https://doi.org/10.7251/SSH2501047H **UDC:** 797.21:796.015.132
Original scientific paper ***Originalni naučni rad***

Improvement in 50-Meter Freestyle Swimming Speed Following 6 Weeks of Plyometric Training in 12-13 Years Old

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Abstract: *Swimming is a fantastic sport to enjoy at all ages, but increasing swimming speed requires proper training. This research aims to determine the effect of 6 weeks of plyometrics exercise on 50-meter freestyle swimming in the 12-13 age group. This study follows a pre-experimental research design, specifically utilizing a One Group pretest-posttest design. The participants in this research were drawn from the Arwana Swimming Club in Bangkalan, East Java, Indonesia male swimmers aged 12-13 with 20 participants. The Plyometric Training Program was implemented for 6 weeks, scheduled for three days each week. The results obtained from this study indicate a significant value of 0.00, which is less than 0.05. The mean values of the pretest (50.1545) and the posttest (49.264). This conclusion shows that there was an improvement in swimming speed, as evidenced by the lower time recorded in the posttest. Therefore, from this research, 6 weeks of plyometric exercises have a significant effect on the performance of 50-meter freestyle swimming in the 12-13 age group. Consequently, it is recommended that training programs be tailored to address the unique needs of male and female swimmers.*
Keywords: *freestyle swimming, speed, plyometric, 12-13 years old.*

Introduction

Swimming is a fantastic sport that people of all age groups can enjoy (Fadhlillah Aufar et al., 2020; Kattoof, Soni & Vedawala, 2022), popular recreational exercises and sports (Ábel et al., 2022), so swimming is a widely embraced mode of physical exercise (Jakubczyk et al., 2019). Inadequate physical activity stands as a distinct risk factor for a range of illnesses (Purwoto et al., 2024). Hence, examining the efficacy of a particular training approach, such as low volume, high intensity training, holds practical importance in enhancing well-being and averting diseases (Nurmukhanbetova et al., 2023). The psychological advantages of swimming are widely recognized, leading to reduced levels of anger, confusion, depression, and increased vitality following a swim. Mood changes indicate a decrease in swimmers' tension and confusion (Ábel et al., 2022). Swimming is an athletic discipline demanding a combination of muscular strength and sustained endurance (Cañas-Jamett et al., 2020a; Fadhlillah Aufar et al., 2020; Vašíčková et al., 2017). Therefore, when incorporating plyometric exercises into your training regimen, the primary focus should be on enhancing muscle strength while concurrently improving endurance capacities (Krzysztofik et al., 2024; Kumar, 2014; Patel, 2014; Sáez De Villarreal et al., 2021). Other research also explains that enhancing swimming performance can be achieved not solely through in-water, sport-specific training, but also through dry land training, particularly in the form of plyometric jump training (Sammoud et al., 2019).

Plyometric jump training stands as a potent technique for enhancing physical fitness indicators, such as muscle strength and power, while also augmenting sport-specific performance, such as time-trial speed, among athletes in water sports (Ramirez-Campillo et al., 2021; Soni & Vedawala, 2022). Plyometric exercises are specifically crafted to optimize the rapid generation of muscular force within the briefest time frame achievable (Kumar, 2014). Plyometric workouts, being a form of exercise that engages every muscle in an athlete's body, are employed as an efficient approach to boost the power and speed capabilities of athletes (Gencer et al., 2018; Ramirez-Campillo et al., 2020, 2021).

Plyometric training proves to be a highly effective method for enhancing force, which is crucial in swimming for the purpose of augmenting speed (Chen et al., 2023). Plyometric training offers numerous benefits compared to other

dry-land training techniques (Ghosh & Biswas, 2020; Pereira et al., 2023). These advantages encompass the convenience of seamlessly integrating such training into regular training sessions and the cost-effectiveness, as it doesn't necessitate specialized equipment (Hermosilla et al., 2021). Plyometric training enhances vertical jump height, flexibility, and the performance in the 200m swim for adult swimmers who engage in recreational training (Cañas-Jamett et al., 2020b). Plyometrics leads to enhancements in physical fitness, encompassing areas such as vertical jumping ability, sprint speed, muscular strength, and endurance (Sole et al., 2021). In the realm of plyometric training, the experimental group has shown notable enhancements in the performance of the 50-meter backstroke (Kumar, 2014). An 8-week plyometric training program has been observed to significantly improve vertical leap performance. However, it did not exhibit the same impact on parameters such as anaerobic power, 30-meter sprint times, and hand grip strength for both right and left hands, as well as 25 and 50-meter freestyle swimming parameters of male swimmers aged 10-11 years (Gencer et al., 2018). Plyometric training for 6 weeks is effective for improving speed and agility abilities in young beginner swimmers (Soni & Vedawala, 2022). Speed plays a pivotal role in sports, particularly in swimming, as it is imperative during competitions to attain peak performance (Shava et al., 2017). The combination of equal-volume plyometric jump training with regular swimming training has proven to be more effective than solely relying on regular swimming training for improving both jump and swim performances (Sammoud et al., 2021a). The performance of young swimmers is a complex, multifaceted, and continually evolving phenomenon that depends on various factors. So, it is very interesting to study (Morais et al., 2021). Observations at the Arwana Swimming Club in Bangkalan, East Java, Indonesia, indicated that swimming speed has not improved with the current training methods. Additionally, the trainer observed that the athletes were unable to follow the training optimally. Therefore, a new training method is needed at the Arwana Swimming Club in Bangkalan.

