INDONESIAN JOURNAL OF SPORT MANAGEMENT
Department of Physical Education, Universitas Majalengka, Indonesia
ISSN 2776-706X.

Optimizing Accurate Smashes through Strengthening Arm Muscles in Badminton

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ABSTRACT

One of the most decisive techniques in badminton is the smash which is used to score points by hitting the shuttlecock powerfully and accurately towards the opponent's court. This study aims to determine the extent to which arm muscle strengthening can optimize smash accuracy in badminton games. The population in this study were all 719 students of SMA Negeri 1 Gu. The research sample consisted of 33 male students who were selected purposively with the criteria of having basic badminton playing skills. The instruments used included a push-up test to measure arm muscle strength and a smash accuracy test. Data analysis was carried out using the Pearson correlation test with the help of SPSS 25 software. The results of the analysis showed a significant positive relationship between arm muscle strength and smash accuracy, with a correlation coefficient (r) of 0.685 and a significance of 0.001 ($p < 0.05$). Based on the interpretation of the correlation map, the relationship between the two variables is in the strong category. The contribution of arm muscle strength to smash accuracy is 46.9%, while the remaining 53.1% is influenced by other physical condition factors such as flexibility, balance, coordination, strength, explosive power, and speed. The study shows that strengthening arm muscles significantly contributes to increasing smash accuracy in badminton. Recommendations for further research, it is recommended to examine the effect of a combination of arm muscle strengthening and specific technique training on overall smash performance and apply this method to various age groups or different skill levels for more general results.

Keywords: Smash; arm muscles; badminton

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Article History:

Submitted: April, 2025
Accepted: May, 2025
Published: May, 2025

Authors' contribution:

A) Conception and design of the study;
B) Acquisition of data;
C) Analysis and interpretation of data;
D) Manuscript preparation;
E) Obtaining funding.

Cite this article:

Hardin, Anugrah, O., Jimrif, F., Mursiddin, <., Pattawe, I., & Ihwal. (2025). Optimizing Accurate Smashes through Strengthening Arm Muscles in Badminton. *Indonesian Journal of Sport Management*, *Vol.* 5(2), 406-416. https://doi.org/10.31949/ijsm.v5i2.15255

INTRODUCTION

Badminton is a popular sport that demands technical skills, speed, agility, and physical strength (Arisman et al., 2018; Suratman et al., 2024; Ramasamy et al., 2021). Among the various basic techniques in badminton, the smash is one of the most decisive attacking techniques in winning a match (Gustaman, 2019; Purnama et al., 2024; Gümüş et al., 2024). An accurate and powerful smash can be a primary weapon in pressuring opponents and scoring points directly (E. S. I. Putra, 2024). Therefore, mastering optimal smash techniques is very important for every player, especially at the student level who are in the skill development phase. However, many students still have inaccurate smash techniques, even though they have technically learned the basic badminton movements (Zharifah, 2024). This can be caused by various factors, one of which is physical condition, especially arm muscle strength. In smashing, arm muscles play a crucial role in generating power and

accuracy. Therefore, it stands to reason that increasing arm muscle strength can directly impact a player's smash quality (Ahyar et al., 2024). Therefore, more focused research is needed to determine the extent to which arm muscle strength contributes to smash accuracy, in order to provide an empirical basis for developing more targeted training programs (Yuliawan, 2017).

Physiologically, muscle strength is a key component of physical condition that significantly influences sports movements, including badminton. According to Marani & Subarkah, (2023), muscle strength is the ability of a muscle or group of muscles to overcome resistance or exert pressure against a load. In the context of badminton smashing, arm muscle strength plays a central role in producing explosive yet controlled hitting power. The smashing movement involves coordination between the shoulder, upper arm, forearm, and wrist muscles. According to biomechanical theory, the stronger the muscles, the greater the kinetic energy that can be transferred to the shuttlecock, thus allowing the shot to be faster and more precise Surahman et al., (2019), In addition, from a motor skills perspective, good strength allows players to maintain stable movements and increase precision in directing the shuttlecock to the desired area.

