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The Influence Of Plyometric Exercise And Leg Muscle Strength Against Increased Breastroke Swimming Speed 50 Meters DistanceFor Vocational School Extracurricular Students Bina Bangsa Kersana Brebes Regancy

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Abstract

This study aimed to examine the effects of plyometric exercises, specifically jump to box and depth jump, and leg muscle strength on 50-metre breaststroke speed in students participating in extracurricular swimming at SMK Bina Bangsa Kersana, Brebes Regency. Using a quantitative experimental approach with a 2x2 factorial design, the study involved students undergoing plyometric training for four weeks, three sessions per week. The dependent variable was 50-metre breaststroke speed, and leg muscle strength was considered an attribute variable. The results indicated that both jump to box and depth jump exercises significantly increased swimming speed ($F=215.207$; $p<0.05$). Leg muscle strength also had a significant impact ($F=51.909$; $p<0.05$), with students possessing higher leg strength achieving faster swimming times. Furthermore, a significant interaction was observed between the type of plyometric exercise and leg muscle strength ($F=8.206$; $p<0.05$), suggesting that exercise effectiveness depends on the student's leg strength. Overall, jump to box training was more effective than depth jump, and students with high leg strength showed the greatest improvement. These findings confirm that structured plyometric training, particularly jump to box exercises, combined with sufficient leg muscle strength, can optimize 50-metre breaststroke performance, making it a recommended approach for enhancing swimming speed in adolescent athletes.

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INTRODUCTION

Education plays an important role in the development of individuals and the survival of a nation. Education is a conscious and planned effort to prepare children through guidance, teaching, and life training in the future. The learning process can take place anytime and anywhere according to the concept of long life education (Sukmawati, 2015; Yandrizal et al., 2023). Physical education, sports, and health are integral parts of the education system that contribute to physical fitness as well as the development of social, emotional, and cognitive skills through sports activities (Muhammad, 2018). Sports learning emphasizes three key aspects: attitudes, knowledge, and interrelated skills in the curriculum (Aritianto & Hartono, 2015). The main goal of physical education is to shape the character, personality, and noble nature of students through the development of physical fitness and a healthy lifestyle (Susanto, 2021).

In the context of learning to swim, especially the breaststroke, the strength of the leg muscles is the main component because leg movements play a dominant role in creating speed. Plyometric exercises, which involve explosive muscle contractions, have been shown to be effective in increasing the explosive power of the leg muscles so that the movement of the thrust while swimming is maximized (Hafiz Nursalam, 2020; Hananingsih, 2017).

According to Mulyono et al. (2019), sports are a part of daily life in society that not only benefit health but also serve as a means of education, achievement enhancement, and the formation of character, personality, discipline, and sportsmanship. Sports have also become a necessity because they can burn fat, improve endurance, and maintain physical fitness. Beside on land, sports can be done in water thru aquatic activities such as swimming, water polo, surfing, diving, rowing, and canoeing, with swimming being the most common. Swimming is increasingly accepted by society and has become a mandatory part of physical education in schools due to its educational value (Maulana et al., 2018), and it is also developed in extracurricular activities.

Extracurricular activities are educational activities outside of class hours that play an important role in supporting the learning process of students. Thru these activities, students can enhance their knowledge and skills as well as develop their potential, talents, and interests. Participation in various types of extracurricular activities, such as arts, organizations, scientific activities, and sports, also helps students express themselves and train their social skills, cooperation, and responsibility. Extracurricular activities become a strategic platform for character building and supporting the balanced development of students, both academically and non-academically (Supiani et al., 2020).

Swimming extracurricular at SMK Bina Bangsa Kersana is an activity to develop students' interests and talents outside of class hours which aims to improve technical skills and physical condition. This activity is carried out programmatically with the guidance of teachers or trainers, including training in style, endurance, and competition simulations. Through this extracurricular, students are prepared to improve their performance and participate in inter-school swimming competitions. Based on observations at SMK Bina Bangsa Kersana, it was found that the leg muscle strength of swimming extracurricular students is still low, with 17 students in the sufficient category and 5 students very poor. This causes students to quickly experience fatigue during the 50-meter breaststroke race and are less able to maintain speed (Ramdhan & Purnamasari, 2020).

The training methods used so far have not been structured, direct breaststroke practice without warm-up or basic exercises, and the management of the exercise program has not been optimal. Interviews with coaches

show that the exercises are not carried out procedurally and measurably, so the student's performance is not optimal. Various plyometric exercise methods, such as jump to box, depth jump, and knee tuck jump, have been shown to increase swimming speed and leg muscle explosiveness (Imbang, 2019; Shava et al., 2017). The strength of the leg and arm muscles has also been shown to have a significant effect on the ability to swim the 50-meter breaststroke (Anam et al., 2017; Ilmah et al., 2021). These findings support the relevance of research on the effect of plyometric exercises and leg muscle strength on the swimming speed of students of SMK Bina Bangsa Kersana.

