2024, Retos, 61, 1344-1350

The differences effects of lunges vs. squats exercise programs on the swimming speed 50-meters butterfly style: a quasi-experimental study

Los efectos diferenciales de los programas de ejercicio de lunges frente a squats sobre la velocidad de natación en estilo mariposa de 50 metros: un estudio cuasi-experimental

*, **Meiriani Armen, **Syahrastani, **Hendri Neldi, **Ilham, *Ary Suud Cahyo Alben, ***Vlad Adrian Geantă
*Universitas Bung Hatta (Indonesia), **Universitas Negeri Padang (Indonesia), ***Aurel Vlaicu University of Arad (Romania)

Abstract. Objective: This study aims to investigate the impact of lunges vs. squats exercise on the swimming speed of the 50-meter butterfly stroke among athletes aged 10-13 in KU III and IV categories. Approach: An experimental method employing a two-group pre-test and post-test design was utilized. The study population consisted of athletes affiliated with the SeaRia Aquatic swimming association. Purposive sampling was employed, selecting male swimmers aged 10-13 who were members of the Searia Aquatic swimming club and willing to participate in training during the study. Twenty athletes met the inclusion criteria. The speed test was conducted using the 50-meter butterfly stroke. Statistical data analysis was performed using t-test with SPSS 25 software, employing a significance level of 0.05. Results: The analysis revealed significant effects: (1) lunge training demonstrated a significant improvement in the swimming speed of the 50-meter butterfly stroke among athletes aged 10-13 at the SeaRia Aquatic swimming association (t-count = 6.046, t-table = 2.23, $P < 0.05$); (2) similarly, squat training led to a significant enhancement in the swimming speed of the 50-meter butterfly stroke among the same age group at the SeaRia Aquatic swimming association (t-count = 6.086, t-table = 2.23, $P < 0.05$). Collectively, both lunges and squats positively influenced swimming speed in the 50-meter butterfly stroke among athletes aged 10-13 affiliated with the Searia Aquatic swimming association. Conclusion: This study underscores the beneficial effects of incorporating lunges vs. squats into training regimens for young athletes aiming to improve their swimming performance, particularly in the butterfly stroke. This study found that squats are more effective than lunges in improving performance in the butterfly swimming stroke. These findings offer valuable insights for coaches, trainers, and athletes interested in enhancing their competitive edge in swimming, particularly in butterfly style.
Keywords: lunges; squat training; exercise; swimming butterfly; 50-meters

Resumen. Objetivo: Este estudio tiene como objetivo investigar el impacto de los ejercicios de lunges frente a squats en la velocidad de natación en el estilo mariposa de 50 metros entre atletas de 10 a 13 años en las categorías KU III y IV. Enfoque: Se utilizó un método experimental empleando un diseño de pre-prueba y post-prueba con dos grupos. La población del estudio consistió en atletas afiliados a la asociación de natación SeaRia Aquatic. Se empleó un muestreo intencionado, seleccionando nadadores masculinos de 10 a 13 años que eran miembros del club de natación Searia Aquatic y que estaban dispuestos a participar en el entrenamiento durante el estudio. Veinte atletas cumplieron con los criterios de inclusión. La prueba de velocidad se realizó utilizando el estilo mariposa de 50 metros. El análisis estadístico de datos se llevó a cabo utilizando la prueba t con el software SPSS 25, empleando un nivel de significancia de 0.05. Resultados: El análisis reveló efectos significativos: (1) el entrenamiento de lunges demostró una mejora significativa en la velocidad de natación en el estilo mariposa de 50 metros entre atletas de 10 a 13 años en la asociación de natación SeaRia Aquatic (t-observado = 6.046, t-tabla = 2.23, $P < 0.05$); (2) de manera similar, el entrenamiento de squats llevó a una mejora significativa en la velocidad de natación en el estilo mariposa de 50 metros entre el mismo grupo de edad en la asociación de natación SeaRia Aquatic (t-observado = 6.086, t-tabla = 2.23, $P < 0.05$). Colectivamente, tanto los lunges como los squats influyeron positivamente en la velocidad de natación en el estilo mariposa de 50 metros entre atletas de 10 a 13 años afiliados a la asociación de natación Searia Aquatic. Conclusión: Este estudio subraya los efectos beneficiosos de incorporar lunges y squats en los regímenes de entrenamiento para jóvenes atletas que buscan mejorar su rendimiento en natación, particularmente en el estilo mariposa. Este estudio encontró que los squats son más efectivos que los lunges para mejorar el rendimiento en el estilo mariposa. Estos hallazgos ofrecen información valiosa para entrenadores, formadores y atletas interesados en mejorar su ventaja competitiva en la natación, especialmente en el estilo mariposa.
Palabras clave: Lunges; entrenamiento de squats; ejercicio; estilo mariposa; 50 metros.