Several previous studies have examined the relationship between arm muscle strength and hitting performance in badminton. Research conducted by Koloway et al., (2021) showed that arm muscle strength significantly influences smashing ability in beginner-level badminton athletes. These results align with the findings of Pramudia et al., (2025), who stated that arm muscle strength training can improve explosive power and hitting accuracy in young players. Meanwhile, research by Althapizen et al., (2025) found that arm muscle strength is not the only factor influencing smash accuracy; it is also influenced by balance, hand-eye coordination, and flexibility. This means that arm muscle strengthening must be supported by other physical condition components to achieve optimal results in smash accuracy. However, most previous studies have focused more on general strength aspects, without quantitatively linking it to smash accuracy using measurable correlation test methods. Therefore, more specific and systematic further research is needed to quantify the relationship between arm muscle strength and smash accuracy using an accurate statistical approach (Parmadi & Kurniawan, 2025).

The novelty of this study lies in its quantitative approach, directly measuring the relationship between arm muscle strength and smash accuracy using valid and reliable instruments. Unlike previous studies that only used qualitative observations or general strength measurements, this study employed a push-up test as an indicator of arm muscle strength and a smash accuracy test to measure technical performance. Furthermore, this study was conducted on a population of high school students, a population not widely explored in similar research. Focusing on male students with basic badminton skills provides a new perspective in the context of sports development at the school level, particularly in developing targeted training programs based on scientific evidence. The primary objective of this study was to determine the extent to which arm muscle strengthening can optimize smash accuracy in badminton. This research is expected to contribute scientifically to the development of sports training theory and practice, particularly in badminton. Theoretically, the results of this study can enrich the literature on the influence of muscle strength on sports technical performance. The finding of a significant correlation between arm muscle strength and smash accuracy can also serve as a basis for developing more targeted training models.

METHOD

Data analysis techniques explain how the collected data were processed and analyzed. The author can include statistical techniques, thematic analysis, or other methods, depending on the type of research conducted. This explanation is essential to ensure that the interpretation of the research results can be justified. These elements can be arranged into subsections for clarity and order, each with a specific subheading. Subheadings do not need to be numbered but should be written in lowercase, starting with a capital letter at the beginning and italicized. This format ensures that readers can easily follow the structure of the research methods presented. Particularly for qualitative research, it is necessary to clearly state the time and place of the research (for quantitative research it is also necessary). Research targets / subjects (for qualitative research) or populations (for quantitative research) need to be described clearly in this section. It is also necessary to write down the techniques for obtaining the subject (qualitative research) and / or the sampling technique (quantitative research).

This study used a quantitative approach with a correlational method to determine the extent to which arm muscle strengthening can optimize smash accuracy in badminton. The research design used was the Pearson Product Moment correlation, as it aimed to statistically test the closeness of the relationship between two variables. The study was conducted from April 10th to 11th, 2025, at SMA Negeri 1 Gu, Central Buton, Southeast Sulawesi. The target of this study was all 719 students of SMA Negeri 1 Gu, and a purposive sampling method was used to select 33 male students with basic badminton skills. This sampling was based on population characteristics relevant to the research objectives.

This study used a quantitative approach with a correlational method to determine the relationship between arm muscle strength and smash accuracy in badminton. The research procedure was carried out through the following steps: determining the research sample, for example, badminton club students or students who actively play badminton, based on certain criteria. Prepare arm muscle strength measuring instruments (such as push-up tests or dynamometers) and smash accuracy tests. Measure each subject's arm muscle strength and smash accuracy individually. Record all test results and input the data into statistical software for analysis. Use statistical correlation tests to determine the relationship between arm muscle strength and smash accuracy. Interpret the analysis results to draw conclusions about whether there is a significant relationship and compile a systematic research report.

The instruments used consist of two tests: a 60-second push-up test to measure arm muscle strength (Saiful, 2021), and a 20-hit smash accuracy test to assess smash accuracy into specific target areas. Both tests have standardized procedures and a measurable scoring system (Asnaldi, 2020). Arm muscle strength is measured using a push-up test, which measures the strength and endurance of the arm and shoulder muscles. The test subject lies face down with the head, back, and legs straight. Both palms rest on the floor beside the chest, with the fingers pointing forward. The soles of the feet are close together, with the toes resting on the floor. When prone, only the chest touches the floor, while the head, abdomen, and lower legs are raised. From the prone position, lift the body by straightening both arms, then lower the body by bending both arms so that the chest touches the floor. Each time the body is raised and lowered, the head, back, and legs remain straight. Scoring is calculated based on each lift. The prone body lift is performed as many times as possible within 60 seconds. The execution is considered correct if the

body is straight when the body is lifted, the head, back, and legs are straight. Testees who fail to perform this position are deemed to have failed and are awarded a score of zero (0).

