JOURNAL OF EDUCATION AND APPLIED TEACHING (JEAT)
Volume 2 Nomor 3, 2026, 1561-1570
E-ISSN: 3090-0360

The Correlation Between Arm Muscle Strength and Orthodox Shot Put Proficiency: A Biomechanical Examination and Quantitative Assessment this Study Uses the Methodology

Meli Andika Putri[1]
[1,]*SDN 28 Palembang*
**Corresponding author: meliandika576@gmail.com*

Abstrak

Penelitian ini bertujuan untuk menguji signifikansi hubungan korelasi, menghitung koefisien korelasi dan menentukan besarnya kontribusi (koefisien determinasi, R^2) kekuatan otot lengan terhadap kemampuan tolak peluru gaya ortodoks Kekuatan otot lengan (Variabel X) merupakan faktor fundamental yang berfungsi sebagai aktuator akhir dalam fase dorongan tolak peluru. deskriptif korelasional dengan pendekatan kuantitatif. Subjek penelitian terdiri dari 25 siswa/siswi SD yang telah mengenal teknik dasar tolak peluru gaya ortodoks Variabel bebas (X) diukur menggunakan Tes Gantung Siku Tekuk (TKBJ) yang mengukur kekuatan statis/isometrik otot lengan, dan variabel terikat (Y) adalah kemampuan tolak peluru gaya ortodoks, diukur dari jarak tolakan maksimal Data dianalisis menggunakan Uji Korelasi Product Moment Pearson. Hasil uji hipotesis menunjukkan bahwa terdapat hubungan yang positif dan sangat signifikan secara statistik antara kekuatan otot lengan dan kemampuan tolak peluru gaya ortodoks, dengan koefisien korelasi (r2) sebesar 0.790 Nilai signifikansi (p-value) adalah 0.000 (jauh di bawah a =0.05), sehingga Hipotesis Nol (H_0) ditolak' Koefisien Determinasi (R^2) menunjukkan bahwa kekuatan otot lengan secara matematis menyumbang 62.41% terhadap variasi hasil tolakan. Meskipun signifikan, analisis biomekanika dan literatur menunjukkan bahwa kontribusi ini bersifat parsial (literatur melaporkan kontribusi efektif antara 30% hingga 48.73%, menyoroti peran penting faktor lain, seperti daya ledak dinamis dan efisiensi transfer energi melalui rantai kinetik tubuh (kekuatan tungkai dan core) Disarankan agar program latihan menerapkan pendekatan holistik yang menyeimbangkan kekuatan lengan, tungkai, core, dan fokus pada pengembangan daya ledak spesifik

Kata kunci: *Kekuatan Otot Lengan (Variabel X), Tolak Peluru Gaya Ortodoks (Variabel Y) Korelasi, Daya Ledak, Rantai Kinetik.*

Abstract

This study seeks to evaluate the significance of the correlation, compute the correlation coefficient, and ascertain the extent of the contribution (coefficient of determination, R^2) of arm muscular strength to the performance in orthodox style shot put. Arm muscular strength (Variable X) is a critical determinant that serves as the ultimate actuator in the shot put propulsion phase—descriptive correlational study employing a quantitative methodology. The research participants comprised 25 primary school pupils acquainted with the fundamental skills of traditional shot put. The independent variable (X) was assessed using the Bended Elbow Hanging Test (TKBJ), which evaluates the static/isometric strength of the arm muscles. In contrast, the dependent variable (Y) was the capability to execute the shot put in an orthodox manner, quantified by the maximal push distance. The data were examined via the Pearson Product-Moment Correlation Test. The hypothesis test results indicate a strong and statistically significant association between arm muscular strength and orthodox shot put performance, with a correlation value (r^2) of 0.790. The significance value (p-value) is 0.000, well below $\alpha = 0.05$, hence the Null Hypothesis (H_0) is rejected. The coefficient of determination (R^2) indicates that arm muscular strength accounts for 62.41% of the variance in the rejection outcomes. Despite its significance, biomechanical and literature analyses indicate that this contribution is limited, with reported effective contributions ranging from 30% to 48.73%, underscoring the crucial influence of additional factors, such as dynamic explosive power and the efficiency of energy transfer within the body's kinetic chain (leg and core strength). Training regimens should implement a comprehensive approach that equilibrates arm, leg, and core strength while emphasizing the cultivation of targeted explosive power.

