.
4. After completing the third rotation, the athlete throws the medicine ball with maximum force at an angle of approximately 45°.
5. Balance must be maintained throughout the performance by keeping the feet on the drawn lines and not stepping outside the circle.

Scoring: (1) Throw Distance: Measured from the center of the circle to the point where the ball lands, using a measuring tape in meters. (2) Balance Deduction: 0.5 m is deducted for each step outside the parallel lines or for leaving the circle. (3) Final Score = Throw Distance – Balance Deductions. (4) Number of Attempts: Three attempts are allowed, and the best attempt is counted.

Complementary (Standardized) Tests (Mohamed Sobhi Hassanein, 1996)

In addition to the proposed test, the following tests were used for comparison purposes, to validate the results of the proposed test, and to ensure its scientific basis:

1. Vertical Jump Test (Standing Vertical Jump) - Objective: To measure the explosive power of the legs.
2. Standing Long Jump Test - Objective: To measure the horizontal power of the trunk and leg muscles.
3. Medicine Ball Throw Test (5 kg) from a Standing Position - Objective: To measure the explosive strength of the trunk and arms.

Pilot Experiment

The pilot experiment was conducted on a sample of ten athletes from the main standardization sample during the period from August 15 to 20, 2025. It aimed to demonstrate the procedures for applying the proposed test of explosive strength and dynamic balance, identify difficulties encountered by both the researcher and the participants during performance, and determine the appropriate number of judges needed to monitor rotation, balance, and throwing. The experiment also served to verify the suitability and readiness of the equipment and tools used, as well as the preparedness of the sample, while ensuring the scientific validity of the test procedures.

Test Validity (Validity)

The validity of the proposed test was calculated using two methods:

JOR ReKat (Rekreasi Masyarakat)
Prodi Olahraga Rekreasi
Fakultas Ilmu Olahraga
Universitas Negeri Jakarta

1. Content Validity : The test was presented to a group of experts specialized in sports training, athletics, and measurement and evaluation. The experts reached a 100% agreement on the suitability of the test for measuring what it was designed to assess.
2. Discriminant Validity: The test was applied to two groups: the distinguished group, consisting of 15 advanced-level athletes who participated in international competitions, and the non-distinguished group, consisting of 15 beginner-level athletes.

Table 3. Discriminant Validity of the Proposed Test

Group	Sample Size	Mean	Standard Deviation	Calculated t	Significance Level
Distinguished	15	14.23	1.54	8.94	0.000
Non-Distinguished	15	9.87	1.68		

Since the confidence level in the results above is 0.000, which is less than the significance level (0.05), the differences are statistically significant, confirming the test's ability to discriminate between different performance levels.

Test Reliability

The reliability of the test was calculated using the Test-Retest method, where the test was applied twice on the reliability sample (n = 20) with a 7-day interval between applications. The Pearson correlation coefficient was calculated between the two applications.

Table 4. Reliability Coefficients of the Tests Used

Test	First Application (Mean ± SD)	Second Application (Mean ± SD)	Correlation Coefficient (r)	Significance Level
Proposed Test	11.45 ± 1.82	11.62 ± 1.75	0.91	Significant at 0.01
Vertical Jump	48.35 ± 6.21	48.90 ± 6.15	0.94	Significant at 0.01
Standing Long Jump	2.41 ± 0.28	2.43 ± 0.27	0.89	Significant at 0.01
Medicine Ball Throw	13.68 ± 1.95	13.82 ± 1.88	0.92	Significant at 0.01

It is evident from the table that all correlation coefficients are statistically significant and high (0.89–0.94), confirming the reliability of the tests and their ability to produce consistent results.

JOR ReKat (Rekreasi Masyarakat)
Prodi Olahraga Rekreasi
Fakultas Ilmu Olahraga
Universitas Negeri Jakarta

Test Objectivity

The objectivity of the proposed test was assessed by having three independent judges evaluate the performance of 15 athletes simultaneously. The correlation coefficient between the judges' scores was then calculated.

Table 5. Objectivity Coefficients Among the Three Judges

Judges	Correlation Coefficient (r)	Significance Level
Judge 1 – Judge 2	0.96	Significant at 0.01
Judge 1 – Judge 3	0.94	Significant at 0.01
Judge 2 – Judge 3	0.95	Significant at 0.01
Average	0.95	Significant at 0.01

It is evident that the objectivity coefficients are very high, with an average of 0.95, indicating that the results are consistent regardless of the judge. This confirms the objectivity of the proposed test.