The purpose of the smash accuracy test is to measure the testee's level of accuracy and precision in executing smashes. Before the test begins, players are given an explanation and examples of the test, which consist of two attempts at a straight smash and a cross smash, before proceeding to the test. Each time the testee performs a smash, the official records the results according to the shuttlecock's landing on the table. The testee positions the shuttlecock in a predetermined position. The tester tosses the shuttlecock backward, and the testee moves backward to smash, returning the shuttlecock to its original position. The testee smashes after being served a long forehand. After receiving the pass, the testee smashes. The target is aimed from the right to the opponent's right and from the left to the opponent's left, provided the target areas have the same value. Smashes that land in the target area or above the back line of the long service line for singles are considered valid and receive a score of 5. Smashes that land outside the target area or outside the court receive a score of 0 (zero). The data obtained were analyzed using SPSS version 25, following the following steps: normality test, linearity test, and hypothesis testing. The normality test was performed using the Kolmogorov-Smirnov method, while the linearity test used ANOVA. The Pearson correlation test was used to determine the relationship between arm muscle strength and smash accuracy. Correlation test results.

RESULTS AND DISCUSSION

Based on the results of measurements of arm muscle strength and smash accuracy conducted on students of SMA Negeri 1 Gu, a number of descriptive data were obtained, including the lowest (minimum) value, the highest (maximum) value, the average (mean), and the standard deviation (standard deviation) for each variable. This information provides an initial overview of the distribution and trends of the data for the two variables studied. To see the details of these results in a more structured manner, please refer to Table 1 below.

Table 1. Descriptive statistics of arm muscle strength and accuracy of badminton smash

Variable	Mean	Standard deviation	Maximum value	Minimum value
X	22,70	3,331	28	17
Y	27,15	3,104	33	22

Based on the data in Table 1, the average (mean) value of arm muscle strength (variable X) was 22.70 with a standard deviation of 3.331, indicating that most students had moderate to strong arm muscle strength. The minimum value of 17 and the maximum value of 28 reflect the varying range of abilities between individuals. Meanwhile, smash accuracy (variable Y) had an average of 27.15 with a standard deviation of 3.104, indicating that most students showed a fairly good level of smash accuracy. The minimum value of 22 and the maximum value of 33 indicate differences in individual technical abilities in executing smashes accurately. In general, these descriptive data indicate a tendency that the higher the arm muscle strength, the better the smash accuracy produced by students.

Table 2. Distribution of interval classes, frequency and percentage of arm muscle strength data

Class Interval	Frequency	Percentage
17-18	5	15,15%
19-20	4	12,12%

21-22	8	24,24%
23-24	6	18,18%
25-26	5	15,15%
27-28	5	15,15%
Total	33	100%

T Table 2 shows the distribution of students' arm muscle strength based on class interval, frequency, and percentage. The 21–22 interval had the highest frequency of 8 students (24.24%), indicating that most students were at a moderate level of arm muscle strength. This is followed by the 23–24 interval with 6 students (18.18%), while the 19–20 interval has the lowest frequency of 4 students (12.12%). This distribution shows that the majority of students have arm muscle strength in the moderate to high range, while only a small number of students are in the low strength category. This indicates that in general, students' physical abilities in terms of arm muscle strength are quite good and evenly distributed.