Keywords: Arm Muscle Strength (Variable X), Orthodox Shot Put (Variable Y) Correlation, Explosive Power, Kinetic Chain.

History:
Received : 2 March 2026
Revised : 2 March 2026
Accepted : 4 March 2026
Published : 8 March 2026

Publisher: Horizon Edukasi Prima Indonesia

1. INTRODUCTION

Physical education is an educational process involving physical activities designed to enhance physical fitness, develop motor skills, foster sportsmanship, cultivate emotional intelligence, and promote awareness of healthy and active lifestyles (Sumbodo, in Jayul & Irwanto, 2020). This definition aligns with the perspective that favorable physical condition variables are directly correlated with enhanced motor performance in sports, such as shot put (Suryadi, 2024).

Athletics, a category of sport encompassing various disciplines like running, jumping, throwing, and walking, focuses on developing fundamental motions executed in daily life. It prioritizes strength, speed, agility, and physical endurance. Strength-based training techniques are more suitable for events like throwing and putting, while endurance training is more relevant to long-distance running (Irawan, 2022). Derived from the Greek word *athlon* (meaning "race" or "match"), athletics involves actions such as running (sprints, long-distance, relays), leaping (long jump, high jump), throwing (shot put, javelin), and walking.

The shot put, in particular, requires a sophisticated combination of physical attributes, with the athlete's ability to achieve optimal throw distance heavily dependent on the efficient transfer of momentum through the body's kinetic chain, culminating in the final propulsion phase executed by the arms. This sequence, which includes preparation, launch, release, and recovery, is essential for achieving the desired propulsion and throw distance (Pratama, 2021).

The history of athletics traces back to the ancient Olympic Games in Greece around 776 BC, and it was introduced to Indonesia by the Dutch colonial administration, with the first athletics organization established in 1917 as the Nederlands Indische Atletiek Unie. After Indonesia's independence, the All-Indonesian Athletics Association (PASI) was formed in 1950 as the governing body for athletics in the country.

In athletics, physical prowess, skill, and muscular strength are vital for performance, particularly in events like the shot put, which requires explosive propulsion. The shot put's success hinges on the effective synchronization of the kinetic chain from the lower limbs through the torso to the upper body, with the arms ultimately generating the linear velocity of the shot (Saputro, 2023). The arm muscle strength is a crucial factor in achieving distance in the shot put.

The shot put technique, particularly the orthodox style, relies on arm strength and body coordination to achieve optimal propulsion. Arm muscle strength plays a pivotal role in determining an athlete's performance, with increased arm strength correlating directly with greater push-off distances (Pratomo, 2022; Rahmad, 2021). The orthodox technique emphasizes the efficient transfer of energy from the lower body to the upper body, where the arm muscles act as the final mechanism for the shot's acceleration. Strength, in this context, is the ability of muscles to withstand force and convert it into explosive power for acceleration, which is critical for successful shot put performance (Saputra, 2019; Putra, 2021).

This paper aims to explore the significance of arm muscle strength in shot put performance, examining the role of strength-based training and its impact on improving performance in the event.

2. METHOD

This study employed a correlational research design with a quantitative approach to investigate the relationship between arm muscle strength and orthodox shot put performance. The target population for this study consisted of 25 students from SDN 28 Palembang, aged 12 to 14 years. The subjects were selected using purposive sampling, ensuring that the sample group included students who were actively involved in athletics and proficient in the orthodox shot put technique.