Fecha recepción: 09-10-24. Fecha de aceptación: 19-10-24
Ilham
ilhamf@fik.unp.ac.id

Introduction

Nowadays, swimming endurance is one of the most physical activities that receive the most attention to the detriment of other aspects (Rodríguez González et al., 2022). The main medium of swimming activity is in a body of water either in lakes, oceans, seas, and swimming pools. In swimming completing medium like swimming pools, the length of the pool used for competition and swim training varies mostly between countries and times and so forth. Take for instance, pool lengths for competitive swimming include 25 yards (short course), 25 meters (short course), and 50-meter distances (long course) (Kao, 2018). To our best intuition in professional swimming, competitive swimming consists of five different stroke disciplines including the butterfly, backstroke, breaststroke, freestyle, and individual medley. According to Neiva et al. (2014) the butterfly, backstroke, and breaststroke swimming, competitive distances include the 50-, 100-, and 200-meter and yard distance races, whereas the individual medley requires a swimmer to combine both the

butterfly, backstroke, breaststroke, and freestyle but in consecutive order. In swimming, feet, and hands are both used to move the body in the water in back-forward directions. People swim for different reasons; some swim for fish, to earn money, to exercise, or just for fun (Van Duijn et al., 2021). People of all ages, from babies to the elderly, can swim. Being healthier and helping in maintaining physical fitness are some of the benefits that can be obtained after performing swimming activities including some mechanical principles. In other words, the mechanics of the swimming stroke, for instance, are based on a unique mechanical concept. Imbang, (2014), stated that there are several mechanical principles that swimmers must pay attention to. Some of these include the principle of resistance to thrust in swimming, and forward speed as the result of two forces namely (1) the force that tends to hold the swimmer, also known as resistance; carried by the water, and (2) the encouragement, which is received from the movement of the arms and legs referring to a push. In contrast to this, a swimmer is propelled forward by thrust, which is produced by arm, and sometimes leg motion. The force that the arms and legs apply when pushing back is really what causes this forward movement (Stosic, 2020). Such force is also referred to as the third law of Newton's footwork, the law of action-reaction, as the principle of force mechanics.

Pushing forward with regular movements is better and more efficient than doing them irregularly. For the body to move forward at a predictable rate, the mechanics of force were perfected where energy is consumed. Swimmers lose a lot of energy when they accelerate and slow down by pausing and continuing forward, which is how they overcome water resistance (Pyne & Sharp, 2014). However, recovery of energy lost is possible by using the law of action-reaction (recovery). That said, the efficiency and speed of the swimmer are affected by the recovery mechanism of the arms (Seifert et al., 2010). In tandem, pursuant to (Guyton, 2008) in the book ''Textbook of Medical Physiology''poor recovery can cause a person to pull things which causes the arm to pull too fast, too slow, or even shorter as well as causing a person to launch their arm pulls for too long. Then, one of the reliable means to help the swimmer overcome the side effects due to poor recovery is the duty of a coach. A coach must master the science of swimming to help swimming athletes achieve their goals (Brackley et al., 2020). These pieces of knowledge include basic swimming mechanics; physical development on land; mastery of the four strokes, starting, turning, fast swimming, and finishing; mental and environmental adaptation; and bearing staple intuition to organizing and arranging swimming competitions. Apart from that, techniques and tactics are required for all swimming styles for short, medium, and long distances.