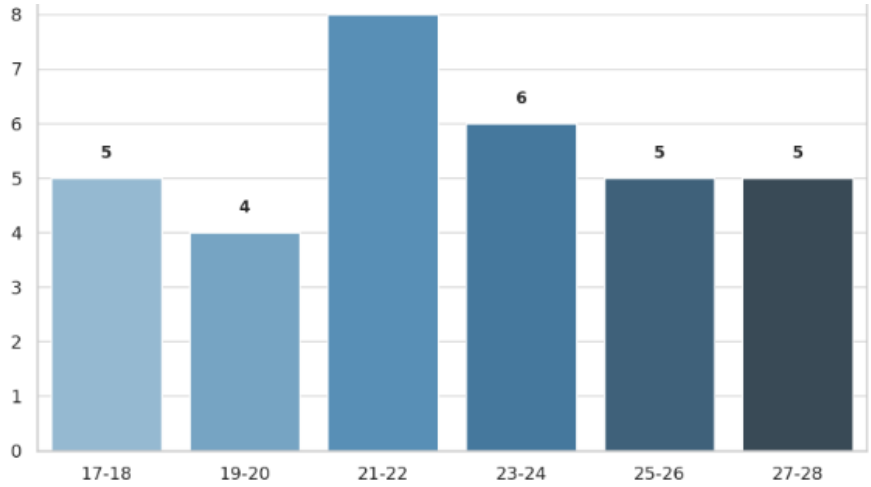

Figure 1. Histogram of the frequency distribution of arm muscle strength data

Table 3. Distribution of badminton-smash accuracy

Class Interval	Frequency	Percentage
22-23	5	15,15%
24-25	7	21,21%
26-27	5	15,15%
28-29	6	18,18%
30-31	8	24,24%
32-33	2	6,06%
Total	33	100%

Based on Table 3, the distribution of badminton smash accuracy shows that the majority of students are in the 30–31 interval class with the highest frequency of 8 students (24.24%), followed by the 24–25 class with 7 students (21.21%). Meanwhile, the lowest frequency is in the 32–33 interval, only 2 students (6.06%). This illustrates that most students have a fairly good level of smash accuracy, although there are still a small number who have very high accuracy or vice versa. For more clarity graphically, the frequency distribution of smash accuracy data can be seen in the following graph.

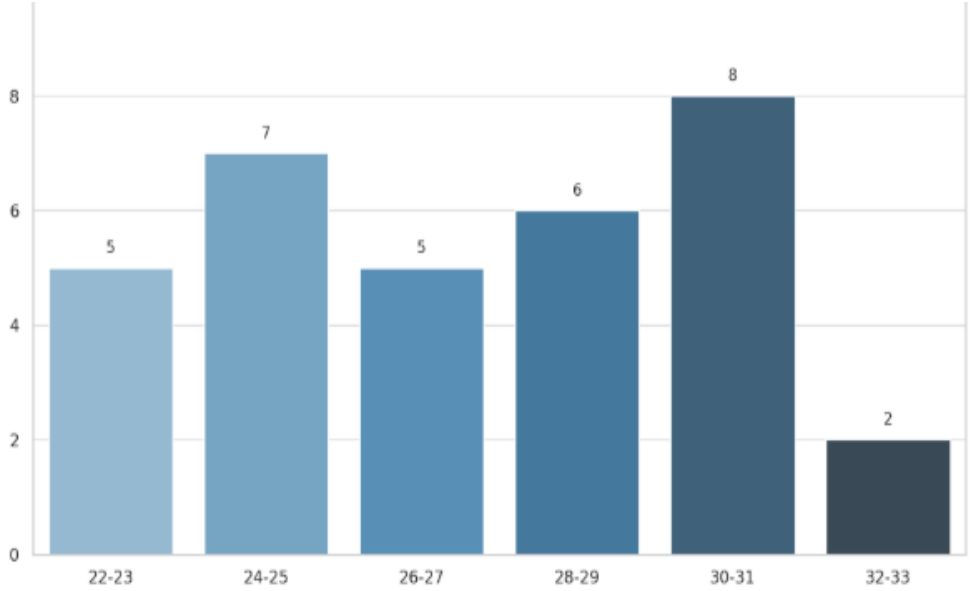

Figure 2. Histogram of the frequency distribution of smash accuracy data (Y)

Table 4. Normality test of arm muscle strength and, smash accuracy

Variable	*Sig*	*Asymp. Sig*	Conclusion
Arm muscle strength	0,05	0,200	Normal
Smash accuracy	0,05	0,200	Normal

Table 4 shows the results of the normality test for two variables, namely arm muscle strength (X) and smash accuracy (Y), using the Kolmogorov-Smirnov test. Based on the calculation results, the Asymp. Sig. value for both variables is 0.200, which is greater than the significance value of α = 0.05. This means that the data from both variables are normally distributed. Thus, it can be concluded that the data for the arm muscle strength and smash accuracy variables meet the assumption of normality. This is important because the normality test is a prerequisite in conducting parametric statistical analysis such as Pearson correlation or linear regression tests. Data normality provides a strong foundation for continuing further inferential analysis in a valid and reliable manner.