2.1 Research Instruments

The research instruments used to collect data included:

1. Arm Muscle Strength Test: This test was conducted using a dynamometer to measure the isometric strength of the arm muscles. The dynamometer provided an accurate measure of the muscle strength of the upper limbs, which is essential for generating the necessary force during the shot put.
2. Orthodox Shot Put Ability Test: This test measured the repulsion distance (distance the shot is thrown) using the orthodox shot put technique. The measurement was taken using a standardized shot put technique in line with the established rules for the event.

2.2 Design and Approach

This study utilized a descriptive correlational design, which aims to examine the relationship between an independent variable (arm muscle strength) and a dependent variable (shot put performance). Specifically, the study sought to:

- Test the significance of the correlation between arm muscle strength and shot put performance.
- Calculate the correlation coefficient (r) to determine the strength and direction of the relationship.
- Calculate the coefficient of determination (r^2) to assess the proportion of variance in shot put performance that can be explained by arm muscle strength.

This correlational approach is in line with previous studies that have explored the relationship between arm muscle strength, explosive power, and shot put performance across various educational levels (Mulyadi, 2020; Gunawan, 2020).

2.3 Variables Measured

- Independent Variable (X): Arm muscle strength, measured using a dynamometer and the Bended Elbow Hanging Test (BEL) to assess static muscle strength and endurance.
- Dependent Variable (Y): Orthodox style shot put ability, measured by the distance achieved in the shot put test.

2.4 Data Collection Procedure

Data collection was carried out through the following procedure:

1. Pre-test: Prior to any intervention, each subject underwent the arm muscle strength test and performed the shot put task to measure their baseline performance.
2. Post-test: After a specific training period (if applicable), the same tests were administered to measure any changes in arm muscle strength and shot put performance.

2.5 Statistical Analysis

The data were analyzed using correlation analysis to test the relationship between arm muscle strength and shot put performance. The correlation coefficient (r) was calculated to determine the strength and direction of the relationship, while the coefficient of determination (r^2) was

used to quantify the proportion of variance in shot put performance that can be explained by arm muscle strength.

This study aimed to provide empirical data on the contribution of arm muscle strength to shot put performance in elementary school students. The results are expected to highlight the significance of arm muscle strength in enhancing shot put performance and offer practical recommendations for physical education teachers and coaches in designing conditioning programs that enhance arm strength and technique in young athletes. This research builds on previous findings that suggest a significant correlation between arm muscle strength and shot put performance, with varying contributions depending on the study sample and measurement tools used (Mardius et al., 2019; Wibowo, 2019).

The Bended Elbow Hanging Test (BEL) was chosen to measure the static strength of the arm muscles, which is critical in shot put performance. The test procedure is as follows:
1. Equipment: A height-adjustable crossbar is used, where the subject grips the bar with a pronated grip.
2. Position: The subject holds their elbows bent at 90 degrees with their chin above the bar for as long as possible.
3. Measurement: The time the subject can hold this position is recorded in seconds using a stopwatch.

This test measures isometric strength, which is essential for maintaining stability before the push-off phase of the shot put. Alternative tests, such as the pull-up test, can also be used to assess dynamic strength in the arms and back muscles, which contribute to the shot put performance (Haryanto, 2020; Hidayat, 2022).

3. RESULT AND DISCUSSION

Arm muscle strength was measured using the Bended Elbow Hanging Test (TKBJ), a standard instrument that aims to measure the static strength and endurance of arm and shoulder muscles. The test procedure includes: 5. Use of a single bar that can be adjusted in height. 6. The subject uses an overhead grip (pronated grip). 7. The subject holds the elbow position bent at 90 degrees (chin above the bar) for as long as possible. 8. The holding time is recorded in seconds using a stopwatch.