The formulation of the problem in this study is: first, is there a difference in the effect of plyometric jump to box and depth jump exercises on the speed of 50-meter breaststroke swimming; second, is there a difference in the effect of high and low category leg muscle strength on breaststroke swimming speed; and third, is there an interaction between plyometric exercises and leg muscle strength to increase the speed of a 50-meter breaststroke swim. The purpose of this study is to analyze the difference in the influence of the two types of plyometric exercises, analyze the influence of high and low category leg muscle strength, and examine the interaction between exercise methods and leg muscle strength. The research hypothesis states that there are significant differences between the types of plyometric exercises, there are differences between the categories of leg muscle strength, and there is a significant interaction between plyometric exercises and leg muscle strength on breaststroke swimming speed.

This research is expected to provide theoretical benefits, namely adding to the foundation of knowledge about plyometric exercises and the role of leg muscle strength in swimming performance, as well as practical benefits for students, teachers/coaches, schools, and future researchers. The novelty of this study lies in the population studied, namely extracurricular students of SMK Bina Bangsa Kersana, the use of plyometric training methods combined with leg muscle strength measurements, and the focus on the speed of the 50-meter breaststroke swim, which is still rarely studied specifically. Thus, this research is expected to make a significant contribution to the development of school-based training methods and academic references in the field of sports science.

METHODS

This study uses a quantitative approach with experimental methods to uncover the relationships between variables through the manipulation of independent variables (Mohajan, 2020; Hasan, 2024). The research design applied was a two factor design or 2x2, which divided the sample into plyometric jump to box and depth jump exercise groups with high and low leg muscle strength categories. The research population consisted of 32 male swimming extracurricular students at SMK Bina Bangsa Kersana for the 2024/2025 school year, with samples taken by purposive sampling based on active criteria, leg muscle strength levels, and grading was carried out for the division of exercise groups using ordinal pairing (Sugiyono, 2013; Turner, 2020). The sample was divided into four experimental groups, each consisting of 8 students, according to the combination of exercises and leg muscle strength categories

The study variables consisted of independent variables in the form of plyometric exercises (jump to box and depth jump), leg muscle strength attributes variables (height and low), and bound variables, namely 50-meter breaststroke swimming speed. Jump to box plyometric exercises emphasize leg muscle explosiveness with an intensity of 65–90% and a duration of 65 minutes per session (Staniszewski et al., 2024), while depth jump exercises leg strength, hips, and lower back with an intensity of 75–90% per session (Kook et al.,

2020). Muscle strength is measured using a leg dynamometer on a kilogram scale (Suchomel et al., 2018; Yuliawan & Pustaka, 2025), while swimming speed is measured with a digital stopwatch (Khairoh et al., 2021; Marvian et al., 2015). The research took place in the swimming pool of SMK Bina Bangsa Kersana from November 3 to December 10, 2025, with the provision of exercises three times per week for 16 meetings (K. A. Nugroho, 2023; Suryadi et al., 2021).

Data was collected through pretest and posttest using a leg dynamometer to measure leg muscle strength and a digital stopwatch for swim speed. The research instrument is guaranteed to be valid by considering internal validity, such as the timing of the research, the use of pretests, reliable instruments, the similarity of the characteristics of the subjects, and the experimental morality procedures to prevent data loss (Campbell & Stanley, 2015). External validity is observed through the selection of homogeneous subjects, the lack of researcher intervention during the exercise (Hawthorne effect), and the ability to replicate the exercise program systematically and explicitly (Creswell, 2012).

Prior to hypothesis testing, the data were tested for normality and homogeneity using the Kolmogorov-Smirnov test and Levene's test to ensure the distribution of normal data and homogeneous variants (Nuryadi et al., 2017; Sianturi, 2022). Hypothesis analysis was conducted with two-way ANOVA to test the simultaneous effect of plyometric exercise and muscle strength category on swimming speed, with a significance criterion of $p<0.05$. This procedure allowed researchers to draw valid conclusions about the influence of both independent variables, both individually and interactively, on the performance of students' 50-meter breaststroke swim speed (F. Nugroho et al., 2023)..