Table 5. Linearity test of arm muscle strength and accuracy of badminton smash

Variable	Significant	Conclusion
Arm muscle strength accuracy of smash	0,730	Linear

Table 5 presents the results of the linearity test between the variables of arm muscle strength (X) and smash accuracy (Y). Based on the analysis results, the significance value of 0.730 is greater than the significance level of α = 0.05, which means there is no deviation from the linear relationship between the two variables. Thus, it can be concluded that the relationship between arm muscle strength and smash accuracy is linear. These results indicate that greater arm muscle strength will proportionally affect the increase in accuracy in executing smashes in badminton. This provides a strong basis for continuing the analysis of the relationship or correlation between the two variables using parametric statistical methods.

Table 6. Correlation Test of Arm Muscle Strength with Badminton Smash Accuracy

Correlation type	*r Calculate*	*Sig* 0,05	*r square (Coefficient of determination)*	*Description*

X-Y	0,685	0,001	0,469	Significant

Table 6 shows the results of the correlation test between the variables of arm muscle strength (X) and smash accuracy (Y). The correlation coefficient (r count) of 0.685 indicates a strong and positive relationship between the two variables. This means that the greater the arm muscle strength, the higher the level of smash accuracy in badminton. The significance value of 0.001 is smaller than the significance level of 0.05, which means the relationship is statistically significant. Thus, it can be concluded that there is a real relationship between arm muscle strength and smash accuracy. In addition, the coefficient of determination (r^2) of 0.469 indicates that approximately 46.9% of the variation in smash accuracy can be explained by arm muscle strength. The remaining 53.1% is influenced by other factors outside the variables studied, such as technique, hand-eye coordination, playing experience, or the player's psychological condition. These results confirm that training that focuses on increasing arm muscle strength has great potential to improve smash performance, especially in terms of accuracy.

Discussion

Badminton demands a combination of speed, agility, technique, and physical strength. One crucial element of the game is the smash, the primary attacking shot used to score points (Hasanuddin & Zainuddin, 2024; Wea & Samri, 2022; Gómez et al., 2020). This study focuses on the relationship between arm muscle strength and smash accuracy, a crucial aspect of successful offensive play. The results show that arm muscle strength has a significant and positive relationship with smash accuracy. This relationship indicates that the higher a player's arm muscle strength, the better the accuracy of their smash (Schmidt et al., 2021; Putra & Lumintuarso, 2020). This finding directly addresses the research question: whether there is a significant relationship between arm muscle strength and smash accuracy in badminton. Theoretically, these results support the view of sports and physiology experts that muscle strength plays a crucial role in the effectiveness of hitting techniques. Biomechanical theory states that arm muscle strength is the primary source of power in the execution of overhead shots, including smashes. Strengthening the arm muscles contributes not only to shot speed but also to control and stability during the shot. This aligns with previous research by Kumesan, (2025), which stated that arm muscle strength significantly contributes to overhead shot performance in badminton.

Another study by Wijaya et al., (2025) also found that regular arm muscle strength training can improve shot accuracy in high school students. The findings of this study not only reinforce the results of previous studies but also provide a new contribution in the context of developing smash technique training with a greater focus on arm muscle strength. It is noteworthy that the focus on smash accuracy sets this study apart, given that many previous studies have focused solely on shot speed or power. In training practice, the results of this study offer important implications. Coaches and physical education teachers are advised to pay special attention to arm muscle strengthening programs, whether through light weight training, isometric exercises, or explosive exercises such as interval push-ups and resistance band training. Such training should be designed not only to increase muscle strength but also to integrate it with smash technique to achieve maximum shot accuracy. The strength of this study lies in its quantitative approach, complemented by tests for normality, linearity, and correlation, ensuring objective and statistically reliable analysis. Furthermore, this study used a sample from an

