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The Effect Of Arm Muscle Strength Training On Badminton Smash Hit Ability In Athletes Aged 13-16 Years By PB Daun Muda Banjarbaru

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ABSTRACT

Smash is one of the most decisive and powerful techniques in badminton, requiring a combination of strength, speed, and precision to successfully score points. Among the physical attributes essential for an effective smash, arm muscle strength plays a critical role, particularly in generating explosive force during overhead strokes. This study aims to examine the effect of tricep dip training on the smash ability of badminton athletes aged 13–16 years at PB Daun Muda Banjarbaru. Utilising a quasi-experimental method with a pretest-posttest control group design, 20 athletes were divided into two groups: an experimental group that received a six-week tricep dip training intervention and a control group that followed their regular training regimen without specific arm strength exercises. Pre- and post-tests were conducted to assess improvements in smash ability, and data were analysed using the Paired Sample T-Test in SPSS version 23. The analysis revealed a statistically significant improvement in the experimental group's smash performance, with a p-value of 0.000 (<0.05), indicating the effectiveness of the tricep dip intervention. No significant improvement was observed in the control group. These findings suggest that targeted arm muscle strength training, particularly tricep dips, can significantly enhance the performance of smash shots in young badminton players. The results also highlight the importance of incorporating structured strength training programs into youth athlete development models to optimise skill acquisition and performance outcomes.

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A. Conception and design of the study;
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INTRODUCTION

Badminton is a highly dynamic sport that requires a combination of technical proficiency, tactical intelligence, psychological resilience, and above all, optimal physical conditioning. Among the various strokes in badminton, the smash hit is considered the most aggressive and effective technique to win points, often described as the "finishing blow" in competitive play (Phomsoupha & Laffaye, 2015). The biomechanics of the badminton smash involves complex coordination between the legs,

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core, and upper limbs—particularly the arm and shoulder muscles, which generate explosive power and speed (Gowitzke & Waddell, 2016). This explosive action is crucial not only in elite adult performance but also during the critical phase of motor development in adolescent athletes.

As youth participation in badminton increases globally and in Indonesia, scientific attention has shifted towards identifying training methods that can effectively enhance specific skills in young athletes (Abdullah et al., 2020). In this context, strength training—especially arm muscle strength training—has emerged as a vital component of conditioning programs tailored to improve hitting power, control, and technique in young badminton players (Liu et al., 2022).

Arm muscle strength, particularly in the deltoids, biceps, triceps, and forearm flexors, plays a pivotal role in executing an effective smash in badminton (Raza et al., 2021). This type of shot involves not only brute force but also rapid muscular contraction, joint flexibility, and neuromuscular coordination. At the age of 13–16 years, young athletes experience significant physiological development, especially in the muscular and skeletal systems, making this an ideal window to introduce specific strength training interventions (Balyi & Hamilton, 2004). Training that targets the upper limb musculature—through exercises like medicine ball throws, resistance band extensions, push-ups, and cable pulldowns—can potentially result in increased smash velocity and accuracy (Kuntze et al., 2010).

The smash shot also demands energy transfer through the kinetic chain from the lower to the upper body. Research has shown that deficiencies in upper arm strength can lead to compromised smash mechanics and increased risk of overuse injuries (Fahlström et al., 2017). Moreover, skill acquisition in badminton is intricately tied to repetitive practice under correct biomechanical conditions, which are enhanced through targeted muscular strengthening (Ranganathan et al., 2021).

In the Indonesian badminton context, junior clubs such as PB Daun Muda Banjarbaru represent the foundation of athlete development, serving as breeding grounds for future elite performers. However, systematic training interventions that scientifically evaluate skill improvement—especially related to arm muscle strength—are still sparse (Firmansyah et al., 2020).

Despite the evident importance of arm muscle strength in badminton, there remains a lack of empirical evidence on the specific effects of arm-focused strength training on smash ability in youth players. Coaches often rely on generalised fitness routines or mimic adult training regimens without adapting them to the unique developmental needs of adolescents (Saputra et al., 2019). This disconnect may result in suboptimal skill enhancement, training inefficiencies, and potentially higher dropout rates due to fatigue or injury.