RESULTS AND DISCUSSION

The characteristics of the sample in this study consisted of 32 male students who participated in swimming extracurricular at SMK Bina Bangsa Kersana, Brebes Regency, divided into four groups, 8 people each, namely plyometric jump to box exercises with high muscle strength, plyometric jump to box with low muscle strength, plyometric depth jump with high muscle strength, and plyometric depth jump with low muscle strength. The average age between groups was relatively homogeneous, namely 15.63 ± 0.52 years (high jump to box), 15.38 ± 0.52 years (low jump to box), 15.13 ± 0.35 years (high depth jump), and 15.25 ± 0.46 years (low depth jump), in the range of 15 years. Weight showed a comparable variation, with an average of 58.75 ± 10.63 kg (high jump to box), 56.75 ± 11.66 kg (low jump to box), 62.50 ± 7.17 kg (high depth jump), and 66.13 ± 11.12 kg (low jump depth). Meanwhile, the height between the groups was also relatively uniform, namely 162.88 ± 4.73 cm (high jump to box), 161.38 ± 4.63 cm (low jump to box), 162.25 ± 5.55 cm (high jump depth), and 161.38 ± 3.96 cm (low jump depth), indicating that the sample had balanced physical characteristics.

Description of Pre Test and Post Test Swim Speed Data

Table 1. Pretest and Posttest Data on Swimming Speed

No	Exercise Methods	Muscle Strength	Data	Quantity (N)	Average	*Std. Dev*
1	*Pliometrik Jump To Box*	Height	*Pretest*	8	224,25	1,22

			Posttest	8	187,81	1,03
		Low	*Pretest*	8	224,94	1,21
			Posttest	8	191,44	0,90
2	*Pliometrik Depth Jump*	Height	*Pretest*	8	226,69	1,13
			Posttest	8	194,13	0,69
		Low	*Pretest*	8	226,13	1,16
			Posttest	8	195,69	1,33

Based on the research data, the breaststroke swimming speed over a distance of 50 meters was measured thru Pre-Test and Post-Test for all plyometric training groups. In the plyometric jump to box group with high muscle strength, the average Pre-Test time was 224.25 ± 1.22 seconds, decreasing to 187.81 ± 1.03 seconds in the Post-Test. The group with low muscle strength experienced a decrease from. The group with low muscle strength experienced a decrease from 224.94 ± 1.21 seconds to 191.44 ± 0.90 seconds. In the depth jump plyometric group, the high muscle strength group had an average Pre-Test time of 226.69 ± 1.13 seconds, which decreased to 194.13 ± 0.69 seconds in the Post-Test. Meanwhile, the low muscle strength group decreased from 226.13 ± 1.16 seconds to 195.69 ± 1.33 seconds. From the comparison of Post-Test data, it is evident that the high muscle strength group in the jump to box plyometric had the fastest average time (187.81 seconds) compared to other groups, followed by the high muscle strength group in the depth jump plyometric (194.13 seconds), and then the low muscle strength group. This shows that the plyometric jump to box exercise for participants with high muscle strength results in a faster 50-meter breaststroke swimming time compared to other groups.

Comparison of Data Before and After Jump To Box Plyometric Exercises

Table 2. Paired Sample Test T Test Plyometric Exercise Jump to box

		Paired Differences						
				95% Confidence Interval of the Difference				
	Mean	*Std. Dev.*	*Hours Error Mean*	*Lower*	*Upper*	*T*	*df*	*Sig (2-tailed)*
Vertical Jump	*Pre-Post*	-26.68750	1.13835	.28459	-27.29408	-26.08092	-93.776	15	.000
Leg Dynamometer	*Pre-Post*	-61.87500	4.14528	1.03632	-64.08386	-59.66614	-59.706	15	.000
Swim 50 m (sec)	*Pre-Post*	34.96875	2.08542	.52135	33.85751	36.07999	67.073	15	.000

The results of the Paired Sample T-Test showed that the plyometric jump to box exercise significantly increased leg muscle strength (mean gain of 61.88 kg, p=0.000), vertical jump ability (average gain of 26.69 cm, p=0.000), and decreased the swimming time of the 50 meters breaststroke (average decrease of 34.97 seconds, p=0.000). The exercises were carried out for 16 meetings in stages with increased intensity, sets reps, and rest time, including warm-ups, training cores, and cooling, so that it proved effective in improving the physical performance of male students of SMK Bina Bangsa Kersana

Comparison of Data Before and After Plyometric Depth Jump Exercises

Table 3. Paired Sample Test T-Test Plyometric Exercise Depth Jump

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Dev.	Hours Error Mean	Lower	Upper	t	df	Sig (2-tailed)
Vertical Jump	Pre-Post	12.500000	1.54919	.38730	-13.32551	-11.67449	-32.275	15	.000
Leg Dynamometer	Pre-Post	55.31250	1.81544	.45386	-56.27988	54.34512	-121.871	15	.000
Swim 50 m (sec)	Pre-Post	31.50000	1.37840	.34460	30.76550	32.23450	91.410	15	.000

The results of the Paired Sample T-Test showed that the plyometric depth jump exercise significantly increased muscle strength (average gain of 55.31 kg, p=0.000), vertical jump ability (average gain of 12.50 cm, p=0.000), and decreased the swimming time of 50 meters breaststroke (average decrease of 31.50 seconds, p=0.000). The exercises are conducted over 16 meetings in stages with an intensity of 60–90%, set number 6–9, 10 reps, and a rest time of 120–180 seconds, including warm-ups, core exercises jumping from the box to the floor, and cooling-down. These results show that exercise is effective in improving physical performance, although the increase is lower than jumping to box.