A butterfly is a style that has difficult challenges, methods, and techniques because it has a unique style structure compared to other styles (Strzała et al., 2017). As a result, both male and female swimmers rarely compete in butterfly competitions. The recommendations of the experts above are an important element of swimming instruction for coaches and athletes at the SeaRIA Aquatic swimming association. Physical training is an indispensable factor that helps swimmers succeed; even though the physique is not good, rather the technique. However, having a balanced physique, technique, and mentality will be even better, making it easier for athletes to achieve success. Based on these problems, the researchers tried to integrate the 50-meter butterfly swimming at KU II and IV SeaRIA Aquatic Swimming with the Lunges and Squat training method. Budiwanto, (2012) asserted that the main purpose of training is to support athletes as they improve their performance and abilities. Athletes must focus on and practice well the following 4 components of training to achieve the goal: physical training, technical training, tactical training, and mental training. In addition, the training process must be consistent and progressive (Ilham, Agus, et al., 2024; Makadada et al., 2024; Plotkin et al., 2022; Rifki et al., 2023; Tirtawirya et al., 2024). Regular implies that the activity must be performed in a sophisticated and enduring (constant) way. The training material is given progressively from an easy level. To ensure that skills understanding and mastery are permanent, goals and objectives should be set for each face-to-face meeting (one session/one unit of training). The training materials should also contain theoretical and practical information, and they should use in the most efficient way. Effectiveness comes from a step-by-step plan that considers aspects including difficulty, movement complexity, and an emphasis on training goals (Cross, 1996; Ilham, Sari, et al., 2024; Sridadi et al., 2021; Yendrizal et al., 2023). Lunges are the act of taking a step forward by using one foot as a fulcrum and bending the other leg into a 90-degree angle while standing straight and placing both hands below (Marchetti et al., 2018). Exercises like lunges are beneficial for sportsmen where joint mobility, strength, flexibility, core stability, and the cardiovascular system include. Besides, squats are one of the easiest and most effective exercises to develop a stronger and physically fit body (Gregory D. et al., 2014). To do so, squats should always be performed at a 90-degree angle. Squats are for people who want to develop toned buttocks.

In swimming, four kinds of styles are basically acknowledged and used, that is crawl style (free), breaststroke (frog), backstroke, and dolphin style (butterfly). Freestyle is simply understood as a simple and well-known style because apart from being simple, people of all ages often use it when bathing in the river or when playing in the water (Aisyah & Herywansyah, 2021). Swimming can be played for recreation, as a means of learning, and as a competitive activity where learning can be from young age. Moura et al., (2021) stated that children can start learning to swim from the age of 3–7 years and can specialize between the ages of

10–12 years. As audited in the preceding sections, swimming is an excellent sport for maintaining and improving physical fitness since it uses many large muscles, especially those in the arms and legs. Swimming is also very liked by the general public because it can be used for relaxation, entertainment, and competition. Therefore, in Indonesia swimming pool facilities are scattered in different areas (especially in big cities) for different use and benefits.

Research Material and Method

Study design

An experimental method employing a two-group pre-test and post-test design was utilized to evaluate the impact of treatment on two groups of participants. The experimental group was divided based on proficiency in the butterfly swimming style, with subjects further allocated to either Group A (lunges exercise) or Group B (squats exercise group). The study was conducted at the Searia Water Swimming Association in Universitas Negeri Padang Swimming Pool Venue. Whereas, the exercise was conducted at in six weeks, comprising three sessions per week for a total of 16 meetings. A 50-meter butterfly sprint served as the pretest and posttest (times recorded using stopwatches) to assign participants to treatment groups, resulting in ten participants per group following an A-B-B-A sequence. Treatment methods included squats and lunges, with specific exercise programs administered to each group as outlined in the subsequent Table 1 and 2.

Table 1.
Training Session with Lunges Method

Training sessions	Training program	Dosage
1, 2, 3, 4	Lunges	Set 5; Rep 16; Rec 45
5, 6, 7, 8	Lunges	Set 6; Rep 20; Rec 45
9, 10, 11, 12	Lunges	Set 8; Rep 25; Rec 30
13, 14, 15, 16	Lunges	Set 10; Rep 25; Rec 30

Note: Rep: Repetition. Rec: Recovery.

Table 2.
Training Session with Squat Method

Training sessions	Training material	Dosage
1, 2, 3, 4	Squat	Set 5; Rep 16; Rec 45
5, 6, 7, 8	Squat	Set 6; Rep 20; Rec 45
9, 10, 11, 12	Squat	Set 8; Rep 25; Rec 30
13, 14, 15, 16	Squat	Set 10; Rep 25; Rec 30

Note: Rep: Repetition. Rec: Recovery

Participants

The participant population comprised 50 athletes affiliated with the SeaRIA Aquatic Swimming Association, from which a purposive sample of (n=20) athletes aged 10 to 13 years, meeting specific criteria such as optimal body weight and proficiency in at least two swimming styles, was selected butterfly style. The age of the participants is 12.7 ± 6.2 years. Meanwhile, body weight 45.6 ± 1.51 and body height 139.6 ± 3.40 cm. and BMI 23.39 ± 1.22.