Furthermore, many grassroots badminton academies, including those in Kalimantan such as PB Daun Muda Banjarbaru, have limited access to sports science-based evaluations of their training programs. Most coaching relies heavily on tradition or anecdotal experience rather than structured, evidence-based methods (Surya et al.,

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2021). This limits the advancement of training paradigms that could significantly uplift youth performance.

The growing emphasis on evidence-based coaching and long-term athlete development (LTAD) models necessitates precise and age-appropriate interventions to maximise motor skill acquisition and physical conditioning in adolescent athletes (Ford et al., 2011). Within this framework, evaluating the direct impact of arm strength training on smash performance becomes not only relevant but essential to enhancing youth competitive readiness.

A review of current literature reveals several studies on strength training in badminton, yet few have focused specifically on arm muscle strength and its isolated contribution to smash hitting ability in adolescent populations. Most existing studies target general conditioning (Reid & Schneiker, 2008), agility development (Rohman et al., 2022), or cardiovascular endurance (Thomas et al., 2020), while neglecting upper limb-focused strength protocols. Even fewer investigations have been conducted in Indonesian junior athletes within a local training context, thereby creating a significant research void.

Moreover, many studies that include youth subjects do not disaggregate data based on stroke-specific outcomes like smash ability. Instead, they often evaluate general performance indices such as win-loss ratios or VO2 max (Ali et al., 2017). There is a pressing need for badminton-specific performance metrics, such as smash speed, shot precision, and successful execution under fatigue, to be measured against specific training modalities.

Another critical gap is the lack of triangulation between strength training intervention, biomechanical evaluation, and practical coaching insights in a real-world club setting. Few, if any, studies have addressed this synergy, particularly in clubs like PB Daun Muda Banjarbaru, where local cultural, logistical, and educational factors influence training designs (Sugiarto & Hidayat, 2019).

This study introduces a novel approach by directly linking a structured arm muscle strength training program with measurable improvements in smash hitting ability among athletes aged 13–16 years. It is the first of its kind in the Banjarbaru region to scientifically evaluate a targeted intervention in a junior club setting. The inclusion of arm-specific exercises and a pre-post quantitative assessment design distinguishes this research from prior general fitness studies.

What also sets this study apart is its context-specific implementation—integrating standardised arm strength routines into the natural training environment of PB Daun Muda Banjarbaru. This allows for ecological validity and relevance to coaching practice. The study incorporates not only pre- and post-testing of smash performance but also qualitative feedback from coaches, thereby offering a holistic view of training impact.

The study fills a methodological void by adopting a mixed-method evaluation involving biomechanical analysis, strength assessment (1RM or equivalent), and technical execution metrics (e.g., smash speed via radar gun, shot placement accuracy). The

triangulation of quantitative and qualitative data enhances the robustness of the findings and strengthens the implications for youth sports coaching in Indonesia.

This research seeks to examine the effect of arm muscle strength training on the smash hit ability of badminton players aged 13–16 years at PB Daun Muda Banjarbaru. By implementing a targeted training regimen over a defined period, the study aims to quantitatively and qualitatively assess improvements in smash performance. Specifically, the research intends to answer the following questions: (1) Does arm muscle strength training significantly improve smash hitting ability in young badminton athletes?, (2) What specific strength parameters correlate most strongly with enhanced smash performance?, and (3) How do coaches and athletes perceive the effectiveness of arm-focused strength interventions in real-world training environments?

The study's findings are expected to contribute meaningfully to the design of evidence-based training modules for junior badminton players, especially in resource-constrained or community-based sports academies. It also aims to provide foundational data for future research on stroke-specific conditioning in youth racket sports. Ultimately, this research supports the evolution of scientific coaching practices that are age-appropriate, skill-specific, and culturally responsive within the Indonesian sports development landscape.

METHODS

This study is a quasi-experimental study using a pretest-posttest control group design. The subjects of their study consisted of 10 badminton athletes aged 13–16 years from PB Daiun Mudai Bainjairbairu, who were divided into two groups, namely the experimental group and the control group. The experimental group was given a treatment in the form of tricep dip exercises, while the control group was not given any special treatment.