The study mentioned above has sparked an ongoing debate. While some argue that plyometric training may influence speed, others contend that its impact is not substantial. Plyometric training for freestyle swimming is still limited. Furthermore, the applicability of plyometric training for swimmers in the 12-13 age group remains uncertain. Hence, the objective of this research is to investigate the impact of a 6-week plyometric training regimen on the performance of 50-Meter Freestyle Swimming in individuals aged 12-13.

Materials and Methods

Participants

The participants in this research were drawn from the Arwana Swimming Club in Bangkalan, East Java, Indonesia. Inclusion criteria for this study encompassed male swimmers aged 12-13, with a minimum of one year of consistent swimming practice. Sample selection was conducted using purposive sampling techniques (Syahza, 2021), adhering to the specified criteria, which yielded a total of 20 participants.

Table 1. *Participants characteristic*

Variables	Test	N	Mean	Std.Deviation
Age	Pretest	20	12.45	0.51
	Posttest	20	12.45	0.51
Weight	Pretest	20	35.69	0.85
	Posttest	20	35.15	2.34
Height	Pretest	20	1.40	0.082
	Posttest	20	1.40	0.082

Experimental approach

This study employs a pre-experimental research design, specifically a one-group pretest-posttest design. This method assesses the impact of an intervention on a single group by measuring outcomes before and after the treatment. Within the scope of this study, a Plyometric Training Program was implemented during 6 weeks (Plyometric Exercise on Table 2) which modifies previous research (Cañas-Jamett et al., 2020b), scheduled for three days each week (specifically on Monday, Wednesday, and Friday) (Gencer et al., 2018), with careful consideration given to rest intervals. This research has been declared ethically acceptable by the STKIP PGRI Bangkalan Ethics Committee with the number 016/C8/6/I/2024.

Table 2. *Plyometric Exercise for 6 Weeks*

Weeks	(Sets and Repetition)	Recovery Time
1-2	20 cm drop jump (2x9)	5 x 60 seconds
	30 cm drop jump (2x9)	5 x 60 seconds
	Long Jump (2x9)	10x20 seconds
3-4	30 cm drop jump (2x9)	5 x 60 seconds
	40 cm drop jump (2x9)	5 x 60 seconds
	Long Jump (2x9)	10x20 seconds
5-6	50 cm drop jump (2x10)	5 x 60 seconds
	60 cm drop jump (2x10)	5 x 60 seconds
	Long Jump (2x10)	10x20 seconds

Statistical Analysis

The primary statistical test used to analyze data from a one-group pretest-posttest design is the paired sample t-test. This test compares the means of the pretest and posttest scores to determine if there is a statistically significant difference. Data analysis for this study included descriptive statistics, normality testing using the Shapiro-Wilk test, and Hypothesis testing was performed using the paired sample t-test, with statistical significance set at $p < 0.05$. All data analyses were conducted using SPSS version 25 (Krzysztofik et al., 2019; Purwoto et al., 2024).

Results

The descriptive sample above explains the age, weight and height of the sample. Mean age on pretest 12,45 years and post test 12,45. Mean weight on pretest 35,69 kg and post test 35,15 kg. Mean height on pretest 1,40 m and posttest 1,4 m. (Table 1)

Table 3. *Descriptive Results*

No	Pre Test	Post Test	Difference
1	45.2	45.1	0.1
2	51.78	51.69	0.09
3	54.33	53.47	0.86
4	48.83	48.31	0.52
5	55.45	54.76	0.69
6	44.33	43.71	0.62
7	47.68	47.58	0.1
8	56.87	55.02	1.85
9	52.03	51.49	0.54
10	48.96	47.96	1
11	48.6	48.48	0.12
12	55.45	54.76	0.69
13	44.4	43.75	0.65
14	47.6	47.51	0.09
15	51.72	50.89	0.83
16	53.78	52.76	1.02
17	48.9	47.23	1.67
18	47.58	45.9	1.68
19	55.4	53.87	1.53
20	44.2	41.04	3.16
Sum	1003.09	985.28	17.81
Mean	50.1545	49.264	0.890
Std.Dev.	4.112	4.161	0.772

The table above presents the results of the pretest and posttest, including the sum, mean, and standard deviation. The mean results are illustrated in the image below:

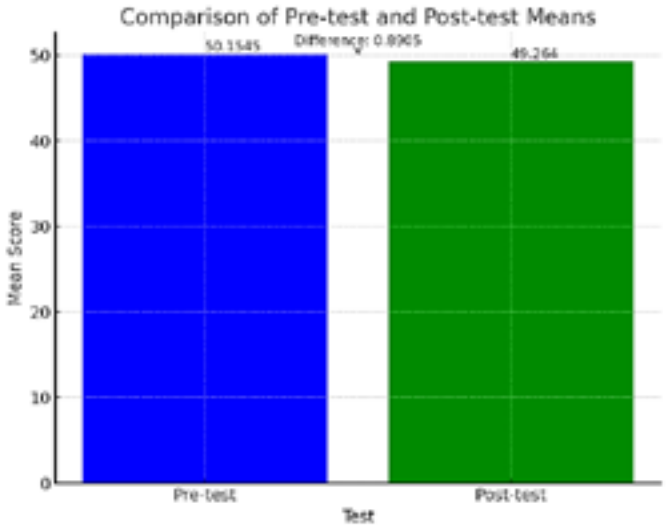

Figure 1. *Pre test and Post test of 50 Meter Freestyle Swimming*

Based on Table 3 and Figure 1, it shows that the post test score is lower than the pretest, this shows that the swimming speed after plyometric training is better than the pretest. Next, the results of the normality test will be presented.

Tabel 4. *Normality Test*

	Shapiro-Wilk		
	Statistic	**df**	**Statistic**
Pretest	0.929	20	0.149
Posttest	0.948	20	0.334

The results of the Shapiro Wilk normality test showed that the data distribution was normal (Sig > 0,05) so that the parametric paired sample test could be continued.

Table 5. *Paired Samples Test*

Pair 1	**Pretest-Posttest**	**Mean**	**Std.Deviation**	**Std. Error Mean**	**Sig. (2-tailed)**
		0.895	0.767	0.176	0.000

The results of the paired sample test show that the significance value is 0.000, this shows that sig 0.000 < 0.05 so there is a significant influence.

Discussion

The findings from this research demonstrate that plyometric training has the potential to enhance the 50-meter freestyle swimming speed in novice swimmers aged 12-13 years. In line with previous research that plyometric training for 6 weeks is effective for improving speed and agility abilities in young beginner swimmers (Soni & Vedawala, 2022). The improvement in swimming speed is likely attributable to the efficacy of the plyometric exercises undertaken. Enhancements in swimming performance may result from an increase in muscle activation in the targeted muscle groups (Rodríguez González et al., 2023). Plyometric exercises induce modifications in muscle power, which are conducive to extending the distance that a swimmer's body can reach before entering the water (Jastrzebski et al., 2014; Pereira et al., 2023). Plyometric training consists of rapid lower body muscle contractions over a short

time frame, involving high velocity eccentric contractions followed by swift concentric contractions. Over a span of several weeks, this training prompts neural adaptations in swimmers, resulting in substantial enhancements in their capacity for greater force production, ultimately contributing to improved speed (Yu Kwok et al., 2021).

The rise in speed for the 50-meter freestyle swim could also be attributed to the appropriateness of plyometric training for the 12-13-year-old participants. This is corroborated by the rationale that plyometric training resulted in a substantial rise in quadriceps muscle thickness, leg muscle volume, and the average cross-sectional area of the thigh in young athletes (Cañas-Jamett et al., 2020b). Enhancements in swimming speed can be attributed to plyometric training, which has the capacity to augment the explosive power of leg muscles, subsequently influencing speed (Wicaksono & Putri, 2020). Between the ages of 10-12, significant distinctions exist among muscle groups, and it is advisable to incorporate the lessons that facilitate skill development. One of these attributes is motor skills, which, in turn, enhances technique and promotes the perception and execution of movements in each lesson (Alin Adrian et al., 2021). This deserves attention, because the sample in this study was 12-13 years old.

Physiologically, six weeks of plyometric training can enhance freestyle swimming speed due to the specific effects of plyometric exercises. Plyometric training stimulates the stretch-shortening cycle (SSC) of the musculotendinous system, which involves an eccentric muscle action followed immediately by a concentric muscle shortening (Sammoud et al., 2021b). The goal of plyometrics is to generate maximal forces in the shortest possible time (Abi et al., 2022). Consequently, plyometrics effectively bridges the gap between strength and speed adaptations (Cañas-Jamett et al., 2020a), leading to improved freestyle swimming speed in the 12-13 age group after six weeks of training.

The training program used in this exercise is effective because it has been shown to increase speed. For the 12-13 age group, training three times a week has led to significant improvements (Demirkan et al., 2023; Gencer et al., 2018). This indicates that the 6-week plyometric training program for this age group is implemented successfully.

Conclusions

Based on the results of the paired sample t-test and the difference between the mean pretest and posttest scores, it can be concluded that six weeks of plyometric training improves the speed of 50-meter freestyle swimming in the 12-13 age group. This study recommends continuing to develop plyometric training to accommodate all swimming styles.

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Primljen: 30. mart 2025. / Received: March 30, 2025
Prihvaćen: 10. jun 2025. / Accepted: June 12, 2025