Procedure and measurement

The first step in this study involved handling various administrative tasks, such as obtaining research permits, participant consent forms, and ethical clearance from Padang State University. Subsequently, all necessary tests, equipment, and facilities were prepared. The entire population underwent pre- and post-test measurements, with n=50 young swimmers. The data were then filtered based on inclusion criteria, resulting in a final sample of n=20 swimmers with similar BMI and ages ranging from 10 to 13 years. Ordinal pairing was used to randomize and balance the abilities of group A (n=10) and group B (n=10). Group A received lunges training, while group B received squats training. The speed test was conducted using the 50-meter butterfly stroke (pre-post-test) (V=0.86 and R=0).

Treatment

This study employed lunges and squats training programs for groups A and B, respectively, to observe improvements in butterfly swimming speed. Each training program, whether using lunges or squats, lasted approximately 6 weeks, with three sessions per week. Each training session began with a 10-15-minute warm-up, followed by 45 minutes of core training, and concluded with a 10-15-minute cooldown.

The training dose was increased each week until the third consecutive week. In accordance with the training principles, overload, progressive, and individual principles were applied. In some weeks, for example, the fourth week, the training dose was equal to that of the second week, and the dose was the same as that of the fourth week. It means that there is a decrease in training load. This aims to prepare for or recover from efforts to increase the dose of exercise. The training dose escalation model was continued until week 6, before the post-test was conducted.

Statistical analysis

Descriptive statistics were used to categorize the results based on the mean differences and standard deviations between each treatment. Prior to hypothesis testing, normality and homogeneity tests were conducted. Subsequently, hypothesis testing was performed using a t-test with SPSS version 25 software to determine the significance of the differences between the pretest and posttest for each group. All results were analyzed using a significance level of 0.05.

Results

This study reports the mean and standard deviation results for the pretest and posttest of the 50-meter butterfly stroke as follows: Pretest to posttest for group A (68.90±2.859 to 66.40±2.791) and Pretest to posttest for group B (69.12±4.067 to 65.29±3.374). The highest percentage of improvement was observed in the group that performed

squats, with a difference in improvement between the lunges and squats groups of 2.5 vs. 3.83, respectively. For more details, refer to the Table 3.

Table 3.
The mean differences, standard deviations, and percentage improvements in pretest and posttest scores of footwork agility for each treatment group

Exercise Model (Group A&B) (n=20)		Pretest Mean±SD	Differences	%
Lunges	Pretest (A)	68.90±2.859	2.5	3.76
	Posttest (A)	66.40±2.791		
Squats	Pretest (B)	69.12±4.067	3.83	5.86
	Posttest (B)	65.29±3.374		

Before conducting inferential hypothesis testing, we performed a normality test to determine whether the research variables were normally distributed. In other words, this step was necessary to assess the degree of data normality. The Kolmogorov-Smirnov-Z formula was used as a staple reference to test and calculate such normality. Based on the Table 4. show that the variables are normally distributed ($P > 0.05$). The results of the homogeneity test, as shown in Table 5. demonstrate that all data are homogeneous for both the pretest and posttest across all groups ($P > 0.05$). Since the data is homogeneous, then parametric statistics can be used to continue data analysis. Based on the results of the pre-test and post-test, the t-test was used to assess the hypothesis posed in the following statement: ''lunges and squat exercises will have an impact on accelerating the speed of swimming the 50-meter butterfly if the analysis results show a significant difference''. If T-calculated is > T-table and the sig value is less than 0.05 (Sig 0.05), then the research conclusion is considered significant. Then, the findings of the analysis lead to the collection of the following information.