active badminton club, enhancing the external validity of the findings for application in real-world training settings. However, several limitations warrant consideration. First, this study used only one independent variable: arm muscle strength, while other variables that influence smash accuracy, such as eye-hand coordination, body balance, racket swing technique, and psychological factors, were not included in the analysis model. Second, the limited sample size and the fact that it was drawn from a single club require caution in generalizing the results. Furthermore, the method for measuring muscle strength and smash accuracy used an observational approach, so the possibility of measurement bias remains to be anticipated.

This study opens up opportunities for more comprehensive follow-up studies, such as using experimental methods to test the effectiveness of muscle strengthening training programs on smash accuracy, or using a mixed-method approach that combines quantitative and qualitative data from coaches and athletes. Furthermore, the development of more objective and digital instruments to precisely measure smash accuracy could be innovative in evaluating athlete performance. Overall, this research makes a significant contribution to the field of sports training, particularly in developing badminton hitting techniques. The findings underscore the importance of arm muscle strength as a key factor in achieving smash accuracy and provide a solid foundation for the development of more efficient, evidence-based training methods.

CONCLUSION

Based on the results of a correlational study conducted to examine the relationship between arm muscle strength and accurate smashing ability in badminton, it can be concluded that there is a positive and significant relationship between these variables. This finding indicates that the stronger a player's arm muscle strength, the higher their tendency to smash with optimal accuracy. Arm muscle strength plays a crucial role in producing a powerful, directed, and controlled shot, allowing the shuttlecock to be accurately directed to the opponent's target area. Smashing in badminton relies not only on power but also requires control and precision, both of which are directly influenced by the strength of key muscles such as the biceps, triceps, and shoulder muscles. During a smash, the arm muscles work synergistically to generate high racket swing speeds, accompanied by movement control to determine the direction of the shuttlecock's impact. Therefore, players with better arm muscle strength tend to have more stable coordination, allowing them to maintain smash accuracy even in dynamic playing conditions.

This study also demonstrates that arm muscle strengthening exercises not only increase power but are also closely related to improvements in technical skills such as shot accuracy. This is important for coaches and physical education teachers to consider when developing structured training programs tailored to athletes' needs. The focus of training should not only be on playing technique but also on developing physical conditioning that supports technical skills. Furthermore, the results of this study can be used as a reference in the development of young athletes, as proper muscle strengthening at this stage can lay a crucial foundation for mastering good badminton techniques in the future.

In a learning context, teachers can also utilize these findings to integrate arm muscle strengthening material into the physical education curriculum, particularly in sports like badminton. This way, students not only understand basic playing techniques but also gain firsthand experience of the importance of physical conditioning in supporting sports performance. This research theoretically reinforces the view in motor skills theory, which

states that complex movement abilities will be more effective when supported by adequate muscle strength components.

As a follow-up, this research opens up opportunities for broader exploration of the influence of other physical components on badminton technique. For example, future studies could examine the relationship between shoulder flexibility, reaction speed, or hand-eye coordination with badminton hitting ability. Further research could also utilize a more complex experimental design to determine the extent to which arm muscle strengthening exercises contribute to overall improvement in smash performance (including strength, speed, and accuracy). Therefore, the findings of this study are expected to contribute not only to theoretical development in sports education but also to have practical value in improving the quality of badminton training and learning at various levels.

AKCNKOWLWDGEMENT

Thank you to the Principal of SMA Negeri 1 Gu, the Physical Education and Health teachers, and the students who were the subjects of this research. We would like to thank all parties who have assisted in the research process until its completion.

CONFLICT OF INTEREST

There were no conflicts that occurred in this study.