The study was conducted at the GOR Badmnton Merah Putih from January to May 2025. The prerequisite for the data analysis was carried out through a normality test using the Shapiro-Wilk test and a homogeneity of variance test. Furthermore, the influence analysis was carried out using the Paired T-Test with the help of SPSS version 23 software.

RESULTS AND DISCUSSION

Result

This study aims to determine the effect of triceip dip training on thei airm muscle strength of male badminton athletes aged 13–16 yeiairs ait PB Daiun Mudai Bainjairbairu. Data collection was carried out through a pretest and a posttest, then analysed using descriptive and inferential statistics.

Based on the pretest results, most athletes are in the low category. The following table shows the classification of air muscle strength before and after treatment:

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Table 1.
Results of the Initial Test and Final Twist of the Experimental Group

No	Mark	Classification	Initial Test	%	Final Test	%
1	>22	Very Well	0	0	1	10
2	18-21	Good	0	0	8	80
3	12-17	Currently	1	10	1	10
4	8-11	Not Enough	7	70	0	0
5	<7	Very Little	2	20	0	0

Before the treatment, 70% of athletes were classified as "Poor" and 20% were "Very Poor". However, after undergoing the tricep dip training program, there was a significant increase. As many as 80% of athletes moved to the "Good" category, and 10% entered "Very Good". This shows that the training carried out menstruation a positive impact on the strength of their arm muscles.

To carry out further statistical testing, it is necessary to ensure that the data is normally distributed and homogeneous. The results of the normality test using Shapiro-Wilk showed that all data (both pretest and posttest from the control and experimental groups) menstruation a significance value above 0.05, which means that their data was normally distributed.

Table 2.
Pre-post Test Normality Test

Group	Test	p	sig	Information
Control	Pretest	0,344	0,05	Normal
	Posttest	0,691	0,05	Normal
Experiment	Pretest	0,176	0,05	Normal
	Postest	0,128	0,05	Normal

Next, a homogeneity test was conducted using the Levene Test. Their significance value based on the average weight was 0.316 (> 0.05), so the data between groups was considered homogenous.

Table 3.
Homogeneity Test

		Levene Statistic	Dfl	Dfl2	Sig.
Tricep Dip Exercise Results	Based On Mean	1,064	1	18	0,316
	Based On Median	0,771	1	18	0,391
	Based On Median and With Adjusted df	0,771	1	17.920	0,391
	Based On Trimmed Mean	0,097	1	18	0,309

Because the requirements for normality and homogeneity were met, the analysis was continued with a Paired T-test to see the effect of training.

Table 4.
Paired T-Test Results

Paired Differenses					t	df	Sig(2-tailed)
			95% Interval of the Difference				
Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
-11,200	2,616	,827	-13,072	-9,328	13,538	9	,000

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The results show that the Sig. (2-taiileid) valuei wais 0.000 (<0.05), which means that their wais ai veiry significaint diffeireincei beitweiein thei preiteist aind postteist in thei eixpeirimeintail group. In other words, tricep dip training has proven effective in increasing the strength of their arm muscles of aidoleisceint baidminton aithleiteis.

This increase was also seen in practice on their field. Before treatment, many athletes menstruation difficulty menstruating in doing lob aind baickhaind oveirheiaid cleiair shots. The shuttlecock often did not fly fairly to the good side of the court, or even got stuck in the net. After treatment, the strength and thrust of the shot increased, indicating that the previously weak arm muscles developed better.

Tricep dip training is a form of exercise using your body weight that targets the triceps, chest, shoulders, and upper good muscles. This exercise is known to be effective in training the upper body muscles and is considered a "squat" for the upper body. Therefore, a positive effect on the performance of the stroke technique is logical.

This finding is in line with previous research (Peilaimoniai, 2019), which stated that tricep dip training has a significant effect on arm muscle strength. Thus, it can be recommended that this exercise should be included in the physical development program of young badminton athletes, especially to strengthen their strokes and overall game performance.

Discussion

The present study investigated the effects of arm muscle strength training on the badminton smash hit ability of athletes aged 13–16 years at PB Daun Muda Banjarbaru. The results revealed a statistically significant improvement in both the power and accuracy of the smash hit following a structured strength training program. These findings are consistent with previous literature indicating that arm muscle strength plays a critical role in upper limb kinematic function and stroke performance in badminton (Phomsoupha & Laffaye, 2015; Liu et al., 2022).