Table 4.
Test of normality outputs

Group		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Results	A_pre	0.139	10	0.200*	0.947	10	0.922
	A_post	0.189	10	0.200*	0.957	10	0.755
	B_pre	0.160	10	0.200*	0.950	10	0.664
	B_post	0.170	10	0.200*	0.937	10	0.519

Information: *: true significance. [a]: Liliefors significance correction

Table 5.
Homogeneity Data Distribution

		Levene Statistic	df1	df2	Sig.
Results	Based on Mean	0.990	1	18	0.333
	Based on Median	0.995	1	18	0.332
	Based on Median and with adjusted df	0.995	1	18	0.332
	Based on Trimmed Mean	0.985	1	18	0.334

Table 6.
T-Test Data from Lunges Testing

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pretest_Lunges-Posttest_Lunges	1.609	0.841	2.666	1.006	2.211	6.046	9	0.000

Table 7.
T-Test Data from Data Squat Testing

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pretest_Squat-Posttest_Squat	1.849	0.960	0.303	1.161	2.253	6.086	9	0.000

The results of the T-test show a T-count of 6.046 and a T-table of 2.23. (df 9). The findings show a significant difference because the T-count is 6.046 > and the T-table is 2.23. The alternative hypothesis (Ha) which states that there is a relationship between lunge training and 50-meter butterfly swimming speed is accepted. This means that the 50-meter butterfly swim can be completed more quickly after lunging.

The results of the t-finding test show that the t count is 6.086 and the t table is 2.23. (df 9). The results showed a significant difference because t count 6.086 > t table 2.23. Therefore, the alternative hypothesis (Ha) is accepted which states that "There is an effect of squat training on the speed of 50-meter butterfly swimming". The results of the t-finding test show that the t count is 6.086 and the t table is 2.23 (df 9). The results showed a significant difference because t count 6.086 > t table 2.23. Therefore, the alternative hypothesis (Ha) is accepted, which states that "There is an effect of squat training on the speed of 50-meter butterfly swimming." At the same time, the null hypothesis (Ho) is rejected, which implies that "There is no effect of squat training on the speed of 50-meter butterfly swimming." This confirms that the squat exercise has a significant effect on the swimming speed of the 50-meter butterfly swimmer, based on pre and post-test results. The attached diagram shows additional squats and lunges and their effects: As we can view it from the different Tables 6 and 7, the group studied experienced significant improvement as a result of the analysis of the research data. The athlete swimming a number of 50 meters butterfly style in the SeaRIA Aquatic swimming association experienced an increase in swimming speed after receiving treatment for 16 sessions with a frequency of three times per week. The exercises in this study were performed at maximum intensity, with the first three sessions consisting of four sets of 20 repetitions, and the training volume was increased by four repetitions for the last session (session

16). With a training schedule of three times per week, body weight was recalled as the method of execution (body weight). Speed training, on the other hand, has an intensity of 30% to 60% of one's maximum strength (1 RM), a training volume of 4 sets per session of 15-20 reps per set, and a frequency of 3 times per week session.