REFERENCES

Ahyar, M., Solihin, A. O., & Syamsudar, B. (2024). Hubungan Kekuatan Otot Lengan Dan Power Tungkai Terhadap Ketepatan Smash Dalam Permainan Bulutangkis. *Jurnal Ilmiah Wahana Pendidikan*, *10*(10), 1067–1079. https://doi.org/10.5281/zenodo.11627937

Althapizen, F., Atradinal, A., & Arnando, M. (2025). Kontribusi Daya Ledak Otot Lengan Dan Kelentukan Terhadap Ketepatan Smash Dalam Cabang Olahraga Bulutangkis Atlet PB. Alba Badminton Rejang Lebong. *Jurnal JPDO*, *8*(1), 20–27. http://jpdo.ppj.unp.ac.id/index.php/jpdo/article/view/2119

Arisman, A., Saripin, S., & Vai, A. (2018). Hubungan kelentukan pergelangan tangan dan power otot lengan-bahu dengan hasil akurasi smash bulutangkis putra pada PB. Angkasa Pekanbaru. *Journal Of Sport Education (JOPE)*, *1*(1), 9–16. https://doi.org/10.31258/jope.1.1.9-16

Asnaldi, A. (2020). Hubungan Kelentukan dan Daya Ledak Otot Lengan Terhadap Ketepatan Smash Bolavoli. *Physical Activity Journal (PAJU)*, *1*(2), 160–175. https://doi.org/10.20884/1.paju.2020.1.2.2556

Gómez, M., Rivas, F., Leicht, A. S., & Buldú, J. M. (2020). Using network science to unveil badminton performance patterns. *Chaos, Solitons & Fractals*, *135*, 109834. https://doi.org/10.1016/j.chaos.2020.109834

Gümüş, M., UDUM, Y., SUVEREN ERDOĞAN, C., & ÇAKIR, V. (2024). Do Isokinetic Strength and Shoulder Mobility Influence Ball Velocity? A Study of Female Badminton Players. *International Journal of Religion*, *5*(5). https://doi.org/10.61707/jfxr3c06

Gustaman, G. P. (2019). Hubungan Footwork, Kekuatan Otot Tungkai Dan Tinggi Lompatan

Terhadap Kemampuan Smash Bulutangkis. *JUARA: Jurnal Olahraga*, *4*(1), 1–8. https://doi.org/10.33222/juara.v4i1.512

Hasanuddin, M. I., & Zainuddin, M. S. (2024). Analisis Tingkat Keberhasilan Servis Pendek Forehand Dalam Permainan Bulutangkis. *Jurnal Dunia Pendidikan*, *4*(3), 1471–1480. https://doi.org/10.55081/jurdip.v4i3.2101

Koloway, C. B. G., Runtuwene, J., & Langi, F. L. F. G. (2021). Kekuatan Otot Perut, Daya Ledak Otot Lengan, Tinggi Lompatan dan Hasil Pukulan Smash Penuh pada Atlet Bulutangkis. *Sam Ratulangi Journal of Public Health*, *2*(1), 22–31. https://doi.org/10.35801/srjoph.v2i1.33887

Kumesan, S. S. (2025). Hubungan Antara Kekuatan Otot Lengan Dengan Kemampuan Servis Panjang Dalam Permainan Bulu Tangkis Pada Peserta Didik SMP Negeri 2 Tondano. *VitaMedica: Jurnal Rumpun Kesehatan Umum*, *3*(3), 129–132. https://doi.org/10.62027/vitamedica.v3i3.391

Marani, I. N., & Subarkah, A. (2023). Pengaruh Kelentukan Togok, Koordinasi Dan Power Otot Lengan Terhadap Hasil Pukulan Smash Pada Olahraga Bulutangkis. *Jurnal MensSana*, *8*(2), 96–102. https://doi.org/10.24036/MensSana.08022023.13

Parmadi, M., & Kurniawan, A. S. (2025). Akurasi Pukulan Smash pada Atlet Bulutangkis Pb Talenta Kebumen Menggunakan Metode Drill Usia 9-12 Tahun: Penelitian. *Jurnal Pengabdian Masyarakat Dan Riset Pendidikan*, *3*(4), 2610–2616. https://doi.org/10.31004/jerkin.v3i4.977

Pramudia, H., Sulastio, A., & Hidayat, H. (2025). Hubungan Power Otot Lengan Dan Fleksibilitas Pergelangan Tangan Dengan Akurasi Forhand Smash Bulu Tangkis Pada Siswa Ekstrakurikuler SMA Negeri 1 Kuantan Hilir. *Jurnal Dunia Pendidikan*, *5*(5), 1990–2005. https://doi.org/10.55081/jurdip.v5i5.3860