Main Application of the Tests

The pre-tests were conducted on the main research sample (n = 30) during the period from September 15 to 20, 2025, at athletics fields in the provinces included in the study. The researcher followed all procedures and scientific steps for designing and implementing the tests, including standardizing test conditions, adhering to warm-up and performance timings, determining the number of judges, observing rest intervals between tests, ensuring a logical sequence of tests, and verifying the suitability and readiness of equipment and tools.

Statistical Tools

The researcher used SPSS (Version 26) for data processing and applied the following statistical procedures: Mean (Average), Standard Deviation, Median, Skewness Coefficient, Pearson Correlation Coefficient, Independent Samples t-test and Percentage.

C. RESULTS AND DISCUSSION

Results

Table 6. Statistical Description of Physical Test Results and Digital Performance Level

Test	Unit	Mean	Median	Standard Deviation	Minimum	Maximum	Skewness
Proposed Test	m	11.82	11.75	1.94	8.10	15.80	0.18
Vertical Jump	cm	49.67	49.50	7.23	36.00	64.00	0.12
Standing Long Jump	m	2.46	2.45	0.31	1.90	3.05	0.21
Medicine Ball Throw	m	14.12	14.00	2.08	10.00	18.50	0.15
Digital Performance	m	52.18	52.00	4.87	42.80	61.50	0.12

It is evident from the table that all skewness values are within the range of (±1), indicating a normal distribution. Additionally, the mean values are close to the median for all tests, which confirms the homogeneity of the sample.

Table 7. Correlation Matrix Between Different Physical Tests

Test	Proposed Test	Vertical Jump	Standing Long Jump	Medicine Ball Throw	Digital Performance
Proposed Test	1.000	0.78**	0.81**	0.84**	0.89**
Vertical Jump	-	1.000	0.72**	0.69**	0.71**
Standing Long Jump	-	-	1.000	0.74**	0.76**
Medicine Ball Throw	-	-	-	1.000	0.79**
Digital Performance	-	-	-	-	1.000

The results indicate a strong correlation between the proposed test and all other physical tests, with the highest correlation observed with digital performance (r = 0.89).

Table 8. Correlation and Determination Coefficients Between Physical Tests and Digital Performance

Strength Test	Correlation (r)	Determination (r^2)	Significance	Strength of Relationship
Vertical Jump	0.71	0.50	0.000	Strong
Standing Long Jump	0.76	0.58	0.000	Strong
Medicine Ball Throw	0.79	0.62	0.000	Very Strong
Proposed Test	0.89	0.79	0.000	Very Strong

From Tables 7 and 8, the proposed test shows the highest correlation with digital performance, confirming its relevance. Additionally, the proposed test correlates significantly with all other physical tests.

Table 9. Contribution of Each Variable in Predicting Digital Performance

Independent Variable	Regression Coefficient (B)	Standard Error	Beta	t-value	Significance	Contribution (%)
Constant	8.432	3.125	-	2.698	0.012	-
Proposed Test	2.186	0.215	0.871	10.167	0.000	76%
Medicine Ball Throw	0.542	0.198	0.231	2.737	0.011	14%
Standing Long Jump	0.318	0.156	0.146	2.038	0.051	6%

JOR ReKat (Rekreasi Masyarakat)
Prodi Olahraga Rekreasi
Fakultas Ilmu Olahraga
Universitas Negeri Jakarta

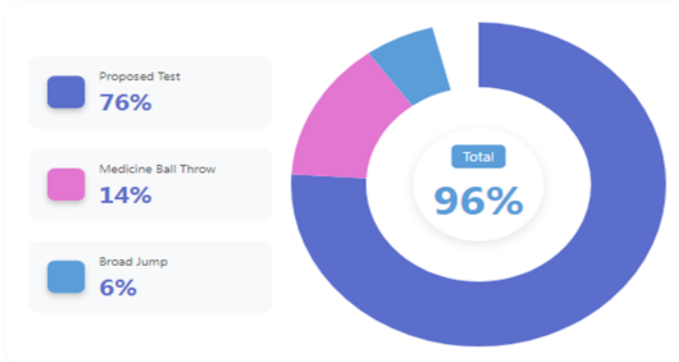

Figure 1. Illustrating the Contribution Percentages of Variables to Performance

Interpretation:

1. The proposed test is the strongest predictor of performance, accounting for 76% of the variance.
2. The overall model explains 85.4% of the variance in digital performance.
3. This highlights the importance of integrating strength and balance into a single test.

The standardized levels were established using modified T-scores, dividing the sample into six levels according to the normal distribution curve.