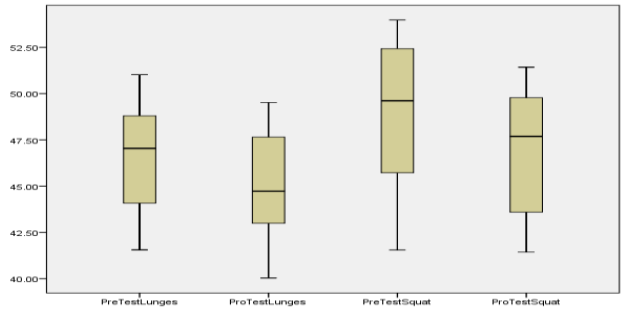

Figure 1. The Extent/Effect of Training with Lunges and Squat

Discussion

The main purpose of this study is to investigate whether training with squats and lunges has significant effects on swimming speed in 50-meter butterfly style Ku III and IV at Searia Aquatic Swimming Association. In other words, there is a relationship between training with squats and lunges on swimming speed 50-meter butterfly style Ku III and IV. Hence, after addressing and analyzing all research data it was then revealed that there has been a signification increase among the group studied. That said this treatment increased the swimming speed of SeaRIA Aquatic swimmers for the 50-meter butterfly for 16 sessions with a training frequency of three times per week. The volume of training for this program is 4 sets of 20 reps in the first 3 sessions, then increasing by 4 reps every 3 sessions after that until the last session (sum 16). three times per week, with practice. Speed training, on the other hand, has an intensity of 30% to 60% of one's maximum strength (1 RM), a training volume of 4 sets per session of 15-20 reps per set, and a frequency of 3 per weekly session. The speed training menu recommended to increase speed is maximum intensity (maximum speed), heart rate: 185-200 beats per minute, volume: 5-10 repetitions per set, and 3 to 5 sets per session, (Marc R, 2019; Nummela et al., 2016). The results of the analysis showed an increase in swimming speed of 50 meters butterfly style for SeaRIA Aquatic athletes after being given squat exercises. This is indicated by the value of t\T-count equal to 6.046 > T-table 2.23; then it shows that there is a significant difference. Thus, the alternative hypothesis (Ha) which reads "There is an effect of lunges training on the 50-meter butterfly swimming speed of SeaRIA Aquatic athletes", is accepted. This means that the lunges exercise has an influence on the swimming speed of the 50-meter butterfly stroke of SeaRIA Aquatic swimming athletes. Exercises like lunges improve the cardiovascular system, core muscles, and joint mobility (Ahmad Fauzi et al., 2020; Saeterbakken et al., 2019). To maintain proper alignment and stability, the hip, ankle, and knee joints must move. Doing lunges helps the athlete's hamstring strength and running speed. This exercise makes the hips have higher flexibility and mobility. Then, lunges involve small muscles when doing lower limb exercises in running or cycling. The results of the analysis of squat exercises also show differences as indicated by the T-count of 6.086 > T-table 2.23. The accepted alternative hypothesis (Ha) is that sound like squat exercise has an impact on the 50-meter butterfly swimming speed. This shows that the 50-meter butterfly stroke is influenced by squat training in terms of speed. Under the principle of the plyometric exercise movement, squat training increases the speed and strength of the athlete's limbs (Adams et al., 1992; Turner, 2009). Repeating exercises and increasing the intensity with each session can help the trainee to build leg strength. In tandem, according to the principle of the plyometrics exercise movement, these two exercises (squat and lunges) cause the muscles to contract rapidly when lengthening (eccentric) and shortening (concentric). The more demands on the strength and speed placed on the muscles during contraction, the stronger the effect of increasing the leg muscle strength, which directly affects the increase in swimming speed.

Conclusion

Out of necessity, athletes or any individual fascinated by sport swimming should be aware that strength and speed training must focus on optimizing the power flow of linear and rational energy transfer or consumed during swimming performance. Then, training and enhancing this transition phase requires a commitment, and complex athletic weight training where squats and lunges include. Such a training program challenges an athlete to strengthen and develop some typical muscles needed in butterfly swimming (the focus of this study) through a wide range of multiple joint movements. As said by Adams et al., (1992), a high magnitude of explosive strength is the result. Then we basically conclude that the new training introduced during the treatment session has induced a significant change in the 50-meter butterfly swimmer from the SeaRIA Aquatic swimming association these particular individuals used as a sample size in this research experienced an increase in swimming speed after doing lunges which are indicated by the T-count 6.046 > T-table 2.23. Also, swimmers experience an increase in swimming speed after doing squats as indicated by T-count 6.086 > T-table 2.23. 3.

Both squats and lunges speed up a swimmer's 50-meter butterfly swim. This training is with valuable effects, especially for those who intended to perform better in swimming pools in terms of speed and rapidity.

Acknowledgment

We deeply acknowledge that this piece of scientific work would not be presented as it without the insights and informative support of my promoter Prof. Dr. Syafruddin, MP.d, and co-promoter Prof. Dr. Syahrasthani. M. Kes, AIFO-P.

References

Adams, K., O'Shea, J. P., O'Shea, K. L., & Climstein, M. (1992). The Effect of 6 weks of Squat , Plyo and Squat Plyo on Power Performance.pdf. In *Journal of Applied Sport Science Research* (Vol. 6, Issue 1, pp. 36–41).

Ahmad Fauzi, R., Suherman, A., Safari, I., & Saptani, E. (2020). Simple Exercises at Home During Social Distancing to Avoid Covid-19. *Journal of Physical Education, Health*, *7*(2), 31–37.

Aisyah, diah siti, & Herywansyah. (2021). Perbedaan Pengaruh Latihan Kaki dengan Menggunakan Pelampung dan Stang Terhadap Prestasi Renang Gaya Crawl Jarak 50 Meter. *Jurnal Kepelatihan Olahraga SMART SPORT*, *2(8)*, 9–16.