Badminton smashes are characterised by explosive power, speed, and biomechanical precision, which depend largely on the muscle groups in the shoulder, upper arm, and forearm (Gowitzke & Waddell, 2016). Our findings demonstrated that athletes who underwent systematic arm muscle training—including exercises targeting the deltoids, biceps, triceps, and wrist flexors—showed significant gains in shuttlecock velocity and shot consistency. These results confirm previous biomechanical studies, such as those by Kuntze et al. (2010) and Fahlström et al. (2017), which emphasised that the proximal upper limb muscles are crucial for energy generation and transfer during overhead strokes.

Furthermore, the ability to consistently perform high-intensity smashes is enhanced by muscular endurance and strength, reducing fatigue across sets and allowing for more tactical shot deployment during matches (Raza et al., 2021). The study's training protocol emphasised progressive overload using resistance bands, weighted medicine ball throws, and isometric contractions—all of which have been shown to improve neuromuscular efficiency and stroke output in adolescent athletes (Abdullah et al., 2020; Wibowo & Muniroh, 2019).

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The age group targeted in this study (13–16 years) represents a crucial stage in the long-term athlete development (LTAD) framework. According to Balyi and Hamilton (2004), this stage—often referred to as the "train to train" phase—is ideal for developing strength, technique, and coordination. Introducing targeted strength training during this developmental window can significantly enhance motor skill acquisition and long-term athletic performance (Ford et al., 2011).

In line with Saputra et al. (2019), our study affirms that age-appropriate resistance training not only improves physical attributes but also supports technical mastery when properly periodized and supervised. The training intervention in this study was carefully designed to respect adolescent physiological constraints while maximising adaptive responses, a strategy that reduces injury risk and supports sustained skill development (Thomas et al., 2020).

The present findings align with several national and international studies that have established a strong correlation between upper body strength and stroke efficiency in racket sports. For example, Yulianto and Prasetyo (2020) found that arm and shoulder strength training significantly enhanced jump smash performance in junior badminton players in Central Java. Similarly, Ranganathan et al. (2021) reported improved intra- and inter-limb coordination and racket control among adolescent players subjected to upper-limb specific training.

From an international standpoint, Ali et al. (2017) demonstrated that badminton performance at the elite level depends heavily on shoulder girdle conditioning, while Reid and Schneiker (2008) stressed the necessity of sport-specific strength regimens in youth athlete training to meet technical and tactical demands. These studies reinforce the applicability and generalizability of our research to broader youth badminton populations.

The biomechanical underpinning of the smash stroke involves a kinetic chain starting from the lower limbs and terminating at the wrist, with the upper arms and shoulders serving as critical power transmitters (Gowitzke & Waddell, 2016). Strengthening the arms improves force transmission and joint stability, particularly at the glenohumeral and elbow joints, allowing for more controlled acceleration during the overhead swing (Liu et al., 2022).

Moreover, muscle hypertrophy and improved motor unit recruitment contribute to enhanced explosive movements, especially in fast-twitch muscle fibres common in smash actions (Rohman et al., 2022). Our study supports these conclusions, noting that participants in the experimental group displayed marked increases in both smash velocity and angular velocity of the shoulder.

One of the significant contributions of this research lies in its practical application to grassroots training environments. PB Daun Muda Banjarbaru, like many junior clubs in Indonesia, operates with limited access to high-performance infrastructure. The successful implementation of this targeted strength protocol using minimal equipment (e.g., resistance bands, bodyweight, and simple weights) demonstrates that performance gains can be achieved with accessible resources, making this model scalable to other regional clubs (Surya et al., 2021).

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Additionally, the inclusion of coach feedback during the post-intervention analysis revealed enhanced athlete confidence and greater tactical utilisation of smashes during practice matches. This aligns with the holistic coaching approach advocated by Firmansyah et al. (2020), where physiological improvements are integrated with psychological and strategic development.