Table 10. Standardized Levels of the Proposed Test (Raw and T-Scores)

Level	Raw Score (m)	T-Score	Frequency	Percentage	Rating
Excellent Very High	≥ 15.70	≥ 70	2	6.7%	*****
Excellent	13.76 – 15.69	60 – 69	4	13.3%	****
Very Good	11.82 – 13.75	50 – 59	9	30.0%	***
Good	9.88 – 11.81	40 – 49	9	30.0%	**
Acceptable	7.94 – 9.87	30 – 39	4	13.3%	*
Poor	< 7.94	< 30	2	6.7%	✗
Total	-	-	30	100%	-

Discussion

The analysis of the study results revealed that the proposed test contributes 76% in predicting performance, which is considerably higher compared to the other tests. This emphasizes the importance of integrating explosive muscular strength with dynamic balance, highlighting the critical role of the proposed test in assessing hammer throwers' abilities. The test not only facilitates evaluating the effectiveness of training programs, but also aids in selecting athletes when progressing to higher competitive levels (Gunawan et al., 2023; Hardinata et al., 2023; Suniga et al., 2025).

JOR ReKat (Rekreasi Masyarakat)
Prodi Olahraga Rekreasi
Fakultas Ilmu Olahraga
Universitas Negeri Jakarta

Complex movements requiring coordination between strength and balance demand a high level of development in the central nervous system (Abdel-Maqsoud, 1997). The researcher notes that successful hammer throwing performance requires precise coordination between the neuromuscular system, as the thrower must generate high force while maintaining balance simultaneously.

From a biomechanical perspective, during the player's 3–4 rotational cycles, the thrower experiences significant centrifugal forces that must be controlled. Players need muscular strength and stability to maintain proper movement form, achieve acceptable throw distances, and prevent injuries (Erickson et al., 2016). Even a brief loss of balance can reduce the throwing distance by several meters (Ahmed Fouad El-Shazly, 2008).

Maintaining balance during rotation requires substantial muscular strength, especially in the trunk and leg muscles, to preserve proper posture. This explains why the proposed test—which combines strength and balance—was more strongly correlated with performance than tests measuring each ability separately (Islam et al., 2024).

Highly skilled athletes can achieve successful performance even with increased body sway, demonstrating their ability to control and balance their body during skill execution. These findings provide deeper insight into the body posture control system under different performance demands and offer valuable information for designing training programs in specific sports (Zemková, 2014).

D. CONCLUSION

In light of the study's objectives and findings, the researcher reached the following conclusions: The proposed test is scientifically valid and effectively measures both muscular strength and dynamic balance in a way that simulates actual hammer throw performance. The proposed test achieved the highest correlation with digital performance compared to traditional tests. Integrating strength and balance into a single test is more effective than measuring them separately, as muscular strength and dynamic balance interact to determine performance level. Using the proposed test as a primary tool for evaluating and selecting young hammer throw athletes. Designing training programs that integrate the development of muscular strength and dynamic balance. Including the proposed test within the official battery of athletic tests.

E. ACKNOWLEDGMENT

The author extends sincere appreciation to all those who contributed to the success of this research.

F. AUTHOR CONTRIBUTION STATEMENT

Mahdi Lafta Rahi Abd is fully responsible for the content of the article.

G. REFERENCE

Ahmed Fouad El-Shazly (2008). *Sports Encyclopedia in Biomechanics of Balance.* Alexandria: Al-Maaref Publishing.

Al-Sayed Abdel-Maqsoud (1997). *Theories of Sports Training – Strength Training and Physiology.* Cairo: Center for Book Publishing.

Ardian, R., Dewantara, J., & Shareef, Q. B. (2025). Circuit training on VO2max physical condition: How does it affect handball athletes? *Journal of Applied Movement and Sport Science*, *1*(3 SE-Research Articles), 30–38. https://doi.org/10.65575/jamss.v1i3.93

Ardian, R., & Shareef, Q. B. (2025). Effectiveness of a 12-week structured training program on performance improvement in recreational male tennis players (NTRP 2.5): Controlled experimental study. *Journal of Applied Movement and Sport Science*, *1*(2 SE-Research Articles), 17–23. https://journals.khatec.id/index.php/jamss/article/view/66

Dafun JR, P. B., & Custodio, J. M. (2025). Application of plyometric training: How does it affect throwing strength and speed in handball? *Journal of Applied Movement and Sport Science*, *1*(1 SE-Research Articles), 1–9. https://doi.org/10.65575/jamss.v1i1.4

Essam El-Din Abdel-Khalek Mustafa (2003). *Sports Training – Theories and Applications* (12th ed.). Cairo: Al-Maaref Publishing.