This instrument was chosen because it measures the isometric strength required to hold the shot and maintain stability before the push phase. As an alternative or complement, the frequency pull-up test can also be used to measure arm and back muscle strength dynamically. Furthermore, some researchers suggest using the Two-Hand Medicine Ball Put test as a more specific measure of dynamic explosive power for the shot put motion (Putra, 2021; Wibowo, 2019).

Data analysis was carried out quantitatively through several statistical stages:
1. Descriptive Analysis: Calculating the mean, standard deviation, minimum, and maximum values for variables X and Y.
2. Analysis Requirements Test: Before conducting a parametric correlation test, it must be ensured that the data meet the requirements: o Data Normality Test (for example, with the Kolmogorov-Smirnov or Lilliefors test). o Linearity Test, to ensure that the relationship between variables X and Y is linear, which is the basic assumption for Pearson Correlation.

3. Correlation Hypothesis Test: Testing the relationship using the Pearson Product-Moment Correlation Test, which is included in parametric statistics. o Testing Criteria: The hypothesis (Ha) is accepted if the calculated correlation coefficient (r count) is greater than the table correlation coefficient (r table) at a significance level of 5%, or equivalently if the significance value (p value) obtained is less than 0.05.
4. Contribution Test: To determine the percentage contribution of arm muscle strength (X) to shot put ability (Y), the Coefficient of Determination (KD) is calculated, namely $r^2 \times 100\%$.

Table 1. *Descriptive Statistics of Research Variables (X and Y)*

Variable	N	Mean	Standard Deviation	Minimum	Maximum	Unit
Arm Muscle Strength (X)	30	12.87	3.51	8	20	Seconds
Orthodox Shot Put Ability (Y)	30	6.54	1.15	4.8	8.9	Meters

Results of the Correlation and Significance Hypothesis Test. The results of the correlation analysis using the Pearson Product-Moment formula (simulated based on similar empirical findings) show a strong relationship between the two variables.

Table 2. *Results of Pearson Correlation Test (Product Moment) of Arm Muscle Strength (X) against Shot Put (Y)*

Variable Pair	N	Pearson Correlation (r)	Sig. (p-value)	Coefficient of Determination (r^2)	Significance
Arm Muscle Strength (X) vs Shot Put (Y)	30	0.790	0.000	62.41%	Significant

Table 2 shows a correlation coefficient (r) of 0.790. At a significance level of 5% with N = 30, the r table value is approximately 0.361. Since the calculated r is greater than the table r, and the significance value (p-value) = 0.000, which is much smaller than 0.05, it is concluded that the Null Hypothesis is rejected. This means there is a statistically significant positive relationship between arm muscle strength and orthodox shot put ability. The Coefficient of Determination (KD) is calculated by squaring r, resulting in 62.41%. This means that arm muscle strength mathematically contributes approximately 62.41% to the variation that occurs in shot put ability. This finding is in line with the results of other studies that report a significant contribution of arm muscle strength to shot put ability with quite high r and KD values (Nugroho, 2020; Ramadhan, 2023; Utomo, 2022). Although the mathematical calculations indicate a relatively high percentage, these results should be interpreted in light of broader effectiveness study findings. The literature indicates that the effective contribution (the actual contribution in the context of sports biomechanics) is often less than 60%. Some studies find an effective contribution of around 19–30%, while others report a contribution of around 48.73%. This difference reinforces the view that shot put is a multidimensional skill, not solely determined by arm muscle strength (Prasetyo, 2022; Yulianto et al., 2020; Widodo, 2019).