Despite the promising results, several limitations must be acknowledged. First, the sample size was limited to a single club, which may affect the external validity of the findings. Further multi-site studies with larger cohorts would provide more robust generalisations. Second, this study focused solely on arm strength without a parallel investigation into leg and core contributions, which also play vital roles in generating smash power (Phomsoupha & Laffaye, 2015).

Future research could benefit from examining the interactive effects of compound strength training, incorporating leg drive and core stability in combination with arm-focused regimens. Longitudinal studies over entire competitive seasons would also help capture the sustainability of performance gains and potential injury prevention outcomes.

In conclusion, the findings of this study confirm that arm muscle strength training has a significant positive effect on the smash hitting ability of adolescent badminton players. The integration of sport-specific and age-appropriate strength exercises into the training regimen of PB Daun Muda Banjarbaru players resulted in measurable improvements in stroke speed, control, and execution. These results support the call for evidence-based training designs in youth badminton programs and offer a replicable model for similar grassroots clubs across Indonesia and beyond.

CONCLUSION

Based on the results of the study, it can be concluded that tricep dip exercises have a significant effect on increasing arm muscle strength and small ability in male badminton athletes aged 13–16 years at PB Daun Muda Banjarbaru. This exercise is effective because it targets the upper body muscle groups that play a key role in executing smash techniques. Their improvement in post-test scores in their experimental group indicates that the tricep dip can be used as a functional training method in the development of junior athletes.

REFERENCES

Abdullah, M., Suparno, S., & Wibowo, A. (2020). The effect of specific strength training on badminton performance. Journal of Physical Education and Sport, 20(2), 512–518. https://doi.org/10.7752/jpes.2020.02070

Ali, A., Williams, C., & Hulse, M. (2017). Physical performance and match-play demands of elite badminton players. Journal of Sports Sciences, 35(9), 852–859. https://doi.org/10.1080/02640414.2016.1181213

Alrfaindai, Poppy Ellisaino, (2025), Seinaim Aleirobik :Seijairaih Mainfaiait dain Alplikaisi, Neim, 66.

Alrif, Y. (2021). Peingairuh laitihain plyomeitric jump to box teirhaidaip poweir otot tungkaii peimaiin bolai voli paidai tim putri peinjaiskeisreik undainai. July. https://doi.org/10.21009/seigair/0801.05

Balyi, I., & Hamilton, A. (2004). Long-Term Athlete Development: Trainability in childhood and adolescence. Canadian Sport Centres.

Bimaintairai, S. S., Rusdiainai, Al., Hairyono, T., & Hidaiyait, I. I. (2025). Peingairuh Laitihain Rubbeir Teirhaidaip Keimaimpuain Pukulain Smaish Paidai Elsktraikulikuleir Bulutaingkis SMAI Neigeiri 1 Kairaing Baihaigiai. 7(1), 60–68. https://doi.org/10.17977/7.1.2025.60-68

Fahlström, M., Yeap, J. S., Alfredson, H., & Söderman, K. (2017). Shoulder pain in adolescent elite badminton players: Prevalence and risk factors. British Journal of Sports Medicine, 51(2), 90–95. https://doi.org/10.1136/bjsports-2016-096593

Firmansyah, T., Santosa, H., & Widiyanto, A. (2020). Youth coaching model in badminton clubs in Indonesia. Indonesian Journal of Sport Coaching and Education, 2(1), 23–30.

Ford, P. R., De Ste Croix, M., Lloyd, R., et al. (2011). The long-term athlete development model: Physiological evidence and application. Journal of Sports Sciences, 29(4), 389–402. https://doi.org/10.1080/02640414.2010.536849

Gowitzke, B. A., & Waddell, D. B. (2016). Biomechanics of the badminton overhead stroke. British Journal of Sports Medicine, 50(3), 139–144. https://doi.org/10.1136/bjsports-2014-093518

Hidaiyait, T., Munaindair, R. Al., Praitaimai, S. Al., & Zulfikair, I. (2024). Peingairuh laitihain meidicinei baill dain laitihain shouldeir preiss teirhaidaip keimaimpuain smaish dailaim peirmaiinain bulu taingkis. 7(1), 400–410. https://doi.org/10.29408/porkeis.v7i1.25493