Erickson, et al. (2016). The Biomechanics of Throwing. *Operative Techniques in Sports Medicine*. 24(3). 156–161. https://doi.org/10.1053/j.otsm.2016.04.002

Gunawan, D., Custodio, J. M., Suniga, J. P. C., Laoan, M. I., & Stojmenović, D. (2023). Impact of Pocari and Mineral drinks on pulse rate after running 1200 meters with a 5-minute rest interval. *Tanjungpura Journal of Coaching Research*, *1*(3), 86–93. https://doi.org/10.26418/tajor.v1i3.73045

Hardinata, R., Fakhruddin Fakhruddin, Syarif, A., Ahwan, M. T. R., Abidin, M. Z., Alamsyah, A., Abdulrahman, D., Shukla, M., Malek, N. F. A., & Sa'adah, S. P. (2023). The use of audio-visual media: how does it affect rhythmic movement skills? *Tanjungpura Journal of Coaching Research*, *1*(2), 38–47. https://doi.org/10.26418/tajor.v1i2.66586

Hassanein, M. S. (1995). *Measurement and Evaluation in Physical Education and Sports* (3rd ed.). Cairo: Dar Al-Fikr Al-Arabi.

Hassanein, M. S. (1996). *Measurement and Evaluation in Physical and Sports Education, Part 1* (4th ed.). Cairo: Dar Al-Fikr Al-Arabi.

Ibragimov, S. (2025). Modern Testing and Evaluation Systems for Assessing Physical Fitness. *Journal of Science-Innovative Research in Uzbekistan*, 3(4), 236–248. https://zenodo.org/records/1522501

Imka, A. J., Jatra, R., & Dafun JR, P. B. (2025). The contribution of leg muscle power and eye-foot coordination to the accuracy of futsal shooting of students. *Journal of Applied Movement and Sport Science*, *1*(3 SE-Research Articles), 20–29. https://doi.org/10.65575/jamss.v1i3.87

Islam, S., Husein, M., Abadi, A. K., Pratama, O. P. A., Nubatonis, J. D., Kristiono, A. A., Dewi, I. S., Wijaya, M. B., & Salacup, V. L. D. (2024). What is the relationship between body mass index and reaction speed in PPLOP boxing athletes in Central Java? *Tanjungpura Journal of Coaching Research*, *2*(2), 88–96. https://doi.org/10.26418/tajor.v2i2.79361

Nubatonis, J. D., Dzakiyyah, D. M. N., Husein, M., Németh, Z., & Dafun JR, P. B. (2025). The Effect of Pencak Silat Extracurricular Activities in Student Character Building: A Literature Review as a Theoretical Approach. *Journal of Applied Movement and Sport Science*, *1*(2 SE-Research Articles), 1–8. https://journals.khatec.id/index.php/jamss/article/view/48

Pamungkas, G. R., Jatra, R., & Németh, Z. (2025). Physical condition levels of futsal extracurricular students at YLPI Perhentian Marpoyan Junior High School. *Journal of Applied Movement and Sport Science*, *1*(3 SE-Research Articles), 1–11. https://doi.org/10.65575/jamss.v1i3.91

Ressel, E., Yonker, J. C., Kras, J., & Heath, E. M. (2007). Comparison of Static and Dynamic Balance in Female Collegiate Soccer, Basketball, and Gymnastic Athletes. *Journal of Athletic Training*, 42(1), 42–46.

Sookbat, T. (2019). Muscle Strength of Upper Extremities and Trunk in Collegiate Throwing Players. *Naresuan University Journal: Science and Technology*, 27, 2127.

Suniga, J. P. C., Custodio, J. M., Roldan, P. J. B., Shlool, H. A., & Abumoh'D, M. F. (2025). How effective is circuit training on physical fitness? A high-intensity study in the sport of futsal. *Tanjungpura Journal of Coaching Research*, *3*(1), 32–40. https://doi.org/10.26418/tajor.v3i1.88062

Suryadi, D., Ivanov, D., & Zulnadila, Z. (2025). Stimulation of physical fitness through traditional games in elementary school students: A systematic review in Indonesia. *Journal of Applied Movement and Sport Science*, *1*(3 SE-Research Articles), 12–19. https://doi.org/10.65575/jamss.v1i3.92

Zago, M., Mapelli, A., Shirai, Y. F., Ciprandi, D., Lovecchio, N., Galvani, C., & Sforza, C. (2015). Dynamic Balance in Elite Karateka. *Journal of Electromyography and Kinesiology*, 25(6), 894–900.

Zemková, E. (2014). Sport-Specific Balance. *Sports Med. 44* (5) 579–590. https://doi.org/10.1007/s40279-013-0130-1

Zulnadila, Z. (2025). Efforts to improve speed in non-professional athletes: An application of plyometric training in badminton. *Journal of Applied Movement and Sport Science*, *1*(2 SE-Research Articles), 33–37. https://journals.khatec.id/index.php/jamss/article/view/67