Brackley, V., Barris, S., Tor, E., & Farrow, D. (2020). Coaches' perspective towards skill acquisition in swimming: What practice approaches are typically applied in training? *Journal of Sports Sciences*, *00*(00), 2532–2542. https://doi.org/10.1080/02640414.2020.1792703

BUDIWANTO, S. (2012). *METODOLOGI LATIHAN OLAHRAGA*.

Cross, A. R. (1996). *Safety Training for Swim Coaches*.

Gregory D. Myer1, 2, 3, 4, Adam M. Kushner1, Jensen L. Brent5, Brad J. Schoenfeld6, J., Hugentobler, Rhodri S. Lloyd, Al Vermeil, Donald A. Chu, Jason Harbin, A., & McGill, S. M. (2014). *The back squat: A proposed assessment of functional deficits and technical factors that limit performance* (Vol. 36, Issue 6). https://doi.org/10.1519/SSC.0000000000000103.The

Guyton, A. C. (2008). *Textbook of Medical Physiology*.

Ilham, Agus, A., Tomoliyus, Sugiyanto, F. X., Tirtawirya, D., Lumintuarso, R., Berhimpong, M. W., Alsyifa, R. A., Kurniawan, R., Effendi, R., Ayubi, N., Alben, A. S. C., Perdana, G. S., Rifki, M. S., Ndayisenga, J., Sibomana, A., & Jean-Berchman, B. (2024). Comparative Analysis of Adaptations Progress in VO2max , Leg Power , and Agility among Male and Female Sports Science Students Análisis Comparativo del Progreso de las Adaptaciones en VO2max , Potencia de Piernas y Agilidad entre Estudiantes Masculinos y. *Retos*, *57*(7), 245–257.

Ilham, Sari, A. P., Bafirman, Rifki, M. S., Alnedral, Welis, W., Umar, Kurniawan, R., Putra, R. A., Prasetyo, T., Car, B., Pavlovic, R., Makadada, F. A., Perdana, G. S., Lolowang, D. M., Piri, N., Baan, A. B., & Jimenez, J. V. G. (2024). The effect of plyometric training (hurddle jumps), body weight training (lunges) and speed on increasing leg muscle explosive power of futsal players: a factorial experimental design. *Paper Knowledge . Toward a Media History of Documents*, *59*(9), 497–508.

Imbang, P. P. (2014). Pengaruh Latihan Lunges Dan Squatterhadap Peningkatan Kecepatan Berenang 50 Meter Gaya Dada Ku Senior Perkumpulan Renang Ratu Bilqis Kabupaten Gunungkidul. *Jurnal Keperawatan*, *2*(2), 1–6.

Kao, S. (2018). The Relationship Between Strength and Power Measures with Sprint Freestyle Performance in Division 1 Collegiate Swimmers. *Angewandte Chemie International Edition, 6(11), 951–952.*, *August*, 2013–2015.

Makadada, F. A., Hadjarati, H., Berhimpong, M. W., Piri, N., Baan, A. B., Mangolo, E. W., Perdana, G. S., Ndayisenga, J., & Ilham. (2024). The effects of game-based passive, static stretching, and trunk flexibility on the execution of forward roll in floor exercise: A factorial experimental design. *Journal of Physical Education and Sport*, *24*(4), 872–885. https://doi.org/10.7752/jpes.2024.04100

Marc R, A. (2019). Acute Heart Rate Responses to Resistance Exercise at Different Cadences. *International Journal of Sports and Exercise Medicine*, *5*(9), 1–8. https://doi.org/10.23937/2469-5718/1510143

Marchetti, P. H., Guiselini, M. A., Da Silva, J. J., Tucker, R., Behm, D. G., & Brown, L. E. (2018). Balance and Lower Limb Muscle Activation between in-Line and Traditional Lunge Exercises. *Journal of Human Kinetics*, *62*(1), 15–22. https://doi.org/10.1515/hukin-2017-0174

Moura, O. M., Marinho, D. A., Forte, P., Faíl, L. B., & Neiva, H. P. (2021). School-based swimming lessons enhance specific skills and motor coordination in children: the comparison between two interventions. *Motricidade*, *17*(4), 367–374. https://doi.org/10.6063/motricidade.24557

Nummela, A., Hynynen, E., Kaikkonen, P., & Rusko, H. (2016). High-intensity endurance training increases nocturnal heart rate variability in sedentary participants. *Biology of Sport*, *33*(1), 7–13. https://doi.org/10.5604/20831862.1180171