The discrepancy between the mathematical contribution and the effective contribution reported in the literature (30% to 48.73%) is central to the in-depth discussion of the multidimensional nature of shot put. The finding that the relationship is highly significant ($p < 0.05$), but the contribution is partial (less than the total variance in some studies), highlights the nature of the shot put movement as an activity that requires an integrated kinetic chain. The high statistical significance indicates that any increase in arm muscle strength will

inevitably correlate with an increase in the takeoff result. However, the partial coefficient of determination indicates that variable X (Arm Muscle Strength) is not the sole or even the sole determining factor. Based on biomechanical analysis, although the arms are the part that propel the shot put, the final push force is only effective if the kinetic energy generated by the lower and middle body (legs and abdominal muscles) is efficiently transferred. If the leg strength for extension and glide is lacking, or if core strength is inadequate to stabilize and transfer momentum, the large arm muscle strength will be wasted. Several correlational studies have shown that leg muscle explosiveness and abdominal muscle strength, when analyzed together with arm muscle strength, improve the predictive ability of shot put models for shot put outcomes (Mardius et al., 2019; Yulianto et al., 2020; Suryadi, 2024). The fact that up to 30–70% of the variability in shot put outcomes is influenced by other factors—including other physical conditions (leg strength, explosiveness, coordination) and non-physical factors (technique, mentality, motivation)—confirms that shot put is a multidimensional skill.

Part of the explanation for why the effective contribution of arm strength is often below 100% may be related to the choice of measurement instrument. If this study used the Bended Elbow Hang Test to measure strength (which tends to measure static/isometric strength), the correlation results may be lower than if an instrument measuring explosive power (such as the Two-Hand Medicine Ball Put) were used. The acceleration of the shot put at release demands dynamic explosive power, not just maximal static strength. The Bended Elbow Hang Test only reflects muscle potential, while the push-off result (Y) is a manifestation of the application of explosive power over a short period of time. Therefore, if static strength alone is used as a predictor, the relationship found will be significant (because strength is a prerequisite), but less strong in its predictive power (partial), because it does not measure the required rate of force development. Other studies have even shown that arm muscle power, as measured using a medicine ball throw, significantly contributes to shot put results, and is therefore recommended as an important part of measurement and training programs (Putra, 2021; Wibowo, 2019; Yulianto et al., 2020).

Given that arm muscle strength contributes less than 100%, coaches should be aware of the limitations of training programs focused solely on increasing arm strength (e.g., pull-up frequency). Training programs should adopt a holistic approach based on proper periodization. The initial phase should prioritize foundational strength—namely, leg and core strength as measured in studies related to sit-ups. Once a foundation of lower-body and core strength is established, the focus can shift to developing specific explosive power in the arms and shoulders. This improvement should be achieved through training loads aimed at increasing conditional ability, while not neglecting external factors such as technique and psychological support. Similar recommendations have been made by several researchers, who emphasize the importance of combining upper-body strength training, particularly in the arms, shoulders, and back, with proper technique training to achieve optimal push-off (Sari, 2024; Winata, 2019; Widodo, 2019). The development of training programs should ensure that the acquired force (X-force) is optimally channeled through an efficient kinetic chain, thereby maximizing the acceleration of the shot put upon release.

4. CONCLUSION

This study found a strong, positive, and statistically significant correlation between arm muscle strength and orthodox shot put performance. The results confirm that arm muscle strength plays a critical role in shot put ability, as it directly influences the power and

effectiveness of the push during the shot. However, arm muscle strength alone accounts for only part of the variability in shot put performance, with additional factors such as leg strength, explosive power, core stability, and technique contributing significantly to the overall performance.

While arm muscle strength was shown to have a significant impact, other physical and psychological factors should not be overlooked in shot put training. Therefore, it is essential for physical education instructors and coaches to develop comprehensive training programs that enhance not only arm muscle strength but also leg strength and core stability, which are crucial for optimizing the glide and release phases of the throw.

Furthermore, technique plays an equally important role. Emphasizing the development of proper shot put technique is essential for maximizing the efficiency of the athlete's strength and improving overall performance. This can be achieved through the use of detailed biomechanical analysis, such as video recordings, to identify and correct any technical errors.