Purnama, A. R., Kusdinar, Y., & Kardjono, K. (2024). The Relationship Between Wrist Flexibility and Arm Muscle Strength with the Accuracy and Speed of Smash for Badminton Athletes Universitas Pendidikan Indonesia (UPI). *Journal of Physical Education Health and Sport*, *11*(2), 75–78. https://doi.org/10.15294/jpehs.v11i2.18563

Putra, E. S. I. (2024). Kontribusi Kelentukan Pergelangan Tangan dan Daya Ledak Otot Tungkai Terhadap Hasil Smash Forehand Bulutangkis Atlet PB. Tamvan. *JOI (Jurnal Olahraga Indragiri): Olahraga, Pendidikan, Kesehatan, Rekreasi*, *8*(2), 125–134. https://doi.org/10.61672/joi.v8i2.2816

Putra, G. E., & Lumintuarso, R. (2020). What is the biomechanical principle of forehand smash in badminton? Article review. *Fizičko Vaspitanje i Sport Kroz Vekove*, *7*(2), 221–229. https://doi.org/10.2478/spes-2020-0018

Ramasamy, Y., Usman, J., Sundar, V., Towler, H., & King, M. (2021). Kinetic and kinematic determinants of shuttlecock speed in the forehand jump smash performed by elite male Malaysian badminton players. *Sports Biomechanics*, 1–16.

Saiful. (2021). *Tes dan Pengukuran dalam Olahraga*. UD Al Hasanah.

Schmidt, S. V., Engelhardt, J. A., Cools, A., Magnusson, S. P., & Couppé, C. (2021). Acromio-humeral distance is associated with shoulder external strength in national elite badminton players—A preliminary study. *Sports*, *9*(4), 48.

https://doi.org/10.3390/sports9040048

Surahman, F., Yeni, H. O., & Sanusi, R. (2019). Hubungan Daya Ledak Otot Lengan dan Kelentukan Pinggang dengan Kemampuan Smash Bulutangkis pada Ekstrakurikuler Siswa Sma N 2 Karimun. *Jurnal Minda*, *1*(1), 42–53. https://www.ejurnal.universitaskarimun.ac.id/index.php/mindafkip/article/view/18

Suratman, S., Nasution, M., Romadhoni, S., & Elliana, D. (2024). Meningkatkan Kelincahan dan Kecepatan Pemain Bulutangkis Menggunakan Skipping Rope dan Shuttle Run. *Journal of Sport Coaching and Physical Education*, 9(1), 98–104. https://journal.unnes.ac.id/journals/jscpe/article/view/6879

Wea, Y. M., & Samri, F. (2022). Pengaruh Latihan Plyometric Depth Jump Terhadap Kemampuan Melakukan Jumping Smash Dalam Permainan Bulutangkis. *Jurnal Penjakora*, 9(1). https://doi.org/10.23887/penjakora.v9i1.45977

Wijaya, S. F., Simanjuntak, V. G., & Yanti, N. (2025). Hubungan Kekuatan Otot Lengan Terhadap Servis Panjang Dalam Permainan Bulutangkis Pada Atlet Pemula Putra PB Camp 43 Pontianak. *Jurnal Dunia Pendidikan*, 5(5), 1523–1534. https://doi.org/10.55081/jurdip.v5i5.3774

Yuliawan, D. (2017). Hubungan Kekuatan Otot Lengan Dan Kelentukan Pergelangan Tangan Dengan Ketepatan Smash Penuh Dalam Permainan Bulutangkis. *Motion: Jurnal Riset Physical Education*, *8*(1), 13–26. https://doi.org/10.33558/motion.v8i1.438

Zharifah, F. (2024). Hubungan Kekuatan Otot Lengan dan Koordinasi Mata Tangan Dengan Kemampuan Smash Bulutangkis Siswa MAN 4 Pasaman Barat. *Jurnal JPDO*, *7*(4). https://doi.org/10.24036/JPDO.7.4.2024.94