Plotkin, D., Coleman, M., Van Every, D., Maldonado, J., Oberlin, D., Israetel, M., Feather, J., Alto, A., Vigotsky, A. D., & Schoenfeld, B. J. (2022). Progressive overload without progressing load? The effects of load or repetition progression on muscular adaptations. *PeerJ*, *10*, 1–19. https://doi.org/10.7717/peerj.14142

Pyne, D. B., & Sharp, R. L. (2014). Physical and energy requirements of competitive swimming events. *International Journal of Sport Nutrition and Exercise Metabolism*, *24*(4), 351–359. https://doi.org/10.1123/ijsnem.2014-0047

Rifki, M. S., Ilham, Ndayisenga, J., & Zakaria, J. Bin. (2023). The effect of combined continuous run, circuit training, and high-intensity interval training on lung function, asthma control, and VO2max in asthma patients: A quasi-experimental study. *Journal of Physical Education and Sport*, *23*(12), 3264–3270. https://doi.org/10.7752/jpes.2023.12373

Rodríguez González, L., Melguizo-Ibáñez, E., Martín-Moya, R., & González-Valero, G. (2022). Study of strength training on swimming performance. A systematic review. *Science and Sports*, *xxxx*. https://doi.org/10.1016/j.scispo.2022.09.002

Saeterbakken, A. H., Chaudhari, A., van den Tillaar, R., & Andersen, V. (2019). The effects of performing integrated compared to isolated core exercises. *PLoS ONE*, *14*(2). https://doi.org/10.1371/journal.pone.0212216

Seifert, L., Toussaint, H. M., Alberty, M., Schnitzler, C., & Chollet, D. (2010). Arm coordination, power, and swim efficiency in national and regional front crawl swimmers. *Human Movement Science*, *29*(3), 426–439. https://doi.org/10.1016/j.humov.2009.11.003

Sridadi, Tomoliyus, Septiasari, E. A., Parijan, Yuliarto, H., & Ilham. (2021). Effect of technical training using a ball on the dribbling speed for football players aged 10-12 years. *International Journal of Human Movement and Sports Sciences*, *9*(4), 824–831. https://doi.org/10.13189/saj.2021.090429

Stosic, J. (2020). *Transition phase – a new phase from start/turn to free swimming in competitive swimmers*.

Strzała, M., Stanula, A., Krężałek, P., Ostrowski, A., Kaca, M., & Głąb, G. (2017). Butterfly Sprint Swimming Technique, Analysis of Somatic and Spatial-Temporal Coordination Variables. *Journal of Human Kinetics*, *60*(1), 51–62. https://doi.org/10.1515/hukin-2017-0089

Tirtawirya, D., Sudarko, R. A., Tomoliyus, & Ilham. (2024). Kick Flexibility Test Model in Taekwondo Martial Arts: BFS Flexibility Test. *Ido Movement for Culture*, *24*(3), 73–80. https://doi.org/10.14589/ido.24.3.8

Turner, A. (2009). Training For Power : Principles And Practice. *Profesional Strength and Conditioning*, *14*, 20–32.

van Duijn, T., Ng, J. L., Burnay, C., Anderson, N., Uehara, L., Cocker, K., & Button, C. (2021). The Influence of Equipment and Environment on Children and Young Adults Learning Aquatic Skills. *Frontiers in Psychology*, *12*(October). https://doi.org/10.3389/fpsyg.2021.733489

Yendrizal, Kiram, Y., Yenes, R., Komaini, A., Ihsan, N., & Mario, D. T. (2023). Effect of weight training and motor skills on muscle strength: A factorial experimental design. *Journal of Physical Education and Sport*, *23*(6), 1416–1424. https://doi.org/10.7752/jpes.2023.06173

Datos de los/as autores/as y traductor/a:

Meiriani Armen	riaarmen@student.unp.ac.id	Autor/a
Syahrastasni	syahrastani@fik.unp.ac.id	Autor/a
Hendri Neldi	hendrineldi@fik.unp.ac.id	Autor/a
Ary Suud Cahyo Alben	ary.suud.cahyo.alben@bunghatta.ac.id	Autor/a
Ilham	ilhamf@fik.unp.ac.id	Autor/a
Vlad Adrian Geantă	vladu.geanta@gmail.com	Autor/a – Traductor/a