Table 4. Prerequisite Test and Hypothesis Test

No	Uji / Hypothesis	Methods/Instruments	Results
1	Normality Test	Kolmogorov-Smirnov & Shapiro-Wilk (SPSS 27)	KS = 0.200; SW = 0.980
2	Homogeneity Test	Levene's Test	F = 1,30; p = 0,294
3	Influence of plyometric exercise types (jump to box vs depth jump)	Two-way ANOVA	F = 215,207; p = 0,000
4	Influence of leg muscle strength (high vs low)	Two-way ANOVA	F = 51,909; p = 0,000
5	Interaction of plyometric exercises × muscle strength	Two-way ANOVA	F = 8,206; p = 0.008

The swimming speed data met the assumptions of normality and homogeneity. The results of ANOVA showed that the type of exercise, muscle strength, and interaction of the two had a significant effect on increasing the speed of the 50-meter breaststroke swim.

DISCUSSION

Influence of Plyometric Exercise Types

Jump to box plyometric exercises and depth jump have been proven to increase the speed of 50-meter breaststroke swimming in extracurricular students of SMK Bina Bangsa Kersana. The post-test results showed that jump to box was more effective than depth jump, because it emphasized the explosive contraction of the leg muscles when pushing the body in the water. Each training session is carried out progressively for 16 meetings, starting from warm-up, core training, to cool-down. The intensity of the exercise increases from 60% to 90%, sets from 6 to 9, repetitions 10 times per set, and rest time from 120 to 180 seconds, so that the leg muscles can adapt and develop optimally (Shava et al., 2017).

These findings are consistent with research (Shava et al., 2017), which found that jump to box increased swimming speed better than double tuck jumps, especially in athletes with more optimal leg length. In addition, (Hanief et al., 2018) confirms that plyometric training has a significant effect on

swimming speed, and that the interaction between exercise type and athlete's physical characteristics affects performance. This suggests that variations in the types of plyometric exercises exert different effects on swimming speed explosive power of the leg muscles is the main factor in increasing swimming speed

Interaction of Exercise Type and Leg Muscle Strength

Two-Way ANOVA analysis showed a significant interaction between the type of plyometric exercise and the leg muscle strength category on increased swimming speed. The combination of jump to box with high leg muscles results in the most optimal reduction in swimming time, while other combinations are still effective but less than optimal. These results confirm that the effectiveness of exercise depends not only on the type of exercise, but also on the student's basic physical abilities, in particular the explosiveness of the leg muscles (Haryanto & Denay, 2020).

These findings are consistent with (Shava et al., 2017), which shows the interaction between the type of plyometric exercise and leg length affects the speed of swimming, where athletes with long legs and jump to box perform best. (Haniefet al., 2018) It was also found that athletes' physical characteristics affect the effectiveness of exercise on swimming speed, while (Haryanto & Denay, 2020) emphasizing the importance of leg muscle explosiveness in breaststroke swimming performance.

Overall, the increase in the speed of the 50-meter breaststroke swim was influenced by three factors: the type of plyometric exercise, the strength of the leg muscles, and the interaction of the two. Progressively structured plyometric exercises provide optimal stimulation to the leg muscles for rapid and explosive contractions, improve leg thrust, and overall swimming performance. Swimming training programs should consider the initial physical condition of the participants to achieve maximum results

CONCLUSION

Based on the results of the research and data analysis, it can be concluded that the plyometric jump to box and depth jump exercises have a significant effect on increasing the speed of the 50-meter breaststroke swim in extracurricular students of SMK Bina Bangsa Kersana, with jump to box showing higher effectiveness than the depth jump. In addition, leg muscle strength also affects swimming results, where students with high muscle strength experience a more optimal increase in speed than students with low muscle strength. The results of the analysis also showed a significant interaction between the type of plyometric exercise and leg muscle strength with the combination of jump to box and high leg muscles being the most effective in improving swimming performance, where the combination of these two factors explained 90.8% of the variation in swimming speed ($R^2 = 0.908$). These findings confirm the importance of an exercise program that combines plyometric exercises with the gradual development of leg muscle strength to maximize students' swimming abilities.

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