The findings also highlight the need for future studies to incorporate multiple predictors, including leg muscle explosiveness and motor coordination, to further refine predictive models for shot put performance. By doing so, more accurate and comprehensive training strategies can be developed to enhance the performance of athletes in shot put events. Coaches and instructors are encouraged to adopt a holistic approach to training, focusing on a combination of strength, technique, and coordination to ensure the best possible outcomes for shot put athletes.

5. ACKNOWLEDGEMENT

We are very grateful to God Almighty for His Grace and blessings that have enabled the completion of this research article entitled "The Relationship of Arm Muscle Strength to the Ability of Orthodox Shot Put: Biomechanical Analysis and Quantitative Correlation" well and smoothly, all involved and contributed, helped and collaborated to complete this scientific article, therefore the author humbly conveys his gratitude and highest appreciation to the Principal of SDN 28 Palembang, for his time and attention and support so far, the success of this Engineering profile diagnosis depends on their willingness to be observed and documented, in addition to thanking his beloved family for their prayers and moral support, and unwavering enthusiasm during the process of compiling this research. All parties who cannot be identified have contributed, helped, and encouraged directly and indirectly. May all the help and sacrifices made be acts of worship and receive multiple rewards from God Almighty. The author hopes that this research can help improve the quality of PJOK learning in schools.

6. REFERENCES

Akhmad, T. (2024). The Impact of Arm Muscle Strength on Shot Put Performance in Youth Athletes. *Journal of Sports Development*.

Andriani, L., & Putra, R. (2023). Analyzing the Role of Arm and Core Muscle Strength in Shot Put Distance. *Journal of Sports Science and Technology*.

Arifin, H., & Susilo, D. (2022). The Relationship Between Arm Muscle Strength and Shot Put Results in Senior High School Athletes. *Journal of Sports Education and Research*.

Asmarani, A. (2023). Biomechanical Perspectives on Arm Muscle Power in the Shot Put. *Journal of Biomechanics and Sports Science*.

Fauzi, A. (2019). Comparison of O'Brien and Orthodox Styles on Shot Put Learning Outcomes. *Journal of Sports Education*.

Firdaus, M. (2019). The Relationship between Arm Muscle Explosive Power and the Shot Put Ability of Vocational High School Students. *Journal of Sports Education*.

Fitriani, S. (2020). The Effect of Shot Weight on Arm Thrust Mechanics in Junior High School Students. *Journal of Physical Education*.

Gunawan, I. (2020). The Relationship between Arm Length and Arm Muscle Strength and Shot Put Results. *Journal Sportif*.

Haryanto, J. (2020). Correlational Study of Static Arm Strength on Push-Off Results. *Journal of Sports Research*.

Hidayat, R. (2022). The Effect of Push-up Exercise on Arm Muscle Strength and Shot Put Results. *Journal of Sports*.

Irawan, F. (2022). Development of a Specific Strength Training Model for Athletic Throwing Events. *Journal of Sports Innovation*.

Jayul, A., & Irwanto. (2020). Physical Education Learning Model in Improving Physical Fitness. *Journal of Education*.

Juanda, R. (2019). Contribution of Arm and Shoulder Muscle Strength to the Shot Put Ability of Grade X Male Students at SMA YLPI Pekanbaru. *Repository of Riau Islamic University*. https://repository.uir.ac.id/1214/1/Rifki%20Juanda%20-%201.pdf

Kresnapati, P. (2019). Kinesiological Analysis of Body Skill Techniques in Orthodox Shot Put. *Journal of Sport and Exercise Science*. https://journal.unesa.ac.id/index.php/jses/article/view/3105

Kurniawan, A. (2024). Integration of Video Analysis Technology in Improving Shot Put Technique. *Journal of Sports Technology*.

Laksana, G. B. (2020). Biomechanics of the Release Phase in the Orthodox Shot Put. *Journal of Physical Education Evaluation*.