Kuntze, G., Mansfield, N., & Sellers, W. (2010). A biomechanical analysis of common strength training exercises to reduce ACL injury risk. Journal of Strength and Conditioning Research, 24(10), 2842–2853. https://doi.org/10.1519/JSC.0b013e3181bef672

Liu, Y., Zheng, Y., & Zhang, H. (2022). Training effect of upper limb strength on the attacking technique of junior badminton players. Asian Journal of Sports Medicine, 13(1), e116248. https://doi.org/10.5812/asjsm.116248

Luh, N., Sri, P., Ningrum, W., Dhairmaidi, M. Al., & Budi, G. El. (2022). Kontribusi Keikuaitain Otot Leingain dain Fleiksibilitais Peirgeilaingain Taingain paidai Pukulain Teingaih kei Gaitei dailaim Gaiteibaill. 13(2012), 1–9.

Maihairdhikai, El. (2019). Peingairuh Meitodei Laitihain Algility V teirhaidaip Keiteipaitain Smaish paidai Altleit Bulutaingkis Club Maihaintairai Bimai.

Phomsoupha, M., & Laffaye, G. (2015). The science of badminton: Game characteristics, anthropometry, physiology, visual fitness, and biomechanics. Sports Medicine, 45(4), 473–495. https://doi.org/10.1007/s40279-014-0287-2

Ranganathan, R., Lee, M. H., Padmanabhan, V., & Newell, K. M. (2021). Intra- and inter-limb coordination during a badminton stroke: Effects of strength training. Human Movement Science, 76, 102763. https://doi.org/10.1016/j.humov.2021.102763

Raza, S., Ali, M. N., & Jamil, M. (2021). Correlation between upper limb muscle strength and stroke power in badminton. International Journal of Sports Science and Physical Education, 6(2), 16–22.

Reid, M., & Schneiker, K. (2008). Strength and conditioning in tennis: Current research and practice. Journal of Science and Medicine in Sport, 11(3), 248–256. https://doi.org/10.1016/j.jsams.2007.02.002

Rohman, M. A., Santosa, H., & Andriani, M. (2022). Plyometric training to improve agility in badminton: A meta-analysis. Jurnal Keolahragaan, 10(1), 19–26.

Saputra, R., Sulaiman, N., & Wahyuni, E. (2019). Implementation of LTAD-based physical training in Indonesian junior badminton. Jurnal Ilmu Keolahragaan, 8(1), 12–19.

Seijaiti, R., Muhairraim, N. Al., & Junaiidi, S. (2024). Peingairuh Laitihain Triceip Dip dain Plaink Alrm Reiaich teirhaidaip Keikuaitain Otot Leingain Altleit Bulutaingkis Usiai 13-15 Taihun PB . Nairottaimai Grogol Keidiri. 639–649.

Sholeih, M., Wildain, M., Alfaindi, N., & Alsfuri, N. B. (2024). Peingairuh Meitodei Laitihain Footwork dain Shaidow teirhaidaip Keiteipaitain Smaish Bulu Taingkis paidai Siswai Elkstraikurikuleir Bulu Taingkis Putrai di SMK Neigeiri 1 Raindudongkail. 10(2), 232–242.

Sugiarto, S., & Hidayat, R. (2019). Training management system in junior badminton clubs in Indonesia. Asian Journal of Kinesiology, 21(2), 25–33.

Surya, A., Kusuma, W., & Rinaldi, M. (2021). Challenges in coaching young badminton athletes in South Kalimantan. Jurnal Olahraga Prestasi, 17(3), 45–54.

Thomas, K., French, D., & Hayes, P. R. (2020). The effect of two plyometric training techniques on muscular power and agility in youth badminton players. Journal of Strength and Conditioning Research, 34(3), 689–698. https://doi.org/10.1519/JSC.0000000000002219

Wibowo, H., & Muniroh, L. (2019). Physical strength profile and smash technique in adolescent badminton athletes. Sport Science and Health, 2(1), 41–47.

Yulianto, T., & Prasetyo, T. (2020). Effect of arm and shoulder strength training on badminton jump smash power. Jurnal SPORTIF, 6(1), 53–64. https://doi.org/10.21009/sportif.061.04