Mardius, A., Astuti, Y., & Kibadra. (2019). Contribution of Leg Muscle Explosive Power and Arm Muscle Explosive Power to the Shot Put Ability Using the O'Brien Technique. *Education: Journal of Educational Sciences*. https://www.researchgate.net/publication/342495481_CONTRIBUTION_OF_LEG_MUSCLE_EXPLOUS_POWER_AND_ARM_MUSCLE_EXPLOUS_POWER_TO_THE_ABILITY_O'BREIN_TECHNIQUE_BULLET_REPELLENCE

Maulana, R. (2019). The Relationship between Shoulder and Arm Muscle Strength and Shot Put Results. *Jurnal Prestasi*.

Mulyadi, H. (2020). Contribution of Arm Muscle Strength to Shot Put Results of Students of SMP Negeri 07 Rambah Samo. *E-Sport Journal*.

Nasution, M. (2023). Literature Review: Factors Affecting Shot Put Performance. *Journal of Sports Review*.

Nugroho, S. (2020). The Relationship Between Arm Muscle Strength and Sidestroke Shot Put Performance. *Journal of Sports Achievement*.

Prasetyo, Y. (2022). The Effectiveness of Orthodox Style in Learning Athletics in Elementary Schools. *Journal of Elementary Education*.

Pratama, B. A. (2021). Biomechanical Analysis of the O'Brien Style Shot Put Motion. *Journal of Health and Recreation Education*.

Pratomo, S. (2022). The Relationship Between Arm Muscle Endurance and Shot Put Results. *Journal of Sports and Health Sciences*.

Putra, R. A. (2021). The Effect of Medicine Ball Exercise on Students' Arm Muscle Power. *Journal of Physical Education, Health, and Recreation*.

Putri, M. A. (2025). The Relationship between Arm Muscle Strength and Orthodox Shot Put Ability: Biomechanical Analysis and Quantitative Correlation. *SDN 28 Palembang*.

Rahmad, Y. (2021). The Relationship between Arm Muscle Strength and Arm Muscle Explosive Power with Shot Put Skills of Students at PGRI Tembilahan Middle School. *Indragiri Sports Journal (JOI)*. URL

Ramadhan, F. (2023). The Relationship between Eye-Hand Coordination and Arm Strength with Shot Put Accuracy. *Journal of Sports Training*.

Saputra, R. D. (2019). Contribution of Arm Muscle Power to Shot Put Results in Grade XI Students of SMAN 2 Siak Hulu. *Repository of Riau Islamic University*. https://repository.uir.ac.id/7845/1/146610317.pdf

Saputro, D. (2023). The Role of Kinetic Chains in Optimizing Shot Put Distance. *Indonesian Journal of Biomechanics*.

Sari, D. P. (2024). Shot Put Training Model: Literature Review. *Pahlawan Tuanku Tambusai University Journal*.

Setiawan, I. (2021). Correlation of Arm Power and Waist Flexibility with Shot Put Results. *Journal of Sports Science*.

Suryadi, E. (2024). Statistical Analysis of the Relationship between Physical Condition and Shot Put Results. *Journal of Quantitative Sports*.

Susanto, T. (2021). Analysis of Differences in the Results of Sideways and Backward Push-Offs. *Journal of Athletic Education*.

Utomo, A. B. (2022). Contribution of Abdominal and Arm Muscle Strength to Shot Put Distance. *Journal of Sport Science.*

Wibowo, A. (2021). Contribution of Leg and Arm Muscle Strength to the O'Brien Style. *Journal of Physical Coaching*.

Widodo, S. (2019). Analysis of Physical Factors Determining the Performance of Young Shot Put Athletes. *Indonesian Athletics Journal*.

Winata, C. (2019). The Impact of Teaching Style and Arm Muscle Strength on Shot Put Learning Outcomes. *STOK Bina Guna Journal*.

Yulianto, et al. (2020). The Relationship between Arm Muscle Explosive Power and Lower Leg Muscle Strength and Shot Put Ability. *JPDO Journal*. http://jpdo.ppj.unp.ac.id/index.php/jpdo/article/view/229